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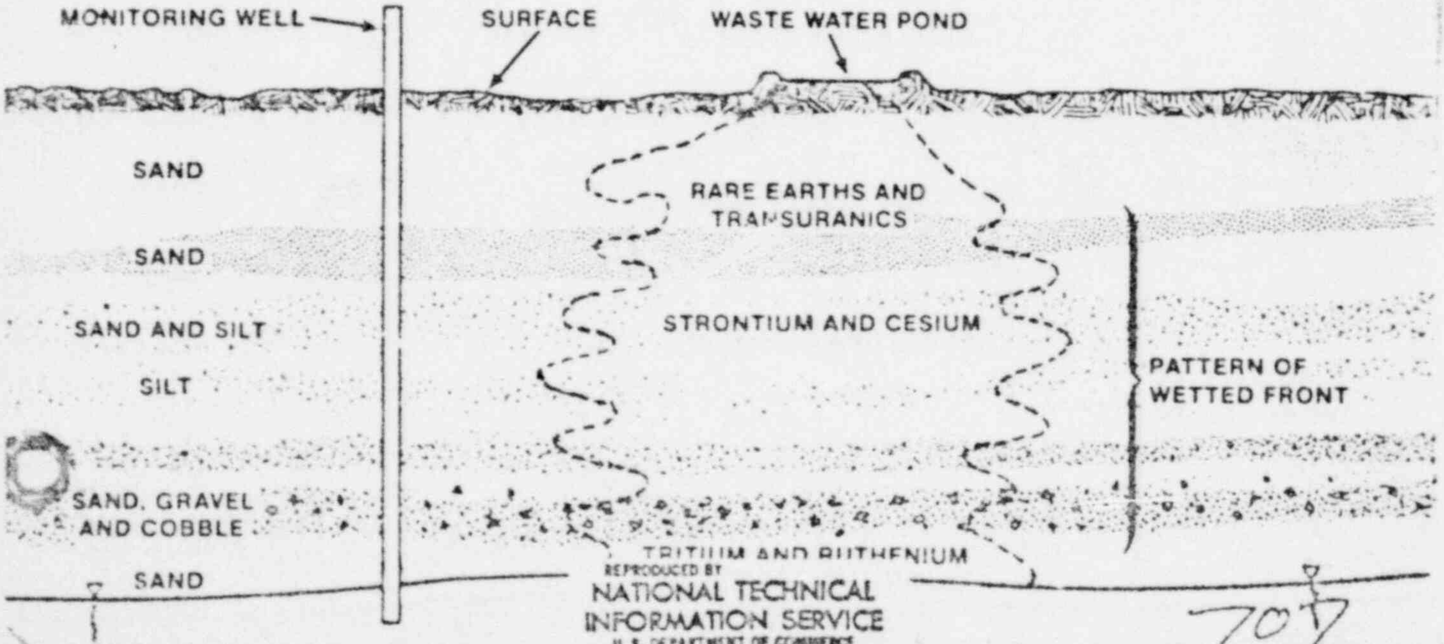
Radionuclide Interactions with Soil and Rock Media

Volume 2-Part B: Annotated Bibliography



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Volume 2 of 2 - Part B

RADIONUCLIDE INTERACTIONS WITH SOIL AND ROCK MEDIA

Volume 2: Annotated Bibliography (in two parts)

by
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Final Report for Contract 68-03-2514

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PREFACE

The Office of Radiation Programs carries out a national program designed to evaluate the exposure of man to ionizing and nonionizing radiation, and to promote the development of controls necessary to protect the public health and safety and assure environmental quality. A current area of great interest and effort within the EPA is the development of environmental protection criteria and standards for the management of radioactive wastes. Accidental or deliberate interactions of such wastes with various geologic media dictate that the Agency have access to current knowledge concerning the occurrence and mobility of selected radionuclides in the lithosphere. Herein lies the purpose and scope of the present study.

Office of Radiation Programs technical reports allow comprehensive and rapid publishing of the results of intramural and contract projects. The reports are distributed to groups who have known interest in this type of information. The study reported on herein is expected to be of considerable interest to the Department of Energy, the U.S. Geological Survey, the Nuclear Regulatory Commission, counterpart organizations in foreign countries facing similar nuclear-related issues, selected private consulting and environmental groups, and factions within industry. Ready availability of technical reports to the scientific community as a whole and to the public is made possible by distribution through the National Technical Information Service.

Readers of this report are encouraged to inform the Office of Radiation Programs of any omissions or errors by contacting the Director, Office of Radiation Programs - Las Vegas Facility, U.S. Environmental Protection Agency, Las Vegas, Nevada 89114.

W. D. Rowe, Ph.D.
Deputy Assistant Administrator
for Radiation Programs

ABSTRACT

The purpose of this bibliography is to abstract the information on radionuclide-soil/rock interactions available in the literature. The authors are listed alphabetically, with pages numbered from 1 at the beginning of each letter. A total of 19 elements were considered including americium, antimony, cerium, cesium, cobalt, curium, europium, iodine, neptunium, plutonium, promethium, radium, ruthenium, strontium, technitium, thorium, tritium, uranium and zirconium. An index by element and subject is given at the end of the bibliography.

The information for this report was obtained from various journals, books, past bibliographies, scientific reports and abstracting services such as Chemical Abstracts and Nuclear Science Abstracts. An effort was made to include all relevant information published from 1944 to December 1976. The abbreviations used at the end of each abstract refer to preparation by the abstracted paper's author (auth), the publishers of Chemical Abstracts (CA), Nuclear Science Abstracts (NSA), ORNL-EIS-72-21, ORNL-EIS-73-21, ORNL-EIS-74-21 (O-21) and ORNL-EIS-75-77 (O-77). Other abstracts were prepared by Battelle.

The bibliography is divided into two volumes. Volume I contains letters A through Mc, while Volume II contains M through Z and the index.

CONTENTS

Volume 2 - Part B

Mackrle, V., O. Dracka, and J. Svec. 1965. Hydrodynamics of the Disposal of Low-level Liquid Radioactive Wastes in Soil. Final Report. NP-15859.

The general aspects of liquid flow carrying suspension through a porous medium was studied in order to obtain data that might serve in evaluating the applicability of injection for the disposal of the radioactive sludge. Theoretical and laboratory studies were made on: injection of diluted suspension; injection of concentrated sludge; and two-dimensional filling of geological formations. The results offer a theoretical basis for the formulation of the requirements for a suitable geological structure as well as for the technology of injection. (NSA)

Magne, R., J. R. Berthelin, and Y. Dommergues. 1974. Solubilization and Insolubilization of Uranium from Granites by Heterotrophic Bacteria. IN: Formation of Uranium Ore Deposits. IAEA-SM-183/18.

Batch cultures and semi-continuous flow perfusions are used as experimental devices to study microbial solubilization and insolubilization of uranium from granites by heterotrophic bacteria. The nutrient media are synthetic (with dextrose or aminc acids) or natural (with mine water containing organic compounds). Microbial activity increases 2 to 97 times the solubilization of uranium. The processes are biosyntheses of complexing or chelating compounds. The micro-organisms involved are soil microflora and bacteria of mine water water and granites. Some species are identified. Microbial insolubilizations of uranium are described in batch cultures. These biodegradations occur after long periods of incubation and promote some neoformations of uranium deposits. Black and yellow deposits are observed and described. These experimental results suggest the model described in the paper. This model seems to apply easily to superficial processes of solubilization and concentration of uranium and in reworking deposits. However, in the case of primary intragranitic uranium deposits it is only an hypothesis correlated by the existence of favorable environmental conditions for bacterial growth and by some geological observations mentioned in the paper. (auth)

Magno, P., T. Reavey, and J. Apidiunakis. 1970. Liquid Waste Effluents from a Nuclear Fuel Reprocessing Plant. BRH/NERHL-70-2.

The liquid waste effluents from Nuclear Fuel Services were studied in detail during a six-month period May through October 1969. The concentrations and amounts of individual radionuclides discharged from the plant were measured and the amounts of sedimentation of individual radionuclides in the lagoon system were estimated.

Tritium, ruthenium-106, strontium-90, cesium-137 and cesium-134 were the principal radionuclides discharged to the environment during this period. No relationship could be established between the amount and burnup of fuel processed and the amount of activity discharged from the plant to the lagoon system during this study. For the Yankee fuel campaign of May-August 1969, the waste management practice and not the amount of fuel processed was the controlling factor in the amount of activity discharged from the plant to the lagoon system.

Magon, L., A. Bismondo, G. Tomat, and A. Cassol. 1972. Interaction of Neptunium (V) with Dicarboxylate Ligands. Radiochimica Acta. 17:164-167.

Equilibria involved in the interaction of neptunyl (V) ion and oxalic, malonic, succinic, phthalic and maleic acides in aqueous solutions have been investigated by means of potentiometric measurements of hydrogen ion concentration at 20°C and in an ionic medium 1M $NaClO_4$.

In the pH range examined, the formation of chelate complexes with one and two ligands for the neptunyl (V)-oxalate system and with one ligand only for the other systems has been ascertained. The formation constants have been determined. The stability of the complexes is briefly discussed in correlation with the different basicity and structure of the ligands. (auth)

Mahdavi, A. 1963. The Thorium, Uranium, and Potassium Contents of Atlantic and Gulf Coast Beach Sands. Thesis. Rice Universit,.

A field radiometric survey was made of the thorium, uranium, and potassium concentrations in the beach sands along the Gulf and Atlantic Coasts. At 31 localities alor [illegible] se coasts a total of 81 field gamma-ray spectrometric determinations w [illegible] ade. Laboratory gamma-ray spectrometry was done on 91 samples taken at the [illegible] tes of the field measurements. On the basis of these measurements and general geologic conditions, the data can be conveniently divided into the following four suites: (1) Those beaches to the west of the Mississippi River. (2) Those beaches to the east of the Mississippi River. (3) Those beaches of the south Atlantic Coast from northern Florida to North Carolina. (4) Those beaches of the north Atlantic Coast from Virginia to Cape Cod, Massachusetts. The highest average was from Suite 3, which consisted of 41 samples, averaging 11 ppm thorium, 4 ppm uranium, and 0.27% chemical potassium. The lowest averages were for the 19 samples from Suite 2, averaging 0.86 ppm thorium, 0.41 ppm uranium, and 0.046% chemical potassium. Suites 1 and 2 averaged 2.07 and 2.78 ppm thorium, 0.84 and 0.8 ppm uranium, and 1.17 and 0.31% potassium, respectively. A Th/U ratio of 2.8 is most frequently observed and the field and laboratory determinations agreed to within ±10% of the amount present on the average. The 100-fold larger system measured with the field instrument is considered to be more representative. Thorium above about 2 ppm and uranium above about 0.8 ppm is generally carried in rare resistate minerals such as zircon and monazite, but most samples fell in the range of 1 to 2 ppm thorium and less than 0.8 ppm uranium. Theoretical arguments suggest that the mean concentration is far above this mode, with considerable percentages (15 to 20%) of the thorium in sedimentary rocks occurring in thin, dispersed placer concentrations of monazite and zircon sand. (auth)

Mandavi, A. 1964. The Thorium, Uranium, and Potassium Contents of Atlantic and Gulf Coast Beach Sands. IN: Natural Radiation Environment. pp. 87-114.

Using 81 field stations and 91 laboratory samples, gamma spectrometric measurements were made on the Th, U, and K contents in beach sands from the

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Atlantic and Gulf Coasts. The field measurements showed that the contents could be determined to less than 10%. The results show that: Th above 1-2 ppm and U above 0.3-0.6 ppm are contained in dense resistate minerals. Most beaches have a Th/U ratio of 2.5 to 3, with only two beaches (Galveston Island and Cape Cod) having a ratio near the crustal average of 3.8. The contents in several cases can be related to provenance and beach processes. Calculated Th and U contents of sands defined geochemically are too high compared with the experimental data. (NSA)

Mahmoud, K. A., Y. A. Yousef, N. I. Abdel-Kerim, and W. E. Y. Abdelmalik. 1968. Affinity of Ismailia Canal Bottom Sediments for Certain Radionuclides. Isotope Radiat. Res. 1:9-18.

The ecological environment of the Ismailia Canal, which runs for a distance of more than one kilometer adjacent to the Western boundaries of the U.A.R. Atomic Energy Establishment site, was studied. Laboratory investigations on Canal water and bottom sediments were performed. The Canal water is moderately hard with low mineral content and limited changes in pH and dissolved solids. Most of the bottom sediments were fine sand and composed of quartz and feldspar, as shown by x-ray diffraction. However, montmorillonite clay mineral was identified in the clayey silt fraction. Cation exchange capacities of samples from bottom sediments were moderately low and exchange capacities were highest in the clay-size fraction. Laboratory studies, using slurry tests, on sorption of some radionuclides such as ^{134}Cs, ^{89}Sr, and ^{60}Co by bottom sediments were conducted. Affinity of these sediments for sorption of radionuclides were influenced by grain-size distribution, contact time and carrier concentration. Linear relationships were noticed between logarithm of capacity of bottom sediments for sorption of radionuclides versus logarithm of carrier concentration. A Freundlich sorption isotherm was identified. (auth)

Mahmoud, K. A., Y. A. Yousef, M. M. Ishak, W.E.Y. Abdel-Malik, S. R. Khalil, A. Shafik, and R.M.K. El-Shinawy. 1973. Transfer Mechanism and Concentrating Processes of Certain Radionuclides in the Aquatic Ecology of the Ismailia Canal. IN: Environmental Behavior of Radionuclides Released in the Nuclear Industry. IAEA, Vienna, pp. 205-215.

The behavior of certain radionuclides in the aquatic ecology of the Ismailia Canal is of great interest for the evaluation of the possible hazards that may occur to man through the movement of such radionuclides via the food chain. Laboratory investigations have been carried out to understand the accumulation and release of ^{134}Cs, ^{60}Co and ^{89}Sr by some of the biota, such as phytoplankton organisms, certain types of aquatic plants, snails and fish, the hydrological characteristics of the Ismailia Canal and the uptake by bottom sediments. The physico-chemical characteristics of Ismailia Canal water were measured periodically for 18 months to determine the seasonal variations in the conductivity, pH, total hardness, alkalinity, organic matter content, anion and cation content, etc. Laboratory investigations of the hydrological characteristics of Ismailia Canal water with respect to the relative distribution of radionuclides between water and bottom sediments were carried out. The distribution of the radioactivity in the bottom sediments was measured and computed and the results presented in the form of histograms for both flowing and nonflowing ecosystems. Possible applications of the experimental laboratory data to the natural conditions prevailing in the Ismailia Canal are also discussed. (auth)

Makhonina, G. I., N. V. Timofeev Resovskii, A. A. Titlyanova, and A. N. Tyuryukanov. 1961. The Distribution of Strontium-90 and Cesium-137 Among Various Ecological Components. Doklady Akad. Nauk SSSR. 140:1209-12 (in Russian).

Aqueous solutions of ^{90}Sr (10 mc) and ^{137}Cs (15 mc) were percolated into 1 m^2 of soil through 81 openings 1, 5, 10 and 15 cm deep in order to obtain a uniform distribution of activity in the top, 15 cm layer of soil. The weight and activity in the biomass above ground and below ground, of the forest litter, and of the soil at depths of 0 to 15 cm, 15 to 20 cm, 20 to 25 cm, and 25 to 30 cm were determined after the passage of three vegetative periods of growth. The biomass above ground contained 0.13 and

0.19%, and the roots of the underground biomass contained 0.11 and 0.13% of the total amount of ^{90}Sr used on two different plots in the Il'mensk National Park in the South Urals. The accumulation of ^{137}Cs is much smaller, 0.007% for the biomass above ground, and 0.011 to 0.021% for the root system. The litter was found to contain 0.5 to 3% of the total ^{90}Sr and ^{137}Cs activity. The accumulation of ^{90}Sr and ^{137}Cs by various plants is presented as the ratio of activity in the above-ground part of the plant to the concentration of activity in the root system, and as the ratio of activity of 1 gram of dry plant material to the activity in one gram of soil. On the average the accumulation of ^{90}Sr by the plants is larger than of ^{137}Cs by an order of magnitude. The ratio of activity in one gram of plant material to the activity in one gram of soil varies from 0.001 to 0.5 for ^{137}Cs, and from 0.01 to 5 for ^{90}Sr. This ratio is greater than one for ^{90}Sr in 10 out of 16 plants tested. Pine and larch accumulate the least amount of ^{137}Cs and ^{90}Sr with a ratio of 0.01 for ^{137}Cs and a ratio of 0.1 for ^{90}Sr. The aspen (Populus tremula) shows a ratio of 0.01 for ^{137}Cs and of 0.06 for ^{90}Sr. Moss and mullein (Verbascum sp.) absorb ^{137}Cs preferentially (activity ratio of 2 to 6 for mullein). The roots of the crowfoot (Ranunculus sp.), veronica, and legumes absorb ^{90}Sr preferentially with an activity ratio of 5.4, 1.2 and 3.4, respectively. However, in general, ^{137}Cs is adsorbed by the root system, and ^{90}Sr by the above-ground part of the plant. (NSA)

Makhonko, K.P. 1972. Migration of Global Radioisotopes in Various Spheres. INIS-mf-887, pp. 235-251 (in Russian).

The migration of radioisotopes in the atmosphere, the hydrosphere, and the biosphere is briefly discussed. The calculation of the radioisotope transport in air, water, and soil is dealt with in more detail. Equations for the calculation of the ^{90}Sr and ^{137}Cs migration in soils are also presented. (NSA)

Malinauskas, A. P., et al. 1971. Isotope Transport. Radioactive Waste Repository Project: Tech. Status Report for Period Ending Sept. 30, 1971. ORNL-4751.

Migration of fluid filled negative crystal cavities in salt to thermally hot waste container and effects of this water vapor on enhancement of oxide and hydroxide waste product vapor pressures. Discusses gas and aerosol transport through crushed and bedded salt. Experimental results of experiments for self-diffusion of Na and interdiffusion other metal ions in NaCl and KCl, self-diffusion of ions in a variety of inorganic salts and interdiffusion of ions in various inorganic salts.

Malone, C. R., and D. E. Reichle. 1973. Chemical Manipulation of Soil Biota in a Fescue Meadow. Soil Biol. Biochem. 5:629-639.

Formalin, phorate, and sodium chlorate were used in field enclosures to create artificial habitats in a fescue meadow containing reduced number of earthworms, reduced numbers of earthworms and soil arthropods, and reduction of total soil fauna and rate of microbial decomposition. Under these conditions, confined fescue litter initially decomposed more rapidly where arthropods or earthworms were suppressed than in controls with full complements of soil animals. After one year, reduction in numbers of soil animals had no net effect on litter decomposition, with faunal activity apparently having been compensated for by increased microbial activity. Where animals and microbial activity were reduced, rate of litter loss was depressed initially but recovered after 10 months as the effects of chemical suppression of microbial populations subsided. Contrary to the effects on annual loss of litter, elimination of all or portions of the soil fauna depressed rates of loss of confined and buried roots, reflecting the role of animals in fragmenting roots before their decomposition by micro-organisms. Habitat manipulations had pronounced effects on the mobility of ^{134}Cs, and loss of the radionuclide from labeled litter was retarded despite an accelerated rate of decomposition. This effect apparently was associated with proliferation of micro-organisms on litter and microbial immobilization of the radionuclide. Immobilization of ^{134}Cs occurred following chemical perturbations, but only after an initial period of rapid loss resulting from increased microbial activity. Distribution of ^{134}Cs in soil beneath tagged litter bags reflected the role of animals in element redistribution within soil. Restricted vertical mobility of the nuclide occurred except where chemical application killed vegetation within the experimental enclosures. (auth)

Malyshev, V. I., Y. V. Sharkov, and Z. A. Sokolova. 1971. Use of Isotopic Analysis to Study Weathering and Halo Formation in Various Uranium-Bearing Areas of the Mountain Taiga Zone. Poiski Uranovykh Mestorozhd. Uslovivakh Gorn. Taigi. pp. 39-55 (in Russian).

The redistribution of radioactive elements occurs in areas of oxidized ores with relatively sufficient amounts of ^{238}U, excess Th, and a high Ra/U ratio. The presence of vertical and horizontal zoning in secondary lithochemical haloes of placer deposits are detected by isotopic analysis of natural radioactive elements. U and Ra contents and ^{234}U/^{238}U, ^{230}Th/^{238}U, Ra/U, ^{228}Th/^{232}Th, and ^{228}Th/^{230}Th ratios of rocks and waters in the mountain-taiga zone are given. (CA)

Malysowa, E., J. Borys, and L. Szerszen. 1967. ^{90}Sr Distribution in the Profiles of Some Arable Soils of Lower Silesia. Rocz. Glebozn. 18:33-41 (in Polish).

Dispersal of ^{90}Sr was tested in samples of ten soil profiles, taken in 1964 from fields near Wroclaw. They include podzols, pseudopodzols, brown and black earths of various mechanical compositions, and boggy turf soil. ^{90}Sr content was determined with the yttrium method of Reissig, exchangeable Ca of Jensen and Henrikson, and a complete pedologic analysis performed with standard methods. It was found that downward eluviation of ^{90}Sr in the profile is inconsiderable and is observed in light soils only. The distribution of ^{90}Sr in the profiles of the tested arable soils is primarily caused by the mechanical soil cultivation. (auth)

Malysowa, E., J. Borys, and L. Szerszen. 1968. Investigations on Profile Distribution of ^{90}Sr in Arable Soils of Lower Silesia. Rocz. Glebozn. 19: Suppl. 1:103-12.

The migration of ^{90}Sr in soils under agricultural cultivation in Lower Silesia (Poland) was investigated. Soil profiles were taken, the amount of precipitation measured, and the ^{90}Sr content in samples was determined. It was concluded that: the surface layer is most highly contaminated in all soils; the depth of ^{90}Sr contamination depends primarily on the kind of soil, the more clay and silt the greater the contamination; ^{90}Sr accumulated in the humus horizon of heavy soils; ^{90}Sr is leached into the depth of the profile of light soils; and the migration of ^{90}Sr into the soil profile seems to be independent of pH, of the presence of base cations, or of the quantity of organic C present. (NSA)

Mango, P., T. Rearey, and J. Apedianaskis. 1970. IN: Proceedings 5th Annual Health Physics Society. Midyear Topical Symposium. pp. 208-220.

The authors reported that the plutonium released to the fresh water became insoluble and settled rapidly in the lagoon system. Ninety-two percent of the plutonium released by the lagoon to the surrounding streams was associated with suspended material.

Manheim, F. 1961. Geochemical Profile in the Baltic Sea. Geochim. et Cosmochim. Acta. 25:52-70.

The relationship between depositional environment and element distribution in central Baltic sediments was investigated by means of chemical composition, pH, Eh, chlorinity, and temperature determinations. Central Baltic sediments show an unusually short, basinward transition from coarse oxygenated sediment to fine stagnant sediment. This is because of the salinity stratification of the Baltic Sea and the permanent O deficit found in deeper layers. Sapropelic sediments with H_2S and high organic contents occur in the deeps, where overlying H_2S-bearing water is stagnant and lacks O. Gyttjas (gray-green organic mucks) with or without H_2S form in quiet areas, where some O renewal takes place in the water. A pH of 7 or less, and lower pH in the sediment than in the overlying water are characteristic of low-carbonate ($<0.1\%$ CO_2) sediments, while higher pH values are found in sediments of higher carbonate contents. Heavy trace metals, such as Cu, Ag, U, and Mo are concentrated in the sapropels. Maximum enrichment, Mo possibly excepted, occurs at the peripheries (transition zones) of the stagnant basins. Owing to coprecipitation, Mo follows Fe sulfides. Maximum U content found in the Baltic is 130 g/ton which is not consistent with the hypothesis of Koezy et al. (CA 51, 7979f). Direct precipitation, or adsorption from water is indicated, not organic complexing. Mn-Fe nodules occur in a peripheral region of aerated bottom water under moderately reducing sediment conditions. The sediment is apparently the source of the Mn and Fe, which are solution in the interstitial, but not in the overlying waters. The concretions differ from deep-sea nodules in their lower trace-element contents. Unusual, Mn-enriched (up to 5.2% MnO), sapropelic sediments were found in two Baltic deposits A mixed Mn-$CaCO_3$ mineral, approximately ($Mn_{72}Ca_{76}Mg_{12}$) carbonate, and structurally suggestive of rhodochrosite, is apparently the carrier. (CA)

Mann, J. F. Jr. 1976. Wastewaters in the Vadose Zone of Arid Regions: Hydrologic Interactions. Ground Water. Vol. 14, No. 6.

In truly arid regions there is essentially no direct penetration of rainfall. Recharge to ground water is not only infrequent, but extremely localized, occurring only where surface runoff has been channelized or ponded. Over those vast desert areas covered by sparse xerophytic vegetation, the scant rainfall has little or no chance of becoming ground-water recharge. Such water is quickly dissipated by capillarity-assisted evaporation, or through rapid evapotranspiration by short-lived annuals. Where perennial xerophytes cover the ground surface, the extensive shallow root systems quickly utilize all of the rainfall stored in the soil. Beneath the infrequently moistened soil zone is the lower part of the vadose zone, extending to water tables which are usually at depths of tens to hundreds of feet. Almost always these vadose zones have moisture contents well below field capacity.

Regardless of the cause, these dry vadose zones are capable of holding additional water, at least up to field capacity. And no water-carried pollutants can reach the water table from the ground surface until a pre-wetted path has been formed for the entire vertical distance. A practical use of this water-holding capacity can be made in the design of wastewater tailings ponds, with predictable safety and with great economic benefit. However, only in predictable geologic conditions, and in limited amounts can the use of this water-holding capacity be recommended. On the other hand, to make no use whatsoever of these great natural dry sponges would be an economic waste. (auth)

Marei, A. N. 1962. Significance of the Bottom Bed as a Regulator of the Specific Radioactivity of Basin Water. Radiats. Gigiena Sb. 2:36-41.

An intense sorption of radioactive substances by the bottom layer and by the hydrobiont occurred, together with contamination of the water, during the delivery of radioactive substances into a basin. Under similar conditions the contamination of the bottom layer depends on its composition. If the layer consists of mud or dense clayey soils, U long-lived decay products can penetrate 25-30 cm. Most of the radioactive isotopes are concentrated in the upper 15 cm. Relatively high concentrations of radioactive substances were observed at 1.5 m depth when the bottom layer was peat. In sand, radioactive substances are present below 1.5 m depth. The distribution of isotopes in the basin bottom is similar to that in soils. (CA)

Marino, M. A. 1974. Distribution of Contaminants in Porous Media Flow. Water Resources Research. 10:1013-1018.

A mathematical analysis is presented of simultaneous dispersion and adsorption of a solute within homogeneous and isotropic porous media in steady unidirectional flow fields. The dispersion systems are adsorbing the solute at rates proportional to their concentration and are subject to input concentrations that vary exponentially with time. Mathematical solutions are developed for predicting the concentration of contaminants in adsorbing and nonadsorbing porous media for prescribed media and fluid parameters. (auth)

Markussen, E. K. 1970. Radiochemical Procedures for the Determination of Plutonium in Environmental Samples. RISO-M-1242.

The environmental samples collected during the radioecological studies after the B-52 accident at Thule were analyzed for plutonium according to the procedures given. The solid samples were ashed at 600 degrees Centigrade, and after the addition of carriers and spikes the ash was melted with potassium pyrosulfate to ensure that all plutonium was in a soluble form before the radiochemical analysis which was developed especially for this purpose by a combination of an American ion-exchange procedure and a Danish solvent extraction method. After the radiochemical analysis, which would be accomplished within a day for most types of samples, the samples were counted on silicon surface barrier gamma counters in connection with a multichannel analyser. (auth)

Marshall, C. E. and G. Garcia. 1959. Exchange Equilibria in a Carboxylic Resin and in Attapulgite Clay. J. Phys. Chem. 63:1663-1666.

Cation-exchange equilibria were determined for the carboxylic exchange resin IRC 50 and for Attapulgite clay using Na-K, Na-Rb, Na-Cs, Mg-Ca. Mg-Sr and Mg-Ba. Curves showing variations in selectivity number with composition of the solid phase were obtained at low ionic strength of the outer solutions. The resin showed small variations in K_s with monovalent cations but very large variations with divalent. This is ascribed to partial blocking of sites by $MgOH^+$ ions. With attapulgite, very large variations in K_s are found, suggesting a polyfunctional character with fixation of K, Rb and Cs by one mechanism, and of Mg by a different mechanism. (auth)

Marshall, J. S., D. N. Edgington, S. A. Spigarelli, and M. A. Wahlgren. 1972. Great Lakes Radioecology: Levels and Distribution of ^{137}Cs. ^{239}Pu, and ^{90}Sr in Lake Michigan. ANL-7960 (Pt. 3), pp. 1-6.

Data are presented on the levels and distribution of fallout ^{137}Cs, ^{90}Sr, and ^{239}Pu in water, sediments, and representative fish species and plankton in Lake Michigan during 1972. Samples were collected at 25 stations throughout the lake. (NSA)

Marshall, J. S., D. N. Edgington and M. A. Wahlgren. 1973. Great Lakes Radioecology Program: Introduction. ANL-8060. Part 3, pp. 1-5.

The Great Lakes Radioecology Program has the ultimate goal of understanding and predicting the biogeochemical behavior and pathways to man of radionuclides and toxic trace elements in Lake Michigan. During 1973 the objective was to measure and assess the distribution of selected natural and long-lived artificial fallout radionuclides in water, sediments, and biota with important roles in their ecosystem cycling and food chains leading to man. As of June 1973, there were seven US nuclear power reactors in operation in the Great Lakes Basin. Because of projected increasing use of Pu in present-day reactors, future breeder reactors, and other applications, studies initiated in 1972 on the behavior of fallout Pu in Lake Michigan were intensified during 1973 and expanded to obtain comparative data on the other Great Lakes. Sampling programs included the collection of water, plankton, and sediment samples at various depths. Approximately 11 samples of Cladophora were collected for an assessment of its potential value as a biological monitor for radionuclides in the Great Lakes. Plutonium measurements to date indicate that the very small fraction of fallout Pu remaining in Lake Michigan water exhibits surprisingly conservative properties, although a pronounced annual depletion and return is observed in the surface waters, and the concentration of Pu in Lake Michigan phytoplankton is several thousand times higher than that in the water, but it decreases by approximately an order of magnitude with each successive link in the food chains leading to man. Measurements of the vertical profiles of fallout ^{210}Pb and ^{137}Cs in sediment cores were used to determine recent sedimentation rates in Lake Michigan. These rates, which are the same as the average over the last 1,000 years, are being used to interpret the distribution of possible pollutants in sediment cores in relation to physiocochemical processes and atmospheric and stream inputs. (NSA)

Martell, E. A., P. A. Goldan, J. J. Krauschaar, D. W. Shea, and R. H. Williams. 1970. Fire. Environment. 12:14-20.

Following the fire at the Rocky Flats plutonium plant in May, 1969, public concern was reflected in formation of a subcommittee of the Colorado Committee for Environmental Information. The subcommittee, consisting of the authors of the article investigated the implications of the fire and previous fires and operations at the plant. Plutonium oxide dust particles produced in fires are among the most serious cancer-producing agents known since radiation from these fires is millions of times more intense than naturally occurring radioactive dust. Since plutonium oxide is very insoluble, it is not readily detected by precipitation, and can be recycled in airborne dust caused by wind. Soil measurements were made and indicate between 100 and 1,000 times more plutonium in the local environment than would be if good containment practices were maintained at the plant. There is too much scientific uncertainty about plutonium hazards without more adequate information. The most difficult and uncertain part of the problem is assessment of the risk to people in the Denver metropolitan area resulting from plutonium present in the soils around the Rocky Flats Plant. Two questions require answers: How many plutonium particles will be deposited in the lungs as a result of surface soil and airborne plutonium contamination; and what is the cancer risk from a given number of particles deposited in the lungs. Some persuasive arguments have been made that indicate standards are as much as 100 times too permissive when applied to plutonium. AEC has announced an expanded offsite monitoring program for air, water, and soil and specific analysis of plutonium content in many of the samples. The Colorado Department of Health has also increased its measurement program. Despite this, the magnitude of the health hazard will be difficult to assess, and the pathway from soil to man must be demonstrated. The question of utmost concern is what level of plutonium oxide particles in the air we breathe and in our lungs is acceptable to the public at large? The answer is needed quickly and until then, statements about the lack of significance of the present off-site contamination are unjustified. (0-21)

Marter, W. L. 1974. Radioactivity from SRP Operations in a Downstream Savannah River Swamp. DP-1370.

Approximately 25 curies of ^{137}Cs, less than 1 curie of ^{60}Co, and trace amounts of ^{90}Sr were deposited in about two square miles of swamp bordering the Savannah River and adjacent to the southeast Savannah River Plant boundary. Most of the radioactivity was released to on-site streams in the 1960's from reactor area irradiated fuel storage basins. During the period of release, annual average ^{137}Cs concentration in on-site streams never exceeded 3.0% of the concentration guide of 2×10^{-5} μCi/ml, and concentrations in the Savannah River never exceeded 1% of the guide. Most of the radioactivity in the off-site swamp is associated with kaolin clay particles deposited in the swamp during river flooding which occurred about 23% of the time each year. Gamma exposure rates in the affected area of the off-site swamp range from 30 to 590 mR/year above background. The swamp is uninhabited, and the most likely incremental radiation dose (above background) to hunters and fishermen who spend from a few hours to several hundred hours in the swamp would range from less than 1 mR to a few tens of mR per year. No restrictions on use of the swamp are considered warranted nor are remedial actions needed. The contaminated sediments are relatively immobile and are expected to remain so. Releases of radioactivity to on-site streams were sharply reduced following 1969 when improvements were made in reactor effluent control. No increase in exposure rates is expected from current releases of radioactivity. However, the swamp will be monitored periodically in the future to provide a basis for continued evaluation. (auth)

Martin, F. M., C. T. Sanders and S. S. Talmage, (eds.). 1974. Environmental Aspects of the Transuranics. A Selected, Annotated Bibliography. ORNL-EIS-74-21 (Supplement 3).

This fourth published bibliography of 528 references is from the computer information file built to provide support to the Nevada Applied Ecology Group of the Atomic Energy Commission Nevada Operations Office. The general scope is environmental aspects of uranium and the transuranic elements, with a preponderance of material on plutonium. In addition, there are supporting materials involving basic ecology or general reviews on other nuclides that are entered at the request of the Nevada Applied Ecology Group. References provide findings-oriented abstracts. Numerical data is referred to in the comment field. Indexes are given for author, subject category, key words, geographic location, permuted title, taxons, and publication description. (auth)

Martin, J. M. 1970. Seasonal Variations in the Radioactivity of Matter Suspended in Rivers. Compt. Rend. Ser. D. 271:1934-7 (in French).

The large seasonal variations in the radioactivity of suspended materials transported by rivers is explained in terms of the radioelement distribution in the various granulometric fractions of the sediments. At least 95% of the entire ^{137}Cs fallout is accumulated in the soil. Only a low percentage of ^{137}Cs is transported; relations between the particle size and specific activity were found. In consequence, radioactivity measurements on suspended materials from rivers are not correlated with fallout in the basin. (NSA)

Martin, W. E. and S. G. Bloom. 1975. Plutonium Transport and Dose Estimation Model. IAEA-SM-199/78.

A Standard Man is assumed to live in and obtain most of his food from a Pu-contaminated area at NTS. A Pu-transport model, based on the results of other studies at NTS, provides a basis for estimating rates of ^{239}Pu inhalation and ingestion as functions of the average concentration of ^{239}Pu (C_s = pCi/g) in the surface soil of the reference area. Assuming the transport system to be in equilibrium, the estimated inhalation and ingestion rates (pCi/day) are 0.002 C_s and 0.269 C_s, respectively.

A dose estimation model, based on parameters recommended in ICRP publications, is used to estimate organ burdens, accumulated doses, and dose commitments as functions of exposure time. Estimated doses (rems) due to inhalation and ingestion of ^{239}Pu for 50 years at the rates indicated above are: thoracic lymph nodes, 0.6 C_s; lung, 0.025 C_s; bone, 0.015 C_s; liver, 0.01 C_s; kidneys, 0.003 C_s; total body, 0.0007 C_s; and gastrointestinal tract (LLI), 0.0003 C_s. Inhalation accounts for 100% of the predicted dose to thoracic lymph nodes and lungs and for about 94% of the predicted dose to bone, liver, kidneys, and total body.

Martin, W. E., S. G. Bloom, and R. J. Yorde, Jr. 1974. NAEG Plutonium Study Modeling Program: Plutonium Transport and Dose Estimation Model. IN: Dunaway, P. B., and M. G. White (ed.). The Dynamics of Plutonium in Desert Environments. NVO-142, pp. 331-360.

A computer program based on a matrix exponential method was used to solve a system of ordinary differential equations which simulate the behavior of Pu-239 in desert ecosystems such as those found at and near the Nevada Test Site. The model was used to estimate the rates of Pu-239 transport, via several environmental pathways, to Standard Man, who was assumed to live in a contaminated area. These estimates were then used to calculate radiation doses and dose commitments, as a function of time, to different organs.

The model provides a method for evaluating the potential radiological hazard to man due to the presence of Pu-239 in a given area. However, the studies designed to implement the model, by providing accurate estimates of critical parameters, are still in progress. Therefore, the results to date are incomplete and inconclusive.

On the basis of present assumptions and parameter values, the model indicates a 70-year dose commitment to the pulmonary lymph nodes of 13.6 rem per pCi (Pu-239)/g (soil). Comparable values for other organs are: bone, 0.14 rem; lung, 0.10 rem; kidney, 0.015 rem; liver, 0.014 rem; G.I. tract, 0.007 rem; and total body, 0.003 rem. Inhalation accounts for 100% of the dose to the lungs and pulmonary lymph nodes, a negligible fraction of the dose to the G.I. tract, and about 56% of the dose to bone, kidney, liver, and total body. This means that all but a negligible fraction of the dose to the G.I. tract and 44% of the Pu-239 entering the bloodstream is due to ingestion of soil, vegetation, milk, beef, and beef liver. It is quite possible that the relative importance of inhalation has been overestimated, while the relative importance of ingestion has been underestimated. (auth)

Masuda, K. and T. Yamamoto. 1971. Studies on Environmental Contamination by Uranium. II. Adsorption of Uranium on Soil and Its Desorption. J. Radiat. Res. 12:94-9.

Experimental studies on the behavior of uranium on soils were carried out using three kinds of soil; volcanic ash, alluvial, and sandy soils. The results showed that uranium dissolved in water (1 to 100 μg as U/ml) was almost completely adsorbed on every soil examined. The desorption of uranium from soil with salt solutions was extremely difficult especially from volcanic ash soil. (auth)

Mather, J. R. and J. K. Nakamura. 1960. The Climatic and Hydrologic Factors Affecting the Redistribution of Sr^{90}. Fnl. Tech. Rpt. No. 1. NP-9213.

Based on the results of experiments using different soils and leaching solutions, a mathematical model of leaching was set up which fairly well reproduced the leaching distribution results. An equation and a table for determining the wave of leaching in the soil are contained. The rate of leaching was found to depend on the cation-exchange capacity of the soil and the quantity and chemical composition of the leaching solution. The influence of climate on these three factors was studied. It was found that the climatic water balance provided a reasonable estimation of the quantity of surplus water or leaching solution which is available for redistributing strontium in the soil in any area. Using data on the climatic moisture index on the cation-exchange capacity or clay content of soils, the influence of climate on exchange capacity was studied. Leaching was much more rapid, per unit of surplus water, in dry climates than in moist climates. A bibliography containing 147 abstracts is presented on the chemistry of leaching. (auth)

Mather, J. R. and J. K. Nakamura. 1961. The Climatic and Hydrologic Factors Affecting the Redistribution of Sr^{90}. AFOSR-1623.

During the present study of the influence of climatic and hydrologic factors on the movement of strontium through the upper layers of the soil, a number of significant results have been achieved.

1. Strontium which has fallen out of the atmosphere has been found to move through the upper part of the soil profile at a rate determined by the volume of leaching solution present and the chemical and cation exchange properties of the soil solution. This rate of movement can be predicted on the basis of physical laws of mass movement.
2. A mathematical model of movement has been established which permits computation of strontium movement in the soil. To use the mathematical model information on a) initial concentration of strontium, b) leaching volume, and c) the leaching efficiency of the soil and water solutions are needed.
3. The volume of the leaching solution is the climatic water surplus or the excess precipitation when the water holding capacity of the soil is filled. The water surplus can be computed on either a daily or monthly basis by means of a bookkeeping procedure devised by Thornthwaite (1945) or on an annual basis for the surface layer of the soil by means of nomograms included with this report.
4. A manual for using high speed computers to compute the factors of the daily water balance has been prepared. This manual discusses the use of the IBM 602A and the IBM 650 computers and presents the necessary program for the computation of the daily water surplus, deficit, actual evapotranspiration, and water storage.
5. The influence of the soil solution in determining the rate of movement of strontium can be expressed in terms of the factor, leaching efficiency, which is found to depend principally on the cation exchange capacity of the soil and the chemical composition of the leaching solution.

6. Leaching efficiency varies geographically from high values in moist regions to low values in dry regions for soils of the same texture. Thus, it requires more water to leach a given quantity of strontium in a dry region than in a moist region.
7. Leaching efficiency is related to the moisture index. Tables and nomograms have been prepared to permit the determination of leaching efficiency from the readily available climatic data.
8. From the data on volume of the leaching solution and the leaching efficiency, it has been possible to determine the rate of redistribution of strontium in the upper layers of the soil at a large number of stations and to plot the results on maps for analysis. Maps showing the time in years for 99 percent removal of strontium from the upper 6 and 12 inches of the profile of a sandy loam soil have been prepared. These show a large region of fairly rapid removal of strontium in the southeastern part of the United States, with strontium removal time increasing regularly westward across the Great Plains and more rapidly and erratically in the mountainous regions of the west. For most of the agricultural or highly populated areas of the country, 99 percent of the initial concentration of strontium would be removed from the first foot of soil within 10 years under normal climatic conditions. Similar maps could be made for other soil types. They would show that strontium removal time decreased by approximately one-half for sands and increased by about four times in clay soils. (auth)

Mathers, W. G. and L. C. Watson. 1962. A Waste Disposal Experiment Using Mineral Exchange on Clinoptilolite. CRCE-1080.

An 8200-liter volume of waste solution containing 400 curies of Cs-137 and 370 curies of Sr-90 was treated by ion exchange with clinoptilolite, a natural zeolite. The Cs and Sr were removed from solution by this treatment and the loaded mineral was buried in a concrete container in the Chalk River B disposal area. Both the preliminary laboratory work and the full-scale operation are described. (auth)

Matlack, G. M. 1974. The Chemistry of Plutonium in Relation to Its Behavior in Biological and Environmental Systems. IN: Plutonium Information Meeting, Los Alamos, New Mexico. CONF-740115, pp. 2-7.

This article is a cram course in plutonium chemistry ranging from a discussion of metallic plutonium through hydrolysis and disproportionation. Inorganic and organic plutonium complexes and ion exchange reactions also listed and discussed.

Matsumura, T. and T. Ishiyama. 1965. Decontamination of Radioactive Waste Water by Humic Acid Column. Ann. Rept. Radiat. Center Osaka Prefect. 5:33-6.

Humic acid has a characteristic cation exchange property. Decontamination of radioactive waste water by a humic acid column was tested. When only very small amounts of foreign matter are present in the water to be decontaminated, ^{89}Sr and ^{137}Cs-^{137}Ba are satisfactorily removed from neutral solution; ^{95}Zr-^{95}Nb, ^{144}Ce-^{144}Pr, and FP are effectively removed by acidification of the liquid, but nitratonitrosylruthenium is not removed effectively. When an appreciable amount of carrier ions is present, the removals of ^{89}Sr and ^{137}Cs-^{137}Ba decrease relatively quickly with the concentration of carrier ions. It seems that the cation exchange property of humic acid works mainly on the surface of the humic acid preparation. (auth)

Maxfield, H. L. 1971. Radioactive Contamination in Unplanned Releases to Ground Within the Chemical Separations Area Control Zone Through 1970. ARH-2015, Pt. 4.

Data are summarized regarding sites containing unconfined radioactive materials resulting from unplanned releases to soil storage in the chemical processing area of the Hanford reservation. Each site is identified with the location, description, and history of the event, as well as the amount and kind of radioactive material present. Included are spills, process transfer line leaks, informal burial sites, locations contaminated by airborne radioactive particulates, and spreads of radioactivity by animals. The report covers releases from plant startup in 1944 through calendar year 1970. (auth)

Mawson, C. A. and A. E. Russell. 1960. Facilities for Waste Management at Chalk River, Canada. IN: Disposal of Radioactive Wastes. I:362-371.

The physical facilities for waste disposal at Chalk River are reviewed, and their relationship to migration of ^{106}Ru-^{106}Rh and much smaller amounts of ^{90}Sr, ^{144}Ce and ^{137}Cs are outlined. Sources of radionuclides include sand trench solid disposal sites, concrete trenches for solids above one millicurie, cement tile holes for still higher activity wastes and bottles of liquid wastes in trenches lined with 5 cm of asphalt.

Maxfield, H. L. 1973. Radioactive Contamination in Unplanned Releases to Ground Within the Chemical Separations Area Control Zone through 1972. (Exclusive of Liquid Waste Storage Tank Farms.) ARH-2757 (Pt. 4.)

Data are summarized regarding sites containing unconfined radioactive materials resulting from unplanned releases to soil storage in the chemical processing area of the Hanford reservation from the time of plant start-up in 1944 through calendar year 1972. Each site is identified with the location, description, and history of the event as well as the amount and kind of radioactive material present. Included are spills, process transfer line leaks, informal burial sites, locations contaminated by airborne radioactive particulates, and spreads of radioactivity by animals. (NSA)

May, I., M. M. Schnepfe, and C. R. Naeser. 1963. Strontium Sorption Studies on Crandallite. U.S.G.S. Bulletin 1144-C.

Crandallite ores may be useful in the treatment of nuclear-waste solutions because of their reactivity with strontium in weakly acid solutions and in alkaline solutions containing aluminum. The exchange capacity of the crandallite sample studied is not very high, being 6 to 10 milliequivalents of strontium and 2 milliequivalents of cesium per 100 grams of active phosphatic material. However, strontium removal is many times more effective in alkaline solutions, with precipitation being the dominant mechanism. The removal of strontium is even more complete in alkaline solutions containing aluminate ions. (auth)

Mazor, E. 1963. Notes Concerning the Geochemistry of Phosphorus, Fluorine, Uranium, and Radium in Some Marine Rocks in Israel. Israel J. Earth-Sci. 12:41-52.

Phosphorus, F, U, Ra, Th, and K were analyzed in 38 samples of marine sediments ranging in age from Santonian to Eocene and including phosphorite, diagenetically changed phosphoritic rocks, limestone, chalk, and marl. The abundances of the first four mentioned elements were found to be in constant ratios, although the P_2O_5 content varied from less than 1 up to 33%. There seems to be essentially one kind of phosphate mineral in all the samples, its F to P ratio being that of a carbonate-fluorapatite. The radioactive equilibrium of the U and Ra indicates that the apatite has not been disturbed by weathering processes for at least the last 10,000 years. All the above geochemical relation agree well with data published on phosphorites in other parts of the world. The carbonate-fluorapatite in the samples of the Senoian Mottled zone formation and in the ferruginous phosphorites, accompanying the Companian-Eocene unconformity in the Ramon area, was not affected by diagenetic processes. (auth)

Mead, F. C., Jr. 1949. Liquid Waste Disposal Research Quarterly Report for April 1, 1949 to June 30, 1949. AECD-4149.

Radiometric procedures have been developed for both routine beta analysis and to determine the radioactive constituents by absorption studies. It is thought that Ru and Cs make up a great portion of the radioactive materials present in the two and one-half year old crib waste. Their presence has been corroborated by absorption studies. A satisfactory method for the quantitative determination of Ru in these solutions has been developed. Initial ion-exchange experiments indicate that is not practical to use ion-exchange resins for the complete decontamination of crib wastes. Coprecipitation experiments for the removal of ruthenium as the sulfide or complex cyanide show some promise. (auth)

Means, J. L., D. A. Crerar, and J. O. Duguid. 1976. Chemical Mechanisms of ^{60}Co Transport in Ground Water from Intermediate-Level Liquid Waste Trench 7: Progress Report for Period Ending June 30, 1975. ORNL/TM-5348.

A seep approximately 50 meters east of trench 7 within the ORNL restricted area contains ^{60}Co in concentrations of 10^4 to 10^6 dpm/g in the soil and 10^3 dpm/ml in the water. Traces of ^{125}Sb and various transuranics have also been detected in the soil. However, because the volume of water discharge from the seep is small, the total radionuclide contribution from the trench 7 area to White Oak Creek and the Clinch River is insignificant.

The ^{60}Co is transported in the ground-water from the trench to the seep as organic complexes and is absorbed by manganese oxides and to a lesser extent by iron sesquioxides in the shale and soil. In the absence of these organic complexing agents, ^{60}Co mobilization would be negligible because the sediment absorption capacity for inorganic forms of ^{60}Co is extremely high.

The primary objective of this study has been to investigate ^{60}Co transport and absorption mechanisms as observed in the study area. Because the organic complexing characteristics of transition metals and transuranics are similar, the mechanisms of ^{60}Co transport determined in this study may also apply to plutonium and other alpha-emitters. Also the experimental and analytical methods employed in this study apply to the identification of other migrating radionuclide complexes from other disposal trenches and pits at ORNL. The increased knowledge of transport and adsorption mechanisms will provide insight into methods of controlling the movement of radionuclides from these and future disposal areas. (auth)

Megumi, K. and Mamuro, T. 1973. Emanation of Radon and Thoron Gases from Soil. Annu. Rep. Radiat. Center Osaka Prefect. 13:35-37.

A soil sample originating from weathering of granite was sieved into six kinds of particle size. The contents of natural radionuclides in each classified soil sample and the radon and thoron exhalation from it were measured. Both the contents of ^{225}Ra (parent nuclide of radon) and ^{244}Ra (parent nuclide of thoron) were found to consist of two components for the samples of more than 10 mesh; one is proportional to the total volume of soil particles and the other proportional to the total surface area of soil particles. On the other hand, the content of ^{40}K showed no remarkable variation with particle size. The thoron emanating power was found to be 20 to 40 percent. It was revealed that smaller soil particles have more contribution to the radon and thoron exhalation from the soil surface than larger soil particles. (auth)

Megumi, K. and Mamuro, T. 1974. Emanation and Exhalation of Radon and Thoron Gases from Soil Particles. J. Geophys. Res. 79:3357-3360.

Samples of soil originating from the weathering of granite rock were sieved into eight classes of particle size. Each sieved sample was measured for its content of ^{226}Ra (parent nuclide of radon), ^{224}Ra (parent nuclide of thoron), ^{228}Ac (grandparent nuclide of ^{224}Ra), K, Ca, and Fe as well as for the radon and thoron emanation from it. There was a trend for the contents of ^{226}Ra and ^{224}Ra to increase as particle size desreased. On the other hand, the K content showed a different variation with particle size from the variations found for ^{226}Ra and ^{224}Ra. On the basis of the results of the emanation measurements, it was concluded that smaller soil particles make relatively more contribution to radon and thoron exhalations from the ground surface than larger soil particles, but they make absolutely less because of their smaller abundance. (auth)

Mel'nikova, M. K. and V. M. Prokhorov. 1966. Effects of Soaking on Adsorption and Desorption of ^{90}Sr by Soil. Zh. Prikl. Khin. 39:1693-6 (in Russian).

Experiments were conducted using slightly argillaceous black soil and turf-podzolized light argillaceous soil samples soaked with water and with 1% OP-7 (polyethyleneglycol octylphenol with 7 ethyleneglycol groups). The presence of OP-7 improved ^{90}Sr desorption from soil eluted with $Ca(NO_3)_2$ and trilon B and increased the coefficient of ^{90}Sr distribution in soaked soils. (NSA)

Mendel, J. E. 1973. A Review of Leaching Test Methods and the Leachability of Various Solid Media Containing Radioactive Wastes. BNWL-1765.

A review of experimental techniques which have been employed to measure the leachability of solidified radioactive wastes in the United States and foreign countries is made. Factors which effect leachability are described. The need for two different kinds of leach tests is emphasized, 1) a rapid comparison test, and 2) a more comprehensive performance test, wherein the actual exposure environment is simulated. (auth)

Menzel, R. G. 1968. Accumulation and Movement of Fission Products in Soils and Plants. TID-7644, p. 177-86.

The effects of temperature on the fixation of Sr^{90} in various soil types were investigated. Four soil types were selected on the basis of known ability to fix Sr and suspected dominance of various mechanisms. For example, Davidson and Dunbar soil types probably fix by absorption and diffusion into amorphous material. Maury soil may fix by precipitation or recrystallization of phosphates. Huntley, a calcareous soil, may fix by precipitation or recrystallization of carbonates. Fixed Sr^{85} was determined at various time intervals after incubating the soil samples at various temperatures with various amounts of Sr carrier. An analysis of experimental results is included. (NSA)

Menzel, R. G. 1965. Soil-Plant Relationships of Radioactive Elements. Health Physics. 11:1325-1332.

The plant concentration of various radioactive elements, after they have been added to soils in water-soluble forms, may be several orders of magnitude higher or lower than the concentration in the soil. Those that are most readily absorbed are soluble in the soil or are isotopic with elements that have metabolic functions in the plant. Those that are least absorbed are quite insoluble in the soil. The gamma radiation doses to plants would come predominantly from the soil, as would the beta radiation doses except for the beta radiation from those few elements which may be highly concentrated in certain plant tissues. The role of plants in movement of radionuclides in soil is minor except over very long periods of time. (auth)

Menzel, R. G. 1968. Uranium, Radium, and Thorium Content in Phosphate Rocks and Their Possible Radiation Hazard. J. Agr. Food Chem. 16:231-34.

A survey of phosphate rock samples from all major phosphate producing areas of the world showed that phosphate rocks from Florida, the main source of fertilizer phosphates in the United States, ranked relatively high in content of uranium, radium, and thorium. In areas where crops are fertilized with high rates of phosphate from Florida, the addition of uranium and radium may equal the amounts occurring naturally in the plow layer of soils, but the addition of thorium would be less than the amount occurring naturally. The radiation hazard, which might result from uptake of radium into food plants, appears to be negligible. (auth)

Menzel, R. G. 1974. Land Surface Erosion and Rainfall as Sources of ^{90}Sr in Streams. J. Environ. Qual. 3:219-223.

Strontium-90 concentrations in streams from 1958 to 1967 reflected the changing concentrations in rainfall and accumulation on the land surface. Correlation analysis of data from nationwide sampling networks shows that the ^{90}Sr concentration in streams was accounted for, on the average, by 1.7% of the rainout 2 months earlier, and annual erosion of 0.58% of the accumulated ^{90}Sr on the land surface. Direct runoff of ^{90}Sr in preceding rainfall was highest, 2.0 to 2.2%, in the north central and eastern United States, ranging down to no measurable direct runoff in the southwestern United States. Annual erosion of ^{90}Sr from the land surface ranged from 0.75% in the Ohio River Basin to 0.17% in the Missouri River Basin. If one allows for differences in time and area of application, these results for land surface erosion indicate the potential movement of persistent, strongly adsorbed pesticides from large land areas. (auth)

Mercer, B. W. 1960. The Removal of Cesium and Strontium from Condensate Wastes with Clinoptilolite. HW-66276.

Effective removal of Cs^+ and Sr^{2+} from simulated and actual waste solutions was achieved by adsorption on beds of clinoptilolite. Removal of Cs^+ and Sr^{2+} to C/C_0 values of 10^{-2} to 10^{-4} was attained at flow rates of 0.5 to 6.3 gal/ft^2/min. Small amounts of suspended solids or organic material were found in the actual wastes. The suspended matter contains radioisotopes which are not removed by ion exchange on clinoptilolite. The organic material tends to foul the clinoptilolite — particularly at low pH. Cesium capacities of 105 meq and 19 meq/100 g of clinoptilolite were measured for 0.1 $\underline{M}$ Cs^+ and 0.001 $\underline{M}$ Cs^+, respectively, in 1 $\underline{M}$ Na^+ solutions. The volume put through a clinoptilolite column to 50% breakthrough was constant for Cs^+ concentrations below 0.001 $\underline{M}$ in 1 $\underline{M}$ Na^+. A 50-g column of clinoptilolite decontaminated trace Cs^+ from 50,000 column volumes of tap water containing 24 ppm total Ca^{2+} and Mg^{2+}. The C/C_0 values were 0.0002 at 2.7 gal/ft^2/min and 0.01 at 6.3 gal/ft^2/min. Clinoptilolite cesium capacity for decontaminating this tap water was more than 30 times the capacity of a commercial ion exchange resin. (auth)

Mercer, B. W. 1966. Adsorption of Trace Ions from Intermediate Level Radioactive Wastes by Ion Exchange. BNWL-180.

Trace cesium and strontium selectivity coefficients were determined for 16 cation exchangers. Mass action equations were derived for determining the cesium and strontium equilibrium distribution coefficients for solutions containing several competing cations. Good agreement was obtained between computed and experimental distribution coefficients. The computed 1% cesium breakthrough points were within 20% of the actual 1% cesium breakthrough points determined previously for two waste treatment pilot plant ion exchange columns with a plant condensate waste. The slopes of the computed breakthrough curves agreed well with the actual curves for the range covered.

A plant condensate waste was steam stripped, filtered, and decontaminated by ion exchange on a pilot plant scale. The inadvertent introduction of bacteria into the plant condensate retention tank complicated the decontamination of this condensate by increasing the filtration requirement. The steam stripped condensate waste containing bacterial residue was successfully filtered with a horizontal plate filter by using diatomaceous earth filter aid. The use of a fine particle zeolite as both a filtration and an ion exchange media for the horizontal plate filter was apparently unsatisfactory because ly a fraction of the zeolite ion exchange capacity was used before the bed became plugged. (auth)

Mercer, B. W. 1967. Ion Exchange Equilibria of Trace Cesium-137 and Strontium-85 in Multicomponent Systems. BNWL-SA-1173.

Trace cesium and strontium selectivity coefficients were determined for 20 cation exchangers at two or more different concentrations of competing cations. The selectivity coefficients are useful for computing equilibrium distribution coefficients, Kds, for dilute electrolyte solutions such as those encountered in radioactive waste treatment or radiochemical analysis by ion exchange. A variety of inorganic ion exchangers with high cesium selectivity were studied. These exchangers may be used in place of conventional organic ion exchange resins when high cesium Kds are desired in systems with significant concentrations of competing cations. Several of the inorganic ion exchangers also show high strontium selectivity in the presence of divalent cations Mg^{+2} and Ca^{+2}.

Since practical application of ion exchange theory is often complicated by the presence of two or more competing ions, equations are derived for computing distribution coefficients in multicomponent systems. The derivation of the equations is based on the independence of the binary exchange equilibria of one ion pair from other ion pairs in the system. Trace ion selectivity coefficients determined in binary systems are used in the equations for computing distribution coefficients in multicomponent systems. Good agreement was obtained between computed and experimental distribution coefficients. (auth)

Mercer, B. W., A. J. Shuckrow, and L. L. Ames. 1971. Fixation of Radioactive Wastes in Soil and Salt Cakes with Organic Polymers. BNWL-1220.

Organic polymers of the type used in fiberglass laminates were evaluated for use in the fixation of radioactivity in soil and preformed salt cakes. In situ fixation of the radioactivity is to be accomplished by injection of the polymers into soil or preformed salt cakes. This approach circumvents the costs and hazards associated with the alternate method for excavating the highly radioactive soil or salt for processing or burial. The results of laboratory studies show that water leach rates of radioisotopes or ions from the soil and salt cakes were reduced by 99.9% or more by incorporation of the soil or salt in a suitable resin matrix. Injection of catalyzed liquid resin into soil with subsequent polymerization to form a hard mixture was successfully demonstrated in both laboratory and field experiments. (auth)

Merewether, E. A., J. A. Sharps, J. R. Gill, and M. E. Cooley. 1973. Shale, Mudstone, and Claystone as Potential Host Rocks for Underground Emplacement of Waste. USGS-4339-5.

The suitability of the argillaceous formations in the conterminous United States as host rocks for underground waste emplacement is reviewed in terms of available geologic information. The strata are considered mainly according to their dimensions, depth, composition, permeability, structural and seismic history, and to the extent of drilling in the area. Shale, mudstone, and claystone of marine origin, in areas of little structural deformation and seismic risk, are generally the most promising. These include the

Ohio Shale of Devonian age in northern Ohio and the Devonian-Mississippian Ellsworth Shale and Mississippian Coldwater Shale in Michigan. In the Rocky Mountain States, the Pierre Shale and other thick shales of Late Cretaceous age are also potential host rocks. (NSA)

Merritt, W. F. 1961. Movement of Radioactive Wastes Through Soil. II. Measurement of Direction and Effective Velocity of Ground Water Movement. CRER-972.

The results of an experiment to determine the direction and effective velocity of ground-water flow in an area of Perch Lake Swamp are given. Results obtained using tritium, S^{35} and fluorescein dye as tracers are compared. Sulfur-35 moved at a rate of 6.7 in. per day, tritium moved 5% faster, and fluorescein 20% more slowly. Although reasonable values for the effective velocity were obtained, the flow pattern is complex. (auth)

Merritt, W. F. 1976. The Leaching of Radioactivity from Highly Radioactive Glass Blocks Buried Below the Water Table: Fifteen Years of Results. AECL-5317.

The results from two test burials of high-level fission products incorporated into nepheline syenite glass indicate that the nuclear wastes from fuel processing for a 30,000 MWe nuclear power industry could be incorporated into such glass and stored beneath the water table in the waste management area of Chalk River Nuclear Laboratories (CRNL) without harm to the environment. (auth)

Merritt, W. F. and C. A. Mawson. 1973. Retention of Radionuclides Deposited in the Chalk River Nuclear Laboratories Waste Management Areas. AECL-4510

Records are presented of the amounts of radionuclides deposited in engineered enclosures and directly into the ground in the waste management areas at the Chalk River Nuclear Laboratories up to the end of 1972. About 5.2 MCi of long-lived radionuclides, mainly in the form of stored reactor fuel, have been placed in engineered facilities and about 32 kCi have been deposited directly into the ground. Any radionuclides escaping into public waters from this system must pass down Perch Creek into the Ottawa River. The total run-off down Perch Creek over the whole period was 13 Ci. The Chalk River site has therefore proved to be very effective in retaining radionuclides in spite of the low ion-exchange capacity of the soil and conditions of climate and water table height that make it less than ideal for radioactive waste management. It is hoped that this information will be useful in planning future waste management operations. (auth)

Merritt, W. F. and P. J. Parsons. 1959. Sampling Devices for Water and Soil. IN: Disposal of Radioactive Wastes II. IAEA, Vienna, pp. 329-38.

Movement of radioactivity below ground is monitored at Chalk River by several methods. Sealed aluminum pipes are set in the ground down to the glacial till. A battery-operated Geiger counter is lowered down the pipe on a cable. It can detect activity of 20 to 50 dpm/ml dissolved in ground water. A portable γ-ray spectrometer is being developed for use in these dry wells. Ground water is sampled at fixed depths by Alundum thimbles connected to the surface by polythene tubing. Samples are withdrawn into an evacuated flask. Several thimbles can be taped to a rod that is positioned inside a casing driven to the required depth; the casing is then withdrawn, leaving the thimbles in position in the soil. Porous bronze piezometers can be pressed or driven to any depth in the absence of rock. Water passes freely through the bronze and is withdrawn into an evacuated flask. Multiple samples of soil may be taken at a series of preselected depths in one hole by samplers set inside connected section of drill rod. Each sampler is a hollow rod pierced by slits which are closed during drilling by a piston. For sampling, the piston is slightly withdrawn and the rod twisted. A second piston, attached to the first, is then drawn up to close the slots and the string of samplers is lifted from the hole. Undisturbed samples of sand are taken below the water table by a sampler containing an air-bell which enables the sample to be withdrawn into an air cavity and be held in the tube by air pressure while the sampler is being brought to the surface. (auth)

Merritt, W. F. and P. J. Parsons. 1964. The Safe Burial of High-Level Fission Product Solutions Incorporated into Glass. Health Physics. 10:655-664.

High-level waste-fission-product solution containing 1000 c was incorporated into glass blocks and the blocks buried for 3 years in sand beneath the water-table. The experiment has shown that, even in saturated soil with low exchange capacity, the method of disposal was safe and the escape of hazardous radionuclides was within acceptably low limits. (auth)

Meyer, G. L. 1975. Preliminary Data on the Occurrence of Transuranium Nuclides in the Environment at the Radioactive Waste Burial Site. Maxey Flats, Kentucky. IAEA-SM-199/105.

Between 1963 and 1974, approximately 104,000 m^3 of solid "low-level" radioactive waste were buried at the Maxey Flats, Kentucky, site. These wastes contained approximately 80 kg of plutonium-239 and a large undermined quantity of other plutonium isotopes. In 1972, elevated levels of radioactivity were detected in monitoring samples collected near the burial facility by the Kentucky Department for Human Resources (KDHR).

Subsequently, the KDHR conducted a special radiological study of the burial site and its environs. Based on the concentration of plutonium present or the ratio of plutonium-238 to -239, 49 of 50 samples collected on or near the burial site were contaminated with plutonium from a source other than atmospheric fallout. Plutonium was detected in surface soil, in soil cores 90 cm deep, in monitoring wells, and in streams which drain the site.

During the past 13 years, infiltrating precipitation collected in the burial trenches, forming a mobile plutonium-contaminated leachate. The chemical forms, pathways, and mechanisms by which the plutonium moved out of the trenches have not been explained satisfactorily. Extensive studies of the burial site are in progress.

Meyer, M. W. and L. T. Alexander. 1965. Strontium 90 Sources in Soils of Arid Regions: Rainfall, Dry Fallout, and Irrigation Water. Soil Science 99:234-5.

Studies were performed on the Colorado River to determine whether ^{90}Sr in river water used for irrigation reaches the land surface in amounts that are significant when compared with amounts brought down by rainfall and dry fallouts. Samplings at two sites (Yuma and Mohave County, Arizona) taken between January 1, and December 31, 1962 showed a definite increase in ^{90}Sr added to the soils. However, the amount of ^{90}Sr was small as compared to that of areas having higher rainfall. (NSA)

Michels, D. E. 1971. Log-Normal Analysis of Data for Plutonium in the Outdoors. IN: Fowler, E. B., R. W. Henderson, and M. F. Milligan. Proceedings of Environmental Plutonium Symposium. LA-4756, pp. 105-111.

Detected amounts of plutonium are distributed log-normally for most groups of samples. When data are plotted on probability paper, sharp distinctions may sometimes be made between the background distribution and increments from a local source.

Because the detected amounts of plutonium are not distributed normally, arithmetical averaging of detected amounts if not valid. Similarly, composited samples from large areas yield analyzed values which cannot be interpreted. Additionally, the proper standard deviation for background samples refers to a ratio of concentrations rather than to an increment as is commonly reported. (auth)

Michels, D. E. 1974. Analysis of Paired Data Sequential in Space or Time and the Relationship to Sampling Continuous Cyclic Distributions. RFP-2165.

Three standard deviations are used to determine what fraction of available information may have been obtained from a set of samples. Discrete data are arranged sequentially in either space or time, and the subject is presumed to exist as a continuous cyclic variable with a continuous trend. The difference between variance for samples of a set and variance for multiple analyses of a single sample define the maximum amount of information obtainable from the set. However, for pairs of samples adjacent in the sequence, variance has an intermediate value. The resolution of the set of samples depends on where the variance for adjacent pairs fits in the range bounded by the other variances. The resolution actually obtained can then be compared with a desired resolution in order to decide whether resampling is required, worth the cost, or whether a new analytical method is needed instead. A procedure for taking composite samples can be based on the cycle length of the continuous variable. Cycle length may be indicated by the standard deviation for adjacent pairs. A worked example problem involves ^{137}Cs fallout in a series of soil samples. (auth)

Michels, D. E. 1974. Cesium-137 Fallout in Red Desert Basin of Wyoming, USA. RFP-2164.

High variability characterizes fallout cesium-137 in the Red Desert Basin of Wyoming in the U.S. Correlations between fallout levels and factors of climate, topography, and vegetation suggest that bare soil more readily captures fallout from wind than does sagebrush; that wet fallout processes are of little significance in this arid place; that association between cesium-137 and snow is weak, hence drifting of snow is not a significant factor in the distribution of fallout; and that impingement of fallout particles directly on soils by wind action may be the dominant mechanism of fallout deposition in the Basin. Analysis was not conclusive when the data were sorted according to a single parameter; either mean annual precipitation or topography or vegetation. However, significant differences between average values and smaller values for standard deviations result when sorting is done according to two parameters, topography and vegetation. Highest levels of cesium-137 were found on barren ridges which, in the Basin, are exposed to persistent synoptic winds. (auth)

Michon, G. 1964. The Disposal of Radioactive Waste Into Irrigation Water. Health Physics Society.

The disposal of radioactive waste into water streams used for irrigation was studied. Accumulation of long-lived radioisotopes in the soil and plants from the irrigation water was studied. Data are presented in tables. It was concluded that the ICRP standards cannot be used as a basis for the disposal of radioactive waste in water used for irrigation since it allows man to be exposed to more radioactivity than is anticipated from the maximum permissible concentration. (NSA)

Mihalik, P. 1968. Uranium Compounds in the Dominion Reefs, and Their Association With Phosphorus Compounds. NIM-415.

Nine samples of uranium ore from the Bramley Shaft of the Dominion Reefs Mine were investigated mineralogically and with the electron microprobe to find the cause of the poor leaching characteristics of a fraction of the uranium minerals. The investigation, which is at present still in its preliminary stage, has shown that, in samples that exhibit good leaching characteristics, uranium is generally not intimately associated with phosphorus compounds, whereas the converse is generally true of samples having poor leaching characteristics. The existence of a number of hitherto unknown uranium minerals is also indicated, and it is suggested that they may contribute to the refractory nature of some of these uranium ores. (auth)

Miller, J. R. and R. F. Reitemeier. 1963. The Leaching of Radiostrontium and Radiocesium Through Soils. Soil Sci. Soc. Am. Proc. 27:141-4.

Experiments were conducted in a greenhouse to determine the downward movement of Cs^{137} and Sr^{90} in soils under intensive leaching. The five soils (Norfolk, Hagerstown, Miami, Fort Collins, and Huntley series) selected for the investigation represented a wide range of soil properties, and the leaching treatments consisted of 30 and 300 in. of deionized water, 0.005N NaCl, and 0.005N $CaCl_2$. There was little downward movement of Cs^{134} when the soils received the applications of deionized water, NaCl, or $CaCl_2$. Radioactive assays of the soil columns showed that 99.6 to 100% of the Cs^{134} was in the surface two layers of the soil columns (average depth 1.4 inches) after 300 inches of leaching. In the leaching experiment with Sr, the $CaCl_2$ produced the greatest movement of Sr^{89} and deionized water the least. The maximum distance Sr^{89} penetrated into the soils when leached with 30 inches of water was 1.3 inches, and with 300 inches of water the distance was 4.3 inches. In general, there was more movement of Sr^{89} in the Norfolk soil and least in the Huntley, with the other soils being intermediate. (auth)

Miller, M. H. and A. J. Ohlrogge. 1958. Water-Soluble Chelating Agents in Organic Materials: I. Characterization of Chelating Agents and Their Reactions with Trace Metals in Soils. Soil Sci. Soc. Am. Proc. 22:225-28.

Water extracts of barnyard manure, dried and ground alfalfa, and animal feces were found to contain complexing agents which were capable of removing zinc from the soil. This zinc could not be removed by water or a potassium chloride solution, but could be removed with a cupric chloride solution. The complexing agents or combination of agents appear to be of plant origin, and were partially inactivated by incubation of the organic material prior to extraction.

It was shown by the principle of resin-exchange equilibrium that the zinc after removal from the soil was complexed by materials in the water extract of manure. There were at least two complexing agents in the extract, one or more of which formed a 2:1 type of complex and one or more of which formed a 1:1 complex, the resulting average being 1.55:1. The "apparent" stability constant of the combination of agents for zinc was found to be 7.8. The ability of the extract to complex zinc increased as the pH of the extract was increased. The formation of a chelate complex between the zinc and the chelating agents in the extract is postulated. (auth)

Milyukova, M. S., N. I. Gusev, I. G. Sentyurin and I. S. Sklyarenko. 1967. Analytical Chemistry of Plutonium Translated by J. Schmorak. Israel Program for Scientific Translations. Weiner Bindery Ldt. Jerusalem.

This book covers the general chemistry of Pu as perceived by Russian workers. Pertinent chapters for this environmental study include those of the behavior of plutonium in aqueous solutions and portions of chapter of separation of Pu which pertain to cation and anion exchange properties of Pu solutions.

Miner, F. J., P. A. Glover and H. W. Miller. Plutonium Behavior in the Soil/Water Environment. RFP-2004-A, pp. 1-3.

A standard solution of less than 10 micrometer PuO_2 particles suspended in water, along with a nitric acid solution as a source of "soluble" plutonium, was used in distribution studies of plutonium between characterized soils and the above solutions. The division between soluble and insoluble plutonium was chosen as 0.02 micrometers in diameter on the basis of plutonium work reported in the literature. This was later modified to 0.1 μm. Equilibrium between Pu in HNO_3 and a Rocky Flats soil was reached in about 3 hours but a South Carolina soil did not attain equilibrium after 24 hours of contact time.

Miner, F. J., P. A. Glover, and W. L. Polzer. 1974. Plutonium Behavior in the Soil/Water Environment I. Sorption of Plutonium by Soils. Agronomy Abstracts. p. 35.

As part of a larger program to study the behavior of plutonium in the environment, the movement of plutonium in soil/water systems is being investigated. Sorption and elution characteristics are being used to measure this movement. The equilibrium sorption of plutonium has been determined for 13 soils. The soils were initially characterized chemically and physically (mechanically). Three plutonium concentrations, 10^{-8}, 10^{-7}, and 10^{-6} moles/liter, were used for the sorption measurements. The plutonium sorption was rapid and quite high: 59% of the time the equilibrium sorption was greater than 99% ($K_d(m) > 430$) and only 5% of the time was it below 90% sorption ($K_d(m) < 39$). Using principal component analysis, a statistically significant relationship was found between the sorption of plutonium and groups of chemical and physical characteristics of the soils that are associated either with the ion exchange capabilities of the soils or their acidities. Plutonium column elution behavior has been investigated for three soils. There is some plutonium in the eluate (less than 2% of the amount of plutonium placed in the soil column) but the amount varies with soil. (auth)

Miner, F. J. and H. W. Miller. 1972. Plutonium Behavior in the Soil/Water Environment. IN: M. A. Thompson (ed.). Research and Ecology Semi-Annual Progress Report January - June 1972. Chemistry Research and Development. RFP-1921-A, pp. 1-3.

Attempts to identify the sorption differences between "soluble" forms of plutonium [$Pu(OH)_m^{4-m}$] and of insoluble forms of plutonium [PuO_2] have been futile.

Distribution coefficients for plutonium on 2 g of soil from 10 ml of solutions will be determined by centrifugation.

Mineyev, D. A., Yu. P. Dikov, B. P. Sobolev, and V. L. Borutskaya. 1966. Differentiation of Rare-Earth Elements Under Supercritical Conditions. Geokhimiya. No. 4:468-470.

Results of experiments using known starting mixtures of La-, Ce-, and Y-oxides and NaF heated for five days in an autoclave with a controlled temperature gradient (550°C at top and 500°C at bottom) support the hypothesis of the transfer of rare earths by fluorine complexes. (auth)

Mishio, N. and T. Sho-ou. 1964. Removal of Radioactive Substances by Korean Acid Clay. Genshiryoku Kogyo. 10:34-7 (in Japanese).

Four kinds of acid clay from the Kyung-buk district in Korea were used as samples. The main components of these samples were found by X-ray and spectroscopic examination to be montmorillonite, zeolite, and quartz. After adding 1,000 ppm acid clay to a pseudo-waste solution of ^{137}Cs and ^{89}Sr (ca 10^{-2} µC/ml) and stirring for 30 min, the sample solution was allowed to stand for 30 min and the supernatant was taken out to measure the radioactivity. In general, baking of the samples lowers the decontamination ratio. The existence of $NaNO_3$ does not affect the decontamination of ^{137}Cs to a great extent; the decontamination of ^{89}Sr is, however, likely to be influenced by the existence of Na^+ and the decontamination ratio decreases appreciably. A pH value of 4 - 11 is suitable. In the treatment of actual waste solutions (5 x 10^{-6} C/ml), about 80% decontamination ratio was obtained. (NSA)

Mishra, U. C. 1972. Natural and Fallout Gamma Nuclides in Indian Soils. CONF-720805-P1, pp. 333-345.

Undisturbed soil samples collected throughout India from various areas and depths were examined by gamma spectrometry for natural radioactivity and fallout radionuclides, with emphasis on ^{137}Cs. It is proposed to cover the entire country as regards the natural radioactivity estimations and conduct a detailed survey of the areas showing anomalies. It is proposed to continue sampling and measurements of fallout gamma nuclides once a year at 5 or 6 selected stations so that the ratio of deposition, elimination, or redistribution can be studied over long time periods. (NSA)

Mishra, U. C. and S. Sadasivan. 1971. Gamma Spectrometric Measurement of Soil Radioactivity. Int. J. Appl. Radiat. Isotop. 22:256-7.

A gamma spectrometric method of estimating concentrations of terrestrial and long-lived bomb-produced gamma emitting isotopes in countryside soil samples is described. The method was used for measuring soil samples collected during 1964 to 1970 from different places in India from undisturbed plain and open areas. The dried samples were powdered and sieved through 30 to 40 mesh size and stored in leak proof containers for at least one month to allow for equilibration of radon and thoron with their daughters. The prominent gamma energies of the isotopes analysed (^{144}Ce + ^{144}Pr, ^{125}Sb, ^{106}Ru + ^{106}Rh, ^{137}Cs + ^{137m}Ba, ^{54}Mn, ^{238}U, ^{232}Th, ^{40}K) and the details of the analyser system used are tabulated. (NSA)

Mishra, U. C. and S. Sadasivan. 1971. Natural Radioactivity Levels in Indian Soils. J. Sci. Ind. Res. 30:59-62.

γ-Spectrometry for ^{232}Th, ^{238}U, ^{226}Ra, and K in 35 Indian soils agrees with chemical methods. An average dose of 41.7 mR/yr is distributed: Th 14.0, U 7.4, and K 20.3. (CA)

Mishra, U. C. and S. Sadasivan. 1972. Fallout Radioactivity in Indian Soils. Health Physics. 23:55-62.

Results of gamma spectrometric measurements of ^{144}Ce, ^{106}Ru, ^{125}Sb and ^{137}Cs activities of fallout origin in samples of Indian soils are reported. The samples were collected during 1966-1970 from a number of places in India. Some of the samples were analyzed for ^{90}Sr by conventional chemical methods and beta counting, and the ratios ^{137}Cs/^{90}Sr were studied. The results were compared with global ^{90}Sr soil measurements and the important differences are brought out. The variations of concentrations with depth, rainfall, latitude, etc. are discussed. The external gamma dose rates due to fallout gamma emitters in soils were computed and compared with estimated dose rates due to natural radioactivity. (auth)

Mitry, E., A. Grawad, S. Emara, and M. Y. Farah. 1965. Further Studies on the Uptake of Long-Lived Fission Products on Some Clays from the United Arab Republic. IAEA-SM-71/63(c).

Further studies in the UAR program on the feasibility of ground disposal of radioactive wastes are reported. New clays from the Nile and Méadi have been studied as well as those of Mokattam and Ainai. Their eventual domestication was demonstrated for long-lived isotopes as exemplified by

^{90}Sr. The effects of competing ions and heat treatment of clays was particularly emphasized, and an interpretation is proposed for the reported behavior. Further studies are being carried out for cesium on some deep mineralizations at Inshas and Bory el Arab reactor sites. (NSA)

Miyake, Y. 1955. Recent Problems in the Chemistry of the Ocean. Kagaku ho Ryoiki. 9:3-8.

A review on the behavior of uranium, ionium, and radium in the ocean, and the measurement of organic production in the sea with C^{14}. (CA)

Miyake, Y., Y. Katsuragi, and Y. Sugimura. 1970. A Study on Plutonium Fallout. J. Geophys. Res. 75:2329-2330.

Total depositions of ^{239,240}Pu and ^{239}Pu from 1958 to April 1969 are, respectively, 0.97 mc/km^2 and 42 μ/km^2 in Tokyo. The ratio of ^{233}Pu to ^{239,240}Pu increased in fallout remarkably since 1967. This increase is considered to be due to ^{238}Pu scattered from SNAP-9A generator in 1964. Surface values of plutonium isotopes of the Japan Sea ranged from 3.0 to 20.4 x 10^{-15} g/l (0.2 to 1.2 x 10^{-3} pc/l) with the ratio of ^{238}Pu to ^{239,240}Pu ranging from 13.2 to 37.7%. We observed the deep penetration of these isotopes in the sea. (CA)

Miyake, H. and M. Michijima. 1972. Nonequilibrium Among Thorium-Series Radionuclides in the Sediments Around a River Mouth. Radioisotopes. 21:74-9 (in Japanese).

The distribution of ^{228}Th and ^{228}Ra concentrations in the sediments were studied by high-resolution γ-ray spectrometry with a Ge(Li) detector without chemical treatment of the sample. The activities of the nuclides were determined from the activities of their daughters (^{212}Pb, ^{208}Tl, and ^{228}Ac). Samples containing monazite sand of known activity were used as the standards in which the Th-series radionuclides were in equilibrium. The radionuclides were mostly accumulated in a narrow band stretching along the stream from the river. The activity ratios of ^{228}Th to ^{232}Th were also measured by α-ray spectrometry with a double grid ionization chamber. The results show the fractionation effect around a river mouth due to the difference of chemical properties between Th and Ra in sea water. (CA)

Miyake, Y., K. Saruhashi, U. Katsuragi, T. Kanazawa, and Y. Sugimura. 1964. Uranium, Radium, Thorium, Ionium, Strontium 90 and Cesium 137 in Coastal Waters of Japan. IN: Recent Research Fields of Hydrosphere, Atmosphere and Nuclear Geochemistry. Maruzen Co. Ltd.

Coastal waters collected in Suruga Bay, Japan in 1960 and 1961 were analyzed for U, Ra, Th, ^{230}Th, ^{90}Sr, and ^{137}Cs. The ^{90}Sr content in the marine organism, *Sergetes lucens* Hansen, was also measured. Data are presented in tables and graphs. Values for ^{90}Sr varied from 0.04 ± 0.03 to 0.48 ± 0.04 μμC/l and for ^{137}Cs from 0.52 ± 0.12 to 1.20 ± 0.36 μμC/l. The value of ^{90}Sr in the marine organism was 0.1 μμC/g ash. The concentration of uranium in Suruga Bay ranged from 1.6 to 1.8 μg/l at the surface and increased with depth to 5 μg/l near the bottom. The content of radium was 0.3 to 0.6 x 10^{-13} g/l at the surface and 0.5 x 10^{-13} g/l at 1200 m. The content of thorium was 0.6 to 0.9 x 10^{-7} g/l and for ^{230}Th the values ranged from 2 to 7 x 10^{-12} g/l. (NSA)

Miyake, Y. and Y. Sugimura. 1961. Ionium-Thorium Chronology of Deep Sea Sediments of the Western North Pacific Ocean. Science. 133:1823-4.

The rate of deposition of deep-sea deposits collected at depths of 6215 to 8450 m in the western part of the North Pacific Ocean was estimated by means of the ionium/thorium ratio. The ratio was determined by an α spectrometer. Results showed the rate of 0.5 to 0.8 mm/10^3 yr for the upper 10-cm layer below the sea bottom. (auth)

Miyake, Y. and Y. Sugimura. 1975. The Plutonium Content in the Pacific Ocean Waters. IAEA-SM-199/22.

The content of plutonium in sea water collected during the cruises of 1968 to 1973 in the entire Pacific Ocean mainly along the line of 170°W and 146°W longitude extending from 50°N to 68°S, not only in the surface layer but also in the deep layer down to 3,000 m depth was determined. Results obtained in the eastern South Pacific and some of the western North Pacific were also reported. The plutonium content in the North Pacific surface water ranged from 2.2 to 9.4 x 10^{-4} pCi/l while it is lower in the South Pacific ranging from 1.3 to 3.4 x 10^{-4} pCi/l. Intimate correlation was observed between the plutonium content in surface water and ^{90}Sr fall rate. The ratio of ^{238}Pu/^{239,240}Pu in surface water ranged from 10 to 81% in the North Pacific and 35 to 240% in the South Pacific. These values are in the same order of magnitude as seen in the land fallout during the same period. ^{239,240}Pu/^{137}Cs in surface water ranged from 0.09 to 0.28% and it is lower than the average ratio of 0.6% in fallout in Tokyo. In the intermediate or deep layer relatively higher ratio was observed as compared with those in surface water. This suggests that a faster downward transport of plutonium in marine environment than strontium or cesium. (auth)

Miyake, Y., T. Yasujima, and Y. Sugimura. 1970. Thorium Concentration and the Activity Ratios ^{230}Th/^{232}Th and ^{228}Th/^{232}Th in Sea Water in the Western North Pacific. Nippon Kaiyo Gakkaishi. 2:130-6.

The concentration of thorium isotopes and the activity ratios of ^{230}Th/^{232}Th and ^{228}Th/^{232}Th in seawater collected in the Kuroshio region, the mixing area of Oyashio and Kuroshio, the Japan Sea and the East China Sea in the western North Pacific were determined. Thorium isotopes were analyzed by α-ray spectrometry after separating them with an anion exchange resin. The average content of thorium (^{232}Th) of 2.2 x 10^{-9} g/l was obtained in the open Pacific waters. The ratio of ^{230}Th/^{232}Th is in agreement with that of the top layer of the sediment in the same area. The high values of ^{228}Th/^{232}Th ratio up to 36 were observed in seawater. The excess ^{228}Th in seawater may be due to the migration of ^{228}Ra through the water-sediment interface. Thorium content in suspended matter was 10 to 20% of the total thorium content in the Pacific water. (auth)

Miyanage, I., A Kasai, and K. Imai. 1973. Preliminary Experiment on the Deposition of Gaseous Radioiodine Onto Environmental Materials. IN: Environmental Behavior of Radionuclides Released in the Nuclear Industry. IAEA-SM-172/11, pp. 157-165.

The deposition rates of gaseous radioiodine onto some environmental materials were measured experimentally with the use of an air-circulating chamber of dimensions 1.0 m x 1.5 m x 2.0 m. The circulating air speed and relative humidity are controllable in the ranges of 0 to 5 m/s and 50 to 100%, respectively, and a water spray device was set in the ceiling. To simulate the composition of airborne radioiodine released from the stack of a fuel reprocessing plant or radioisotope production plant, carrier-free Na ^{131}I was oxidized in 10 N HNO_3 solution and the gas generated was introduced into the chamber after being scrubbed in NaOH solution by continuously bubbling N_2 carrier gas. The composition of ^{131}I compounds in the chamber was analyzed by radio-gas-chromatography. At the start of injection, dominant components were the inorganic iodides, HIO_3 and HIO_4, and then fraction of organic iodides increased and remained at about 80% after about four hours had elapsed. Averaged concentrations in the chamber were in the range 10^{-6} to 10^{-7} μCi/ml and exposure durations were 6 to 7 hours. The environmental materials used were soil, sand, water, vegetables and pine tree leaves. The deposition velocity was determined as the ratio of the deposit per unit area of the surface of the materials to the accumulated concentration in air. The values obtained were in the range 10^{-2} to 10^{-3} cm/s and they decreased in the sequence soil, sand, vegetables, water. Converting the values for the vegetables to values for vegetation per unit area of the ground by using data on area density of vegetation, the deposition velocity to the vegetation was estimated to be almost the same as that to soil. (auth)

Mizuno, A. and T. Mochizuki. 1970. Distribution of Uranium in the Sediments from San'in Off-Shore, Southwestern Japan. Chishitsu Chosasho Geppo. 21: 287-92 (in Japanese).

The distribution of U in the sediments and its relation to the mud, clay, and C contents were studied. The very fine-grained or muddy sands in the Miho Bay contain on the average 1.8 ppm U. An off-shore progressive increase of U contents is observed; in the sand of the shelf area (0.98 ppm U), the clayey silt of outer shelf and upper slope (2.2), and the silty clay of slope (3.1). The abundance of U in the sediments agrees with the general tendency in sea area. U contents are in direct proportion to mud or clay contents, but no regular relation is found between U and C contents. U >5 ppm (maximum 8 ppm) is found in the horizon >30 cm from the top of core, in which the relation between U and C contents is quite different from that of surface sediments. (CA)

Mizuno, A., S. Sekine, J. Nakazawa, A. Takaku, K. Onodera, and M. Ono. 1969. Uranium Concentration in the Bottoms of the Lakes Shinji-ko and Naka-umi, With Special Reference to Its Genetic Relation with the Sedimentary Environment. Chishitsu Chosasho Hokoku. No. 232:317-52 (in Japanese).

The bottom areas of the lakes Shinji-ko and Naka-umi, along the San'in coast of Japan Sea (mainly oligohaline and polyhaline brackish lakes, respectively), are divided into three sections with respect to the U content. The first contains the lower content of U (1-3 ppm), represented by coastal sandy bottoms of both the lakes and the channels, and of the Ohashi-gawa and Sakai-Suido rivers. The second contains an intermediate content (4-5 ppm U), which is widely developed in the muddy bottoms of both lakes. The last contains the higher content (6-11 ppm U), only occurring in the muddy part of the Yonago Bay of Naka-umi. The tentative conclusions as to U distribution in the bottoms of the lakes are as follows: In the sections of lower and intermediate U content, U probably exists in fine-grained minerals such as zircon, derived from granitic rocks. On the other hand, a portion (1-6 ppm) of the U contained in the section of higher U content was probably derived from the lake water containing 2.8 γ U/l (maximum) by direct precipitation and (or) coprecipitation with organic and inorganic colloids, controlled mainly by pH and E_H conditions. (CA)

Mo, T and F. G. Lowman. 1975. Laboratory Experiments on the Transfer Dynamics of Plutonium from Marine Sediments to Seawater and to Marine Organisms. CONF-750503-5.

The leachability of ^{239,240}Pu from a fine contaminated calcareous sediment to aerated open seawater and to anoxic seawater was measured. The distribution coefficient for ^{239,240}Pu from sediment to seawater was 6.1 x 10^{-5} for aerated water and 2.6 x 10^{-6} for anoxic water. Experiments on the uptake of ^{239,240}Pu by the clams Donax denticulatus, and Lucina pectinata, were done in aquaria containing kilogram quantities of sediment from the Bravo Crater at Bikini Atoll. The concentration factor for ^{239,240}Pu by the soft parts of these clams was about 200. All the plutonium taken up in the soft parts was associated with the gill, mantle and siphon. No plutonium was detected in the adductor muscles of hepatopancreas. The smooth surfaces of the shells of the Donax did not show any detectable plutonium, but the rough shell surfaces of the Lucina concentrated plutonium by a factor of 1.10 x 10^4 over that in the seawater. Marine periphyton cultured on glass plates in an aquarium concentrated ^{239,240}Pu by a factor of about 7 x 10^3 over that in the seawater. (auth)

Mo, T., A. D. Suttle, and W. M. Sackett. 1973. Uranium Concentrations in Marine Sediments. Geochim. et Cosmochim. Acta. 37:35-51.

A direct proportionality was observed between the percentage of organic C and U in sediments deposited in an anoxic environment in the Pettaquamscutt River in Rhode Island with concentrations of organic C 7-14% and U 7-30 ppm. A similar relation was found in cores of sediments deposited on the Sigsbee Knolls in the Gulf of Mexico. For Mn nodules a direct relation was found between U and Ca concentrations, and both decrease with increasing depth of deposition. For nodules from 4500 m in the Pacific, concentrations are 3 ppm U and 0.3% Ca compared with 14 ppm U and 1.5% C at 1000 m. Relatively high U concentrations were observed in carbonates deposited in the deepest parts of the Gulf of Mexico, with the >88 μ carbonate fraction in Sigsbee Knoll cores having ≤1.20 ppm. (CA)

Molchanova, I. V. and N. V. Kulikov. 1970. Distribution of ^{90}Sr and ^{137}Cs in the Soil and Vegetation Cover of the Tundra. Dokl. Akad. Nauk SSSR. 195:959-61 (in Russian).

The distribution of radioisotopes in the soil and vegetation of the European section of the USSR has been studied but little is known on this subject with respect to the Far North and especially the tundra region; therefore, a comparative study was carried to determine the distribution of ^{90}Sr and ^{137}Cs in various types of soils and vegetation of the tundra. The examined area included peaks, moraine ranges and foothills of the watershed together with marshy peat-bog areas. During July 1966, specimens were collected from each of the soil types and from the vegetation which consisted mostly of moss and lichen. The ^{90}Sr content of the collected samples was determined radiochemically from the concentration of the ^{90}Y daughter product; the ^{137}Cs concentration in the plants; ^{90}Sr which has a tendency to migrate is accumulated in the soil. (NSA)

Molchanova, I. V. and N. V. Kulikov. 1972. Radioaktivnye Izotopy V Sisteme Pochvarastenie. Moscow; Atomizdat.

Problems of migration, distribution dispersion, and fixation of radioactive isotopes of iron, cobalt, yttrium, and cerium in the soil-plant geocenotic chain are considered. Results of study of the sorption of radioisotopes in the soil as a function of various factors (soil type, solution pH, isotope and nonisotope carrier concentrations, and aqueous extracts of fallout from plants). The strengths of fixation of isotopes in soil are compared, and characteristics of their migration capability in solution-plant and soil-plant systems are presented. Migration and dispersion of radioisotopes in the soil-plant cover of natural and artificial biogenocenosis are considered. (auth)

Molchanova, I. V., N. V. Kulikov, and L. I. Piskunov. 1973. Experimental Study of Strontium-90 Migration in the Soils of Forest Biogeocoenoses. Sov. J. Ecol. 4:416-419.

The migration and distribution of ^{90}Sr in forest soils was studied in adjacent sections of a mountain landscape by introducing radionuclide into the forest floor and by analyzing global radioactive fall-out. The area of ^{90}Sr dissemination within the soil profile of forest biogeocoenoses was found to be larger in the middle part of the slope and at its foot than at the top of the ridge. The radionuclide's vertical distribution in soils is satisfactorily approximated by an exponential function with both artificial and global contamination of biogeocoenoses. (auth)

Montgomery, D. M., H. E. Kolde, and R. L. Blanchard. 1977. Radiological Measurements at the Maxey Flats Radioactive Waste Burial Site 1974-1975. EPA-520/5-76/020

The principal radionuclides detected in off-site surface water samples were ^{3}H and ^{90}Sr. The highest ^{3}H concentration was 179,000 pCi/l in water from a wash on the west side of the site, outside the exclusion area (i.e., unrestricted area). This corresponds to 6% of the maximum permissible concentration (MPC) for ^{3}H in water discharged to unrestricted areas. The highest ^{90}Sr concentration was 80 pCi/l in the Main East Wash, corresponding to 27% of the MPC for ^{90}Sr in water. The ^{3}H and ^{90}Sr levels in Rock Lick Creek were lower than in the primary drainage pathways; the highest concentrations were 4700 pCi/l and 5.8 pCi/l, respectively. the Major aqueous pathways for radionuclides moving from the site were the Main East Wash and the wash on the west side of the site. The principal vehicle of transport appeared to be precipitation run-off from the surface of the burial site. Contamination of the site surface could have resulted from a number of sources, including lateral migration through the soil zone from the trenches to the land surface, spills during burial and trench pumping operations, and deposition from the evaporator plume. However, the relative contribution from these sources could not be determined. Deposition of radionuclides from the evaporator plume, especially ^{3}H, could be a major source of radioactivity observed in surface water, but additional studies would be necessary to evaluate its significance.

Radionuclides detected in stream bed sediment included ^{54}Mn, ^{60}Co, ^{90}Sr, ^{137}Cs, ^{238}Pu and ^{239}Pu. The highest concentrations were in samples from the Main East Wash which is the major drainage pathway for the burial site. The sediment data supported the conclusion, based on surface water measurements, that the transport of radionuclides from the site surface by precipitation run-off was a major source of the radioactivity detected in the drainage pathways.

The radionuclide levels in sediment were quite low and of little significance relative to population exposure. The accumulation of radionuclides in sediment serves as a reservoir or source of radionuclides that can be released by desorption or resuspension of the sediment. Considering the measured concentrations, however, contaminated sediment did not represent a significant source compared to the levels of ^{3}H and ^{90}Sr measured in surface water.

Only ^{3}H was detected in domestic well water at concentrations which reflect contributions from site operations. The source of the contamination may be a combination of surface run-off from the site and deposition from the evaporator plume. A daily intake of one liter of well water with an average concentration of 1700 pCi/l, the highest average concentration measured, would result in a total-body dose of only 0.1 mrem/year.

Radiochemical analyses of milk samples showed that ^{3}H releases from the Maxey Flats burial site have produced low-level contamination of milk from cows located within 3.1 km of the site. The highest ^{3}H concentration was associated with milk from cows drinking from Rock Lick Creek and can be attributed to releases from the site to Rock Lick Creek. Elevated ^{3}H levels in milk from a cow grazing near the site entrance were attributed to site evaporator effluent.

The potential dose to an individual from drinking ^{3}H in milk at the concentrations (300-6,500 pCi/l) detected in samples near the Maxey Flats site is quite low. Daily consumption of one liter of milk containing 6,500 pCi/l of ^{3}H would lead to an annual total body dose of approximately

0.4 mrem. The average dose rate to consumers of local milk is probably less. A more accurate assessment of the dose from this pathway would require more extensive monitoring efforts than attempted in this study.

With the exception of low-level ^3H, radionuclide levels in garden produce--tomatoes, watermelons, corn, grapes and cucumbers--grown near the waste burial site were below detection limits or indistinguishable from atmospheric fallout. Tritium concentrations in vegetables grown in off-site locations ranged from 990 to 4,620 pCi/kg. Higher ^3H concentrations, 3,570 to 78,700 pCi/kg, were measured in vegetables from gardens located on site property. The evaporator plume is the most likely source of this contamination, however, ^3H in surface water run-off may contribute at some garden locations. Differences in ^3H concentration of tissue water from vegetables grown in the same garden were attributed to the different transpiration rates of plants. The total body radiation dose to an individual consuming 100 g per day of tomatoes containing 4,600 pCi ^3H/kg (the highest off-site ^3H concentration observed) during a 90-day season was estimated to be less than 0.01 mrem/year. (auth)

Moore, G. W. 1953. Extraction of Uranium from Aqueous Solution by Coal and Other Materials. TEI-235.

Since U in nature is commonly associated with carbonaceous material, laboratory studies were conducted to determine the relative ability of various types of carbonaceous material and some other substances to remove U from solution. The results of these experiments indicate that the low rank coals are more effective in extracting U than any of the other materials used. A chemical determination shows that nearly 100% of the available U in solution is removed by subbituminous coal. The U is apparently retained in the coal by an irreversible process. The notable affinity of U for coalified plant remains suggests that some U deposits may have been formed over a long period of time by the extraction of U from dilute groundwater solutions. A possible application of the results of this work may be the extraction of U by coal from natural water or from waste solutions from U processing plants. (auth)

Moore, R. H. 1955. Investigation of Solvent Degradation Products in Recycled Uranium Recovery Plant Solvent. HW-34502. (rev.)

Impurities which originate from the diluent and which have been positively identified are: aliphatic nitro compounds, aliphatic carboxylic acids, and aliphatic nitroso compounds. Impurities which are suspected but not positively identified are: aromatic compounds (probably nitro and nitroso), and ketones or aldehydes. Impurities which originate from TBP (tributyl phosphate) are: DBP (dibutyl phosphate), tributoxyethyl phosphate (present originally as an impurity in TBP), and two unidentified phosphorus compounds.

Uranium distribution measurements show that the impurities arising from the diluent are the principal cause of deterioration in solvent quality. It was shown that nitrite esters may be very deleterious while nitro compounds may be relatively innocuous.

Present solvent treatment appears to remove DBP, aromatics, and probably a portion of the organic acids and nitroso compounds. Products resembling observed impurities can be synthesized by nitric and nitrous acid attack on shell spray base at elevated temperatures. (auth)

Moore, W. S. 1967. Amazon and Mississippi River Concentrations of Uranium, Thorium, and Radium Isotopes. Earth Planet. Sci. Lett. 2:231-4.

Concentrations of uranium and thorium series isotopes were measured in two large samples of river water and associated sediment. From these data an oceanic residence time for uranium of 4 million years is calculated. The concentration of ^{232}Th in these rivers is an order of magnitude greater than in surface Atlantic waters. The amounts of ^{230}Th and ^{226}Ra being supplied to the ocean directly from rivers are less than 4% of that coming from other sources. (auth)

Moreira, L. and C. Lalou. 1972. Experimental Study of the Ration $^{234}U/^{238}U$ in Natural Waters Having Passed Through Different Types of Rocks. An. Acad. Brasil. Cienc. 44:13-18 (in French).

Alpha spectrometry measurements of the ratio $^{234}U/^{238}U$ and of uranium-238 content were made in water samples prepared by percolating through various kinds of rocks. Uranium content in the same rocks was measured by gamma spectrometry. The uranium-238 content found in water samples seems to be a function of the soluble uranium content in the rock, and for this reason, of its state of weathering. The $^{234}U/^{238}U$ ratio in the water samples after percolation is in general greater than one, which proves the greater solubility of uranium-234 in nature. A greater radioactive disequilibrium was found in water samples after percolating igneous rocks than after percolating sedimentary rocks. (auth)

Morgan, A. and D. G. Stanbury. 1961. The Contamination of Rivers with Fission Products from Fallout. Health Physics. 5:101-7.

The concentrations of some fission products in rain water falling on the catchment areas of three Thames tributaries are compared with the concentrations in river water over monthly periods. The fission products selected were Sr^{89}, Sr^{90}, Cs^{137}, and Ce^{144}. A comparison of the concentrations in corresponding samples of rain and river water showed that natural decontamination factors were smallest for Sr^{90} and greatest for Ce^{144}. The Sr^{90} concentrations in river water appear to depend to some extent on the permeability of the subsoil in the catchment area, which suggests that surface run-off is an important source of contamination. The amount of Sr^{90} leaving each catchment area in the river is compared with the amount deposited. Normally less than 1% leaves, but in periods of heavy rain and high flow rates this may be considerably increased due to desorption from the soil and enhanced run-off. The effect on the Sr^{90} concentration in river water of increased testing of nuclear weapons and a reactor accident are discussed briefly. (auth)

Morgan, J. M., Jr. 1959. A Stream Survey in the Uranium Mining and Milling Area of the Colorado Plateau, Colorado and Gunnison Rivers. NYO-7831.

During June to August 1958, a stream survey was made of the Colorado-Gunnison River System in Colorado during a period of infrequent rainfall and near-minimum runoff. Approximately one hundred and seventy miles of the Colorado River and one hundred and thirty miles of the Gunnison River were investigated. Water samples were analyzed chemically, physically, and radiologically; aquatic organisms were identified and bacteriological samples taken. River bottom silt and mud samples as well as irrigation area soil samples were investigated radiologically. Three uranium ore reduction mills employing the solvent extraction process were located in the survey area. (auth)

Morisawa, S. 1973. Selection of a Site for the Ground Disposal of Radioactive Wastes. 4. Migration of Multiple Nuclides Under the Ground. Nippon Genshiryoku Gakkaishi. 15:503-508 (in Japanese).

The migration of single radionuclides disposed of underground has been studied extensively, and many results have been reported. The migration of multiple radionuclides under similar conditions, has, on the other hand, scarcely been studied, and yet it is very important for evaluating the safety of the ground disposal of radioactive wastes. A discussion is presented on two theories (that of frontal analysis proposed by Sillen & Inoue's theory) on the behavior of multiple nuclides. It is shown that frontal analysis is applicable theoretically to the estimation of the migration of multiple radionuclides, but that some difficulties are encountered in its practical use in the field. The difficulties are, for instance, the estimation of the quantities of soil on contact with underground water, and the effect of the diffusion of the nuclides in the underground water. Inoue's theory, on the other hand, well depicts the migration of multiple radionuclides under the ground, but the theory requires field observation of the ground water movement. (auth)

Morisawa, S. and Y. Ionoue. 1974. On the Selection of a Ground Disposal Site for Radioactive Wastes by Means of a Computer. Health Physics. 27: 447-457.

The feasibility of disposing of radioactive wastes in the ground, the optimal conditions for the site, and the evaluation of safety factors have been reported in previous papers. This paper discusses processes of selecting optimum locations for the disposal of radioactive wastes by means of a computer. A program for site selection is based on some reasonable assumptions and includes the data required to estimate the dose of radioactivity in the human body due to the disposed wastes of a nuclear facility along a coast. The calculations were made for a model nuclear facility that was chosen to show the general method of selecting a ground disposal site.

An optimum location for a ground disposal site is defined as a location with minimum internal dose caused by the disposed wastes. Four locations were selected using a computer, each location having a minimum internal dose based on the assumption of 0.1 Ci/yr leachate of Sr-90. The minimum internal dose for the four locations was estimated to be lower than 10^{-80} mrem/yr. The method of selecting optimum locations is reasonably promising for solving current problems of site selection for disposal.

A chart to compare the safety of sites by evaluating each with reference to eighteen environmental factors is included.

Mork, H. M. 1970. Redistribution of Plutonium in the Environs of the Nevada Test Site. UCLA 12-590.

Data are presented on redistribution of plutonium as indicated by changes in the concentrations of gummed papers, air filters, soil and animal samples collected in 1956 and 1958. The airborne concentrations were significantly higher in one area than they were two years previous.

The plutonium content of the soil ranged from less than one microgram to 2000 micrograms per square meter in the two areas studied. Some redistribution was occurring.

Plutonium was associated with the liver, the lungs, and the bone of animals in the study areas. The maximum values observed in 1958 were 0.16 and 57.5 disintegrations per minute per animal for the liver and the lungs, respectively, and 2.62 disintegrations per minute per gram of bone ash. (auth)

Morozov, V. I., E. N. Nevesskii, S. S. Petrusev, and Y. P. Fedorovskii. 1969. Radiometric and Spectrometric Analyses of Bottom Sediments on Board the Ship. Okeanologiya. 9:522-7 (in Russian).

The natural radioactivity of bottom sediments from some shelf areas of the Black Sea was measured with low-background radiometric and spectrometric devices. An interrelation between granulometric and material composition of sediments and their total radioactivity was found. Data were obtained on the total radioactivity and the amount of separate isotopes in the near-estuarine zones of some rivers; Kuban, Mzymta, Shakhe, Bryb, as well as in the vicinity of Gelendzhik and Karadag. For the Kuban near-estuarine area, some data are presented showing the predominant westward migration of silty material supplied by the river. (auth)

Morozova, N. G. 1966. Compilation of a Chart Showing the Contents of Natural Long-Life Radioactive Elements in Estonian Soils. Sb. Nauch. Tr. Est. Sel'.-Khoz. Akad. No. 49:165-81 (in Russian).

The Ra and Th contents were determined radiochemically in 87 of the most typical soils having different textures. Indexes of the contents of these elements in the soils, and charts showing [illegible] Ra and Th in the soils depended on the soil-forming rocks. The range of variation of the contents of these elements in Estonian soils was 3 orders from 10^{-12} (for peat soils) to 10^{-9}% (for soddy soils on shale eluvia) for Ra, and 2 orders from 1.3 x 10^{-5} (in peat soils) to 1.6 x 10^{-3}% (in soddy-alluvial soils) for Th. The maximum concentrations of radioactive elements was in the illuvial horizons of the studied soils. (CA)

Morris, D. A., W. E. Teasdale, et al. 1964. Hydrology of Subsurface Waste Disposal National Reactor Testing Station, Idaho. Ann. Prog. Rpt. 1963. IDO-22046.

Results of investigations of the NRTS geological area are presented. Special studies are reported concerning waste disposal. It was found that groundwater underlying NRTS is part of the larger ground-water body underlying the entire Snake River plain. NRTS is underlain by basalt and unconsolidated sediments. Study during 1963 was devoted to determining chemical or radiometric changes that occurred as ground water containing radioactive waste moved through the geologic environments underlying the NRTS area. Results of water level studies and test hole sample analyses are included. (NSA)

Mortensen, J. L. 1963. Complexing of Metals by Soil Organic Matter. Soil Sci. Soc. Am. Proc. 27:179-86.

Soil organic matter forms complexes with metals by ion-exchange, surface adsorption, chelation, and complex coagulation and peptization reactions. Little is known concerning the nature of the ligands in polymeric components of soil organic matter which chelate metals, but carboxyl, hydroxy, and amide groups are probably involved. A number of low molecular weight compounds capable of chelating metals have been isolated from soils.

Metallo-organic matter complexes must be identified and characterized before unequivocal evidence for their formation in soils can be obtained. (auth)

Mortensen, J. L. and E. C. Marcusiu. 1963. Fission Product-Soil Organic Matter Complexes: I. Strontium-90 (Yttrium-90) in Water Extracts and HCl Hydrolysates of Soil. Soil Sci. Soc. Am. Proc. 27:653-56.

Brookston silty clay loam was incubated with 40 μc, Sr^{90} (Y^{90}) for 60 days and extracted with hot water or hydrolyzed with 6N HCl. The supernatant liquid was centrifuged, concentrated, and subjected to electrodialysis, dialysis, gel filtration, and paper electrophoresis.

Some Sr^{90} (Y^{90}) and organic matter migrated to the anode compartment during electrodialysis suggesting the presence of low molecular weight, negatively charged Sr^{90} (Y^{90}) - organic matter complexes. Dialysis did not remove all of the Sr^{90} (Y^{90}) from the extracts.

Gel filtration separated the extracts into several organic matter containing components and showed that Sr^{90} (Y^{90}) was complexed or held on exchange sites by high molecular weight polymers. Presence of radioactivity in the components was correlated with the presence of polyuronides.

Phenols, α-amino acids and α-keto acids were separated from the 6N HCl hydrolysate by paper electrophoresis but no clear correlation between these components and radioactivity on the paper strips was obtained. (auth)

Mortensen, J. L., E. C. Marcusiu, and N. Holowaychuk. 1963. Strontium Exchange Characteristics of Soils from the Ogotoruk Creek Watershed in Alaska. Ohio J. Sci. 63:225-31.

Surface organic layers of 10 unclassified soils were investigated. They were air-dried and crushed to pass a 2 mm sieve. Six soils were classified as organic, the content being determined by dry combustion. Soil reaction (P^H) varied from 3.9 to 5.8 as shown by a glass electrode, using a soil-water ratio of 1 to 3. The cation exchange capacity was determined by chromatography. The exchange of barium and strontium ions for hydrogen ions was studied in 4 representative soils. Hydrogen ions were more readily replaced by strontium than by barium. It is apparent that the soils studied, especially those having high exchange capacity and base status, are capable of adsorbing considerable quantities of ^{90}Sr (^{90}Y). Leaching waters from the more acidic soils release strontium more readily into the drainage waters than in the case of less acid soils. The leaching of fallout Sr from acidic organic soils may occur in a relatively short period of time. Fission product ecology in soils of the area is apparently governed largely by pH and cation exchange. (NSA)

Morton, R. J. (ed.). 1965. Status Report No. 5 on Clinch River Study. ORNL-3721.

Radioactive contamination of the Clinch and Tennessee River systems from April 1962 to December 1963 is reviewed. Data are included on radionuclide and stable-chemical analyses of water samples, sources of release of radionuclides to the Clinch River, core sampling of bottom sediments, behavior of radionuclides in river sediments, distribution of radionuclides in sediments, surveys of bottom sediments for radioactivity in Clinch River sloughs and in the Tennessee River, radioactivity in dredged material removed from the Clinch River during channel improvement, sampling and analysis of river fish, use of specific activities in predicting the uptake of ^{90}Sr by fish, and the movement of fish in the vicinity of White Oak Creek. Data are also presented on hydrologic measurements and analyses, the cooperative program of the USGS, dispersion of radioactive materials in the Melton Hill Reservoir, dye-tracer studies, and safety evaluation studies. (NSA)

Mound Laboratory. 1972. Environmental Monitoring Report: January-June 1971. MLM-1830.

The average concentrations of polonium 210, plutonium 238 and tritium detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio, are presented for the first half of 1971. The average concentrations of these radioisotopes at the water sampling locations and the air sampling stations were well within the stringent standards adopted by the Atomic Energy Commission. The highest average concentrations of polonium, plutonium, and tritium detected in the air sampling areas during the first half of 1971 were 39, 48, and 60% lower, respectively, than those measured during 1970. The highest average concentrations of polonium, plutonium, and tritium measured at any of the water sampling locations during the first half of 1971 were 92, 75, and 89% lower, respectively, than those measured during 1970. The highest scrapings were approximately 2% of the most restrictive levels suggested by Kathren for urban areas. Soil core samples taken during the same period were considerably lower than those reported by Krey and Hardy in an independent Health and Safety Laboratory (HASL) study. (auth)

Mound Laboratory. 1972. Mound Laboratory Chemistry and Physics Progress Report: April-June 1971. MLM-1829, pp. 7-23.

One of the interesting discoveries in recent times is the heptavalent state of plutonium. If this newly discovered oxidation state can be stabilized in water solutions, many new procedures for processing plutonium and making plutonium compounds may become available. Present prospects for easy stabilization of heptavalent plutonium are not sanguine, however. (auth)

Mound Laboratory. 1972. Mound Laboratory Chemistry and Physics Progress Report: October-December 1971. MLM-1888, pp. 12-15.

Silver examines the effects plutonium hydrolysis on ionic plutonium equilibria. Because the second and third hydrolysis reactions are poorly defined, a qualitative idea of effects was obtained from an examination of the first hydrolysis reaction effects on ionic equilibria. Data are given for the distribution of soluble plutonium oxidation states in a water similar to seawater (pH = 8, E = +0.43V).

Mound Laboratory. 1972. Mound Laboratory Chemistry and Physics Progress Report: January-March 1972. MLM-1903, pp. 18-21.

A method of determining the conditions necessary to attain a Pu "quadruple point" [Pu(III) = Pu(IV) = Pu(V) = Pu(VI)] is given by Silver. Applications of the four oxidation states of Pu, or the "general plutonium equilibrium problem," to the study of plutonium in environmental waters was suggested. An example of alpha coefficients for Pu in winter, autumn, and summer in soils of differing organic material content is given.

Mound Laboratory. 1973. Mound Laboratory Isotopic Power Fuels Programs: April-June 1973. MLM-2080, pp. 40-55.

The plutonium triple point at pH 1.06, where concentrations of Pu(IV), Pu(V) and Pu(VI) should be equal, was discussed in terms of required solution acidity, average oxidation number of ionic species, degree of complexation of the ions, degree of hydrolysis and ionic strength. The rapid computation of valence state distributions of Am, U, Np and Pu were outlined by a new method of computation by Silver.

Moxham, R. M. 1964. Radioelement Dispersion in a Sedimentary Environment and Its Effect on Uranium Exploration. Econ. Geol. 59:309-21.

The radioelement content of the major part of the southeast Texas Coastal Plain sedimentary sequence falls within a range common for sandstones and shales. Exceptions to the normal limit are mainly in small, widely scattered areas. One anomalous area, however, covers several tens of square miles and contains most of the important uranium deposits. Both mechanical and chemical dispersion of radioelements takes place in the immediate vicinity of the ore deposits, though no attempt was made to extend this local dispersion model to the large, regional gamma radiation anomaly. It is suggested that the point-source concept for sedimentary uranium deposits is unrealistic and that conventional aeroradiometric survey grid spacing can be substantially enlarged without seriously reducing efficiency in uranium exploration. (auth)

Mullen, A. A., S. R. Lloyd, and R. E. Mosley. 1975. Distribution of Ingested Transuranium Nuclides in Chickens and Subsequent Transport to Eggs. IAEA-SM-199/68.

The soluble citrate complexes of plutonium-238 and americium-241 were orally administered to two groups of white Leghorn laying hens daily for 2 weeks. The relatively insoluble plutonium-238 oxide was administered as a suspension in the same manner to a third group of laying hens. The yolks, whites and shells from the eggs were analyzed for their respective nuclide content. Yolk was the only egg fraction in which radioactivity was observed regardless of the nuclide administered. The activity per yolk tended to plateau after 6 days of dosing with the oxide form of plutonium and after 11 days of dosing with the plutonium citrate. The biological half-time for yolks in eggs laid after the peak concentration was reached was 4.36 ± 0.53 d following the plutonium-238 oxide doses and 1.85 ± 0.48 d followed by a second component greater than 25 d for transfer of the plutonium-238 citrate doses. The americium-241 activity in yolks reached a maximum on the 14th day of dosing. The biological half-times of 2.00 ± 0.18 d and greater than 33 d were indicated by the average concentration values of americium-241 in yolks laid after the maximum activity was reached.

The hens were serially sacrificed at 1, 10, and 20 days after the final administration of americium-241 and 12 and 30 days after the final administration of plutonium-238. Tissue samples were collected and the amount of the respective transuranics determined in the edible portions and feathers of the hens. Results indicate that little plutonium-238 was concentrated in the tissues of hens receiving either form. Americium was detected in most tissues at early times with the main concentration in the liver and skeleton. The highest concentration per organ, 3.03×10^{-3}% of dose, occurred in the liver of hens sacrificed 10 days after final administration of americium-241. (auth)

Mun, A. I. and Z. A. Bazilevich. 1964. Some Characteristics of the Distribution of Iodine in Lake Muds. Geokhimiya. No. 5:468-476.

The abundance and distribution of iodine in lacustrine muds and pore solutions was determined in 7 fresh and salt lakes in central Kazakhstan. Iodine accumulates in the muds of fresh and salt lakes, and especially in the pore solutions of bottom muds regardless of the salinity of the lakes. The concentration of iodine increases with depth below the surface of the muds, possibly as the result of anaerobic decomposition of iodine-bearing organic matter. The content of water-soluble iodine always decreases with depth in the mud. Both fresh and salt lakes are much richer in iodine than sea water, but the iodine content of lacustrine sediments is not necessarily distinguishable from that of marine sediments because the organisms in lakes may concentrate less iodine than marine organisms, and there is a direct correlation between content of organic carbon and iodine content. (auth)

Murray, C. N. and H. Kaursky. 1975. Plutonium and Americium Values in the North Sea and German Coastal Regions. IAEA-SM-199/26.

The North Sea is probably a unique sea region in that the distribution of artificial radionuclides is influenced by the discharge of activity from three nuclear fuel reprocessing plants, those situated at La Hague in Northern France, Windscale in the north west of England and Dounraey in Northern Scotland, as well as from fallout from nuclear weapon testing. Data is presented on the distribution of $^{239+240}Pu$, ^{238}Pu, and ^{241}Am in seawater samples taken from the German Bight and German Baltic coastlines as well as from other parts of the North Sea up to latitude 60°N.

Results from the Pentland Firth in the north of Pentland and the English Channel show $^{239+240}Pu$ activities in seawater between 5-15 times higher than North Atlantic fallout levels. The ratio $^{238}Pu/^{239+240}Pu$ is significantly higher in the Pentland Firth area (0.21 ± 0.01) than in the Channel (0.15 ± 0.02) and this difference may well be a reflection of different input sources of plutonium in these waters. German coastal seawater and sediment plutonium activities appear to be due only to fallout, the isotope ratio being about 0.06 ± 0.02, a value in good agreement with accepted North Atlantic values. (auth)

Murray, C. N. and L. Murray. 1973. Adsorption-Desorption Equilibria of Some Radionuclides in Sediment-Freshwater and Sediment Seawater Systems. <u>IN</u>: Radioactive Contamination of the Marine Environment. IAEA-SM-158/7, pp. 105-124.

Knowledge of the behavior of radionuclides in estuarine environments is required in the understanding of their regulation in coastal areas. Experiments carried out to investigate the uptake of certain radionuclides on freshwater sediments in river water (adsorption) and their subsequent release from the sediments to the seawater (desorption) are described. For the radionuclides studied, ^{60m}Co, ^{65}Zn, ^{110m}Ag, their behavior was very individual. Laboratory results suggest that certain factors strongly affect the adsorption-desorption characteristics of the sediment. The influence of important factors such as the pH of the river, estuary, and seawater, the concentration of sediment and trace element in the river water, the speciation of the trace element, the mineralogy of sediment, the formation of particulate material in the river water and floculation of this by sediment in the estuary and sea, and salinity effects on desorption, are discussed. From a knowledge of these factors, it is possible to predict, as a first approximation, for a given sediment the amount of radionuclide that will be taken up by a given weight of freshwater sediment in a very simple system under equilibrium conditions. When this sediment reaches the marine environment the amount of desorbed radionuclide can be calculated. An example of a predictive calculation for adsorption-desorption of Vat river sediment is given for conditions of pH, sediment load, and tracer concentration that are typically found in this system. (auth)

Murray, E. G. and J. A. S. Adams. 1958. Thorium, Uranium, and Potassium in Some Sandstones. Geochim. et Cosmochim. Acta. 13:260-9.

Nineteen sandstones and sands, including orthoquartzites and placer sands and containing both common and extreme Th/U ratios, were examined by γ-ray spectrometry (cf. C.A. 52, 11658c), fluorimetric U analysis (C.A. 49, 2251f), and α-counting. U determinations on the shell fractions of the Galveston Island sands showed them to have the same U content as the original samples. The Th and U in many common orthoquartzites are contained almost entirely in the quartz grains. The orthoquartzites have an average and nearly uniform concentration of 0.64 ± 0.04% K, 1.7 ± 0.1 ppm Th, 0.45 ± 0.005 ppm U, giving an average Th/U ratio of 3.8 ± 0.8. This ratio may represent an independent determination of the average crystal Th/U ratio. It must be concluded that the mean Th content of sandstones can only be estimated as 2-24 ppm. The heavy detrital minerals, zircon and monazite, do not affect concentration ratios except where concentrated in placer sands, when they contain most of the Th and U. The modern beach sands studied were in radioactive equilibrium. The data indicate that in many sedimentary basins the near-shore sands are depleted in Th and U relative to deeper-water shales. (CA)

Murthy, V. R. and E. Beiser. 1968. Strontium Isotopes in Ocean Water and Marine Sediments. Geochim. et Cosmochim. Acta. 32:1121-6.

The isotopic composition of Sr in the major oceans of the world is uniform at the present time; the average $^{87}Sr/^{86}Sr$ ratio is 0.7094 ± 0.0012 at the 95% confidence level. The clay fractions of the equatorial

Atlantic deep sea sediments contain Sr of variable composition, not in isotopic equilibrium with ocean water. The Sr composition in the sediments is related to provenance and clay mineralogy. (auth)

Myers, D. S., W. J. Silver, D. G. Coles, K. C. Lamson, D. R. McIntyre and B. Mendoza. 1975. Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops. IAEA-SM-199/42.

During the three-week period from 25 May to 16 June 1967, approximately 32 mCi of ^{239}Pu was inadvertently released from Lawrence Livermore Laboratory into the sanitary sewer system. It was concluded at the time from an investigation conducted by LLL in cooperation with ERDA-SAN and the California Department of Public Health that the release did not present a hazard to treatment plant personnel or the community.

The quantity of ^{239}Pu released was determined from the analysis of the samples collected by the Laboratory's sewage sampling system. This system collects a sample which is proportional in volume to the rate of flow in the sewer.

Analysis of the liquid collected by the Laboratory's sewage sampling system indicated that the maximum daily average concentration of the release did not exceed 2.1×10^{-6} μCi/ml. It is not known whether the chemical form of the ^{239}Pu was soluble or insoluble. The MPC for soluble ^{239}Pu, which is more restrictive than for insoluble ^{239}Pu, is 1×10^{-4} μCi/ml.

Immediately following the release, a detailed sampling program was begun at the Livermore sewage treatment plant. The results of this sampling program confirmed that approximately 30 mCi of ^{239}Pu had been released and that the ^{239}Pu was essentially all contained in the digested sludge at the sewage treatment plant. This digested sludge is accumulated in holding lagoons and transferred to drying beds each year during the summer. Sludge taken from the drying beds in recent years has a ^{239}Pu contamination level of about 2.3×10^{-6} μCi/g (dry weight).

Large quantities of the digested sludge from the Livermore sewage treatment plant are used by municipal agencies as a soil conditioner in parks and in landscaping around public buildings. The dried digested sludge is also available without cost to the general public, and is commonly used as a soil conditioner for home lawns and gardens.

In view of this widespread use of the sludge as a soil conditioner, a more recent evaluation was made to confirm the original assessment of the possible adverse implications associated with the use of the sludge. Two potentially significant uptake pathways were studied: (1) the resuspension and inhalation of the ^{239}Pu when the sludge is being used as a soil conditioner, and (2) uptake of the ^{239}Pu by plants grown in the sludge and its subsequent ingestion by people eating the crops. This paper presents the results of these two investigations. (auth)

Mysen, B. O. and M. G. Seitz. 1974. Trace Element Partitioning Determined by Beta Track Mapping: An Experimental Study Using Carbon and Samarium as Examples. J. Geophys. Res. 80:2627-2635.

A technique for experimental determination of concentrations and distribution of trace elements is described. The technique employs nuclear emulsions to register β particles from spontaneous decay of a radioactive isotope. At least 58 elements in the periodic system can be studied experimentally in this way. A detailed description of the technique using carbon 14 and samarium 151 as examples in $\leq$10-mg experimental charges is provided. An assessment of analytical uncertainties and tabulations of corrections for 21 common minerals are also presented. It is shown that an accuracy of better than 5% can be attained for element concentrations less than 1 ppb. The data from carbon 14 and samarium 151 are used in calculation of sensitivities and consideration of analytical problems for 21 commonly used trace elements. (auth)

Myttenaere, C. and U. Marckwordt. 1971. Influence of Water Regime on the Indirect Absorption of Radiocesium, Radiostrontium, and Radiocobalt by Lowland Rice. CONF-710501-P1, pp. 212-217.

Rice soils retain a high percentage of radionuclides transported by irrigation water. The accumulated radioactivity can partly be released to the roots of lowland rice. In order to establish the influence of water regime on the indirect radiocontamination of rice, the availability in soils and the absorption by plants of ^{134}Cs, ^{85}Sr, and ^{60}Co were studied during three successive years (1967, 1968, 1969), using the same variety in flooded and nonflooded conditions. The experimental conditions of the rice culture in lysimeters were checked with data collected in an irrigated rice field. Radiostrontium and radiocesium absorption by plants was not greatly influenced by the different water regimes. Radiocobalt level of plants was found to be considerably higher in flooded rice and thus reflected the increased availability of Co in flooded soils. Concentration factors varied with the radionuclide and the plant organ. The variations in specific activity of radioisotopes in the plant underline a different behavior of the radioactive and stable isotope in the soil. In conclusion, under our experimental conditions, only cations, the solubility of which depends directly on the redox state of the soil, were more available and were taken up by the rice plants. (auth)

Nace, R. L., P. T. Voegeli, J. R. Jones, and M. Deutsch. 1975. Generalized Geologic Framework of the National Reactor Testing Station, Idaho. U.S.G.S. Professinal Paper 725-B.

The Geologic framework of the NRTS (National Reactor Testing Station), Idaho, controls the amount and availability of the water supply, the methods and efficiency of obtaining water, and the behavior of waste materials that are disposed of on the ground and beneath the land surface. This framework also affects the selection of construction sites and the operation of reactors and other facilities.

The NRTS is at the central-northern edge of the semiarid Snake River Plain in southern Idaho, adjacent to the southern foothills of the Lemhi and Lost River Ranges. The plain was formed during the Cenozoic Era. It was formed by large scale crustal deformation in southern Idaho and by several associated episodes of volcanic activity.

The Snake River Plain commonly has been characterized as a great structural downwarp, modified by a complex system of block faulting. Actually, the plain is essentially a graben, downfaulted between horst blocks represented by mountains to the north and south. The depth through Cenozoic volcanic rocks and sediments to the basement floor is not known, but it has been estimated to range from 2,000 to 20,000 feet in the central part of the plain.

Rock units of sedimentary and igneous origin, Palezoic and Cenozoic in age, crop out in the station area. No rock units of Mesozoic age are represented in outcrop. The known geologic materials underlying the station are volcanic rocks interbedded with alluvial sediments of Pleistocene and Holocene age. These in turn are underlain by basement rocks which are probably composed of an older sequence of igneous and sedimentary rocks.

The oldest rocks exposed on the NRTS are Paleozoic in age and consist chiefly of dark-gray to gray sandy limestone with chert nodules. Small amounts of siltstone, sandstone, and conglomerate may be present.

Volcanic rocks of Tertiary age crop out at the station and range in composition from basic to silicic. These volcanic rocks consist chiefly of welded rhyolitic tuff and silicic to basic flow rocks. Locally, beds of white to light-gray compact volcanic ash rest uncomformably on Paleozoic limestone. Basalt of Tertiary age is relatively rare.

Basalt of the Snake River Group of Quaternary age is exposed in about three-fourths of the station area. The basalt, typically gray to black, bluish-black, brown and brick red, ranges from dense to porous and highly vesicular. It occurs in relatively thin interlocking flows; most of the flows are the relatively smooth ropy type (pahoehoe) but a few flows are blocky basalt (aa). Beds of cinders, scoria, and basaltic glass occur locally. Although basalt is the chief rock type of the Snake River Group, the unit also includes interflow beds of windblown, lacustrine, and alluvial sediments. A younger black basalt of Holocene age which consists of a single flow occurs locally in the station and seems to be lithologically similar to flows in the craters of the Moon National Monument.

Petrographic study, megascopic examination, and chemical analyses of 14 representative specimens of these basalts indicate that in color, fabric, density, and other megascopic properties the basalt is diverse, but in mineral and chemical composition it is remarkably uniform.

Basalt flows have individual and internal structures which consist of layering, partings, joints and other fractures, and also various types of natural voids. These structures strongly affect their capacity to store and transmit water and determine their suitability for structural foundations.

Unconsolidated sediments of Quaternary age cover large areas of the station and also are present as interflow beds in the Snake River Group. Unconsolidated materials, chiefly of Holocene age, consist largely of windblown deposits, playa deposits, slopewash, alluvium of Big Lost River and Birch Creek, alluvial fan deposits, and lake beds and associated beach and bar deposits. Some older unconsolidated deposits of undifferentiated origin are of Pleistocene age. At many places in the station the various types of unconsolidated deposits are intermixed, interfingered, and interbedded so that it is difficult to classify them into separate mappable units. This report contains information on particle-size composition, chemical composition, and mineral composition of selected samples of these sediments.

Special geologic factors of the earth materials were studied in relation to movement of fluids in the physical environment of the station. These included ion-exchange capacity of sediments and basalts, and the origin, distribution, and physical characteristics of large desiccation cracks in fine-grained sediments.

Study of the subsurface geology of the NRTS was limited to rock units about which direct evidence was available from test drilling and other subsurface exploration techniques, including electrical-resistivity and seismic surveying and radioactivity logging of wells. Rock units present include basalt of the Snake River Group, alluvium of Big Lost River and Birch Creek, Terreton Lake beds, and interflow sediments.

Detailed factors of the geologic framework that would directly influence site selection, engineering design and construction, and operation of reactors were studied chiefly at specific localities on the station. These factors included the behavior of earth materials during drilling, the availability of raw materials for construction, and the stability of earth materials in excavations—under stress and under a range in moisture conditions.

The Snake River Plain, including the NRTS, is subject to occasional seismic tremors; the oldest recorded shock occurred in 1884. Sixteen earthquakes in Idaho with an epicenter rating of V or more on the Rossi-Forel scale were recorded during the period 1894-1945. Epicenters of these quakes were more than 100 miles distant from the station.

Relatively recent volcanism has occurred in Craters of the Moon National Monument and in at least one place adjacent to the south western part of the NRTS. Recent activity has occurred at several other places on the Snake River Plain, such as at Hells Half Acre to the east. There is no assurance that cessation of volcanic activity in the plain is permanent. However, inasmuch as inactivity has endured for at least 100 years—longer than is ordinary for areas of active volcanism—renewal of activity seems unlikely. (auth)

Naeser, C. R. 1962. Geochemical Studies Pertaining to Ground Studies of Radioactive Wastes. TID-7628, p. 237-47.

Results are reported from geochemical studies pertaining to waste disposal. Both empirical and fundamental approaches to the problem were considered. The behavior of vermiculite, glauconite, crandallite, and anhydrite as scavengers for radio-cesium and/or radio-strontium and the effectiveness of the scavenging process as a function of the pH were investigated. (NSA)

Naeser, C. R. 1961. Ion Exchange Research by the U.S. Geological Survey. TID-7621, p. 117-19.

Studies of radioactive wastes are described in which natural materials are used to remove Cs^{137} and Sr^{90}. Fundamental studies on the nature of clay minerals are also discussed. Vermiculite was studied as a possible Cs^{137} scavenger, and crandallite ($CaAl_3(PO_4)_2 \cdot H_2O$) was studied as a potential Sr^{90} scavenger. Clay studies were devoted to determining if various kinds of exchange sites exist in these materials, and their differences if they do exist. (NSA)

Nagaya, Y. and M. Saiki. 1967. Accumulation of Radionuclides in Coastal Sediment of Japan. I. Fallout Radionuclides in Some Coastal Sediments in 1964-1965. J. Radiat. Res. 8:37-43.

Nineteen samples of sediment collected from Tokyo Bay and coastal water along Fukushima Prefecture were analyzed radiochemically. The HCl-extraction efficiencies of radionuclides in sediment were examined. Recoveries of more than 80% were obtained for ^{144}Ce, ^{106}Ru, and ^{137}Cs in fine mud collected in Tokyo Bay. The "shaver type" sampling device was designed to collect a large amount of sediment of the surface layer of 2 cm thickness. ^{90}Sr, ^{137}Cs, and ^{144}Ce concentrations in fine mud were remarkably higher than those in sandy mud or sand. It was clearly observed that ratios of $^{144}Ce/^{90}Sr$ and $^{137}Cs/^{90}Sr$ in coastal sediments were substantially higher than those in sea water. ^{144}Ce and ^{137}Cs were found to be accumulated more effectively in the surface mud on the bottom of the sea, in comparison with ^{90}Sr. (auth)

Nagayama, S , M. Nagasawa, T. Teraguchi, and S. Matsumoto. 1973. Radioecological Study of Strontium-90 in Osaka District Japan. Bull. Univ. Osaka Prefect., Ser. A.21:331-338.

Studies were undertaken to clarify the monthly depositions and vertical distributions of ^{90}Sr in soils and runoff of ^{90}Sr by river to sea. In Osaka Prefecture, monthly depositions of ^{90}Sr were determined during 1963 to 1970. From 1958 to 1968, annual variations of ^{90}Sr concentration in the waters of the Yodogawa and Yamatogawa Rivers were shown, and the maximum value (1.5 μμc/l) of ^{90}Sr concentrations in waters was found in 1963. From 1963 to 1968, 74 to 79% of total ^{90}Sr in undisturbed soils was included in depth 0 to 6 cm. ^{90}Sr concentration in river water is given by $C = 0.5 R + 0.01 D$, where C is ^{90}Sr concentration (μμc/l) in river water, R is the amount of ^{90}Sr deposition (mCi/km^2) during three months before sampling of water, and D is that of cumulative ground deposit (mCi/km^2) of ^{90}Sr before sampling of water. (NSA)

Naidu, A. S. and D. W. Hood. 1971. Chemical Composition of Bottom Sediments of the Beaufort Sea, Arctic Ocean. RLO-2229-T-1-11.

Several major (Fe, Mn, K, Na, Mg, and Ca) and minor (Rb, Li, Zn, Ni, Co, Cu, and U) elements, organic carbon, and carbonate were analyzed from surface sediments of the Beaufort Sea floor. Compared to the low-latitude deep-sea sediments there was a deficit of all elements except U and lower Mn/Fe, Na/K, and Ca/Mg ratios in the polar sediments presently analyzed. The reason for the relative paucity of these elements in Beaufort Sea sediments is not well understood. This could be due to limited influxes of chemogenous and biogenous components and lower intake of exchangeable ions. Such effects might be related to retarded chemical activity at near freezing temperatures of Arctic waters, and possibly, to lower yearly primary productivity. Chemically, the Arctic sediments analyzed were similar to Antarctic sediments (Angino, 1966). This suggests that glacial-marine sediments have a distinct chemical character and that geochemical criteria have potential use in the recognition of glacial marine paleosediments. Sediments of the shelf (<64 m) were distinguishable from those of the extra-shelf (slope and basin) in being relatively enriched in carbonate and Zn, and having lower Na/K ratio and organic carbon. There was a marked increase in Mn in the abyssal basin sediments. Sediment organic carbon correlated with clay percent, whereas carbonate content correlated with the amounts of coarse calcareous lithogenous and bioclastic components. Elemental geochemistry is discussed, taking into consideration the granulometric and clay mineralogic compositions of the sediments and the interelement associations. (auth)

Nakamura, K. and Y. Nagaya. 1975. Accumulation of Radionuclides in Coastal Sediment of Japan, (2). Contents of Fission Products in Some Coastal Sediments Collected in 1966-1972. J. Radiat. Res. 16:184-192.

The concentrations of fission products ^{90}Sr, ^{137}Cs and ^{144}Ce in the marine sediment of Tokyo Bay and of the coastal seas of Ibaraki, Fukushima, and Fukui prefectures were determined during 1966 to 1972. The radioactivity ranged 0 to 23.3 pCi/kg-dry for ^{90}Sr, 5.3 to 220 pCi/kg-dry for ^{137}Cs and 0 to 12.700 pCi/kg-dry for ^{144}Ce. Generally speaking, the ^{90}Sr level is one order of magnitude lower than that of ^{137}Cs, and ^{144}Ce concentration is higher than that of ^{90}Sr by almost two orders of magnitude. The degree of the radionuclide enrichment in the sediment from sea water is tens for ^{90}Sr, 10^2 for ^{137}Cs and apparently 10^4 for ^{144}Ce, respectively. The wide variation is observed in the horizontal distribution of ^{144}Ce concentration in the sediment of the areas, but the ^{137}Cs concentration shows fairly small horizontal fluctuation. (auth)

Nakayama, F. S. and R. D. Jackson. 1963. Diffusion of Tritiated Water in Soils. Soil Sci. Soc. Am. Proc. 27:255-8.

The apparent diffusion coefficient of tritiated water (D_{THO}) was measured in four soil materials and two sizes of glass beads at about 40% water content by volume, and in agar gel. The apparent tritiated water diffusion coefficient may include diffusion in the liquid, vapor, and possibly adsorbed phases. For Pachappa loam, D_{THO} was determined in detail as a function of water content. The D_{THO} was nearly constant for volumetric water contents of 10 to 40%. As the water content decreased below 10%, the D_{THO} rapidly increased to a maximum at about 4% water content, then rapidly decreased as the water content was further reduced. The maximum value of D_{THO} is 3.5 times greater than D_{THO} at 40% water content. (auth)

Nambiar, E. K. S. 1976. The Uptake of Zinc-65 by Oats in Relation to Soil Water Content and Root Growth. Aust. J. Soil Res. 14:67-74.

Effects of water content of the topsoil on root growth and ^{65}Zn absorption by oats were measured. Seminal roots of oats grew through a labelled uptake layer that had been initially wetted to various water contents. The uptake layer was separated from adjacent layers of wet sand or soil by a thin layer of wax. When the uptake layer was wetted initially and allowed to dry during the uptake period, water content affected root growth and ^{65}Zn uptake similarly. ^{65}Zn absorption by unbranched seminal roots decreased linearly as soil water suction increased from 0.3 to 5 bar. Nevertheless significant amounts of ^{65}Zn were absorbed (40% of that from wet soil) even when the soil water suction exceeded 15 bar, with negligible concomitant uptake of water. Provided the roots had access to water in a subjacent layer, rates of ^{65}Zn absorption from dry soil increased with the age of plants. The exudation of mucilage from the root was enhanced locally where the soil was dry. The mucilage may facilitate the transfer of zinc to the root in dry soil. (auth)

Napravnik, J. and F. Kepak. 1965. The Sorption of Fission Products on the Suspension of the Natural Sorbents Coagulated in an Electric Field. UJV-1296/65.

Results are reported of the laboratory and pilot plant experiments of the sorption of fission products on the suspension of natural aluminosilicates coagulated in an electric field. This method proved to be very suitable for natural sorbents, because no losses of their sorption capacity occurred in contradiction with the chemical coagulation. The influence of the nature of electrodes, current density, temperature, and of pH on the electrocoagulation was determined. The influence of the mode of the coagulation on the sorption properties of used sorbents was investigated. Attention was also paid to the sedimentation time and to the volume of the resulting sludge. (auth)

Nascimben, P. 1970. Distribution of Uranium in Some Italian Deposits of Lignite. Ind. Mineraria. 21:1-27 (in Italian).

A survey was conducted on some Italian lignite deposits in order to determine the uranium content and distribution. To this purpose, geological and radiometric field surveys were supplemented by 548 laboratory analyses for U_3O_8 in lignite ashes. By means of these analyses, the content of U_3O_8 dealing with lignite samples was determined. It was found that about 12,000 tons of U_3O_8 are contained in the lignites of some important deposits. About 90% of this potential is located in the Sulcis area (Sardinia), where the U_3O_8 content (in lignites and in ashes) is substantially higher than that found in the other major lignite deposits. Because of the low U_3O_8 content found in the examined samples, none of the Italian lignite deposits can be regarded as uranium-bearing formations. Furthermore, at the present state of technological progress, uranium extraction from the ashes, as by-product of lignite burning, is not feasible, because of the high cost of chemical processing and the limited quantities of ashes available for treatment. By means of statistical analyses of the analytical data and geological surveys of the deposits it was possible, moreover, to determine which type of lignite is the most favorable for uranium as well as to advance hypotheses on source and accumulation to explain the occurrence for uranium in Italian lignite deposits. (NSA)

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National Academy of Science. 1975. Assessing Potential Ocean Pollutants. National Research Council. 3:27-63.

On balance, our findings indicate an insufficiency of information regarding the chemical and biological behavior of the transuranics in the marine environment. Without such information meaningful quantitative assessment of either current or future impacts is not possible. We cannot dismiss the possibility that marine concentrations of one or more transuranics may approach levels of concern through naturally-acting mechanisms which we do not understand. Present evidence indicates that transuranic elements introduced to marine waters are rapidly transferred to the sediments. If this holds true, then any input from waste treatment or reprocessing will mainly affect the coastal zone near the point of introduction. These sources would, then, not be expected to contribute significantly to open ocean pollution which would be largely due to fallout from atmospheric releases. Predictions of the effect of transuranic elements on the marine environment cannot be formulated until more extensive knowledge of their modes of transport and their biogeochemical and radiobiological behavior is available. On this basis, we recommend conservative approaches to any releases of transuranic elements to the environment. This applies to planning against accidental releases as well as to any planned releases. Both should be kept to an absolute minimum. Recommendations are discussed in Chapter 1. (auth)

National Research Council. 1957. The Disposal of Radioactive Waste on Land. Pub. No. 519. NP-6503.

A committee of geologists and geophysicists was established by the National Academy of Sciences-National Research Council at the request of the Atomic Energy Commission to consider the possibilities of disposing of high level radioactive wastes in quantity within the continental limits of the United States. The group was charged with assembling the existing geologic information pertinent to disposal, delineating the unanswered problems associated with the disposal schemes proposed, and point out areas of research and development meriting first attention; the committee is to serve as continuing adviser on the geological and geophysical aspects of disposal and the research and development program. Two years' consideration of the disposal problems leads to certain general conclusions. Wastes may be disposed of safely at many sites in the United States but, conversely, there are many large areas in which it is unlikely that disposal sites can be found, for example, the Atlantic Seaboard. The research to ascertain feasibility of disposal has for the most part not yet been done. Disposal in cavities mined in salt beds and domes is suggested as the possibility promising the most practical immediate solution of the problem. Disposal could be greatly simplified if the waste could be gotten into solid form of relatively insoluble character. In the future the injection of large volumes of dilute liquid waste into porous rock strata at depths in excess of 5,000 feet may become feasible but means of rendering the waste so solutions compatible with the mineral and fluid components of the rock must first be developed. The main difficulties to the injection method recognized at present are to prevent clogging of pore space as the solutions are pumped into the rock and the prediction or control of the rate and direction of movement. (auth)

Naumov, G. B. 1961. Some Physico-Chemical Peculiarities of Uranium Behavior in Hydrothermal Solutions. Geokhimiya. No. 2:115-32 (in Russian).

The most typical components of uranium-containing hydrotherms are carbon dioxide, silicic acid, fluorine, and sulphur; the most typical cations are alkaline metals. A study of uranium behavior showed transport in the form of complicated complex ions, among which the carbonate and the fluoride ions are the most probable. The processes of complex formation provide a reliable transport of hexavalent uranium under conditions where UO_2^{2+} is reduced to UO_2. On the basis of an analysis of the behavior of complex uranium ions; the principle causes of nasturan deposition were traced. (auth)

Neller, J. R. and C. L. Comar. 1947. Factors Affecting Fixation of Phosphorus in Soils as Determined with Radioactive Phosphorus. Soil Science. 64:379-387.

Nine different soil samples were extracted with a sodium acetate — acetic acid solution, after being previously treated with KH_2PO_4 plus P^{32} as Na_2HPO_4. The amount of P retained was not affected by the method of drying. Soils treated with soluble P, dried, and extracted showed greater P fixation than when the phosphate was added in the extracting solution. The amount of P retained by soils after treatment with a sodium acetate — acetic acid solution containing 50 ppm of P was related to their clay content. (auth)

Nelson, D. J., R. L. Herman, et al. 1961. Clinch River Studies. ORNL-3189, p. 129-39.

Bottom organisms are being used to determine both the fate and radiation effects of radionuclides released to the Clinch River. A model using parameters obtained from laboratory experimentation and field observation showed that the feeding activities of tubificid worms did not contribute significantly to the downstream movement of radioactive river bottom sediments. The bottom-dwelling organisms in the Clinch River received an average dose which is 20 times that from naturally occurring radiation and in White Oak Creek the dose is about 1000 times background. Chironomus tentans Fabr. (midge) is a dipteran species with larval stages living in bottom muds. The use of sensitive cytogenetic techniques and analysis of the salivary gland chromosomes of this species showed a high frequency of chromosomal aberrations, including a number of individuals with three chromosomes instead of the usual four. About 40% of the Co^{60} taken up by crayfish was by adsorption on the exoskeleton and the uptake was directly proportional to the concentration in the environment. The rate of Co^{60} uptake was more rapid for hard-shelled individuals and large individuals. The excretion of Co^{60} was more rapid for small specimens and for those which were tagged by injection rather than in a radioactive solution. In the latter instance there was little or no Co^{60} associated with the exoskeleton from which loss of Co^{60} was slow. Radioassay of crayfish showed that the highest concentration of Co^{60} g^{-1} was in the exoskeleton. The hepatopancreas contained 86%, gut 49%, muscle, gonad, and blood each 0.14% as much Co^{60} as did the exoskeleton. A study of the strontium and calcium in the shells of Tennessee River clams showed that the calcium content was constant and constituted 40% of the shell. The strontium content was proportional to the growth rate of the clam's shell and varied from 150 to 500 ppm. The laboratory releases of Sr^{90} were considered as a tracer and the Sr^{90}-stable strontium atom ratios in clam shells downstream from White Oak Creek could be explained solely on the basis of the dilution of Sr^{90}-contaminated Clinch River water by noncontaminated Tennessee River water. This showed that Sr^{90} released to a surface water stream moves downstream in solution and there is little or no ionic exchange between the strontium in solution and that in the bottom sediments. Tagging fish with numbered tags showed that the white crappie tends to remain in the vicinity of initial capture. This species was selected for a study of fission-product element metabolism. During five months of tagging in 1960 and 1961, 5245 fish were tagged, and there were 150 returns by fishermen and our own netting operations. The fishermen returns showed a movement by white bass from the Clinch River downstream into the Tennessee River portion of Watts Bar Reservoir. (auth)

Nelson, D. M., G. P. Romberg, and W. Prepejchal. 1971. Radionuclide Concentrations Near the Big Rock Point Nuclear Power Station. <u>IN</u>: Proc. of Fourteenth Conference on Great Lakes Research. Ann Arbor, MI, pp. 268-76.

During the summer and fall of 1970, the concentrations of gamma-ray emitting nuclides were determined in samples of water, sediments, and organisms collected near the Big Rock Point reactor (Charlevoix, Michigan). Reactor-produced ^{65}Zn, ^{137}Cs, ^{134}Cs, and ^{60}Co were measurable at distances of up to a few kilometers along the shore in crayfish, water snails, Potamogeton sp., Ranunculus sp., Chara sp., Cladophora sp. and periphyton.

In general, concentrations at 1 km are less than one-tenth those found in the same organism at the discharge point, with somewhat higher concentrations being found toward the east (into little Traverse Bay). Water and bottom samples were found to be quite variable, with concentrations in bottom sands being somewhat lower than the concentrations in organisms living at the same place. Several samples of small fish were also taken from the discharge channel. One meal per day of the most radioactive of these (bluegill) would contribute about 1% of the permissible daily ingestion of these four nuclides. (auth)

Nelson, J. L. 1959. Soil Column Studies with Radiostrontium. I. Effects of Temperature and of Species of Accompanying Ion. HW-62035.

Soil column diameter was found to have no effect on Sr^{2+} breakthrough curves where concentration of Sr^{2+} in effluent divided by concentration of Sr^{2+} in influent is plotted versus number of column volumes. The column volume is defined as the total space occupied by packed soil in the column. Soil column length, on the other hand, had a pronounced effect on the shape of the breakthrough curves. Breakthrough curves of long columns had a steeper slope than those of short columns and the curves cross near the $C/C_0 = 0.5$ point. This indicates that crib capacity predictions based on short laboratory columns are conservative from this standpoint. Attempts are being made to fit equations to the data that will accurately describe the changes in breakthrough curve slope with different column lengths. (auth)

Nelson, J. L. 1960. Soil Column Studies with Radiostrontium. II. Effects of Soil Column Length and Diameter. HW-63930.

Temperature can have a significant effect on the soil sorption of radionuclides. Species of accompanying ion determines the direction and amount of the effect. If the ion accompanying Sr^{2+} is Na^+, increased temperature improves Sr^{2+} sorption while if the accompanying ion is Mg^{2+} or Al^{3+}, the opposite is true. Where Ca^{2+} is the accompanying ion no measurable effect is seen. Where Cs^+ is the trace ion, elevated temperatures would always decrease soil sorption. At equal temperatures, Ca^{2+} and Al^{3+} are strong competitors for exchange sites while Na^+ is a weak one. About 20 times the crib capacity could be expected for neutralization of waste with caustic rather than with limestone. (auth)

Nelson, J. L. 1961. Recent Studies at Hanford on Soil and Mineral Reactions in Waste Disposal. TID-7621, p. 70-82.

A brief review of early Hanford work on equilibrium aspects of soil waste disposal is presented followed by a closer examination of recent laboratory soil studies. In the last two years, soil column and equilibrium studies were conducted to study all known variables involved in the reactions of fission products, especially Sr, with soils. A study of the effects of unsaturation on ion exchange, spreading, and tests with model cribs are also parts of the overall program. Discussions of Sr removal by reactions with calcite and Cs removal by reaction with Zeolites are also included along with graphically presented data. (NSA)

Nelson, J. L. 1963. Hanford Mineral Exchange Program. TID-7644, p. 83-114.

Waste processing by use of clinoptilolite and synthetic exchange materials is reviewed. Data and discussion are included on Cs removal from formaldehyde-treated waste (FTW) and flowsheets for Cs packaging for disposal. Data are also included on the effects of flow rate, temperature, and concentration on Cs breakthrough in clinoptilolite exchange. Information is also included on breakthrough of various ions on clinoptilolite, concentration of fission product tracers in FTW feed and waste, elution of Cs^{137} from clinoptilolite, and elution of Sr and Cs after heating of loaded exchangers. (NSA)

Nelson, J. L., L. L. Ames, Jr., et al. 1962. Chemical Effluents Technology. HW-73337, p. 158-237.

Equations for the prediction of ion exchange column breakthrough curves were modified to insure more consistent results for soil columns of different lengths. An exchange column of pebble phosphate was found to absorb Pu from slightly acidic wastes. The uptake of certain radioisotopes present in spent cooling water from reactors by selected minerals was determined at 80°C. Data are tabulated on the absorption of P^{32}, As^{76}, Np^{239}, Zn^{65}, and Cr^{51} by 25 minerals. Additional studies on P^{32} adsorption by 21 minerals and by mixed mineral beds were carried out. The efficiency of Al turnings for the decontamination of reactor effluent was investigated on pilot-scale beds. A scheme is described for overcoming the computational problem in field permeability measurements on soil. An approximate method is presented of computation for inplace permeability measurement and basic equations are presented to describe steady, partially saturated flow in porous media. Results are reported from recent studies on geologic features and ground water flow at the Hanford Area. The disposal of decontamination wastes from the New Production Reactor to ground at an inland site is discussed. A logging system for well water temperature measurements and a flow meter for measuring vertical currents in wells are described. The effects of temperature and air velocity on uranium oxide particulate production and entrainment and the fractional release of fission-product elements from irradiated uranium during reactor disaster conditions were investigated. The percent release of purified Sr^{89+90}, $Ce^{141+144}$, and Cs^{137} from their respective chemical shipping forms is presented for postulated accidental firing conditions. An analysis was made of thermal deposition of particles in circular ducts based on a simplified model and an equation derived that expresses the resulting change in particulate concentration. (NSA)

Nelson, J. L., D. W. Bensen, and K. C. Knoll. 1961. Hanford Studies in Geochemistry. HW-SA-2273.

In 1957, a research program was initiated at Hanford to quantitatively define the variables that effect the retention of radionuclides by soils.

Chromatographic equations from the literature were applied to soil column breakthrough data, thus permitting a prediction of breakthrough of radionuclides from ground disposal facilities. A study was made of the effects of temperature, species of accompanying ion, concentration of accompanying ion, concentration of trace ion, pH, column diameter, column length, and flow rate on strontium breakthrough curves. Although initial attempts to fit the column length data to chromatographic equations were not successful, some adjustment methods were found which bring the equations into better agreement with laboratory results. The adjustments also tended to provide an improved understanding of the mechanisms involved. In addition to these findings, the results of research on the reactions of rare earths with soils, a study of the effect of hydrodynamic unsaturation on ion exchange, further results from a model crib, and a brief description of the mineral reactions studied at Hanford are presented. (NSA)

Nelson, J. L., W. A. Haney, K. C. Knoll, and D. W. Bensen. 1962. Laboratory, Pilot and Field Scale Studies of Fission Product Migration Rates in Soil. HW-SA-2744.

Results of laboratory, pilot, and actual waste disposal studies relating to the migration rates of fission products in soils are presented. Work planned to obtain a more accurate definition of the radioisotope capacity of specific disposal sights is also described. The variables that influence the rate of movement of trace concentrations of radio-cations in soil were determined. Methods were investigated for extrapolating laboratory results to field disposals, and model waste disposal facilities were constructed. (NSA)

Nelson, J. L. and W. L. Haushild. 1970. Accumulation of Radionuclides in Bed Sediments of the Columbia River Between Hanford Reactors and McNary Dam. Water Resources. 6:130-7.

Amounts of radionuclides from the Hanford reactors in river bed sediments were estimated from data on radionuclide concentration for the bed sediments between the reactors and McNary Dam; and from data on radionuclide discharge for river stations at Pasco, Wash., and Umatilla, Oreg., 3.2 km below the dam. Accumulations in the Pasco to Umatilla reach estimated by the two methods agree within 8%. In October 1965 approximately 16,000 curies of gamma-emitting radionuclides were resident in the bed sediments between reactors and dam. Concentrations of chromium-51, zinc-65, cobalt-60, manganese-54, and scandium-46 generally are higher near the dam, due to an increase downstream from the reactors in the proportion of fine-grained sediment and proportions of transported zinc, cobalt, manganese, and scandium radionuclides associated with sediment particles. (NSA)

Nelson, J. L. and L. L. Humphreys. 1964. Sediment Studies: Particle Size Separation of Bottom Sediments from the McNary Reservoir of the Columbia River. HW-81746, p. 3.81-3.

A wet sieving particle sizing technique was used to size bottom sediments from the McNary Dam reservoir. The radionuclide contents of the size fractions are reported. (auth)

Nelson, J. L., R. W. Perkins, J. M. Nielsen, and W. L. Haushild. 1966. Reactions of Radionuclides from the Hanford Reactors with Columbia River Sediments. IAEA-SM-72/8, pp. 139-61.

On disposal to the Columbia River, effluent water from the nuclear reactors at Hanford contains many different radionuclides. These radionuclides provide numerous tracers for studying river phenomena. Among the radionuclides are activation products produced by n,γ reactions on water salts and smaller amounts of fission products resulting from fission of the trace quantities of uranium in the water. Although most of these radionuclides have such short half-lives or low abundances that they are not useful in studying river processes, ^{51}Cr, ^{65}Zn, ^{46}Sc, ^{54}Mn, ^{58}Co, ^{59}Fe, ^{60}Co, ^{95}Zr-^{95}Nb, ^{106}Ru, ^{124}Sb and ^{140}Ba are present in sufficient amounts to serve as useful tracers. As these radionuclides are diluted and move downstream with the Columbia River water, various processes operate to remove some of each of them from solution. Some become associated with inorganic and organic suspended sediments, which either settle to the river bottom or are carried to the Pacific Ocean. The depletion, sedimentation, scouring and inventory of eleven radionuclides have been studied for a 350-km reach of the Columbia River over a three-year period to show depletions of radionuclides of as much as 90% and total radionuclide inventories in the deposited sediments of about 30,000 Ci. Much of this inventory is in the McNary Dam reservoir, the first major depositional area below Hanford. A study of sediment scouring from this reservoir by the spring freshet using the $^{65}Zn/^{51}Cr$ ratio in suspended sediments as a measure of sediment age indicates that about 30% of the annual deposit may be moved downstream. Studies of the mechanisms of retention and release of radionuclides from the sediments indicate that the attached radionuclides are held tightly. They are not readily replaced by contact with salt solutions; sizeable fractions can, however, be removed with oxidizing agents, reducing agents and acidic solutions. Although no change in oxidation state occurs on sorption of most of the radionuclides by the sediments, ^{51}Cr is reduced from the hexavalent to the trivalent state. These findings have provided an understanding of many important processes in the Columbia River and can be extrapolated to provide predictions of radionuclide behaviour in other river systems. (auth)

Nelson, R. W. 1964. Analysis of Waste Released by Seepage to the Columbia River from the 1301-N Crib. HW-81306.

The 1301-N crib is designed to receive diverted primary coolant from the N-Reactor when a fuel element fails. Information on the rate of release of fission products and concentrations in the Columbia River was needed to evaluate the long-term public safety. Methods are described for predicting the arrival-time distribution of wastes to the river. These methods are specifically applied to provide estimates of the long-term maximum activities of ^{131}I in the river as a result of the disposals to the 1301-N crib. Other radionuclide activities may be obtained through use of the basic flow system results. The methods, presented in detail, provide conservative prediction of river contamination levels after long-term operation. (NSA)

Nelson, R. W. 1965. A Sequence for Predicting Waste Transport by Ground Water. BNWL-SA-406.

An analysis sequence is presented to enable rational predictions of containment concentrations entering streams, rivers, or other potable waters traversing the region of study by ground water transport. The purposes are to give an over-all description of the sequence, briefly describe the methods developed, and indicate the computer programs available to assist in accomplishing the analysis. Throughout the analysis, major emphasis was on realistically evaluating actual situations. The natural sediments are assumed heterogeneous with respect to the permeability, potential measurements can be irregularly located, and boundary conditions may be both mixed and nonuniform. (NSA)

Nelson, R. W. 1965. A Sequence for Predicting Waste Transport by Ground Water. BNWL-63.

Tabular field data and fitting functions submitted to a digital computer give the ground water potential equations for heterogeneous soils. Added to special boundary conditions, this potential equation is the key for computing the permeability distribution. The second computer program has four sequential operations. The first two provide permeability distribution and the last two give water travel time and flux distribution which enables water waste transport calculations. The nonlinear boundary value problem interrelates all pertinent variables, and when solved, gives the new ground water potential for flow system changes. The nonlinear equations are then solved digitally by a piece-wise method for computations of predicted distribution of ground water potentials. The present computer program has a limit on problem size (8000 equations), but an enlarged program is being developed. Travel paths and times of flow and subsequently, the water arrival distribution are determined from the water potential function. An arrival curve is then used to plot the concentration of wastes entering streams. (auth)

Nelson, R. W. and J. R. Eliason. 1966. Prediction of Water Movement Through Soils - A First Step in Waste Transport Analysis. BNWL-SA-678.

Recent theoretical advances made in studies on the flow of fluids in porous media are interrelated to problems involving the transport of pollutants through soils. Three broad phases of analysis are involved in predicting contaminant transport through porous media. They are: the macroscopic fluid flow analysis; the microscopic flow analysis for diffusion and hydrodynamic dispersion, and the reactions or interactions of contaminants with the porous material, organic material or biological components of the soil. Macroscopic flow analysis was determined and used to predict river contaminant concentration. (NSA)

Nelson, R. W. and A. E. Reisenauer. 1962. Hanford Studies on Flow in Porous Media. TID-7628, p. 130-44.

Methods are described for use in studies on the behavior of ground water in both homogeneous and heterogeneous soils. Basic equations are presented for use in hydrodynamic descriptions. A computer program is described for use in solving problems of unsaturated flow, saturated flow problems with either heterogeneous or homogeneous soils, and problems involving combined partially-saturated and saturated flow. Typical applications are included. (NSA)

Nevissi, A. and W. R. Shell. 1975. Distribution of Plutonium and Americium in Bikini Atoll Lagoon. Health Physics. 28:539-547.

Important factors that govern the redistribution and transport of radionuclides in Bikini Atoll Lagoon are particulate size and physical-chemical state. In water samples from Bikini the particulate fraction was collected on 0.3 μm millipore filters and the soluble fraction sorbed onto aluminum oxide beds. Sediments were collected by grab sampling or by coring. The radionuclides measured include Pu 239, 240, and Am 241. The largest source of radionuclides available for transport as indicated by Am 241 and Pu 239, 240 in sediments and water samples reside in the deep water in the northwestern quadrant of the lagoon within approximately 6 km south of the second thermonuclear detonation--Shot Bravo. Small particles and/or ions of radionuclides are released at the sediment-water interface and are transported by the currents. These particles and ions agglomerate during transport away from the sediment surface. Coagulation with detritus and incorporation with plankton would cause the effective particulate size to increase. After about 16 years, since the last nuclear test on the Atoll, the radionuclides are neither buried totally in the lagoon sediments nor have they been discharged completely to the ocean. There is a constant circulation and redistribution of the materials in the lagoon enforced by prevailing lagoon currents. The flux of americium and plutonium away from Bikini Atoll and into the North Equatorial Current are calculated to be about 3 Ci Am 241 and 6 Ci Pu 239, 240 per year. (auth)

Nevissi, A., W. R. Shell, and V. A. Nelson. 1975. Plutonium and Americium in Soils of Bikini Atoll. IAEA-SM-199/63.

A study has been made to determine the concentrations of plutonium and americium in surface soils and in soil profiles on Bikini Atoll. The soils consist of calcareous materials and a thin layer of organic matter which has produced a shallow organic rich horizon suitable for certain plant growth. During the testing period from 1946 through 1958, Bikini Atoll was the site of 23 nuclear detonations which contaminated the islands of the atoll with radioactive fallout including the transuranium elements. Plutonium and americium measurements of surface soil samples collected on 6 of the 26 islands of the atoll show that ^{239,240}Pu values vary from 0.5 to 360 pCi/g and ^{241}Am values from 1.2 to 45 pCi/g. The vertical distribution of plutonium in soil varies from area to area. Although about 98% of the plutonium is retained in the top 25 cm in one core profile, the remaining 2% is detectable as deep as 100 cm. The suspension and resuspension of plutonium and plutonium bearing particles by rainfall (150 to 175 cm/yr) seems to be the principal mode of plutonium transport in the soil. A greater retention of plutonium is found associated with the algal crust of the atoll soils. The present levels of $^{239,240}Pu$ and its distribution at Bikini are not likely to change significantly whereas ^{241}Am levels will increase by ^{241}Pu decay and will attain maximum radioactivity in about 50 years. (auth)

Newell, J. F., C. W. Christenson, E. R. Mathews, C. C. Ruchhoft, H. L. Kreiger, and D. W. Moeller. 1951. Laboratory Studies on Removal of Plutonium from Laundry Wastes. Industrial and Engineering Chemistry. 43:1516-1519.

Comparative studies of the chemical precipitation process and of the trickling filter process for removing plutonium from laundry wastes show the following: 1) Either process will effectively remove plutonium from the wastes. 2) The volume of sludge produced by the chemical process will be in the order of 25 to 30 times the volume produced by the trickling filter process. This factor is extremely important since the sludge is hazardous and complicated. On this basis the trickling filter process appears the more attractive. 3) A trickling filter plant design should provide the following features: a) a holding tank to allow continuous application of the laundry waste to the filter system at a constant rate; b) a two-stage trickling filter system with provisions for varied recirculation ratios. Present data indicate that series operation with a recirculation of 6 to 1 or more over each filter will effect the desired plutonium removal. However, it may be necessary to recirculate at a rate as high as 15 to 1 while placing the filter system into operation. c) extremely low rates of application of the raw laundry waste with respect to volume and BOD. The data show that desired plutonium removal may be effected at an application rate of 0.3 million gallons per acre per day with a BOD loading of about 150 pounds per acre-foot per day, based upon the primary filter. d) facilities for adding supplemental nitrogen and phosphorus to the laundry waste before it is applied to the primary filter. The nitrogen may be added in solution as ammonium sulfate and the phosphorus may be added in solution as trisodium phosphate. The amount of nitrogen in the waste should be sufficient and the mode of operation such as to ensure that the final effluent will contain a relatively high concentration of nitrates. e) the secondary effluent should be filtered to ensure removal of any suspended matter carried over. Exploratory studies indicate that an ordinary rapid sand filter will be effective. The filter backwash should be returned to the laundry waste holding tank. (auth)

Newton, T. D. 1959. On the Dispersion of Fission Products by Ground Water. CRT-866.

On the assumptions that the motion of ions in ground water through soils may be described by reversible processes of exchange and that active ions are present in the ground water only in trace quantities, the distribution of activity through the soil of a uniform disposal area is calculated by a statistical method. The mean delay time in a uniform column is determined by the equilibrium distribution ratio, D, and the shape of the front of activity is fixed by D and a parameter N which represents the average number of transfers from the liquid to the solid state. An appendix shows the relation between the statistical methods used here and the exchange rate equation. (auth)

Newton, T. W. 1975. The Kinetics of the Oxidation-Reduction Reactions of Uranium, Neptunium, Plutonium, and Americium in Aqueous Solutions. TID-26506.

This is a review with about 250 references. Data for 240 reactions are cataloged and quantitative activation parameters are tabulated for 79 of these. Some empirical correlations are given. Twelve typical reactions are discussed in detail, along with the effects of self-irradiation and ionic strength. (auth)

Newton, T. W. and F. B. Baker. 1967. Aqueous Oxidation-Reduction Reactions of Uranium, Neptunium, Plutonium, and Americium. Advances in Chemistry Series. 71:268-295.

The experimental observations on the actinide oxidation-reduction reactions are described, and the empirical results are tabulated. The rate laws have been interpreted in terms of net activation processes, and these have been tabulated together with the associated activation parameters -- ΔF*, ΔH*, and ΔS*. An electrical analog is described which has been useful in interpreting complicated rate laws. Empirical correlations have been found between the formal entropies of the activated complexes and their charges, and for sets of similar reactions, between the hydrogen ion dependence and ΔF°, between ΔF* and ΔF°, and between ΔH* and ΔH°. The kinetic and physical evidence for binuclear species is discussed. (auth)

Nickel, E. H. 1961. The Mineralogy of the Bernic Lake Pegmatite, Southeastern Manitoba. Mines Branch Technical Bulletin TB 20.

The Bernic Lake pegmatite is a complex zoned pegmatite which contains a large number of minerals, some of which are quite unusual. This mineralogical study has been directed primarily at those minerals that are most likely to be of potential economic interest.

The pegmatite contains a relatively large amount of pollucite, a cesium aluminosilicate. Lithium occurs in a number of minerals, chiefly spodumene, lithian micas and amblygonite. Appreciable amounts of rubidium have been found in the lithian micas and in microcline feldspar. Tantalum and tin occur largely as stanniferous tantalite which contains an unusually large amount of chemically combined tin. Beryl occurs in various parts of the deposit. Other minerals found in the pegmatite include quartz, albite, lithiophilite, tapiolite, microlite, cassiterite, apatite, rhodochrosite, magnetite, ilmenite, scheelite, zircon, stannite, tourmaline, clay minerals, and calcite. (auth)

Nielsen, D. R. and J. W. Biggar. 1962. Radioisotopes and Labelled Salts in Soil-Water Movement. STI/PUB-133, pp. 61-76.

The behavior of tracers in several soil-water systems are briefly summarized. It should not be assumed that the tracer always goes where the water goes or a crude estimate of water movement will be found. If tracer behaviour under particular conditions within the soil is accounted for, a better understanding of soil-water movement and its implications to soil science is achieved. (NSA)

Nielsen, D. R. and J. W. Biggar. 1961. Miscible Displacement in Soils: I. Experimental Information. Soil Sci. Soc. Am. Proc. 25:1-3.

When a fluid containing a tracer in solution is displaced from a porous medium by the same fluid without a tracer, this miscible displacement results in a tracer concentration distribution which depends upon microscopic flow velocities, tracer diffusion rates and other chemical and physical processes. Miscible displacement has been studied in several porous materials under saturated and unsaturated conditions at different average flow velocities. The tracer appeared at the end of the soil column well in advance of that expected had no mixing occurred at the boundary of the tracer and tracer-free water. Physical differences between porous materials were manifested by changes in shape and position of breakthrough curves owing to ionic diffusion. One of the more important physical features was the magnitude of the volume of water not readily displaced at saturation and its increase when the soil was desaturated. Because the total flux of water moving through field soils is generally small, the role played by hydrodynamic dispersion and diffusion in transporting dissolved solutes must be included in the theory of most soil-water processes. (auth)

Nielsen, D. R. and J. W. Biggar. 1962. Miscible Displacement:III. Theoretical Considerations. Soil Sci. Soc. Am. Proc. 26:216.

Several theoretical models are examined as to their usefulness in describing miscible displacement in porous materials. These descriptions are discussed for glass beads, sieved aggregates and soils at several water contents and for several flow velocities. It is shown that mathematical descriptions which do not include individual mechanisms are unsatisfactory. The mechanisms that must be considered are discussed with specific reference to experimental data. (auth)

Nikiforova, E. M. 1969. Redistributions of Thorium and Radium in Transbaikalia Topologies and Their Significance on Prospecting for Ore Deposits by an Airborne γ-spectrometric Method. Mikrelem. Lanshaftakh Sov. Soyuza. M. A. Glazovskaya (ed.). Izd. Mosk. Univ. Moscow, USSR. p. 139-57 (in Russian).

The processes of weathering and soil formation promote the removal of Th and Ra and their accumulation in the topologies. A geochemical relation exists between the content of radioelements in the original rocks and in the local topologies. The accumulation of Ra and Th in humus, illuvial, and peaty horizons of soils indicate the presence of their soluble compounds in the corresponding topology and the participation of both Th and Ra in the biological circulation. Trees contain higher amounts of radioelements when compared with grasses. (CA)

Nikolaev, D. S., V. M. Drozhzhin, K. F. Lazarev, and O. P. Korn. 1969. The Geochemical Balance of Radioactive Elements in the Basin of the Black and Azov Seas. II. Reserves of Thorium Isotopes. Radiokhimiya. 11:688-98 (in Russian).

The concentrations of thorium and ionium (thorium-230) were determined in the water and suspensions of the main rivers in the basin of the Black and Azov Seas. On the basis of the data obtained, the main elements of balance and the reserves of thorium and ionium in the Black and Azov Seas were determined. The amounts precipitated in deep and shallow water zones in the Black Sea annually are 143 and 691 tons of thorium and 19100 and

10400 g of ionium. It was calculated that the residence time of thorium in the aqueous phase is 56.5 years for the Black Sea and 160 days in the Azov Sea; for ionium the values are 365 years and 172 days, respectively. (auth)

Nikolaev, D. W., E. I. Efimova, A. I. Il'in, and I. I. Shurko. 1973. Determination of Absolute Age and Sedimentation Rate of Bottom Deposits by an Ionium-Thorium Method. Geokhimiya. No. 2:279-83 (in Russian).

Radiochemical study of bottom deposits (two samples taken from Guinea Bay in the Atlantic Ocean) is described. Distribution of Ra and ^{230}Th as a function of deposit depth does not agree with the element decay. The concentration of ^{232}Th increase irregularly with depth. Abstract age and sedimentation rate of bottom deposits are calculated from the experimentally determined ^{230}Th/^{232}Th ratio, which decreases with the sediment depth. Experimental error in the geochronological study of bottom deposits by the ^{230}Th/^{232}Th method are discussed. (CA)

Nikolaev, D. S., K. F. Lazarev, O. P. Korn, M. I. Yakunin, V. M. Drozhzhin, and A. G. Samartseva. 1965. Isotopic Composition of Uranium in the Waters and Sediments of the Black and Azov Seas. Dokl. Akad. Nauk SSSR. 165: 187-9 (in Russian).

Alpha-spectrometric examinations of uranium separated from the waters and the bottom sediments of the Black and Azov Seas indicated an enrichment of ^{234}U in the samples. The ^{234}U/^{238}U values found were 1.10 to 1.28 for the waters and 0.89 to 1.20 for the sediments, in general somewhat higher than the value of 1.15 quoted for the ocean. This may reflect a different age and geochemical history of the waters. The preferential leaching of the daughter ^{234}U from the rock-forming minerals in comparison with the mother element, ^{238}U, may occur. The degree of enrichment depends on various factors, including the chemical composition of the liquid and solid phases, disintegration of the latter, and time of contact. For the studies the uranium was separated from the waters by precipitation with iron hydroxide from samples of up to 580 liters and from the sediments by acid or bicarbonate leaching. (NSA)

Nikolaevskii, V. B., V. P. Shilov and N. N. Krot. 1974. Estimation of Oxidation Potential of Americium (VI) in an Alkaline Medium. Radiokhimiya. 16:122-3.

Am(VI) is a strong oxidant and is reduced by water to form Am(V). The half-reduction period of Am(VI) in 1M NaOH was 1 hr. Np(VII) is much more stable than Am(VI) changing very little in many days in 1M NaOH. Np was present as NpO_5^{3-}. Am probably present as AmO_4^{-2} or $AmO_2(OH)_4\text{-}(H_2O)_2^{-2}$. In 1M NaOH, the potential value of the Am(VI) to Am(V) couple is $\sim$0.65V.

Nishita, H. and E. H. Essington. 1967. Effect of Chelating Agents on the Movement of Fission Products in Soils. Soil Science. 103:169-176.

Chelating agents (EDTA, DTPA, and EDDHA) and deionized water were evaluated as to their ability to move several radioactive fission products (Sr89, Y91, Ru106, Cs137, and Ce144) in different kinds of soils. Different soils exhibited considerable difference in the effectiveness of the various leaching agents. Irrespective of the kind of soil, the order of magnitude of movement by water leaching generally was Cs137, Y91, Ce144 < Sr89 << Ru106. Except in one soil (Hanford sandy loam), practically no movement of Cs137, Y91, or Ce144 occurred by H_2O leaching. Among the chelating agents, the effectiveness of EDDHA was generally the least, while the relative effectiveness of DTPA and EDTA varied with the soil and radionuclide. The possible causes for the variations in the effectiveness of different leaching agents in different soils were discussed. (auth)

Nishita, H. and M. Hamilton. 1972. Soil Thermoluminescence in Relation to Radiation Exposure Under Field Conditions. Soil Science. 114:430-439.

Experiments were conducted to determine the relationship of soil thermoluminescence to ionizing radiation exposure under the conditions of natural environment using the ^{137}Cs radiation field at the Nevada Test Site. In experiment I soil columns were buried in the ground and irradiated at a fixed distance from the ^{137}Cs source. In experiment II, they were exposed on to ground surface at 12 different distances from the source. Soil thermoluminescence was determined in three ways, i.e., glow curve area below

200°C, glow curve height at 200°C, and total area. Both experiments showed that soil thermoluminescence is highly correlated with radiation exposure level. The first two methods of measuring thermoluminescence indicated above gave correlation coefficients $r > 0.915$. The total area method gave high correlation coefficient $r > 0.951$ for the noncalcareous soil, but low coefficient $r < 0.769$ with the highly calcareous soil studied, indicating that this method cannot be applied to the latter soil type. Under the experimental conditions that prevailed, the minimum radiation exposure level required to produce measurable soil thermoluminescence appeared to be in the 20 to 85 R range. (auth)

Nishita, H., M. Hamilton, and A. J. Steen. 1976. Extractability of ^{238}Pu and ^{242}Cm from a Contaminated Soil as a Function of pH and Certain Soil Components. Presented at Meeting of Soil Science Society of America. November 28-December 3. Houston, Texas.

Extractability of ^{238}Pu and ^{242}Cm from a contaminated soil as a function of pH and certain soil components has been examined. This was done with an equilibrium batch technique using HNO_3-NaOH extracting system. The influence of various soil components on ^{238}Pu and ^{242}Cm extractability was determined indirectly by selectively removing them from the soil. Soil organic matter had a great influence on the extractability of ^{238}Pu and ^{242}Cm. Though to a lesser extent, the free iron oxides and free silica, alumina, and amorphous alumino-silicates appeared also to exert some influence. The influence of these components depended on the pH of the soil suspension. Below pH 4.5, ^{238}Pu appeared to be more strongly sorbed on the mineral fraction of the soil than ^{242}Cm, but above pH 4.5, both were strongly sorbed on the mineral fraction. With the contaminated virgin soil, the ^{238}Pu and ^{242}Cm extractability ranged from 4.82 to 53.05 and 0.15 to 64.58 percent of dose, respectively, depending on the pH of the extracting solution. The liquid to solid K_d' values ranged from 3.2×10^{-4} to 7.2×10^{-3} and 1.0×10^{-5} to 1.2×10^{-2} for ^{238}Pu and ^{242}Cm, respectively. The lowest extractability occurred around pH 7.1 for ^{238}Pu and in the range of pH 4.7 to 5.6 for ^{242}Cm. (auth)

Nishita, H. and R. M. Haug. 1971. Some Physical and Chemical Characteristics of Heated Soils. UCLA-12-819.

The physical and chemical characteristics of five different heated soils were examined. The properties examined include particle size distribution, pH, cation exchange capacity, electrical conductivity, water and ammonium acetate extractable Na, K, Mg, Ca, and Sr, and total N, lime and organic C contents. (auth)

Nishita, H. and R. M. Haug. 1976. Effect of Induced Aggregation of Soil Materials on the Chemical Extractability of Sr^{90} and Pm-147 Contaminants. Soil Science. 121:135-145.

Laboratory experiments were conducted to determine the effect of induced aggregation of soil materials on the chemical extractability of Sr90 and Pm147 contaminants in the soil. Four different binding agents (Portland cement, ferrous sulfate, sodium silicate, and polyester coating resin) were used to induce soil aggregation. In general, each binding agent increased the water-extractable fraction of Sr90, while it decreased the NH_4OAc-extractable fraction. The increase of the water-extractable fraction was due to exchange displacement during the interaction of the soil particulates and the binding agent. The decrease of the NH_4OAc-extractable fraction was considered to be due to the blocking action resulting from the interaction of soil particulates and the binding agent. The extractability of Pm147 differed from Sr90 in that the NH_4OAc-extractable fraction was increased by $FeSO_4$ and the water-extractable fraction was decreased by the resin treatment. Several reasons for these effects are given. (auth)

Nishita, H., R. M. Haug and M. Hamilton. 1968. Influence of Minerals on Sr^{90} and Cs^{137} Uptake by Bean Plans. Soil Science. 105:237-243.

The influence of the addition of several minerals (clinoptilolite, "Verxite", bentonite, illite, kaolinite, vermiculite and bauxite) on the Sr^{90} and Cs^{137} uptake by bean plants grown in two contaminated soils was examined. The Cs^{137} uptake by the plants was relatively small compared to

Sr^{90} uptake with all mineral treatments. Among the minerals studied, clinoptilolite had the greatest effect on both the Sr^{90} and Cs^{137} uptake. The Sr^{90} uptake was significantly reduced, while the Cs^{137} uptake, although small, was increased. The effect of the other minerals ranged from no effect to small effects. Mineral treatment of soil either decreased the plant yield or had no effect. In no case the plant yield increased. (auth)

Nishita, H., R. M. Haug, and A. J. Steen. 1966. Solubility and Plant Availability of Radionuclides in Reactor-Activated Soils. Health Physics. 12:615-20.

The solubility radionuclides formed in reactor activated soils were determined by equilibrium batch and leaching methods and the plant availability of these radionuclides was determined by a modified Neubauer technique. The gamma activity of the equilibrium extracts of activated soils varied from 0.17 to 20.22, 0.36 to 25.09 and 0.20 to 28.76% of total activity in deionized H_2O, 0.1 N HCl and 1 N NH_4Ac, respectively, about 22 hr after irradiation. The activity leachable by the above extractants about 2.5 hr after activation varied among the soils, respectively, as follows: gamma, 0.35 to 16.16, 4.95 to 38.74 and 3.60 to 22.61%; and beta, 0.55 to 17.09, 8.01 to 58.75 and 2.42 to 33.94%. In every instance, the percentage of leachable beta activity was greater than the leachable gamma activity of the corresponding soil. Thus, the relative extraction of beta activity was greater than that of the gamma activity. This effect was reflected in the 18-day-old barley seedlings, which showed much greater beta activity than gamma activity. The dominant gamma-emitting radionuclide in the plants was ^{86}Rb, although ^{46}Sc was the dominant radionuclide in the soil at the time of harvest. (auth)

Nishita, H. and H. A. Hawthorne. 1967. Effect of Moisture Tension of the Concentration of Tracer ^{85}Sr in Expressed Soil Solution. Soil Science. 103:339-45.

The concentration of tracer ^{85}Sr in soil solutions extracted with pressure membrane extractors was examined in relation to variable moisture content in different kinds of soils. The ^{85}Sr radioactivity in the soil solution was expressed as solubility factor, which was defined as the ratio of the amount of ^{85}Sr per ml of soil solution to the amount of ^{85}Sr per g of soil before extraction. For any given soil, the ^{85}Sr solubility factors increased as the soil-moisture tension increased. With soils of low moisture level, the solution extracting system did not attain the apparent equilibrium state by the end of the extraction period. For the majority of the soils studied, the critical moisture level for the attainment of apparent equilibrium state was between 0.1 bar and 1 bar. The ^{85}Sr solubility factors varied over a wide range among the different kinds of soils. For the 0.1-bar moisture range, the solubility factors for extracts at the apparent equilibrium state varied from about 0.009 to about 0.74. Various factors that appeared to affect the magnitudes of solubility factors are discussed. (auth)

Nishita, H., B. W. Kowalewsky, A. J. Steen, and K. H. Larson. 1956. Fixation and Extractability of Fission Products Contaminating Various Soils and Clays. I: ^{90}Sr, ^{91}Y, ^{106}Ru, ^{137}Cs, ^{144}Ce. Soil Science. 81:317-327.

Water-soluble, exchangeable, and nonexchangeable forms of long-lived and medium-lived fission products (Sr90, Y91, Ru106, Cs137, and Ce144) contaminating five soils and two clay minerals were studied by the use of leaching procedures.

With few exceptions, the relative relationships of these fission products in the soils were:

Water-soluble fraction: Ru106 > Sr90 > Y91 ≥ Ce144 > Cs137
Exchangeable fraction: Sr90 > Cs137 > Ru106 ≥ Y91 ≥ Ce144
Nonexchangeable fraction: Ce144, Y91 > Ru106 > Cs137 > Sr90

Exceptions were discussed on the basis of soil pH, chemical properties of radioisotopes, and clay mineral type.

The relative relationships of the radioisotopes in the clay minerals were:

Water-soluble fraction: bentonite; Ru106 > Sr90 > Cs137 > Y91, Ce144
kaolinite; Sr90 > Ru106, Cs137 > Y91 > Ce144
Exchangeable fraction: bentonite; Sr90 > Cs137 > Y91, Ce144 > Ru106
kaolinite; Y91, Ce144 > Sr90 > Cs137 > Ru106
Nonexchangeable fraction: bentonite; Ru106 > Ce144, Y91 > Cs137 > Sr90
kaolinite; Ru106 > Cs137 > Y91, Ce144 > Sr90

In comparison with the other radioisotopes, Cs137 and Ru106 were fixed in relatively large amounts by kaolinite. Bentonite pretreated with dilute acid showed less adsorption of Cs137 and Ce144 than did untreated bentonite, which indicates that the hydrogen ion is more strongly adsorbed than are these ions.

The pH of the leaching solution had great effect on the release of Y91, Cs137, and Ce144.

In the competitive adsorption between the soils and clay minerals and the Pyrex glass of the container, the radioisotopes showed a decidedly greater preference for the soils and clay minerals. (auth)

Nishita, H., E. M. Romney, G. V. Alexander, and K. H. Larson. 1960. Influence of K and Cs on Release of Cs 137 from Three Soils. Soil Science. 89:167-176.

Experiments were conducted to study the influence of stable K and Cs amendments on the uptake of Cs 137 by Ladino clover upon prolonged cropping of contaminated soils.

The addition of K to soils containing relatively high levels of K was ineffective in reducing Cs 137 uptake by plants, but after the soil K was reduced to a low level by cropping, the addition of K to soils reduced Cs 137 uptake by plants. This implies that K added to a soil may reduce Cs 137 uptake by plants when the soil is low in K content but not when high in K. The Cs 137 uptake by plants increased as the K concentration in the soil was reduced by cropping.

The addition of small amounts of Cs to the soil markedly increased Cs 137 uptake by plants and reduced K uptake. The addition of Cs even at a level severely injurious to plants increased Cs 137 uptake rather than reduced it. The threshold level for producing injury to clover appeared to be around 4.5×10^{-4} me, Cs per g soil in Vina loam. The toxic effect of Cs added in injurious amount to the soil was alleviated by the addition of K, K was, thus, antagonistic to Cs.

The amount of Cs and K uptake by plants depended on the soil type. Uptake of Cs 137 by plants was in the order Hanford > Aiken > Vina, and, concurrently, K uptake was in the reverse order. (auth)

Nishita, H., E. M. Romney, and K. H. Larson. 1965. Uptake of Radioactive Fission Products by Plants. IN: Fowler, E. G. (ed.). Radioactive Fallout, Soils, Plants, Foods, Man, Chapter 4, p. 55-81.

Root uptake largely depends upon the solubility of fallout debris, the chemical reactions of individual radionuclides in soils, and the absorptive power of radionuclides by plants. The relative order of magnitude of plant uptake of fission products and plutonium appeared to be ^{89}Sr, ^{90}Sr >> ^{131}I > ^{140}Ba > ^{137}Cs, ^{106}Ru > ^{144}Ce, ^{91}Y, ^{147}Pm, ^{95}Zr-Nb > ^{239}Pu. Although the relative order of magnitude varied little, the absolute magnitude of uptake may be varied by certain soil management practices such as cultivation, fertilization and organic matter application. Aside from differential uptake, there was differential distribution of absorbed radionuclides among different plant parts. The soil-plant step greatly reduces the amount of radionuclides transferred along the food chain to man. (auth)

Nishita, H. and P. Taylor. 1964. Influence of Stable Sr and Ca on Sr^{90} and Ca^{45} in Soils and Clay Minerals. Soil Science. 98:181-6.

Experiments were conducted to study the influence of stable Sr and Ca on the behavior of tracer quantities of ^{90}Sr and ^{45}Ca in soils and clay minerals, using an equilibrium batch method. The sorption of tracer quantities of ^{90}Sr and ^{45}Ca depended on the concentration of the stable Sr and Ca and the kind of soil or clay mineral. Under conditions of low ionic concentration in the equilibration suspensions, more ^{90}Sr was sorbed in Ca systems than in Sr systems. Under conditions of relatively high ionic concentrations, there was no appreciable difference in ^{90}Sr sorption between Ca and Sr systems. Since the initial trace quantities of ^{90}Sr were sorbed firmly, the sequence of addition of the tracer to the soil in relation to stable Sr and Ca was important. (auth)

Nishita, H., P. Taylor, G. V. Alexander, and K. H. Larson. 1962. Influence of Stable Cs and K on the Reactions of ^{137}Cs and ^{42}K in Soils and Clay Minerals. Soil Science. 94:187-197.

Experiments were conducted to study the influence of stable Cs and K on the reactions of tracer quantities of Cs137 and K42 in soils and clay minerals, using an equilibrium batch method.

Tracer quantities of both ^{137}Cs and ^{42}K were strongly sorbed in soils and clay minerals. Cesium was more strongly sorbed than K. Since the initial trace quantities of carrier-free ^{137}Cs were very strongly sorbed, the sequence of the addition of the tracer radioisotope in relation to the addition of stable Cs and K determined the level at which equilibrium was attained. The absolute amount of Cs and K sorption depended on the kind of clay mineral and soil. Cesium sorption relative to K was greater in Ca-clay than in H-Al-clay.

The concentration of the stable Cs and K present was also an important factor. When the tracer ^{137}Cs was diluted to a negligible fraction of the total Cs in solution, only a negligible fraction of ^{137}Cs was sorbed. In equimolar mixtures of Cs and K, the sorption of Cs relative to K decreased as the ionic concentration increased. As a corollary to this effect, under conditions of low ionic concentration, stable Cs was much more effective than K in releasing ^{137}Cs from soils. In high concentrations, however, K may be in certain soils, as effective as stable Cs. (auth)

Nishiwaki, Y., Y. Honda, Y. Kimura, H. Morishima, T. Koga, Y. Miyaguchi, and H. Kawai. 1972. Behavior and Distribution of Radioactive Substances in Coastal and Estuarine Waters. IN: Radioactive Contamination of the Marine Environment. IAEA-SM-158/11, pp. 177-193.

To understand the problems of environmental radioactive contamination due to continuous discharge of low-level liquid radioactive waste into the seawater, a study must be made of the behavior and distribution of various nuclides which may occur in both ionic and colloidal or particulate state in the coastal and estuarine waters. However, the behavior and distribution of the various radionuclides in the estuarine water are much more complicated than those in the open sea, because of the complex topographical and marine meterological variations and the changes in salinities and pH of the water. Since thorium and rare-earth elements had been continuously discharged through a small river into the estuarine water at Osaka Bay, a study was made of the variation of concentration of these elements under various natural conditions. Experimental studies on adsorption of these elements on some bottom sediments were also carried out in the water with different salinites and pH. One important factor influencing the concentration of the elements in the water is tidal oscillation. The gross beta activities in water at the same location in the estuary widely varied at each time of sampling. The average values from April to December in 1966 were 9.5 ± 4.9 pCi/l at higher tidal level, 84 ± 68 pCi/l at middle tidal level and 157 ± 106 pCi/l at lower tidal level, respectively. However, the concentrations of thorium and total rare-earth elements in the water were not observed to change regularly with the tidal change. The dispersion of the elements in the estuarine water were not interpreted by simple dilution and diffusion of the element in water mass. The presence of the mud flats, as well as the marine meteorological conditions, seem to affect markedly the distribution of the element in the estuarine water. The adsorption of the element on the bottom sediment was influenced not only by the coarseness of the sediment but also by the salinity and pH of the water. The highest distribution coefficients of ^{91}Y and ^{144}Ce in the clay sediment were obtained at the chlorosity of 14 g/l and pH 7.3 of the water. (auth)

Noakes, J. E., I. R. Supernaw, and L. K. Akers. 1967. Anomalies in the ^{230}Th/^{232}Th Activity Ratio in Some Mississippi River Sediments. J. Geophys. Res. 72:2679-82.

Unusually high ^{230}Th/^{232}Th activity ratios have been found in the fine sediment deposits of the Mississippi River in the Greenville, Mississippi area. The ratio was approximately 4.0 during 1963 in this area, whereas a ratio of 1.0 or less was found in May 1965. The 1.0 value seems to be the natural background value for the entire valley. It is postulated that a natural source for this anomaly is unlikely. (auth)

Nork, W. E. 1969. Radioactivity in the Hydrologic Environment - Project Rulison. Final Pre-Shot Report. NVO-1229-108.

In the absence of specific information on the hydraulic and chemical-exchange properties of the rocks at the RULISON Site, conservative estimates were made in order to make contamination predictions. Source term concentrations for tritium and strontium-90 were assumed to be 6 x 10^{-2} to 2 x 10^{-1} µCi/ml and 4 x 10^{-2} to 1 x 10^{-1} µCi/ml, respectively. Assumption of high but credible water movement rates and reasonable retardation effects indicates that neither tritium or strontium-90, for example, would move more than a few miles before decay or dilution to below CG levels. In the unlikely event of mass movement of radioactivity upwards to the land surface, transport of nuclide rates might exceed those at depth, but greater-than-CG levels of activity are not expected at any known water use point. (auth)

Nork, W. E. and P. R. Fenske. 1970. Radioactivity in Water - Project Rulison. NVO-1229-131.

The Project RULISON detonation was wholly contained, as planned, within the rocks of the Mesaverde Group. Explosion-produced radioactivity was initially distributed non-uniformly in the collapsed chimney and fractured rock surrounding the working point, WP. Redistribution of the explosion-radioactivity will occur as a result of transport of dissolved and/or particulate matter in any existing mobile ground water in Mesaverde Formation rocks or as a consequence of re-entry drilling and testing.

Quite possibly, ground water in the Mesaverde Formation is immobile. In this case all radioactivity will reside where it was initially emplaced unless it is artificially removed, and will decay eventually to concentrations below CG levels.

Any mobile water in the Mesaverde Formation which becomes contaminated with explosion nuclides, and is located below about 7000 ft is expected to move downward or laterally but not upward. Above 7000 ft any contaminated mobile waters are expected to move laterally. Hydrologic data indicates that the rate of movement of contaminated water will be essentially negligible. Very likely the rate of movement will be low enough and chemical-exchange retardation high enough to prevent transport of nuclides in greater-than-CG concentrations for any significant distances. (auth)

Nork, W. E., E. J. Forslow, and E. H. Essington. 1971. Radioactivity in Water. Central Nevada Test Area. NVO-1229-175.

Experience associated with Project Shoal and Project Long Shot has demonstrated the necessity for documenting pre-detonation background radioactivity levels in environmental waters. Possible natural fluctuations and cyclic variations in background radioactivity levels in water may be distinguished from explosion produced radioactivity by long-term sequential sampling and analysis. A plan for multiple sampling and analysis for the Central Nevada Test Area (CNTA) was prepared and implemented by Teledyne Isotopes (TI) on behalf of the U. S. Atomic Energy Commission (AEC).

Low-level tritium and gross radioactivity analyses for background determinations were made on water samples collected from the CNTA. A series of samples were collected from sampling points of interest at various times and analyzed. Lower limits of tritium and gross radioactivity concentrations in water were reasonably well established. Determination of background radioactivities due to naturally occurring radionuclides in water was established for all proposed sites in Central Nevada. After selection of Hot Creek Valley as the CNTA, sampling efforts were concentrated there and the frequency of sampling at other locations diminished.

Hydraulic test data from wells were analyzed to determine the potential migration characteristics of contaminants in the ground-water system. Radionuclide migration through geologic media is governed by the combined effects of water velocity and retardation of the radionuclide by sorption and dispersion. The degree of radionuclide sorption and retardation are approximated in the laboratory by measurement of distribution of a radionuclide between the mineral and solution phases.

A number of samples from UCe-18 indicated natural radioactivity levels above the reference Concentration Guide values. Specific radiochemical analyses indicated that the radioactivity was due to the presence of natural uranium.

Samples taken in Faultless re-entry drill hole UC-1-P-2SR were analyzed for comparison with pre-event background levels of tritium and gross radioactivity. (auth)

Noshkin, V. E. 1972. Ecological Aspects of Plutonium Dissemination in Aquatic Environments. Health Physics. 22:537-549.

The available data concerning the dissemination of plutonium and other transuranics in the aquatic environment are drawn together for appraisal. The most studied isotope has been ^{235}Pu derived from worldwide fallout. Essentially all the published work has been concerned with levels in the marine environment where plutonium is found widespread among planktonic, pelagic and benthic organisms. The concentrations are higher in organisms feeding on sediment or on surfaces than in those drawing largely on the water itself. Among the species where data are available are a variety of convenient "indicator organisms" for plutonium. There is some evidence that plutonium concentrations are increased in organisms of higher trophic levels. Bone and liver are major repositories for plutonium in marine vertebrates while muscle tissue of both marine vertebrates and invertebrates contain relatively lower concentrations. Plutonium is geochemically separated from both ^{90}Sr and ^{137}Cs in the water column and the sedimentation of ^{239}Pu may be more involved with biological processes than has been found for fallout rare earth isotopes. In marine sediments, as in soils, plutonium is more mobile than was originally expected. What little is known of the behavior of plutonium in the marine environment should be used conservatively to assess the behavior and distribution of new plutonium additions derived from sources other than fallout, and even more conservatively in predicting the impact of other transuranics in the aquatic environment. Considerably more understanding of the aquatic radioecology of several of the elements is a major priority especially since it now appears that when the relative biological effectiveness of alpha versus gamma or beta radiations is considered, fallout ^{239}Pu contributes more than fallout ^{90}Sr or ^{135}Cs to the artificial radiation exposure of many marine species. (auth)

Noshkin, V. E. and V. T. Bowen. 1971. Fallout Radionuclides in Near Shore Sediments (quoted by Noshkin, 1972).

The sandy deposits contained 30 to 40 times less ^{239}Pu per unit weight in the upper 3 cm of sediment than do silty deposits of the Bay. The reasons for these differences may be real and may relate to both the lithology and chemical differences of the sediment samples. The penetration ratio (amount in 15-23 cm depth divided by amount in 0-5 cm depth) for plutonium and cesium was 0.04 and 0.2, respectively.

Noshkin, V. E. and V. T. Bowen. 1973. Concentrations and Distributions of Long-Lived Fallout Radionuclides in Open Ocean Sediments. IN: Radioactive Contamination of the Marine Environment. IAEA-SM-158/45, pp. 671-686.

Analysis of deep open-ocean sediment cores from the north and south Atlantic and the Mediterranean Sea show the presence of ^{90}Sr, ^{137}Cs, and ^{239,240}Pu in measurable amounts distributed to depth within the sediment columns. Comparison of the quantities of these radionuclides accumulated in the sediments with either estimated integrated deliveries to the sea surface or the measured inventories in the overlying water masses has been used to estimate the residence times of the radionuclides in the water column. For ^{90}Sr and ^{137}Cs these computed residence times are orders of magnitude shorter than those estimated for the stable elements. Plutonium, we find, is being removed from the water column significantly more rapidly than either ^{90}Sr or ^{137}Cs. The ratio of ^{137}Cs to ^{90}Sr in the sediments is higher than that found in precipitation, suggesting that a large fraction of ocean water ^{137}Cs is associated with sedimenting particles than has been previously assumed. A simple model assuming plutonium to associate with a mixed population of particles, sinking at rates of 392 to 70 m/yr, predicts very well both the relation of sediment inventory of plutonium to depth of sediment, and the plutonium distribution vertically in the water column. (auth)

Noshkin, V. E., V. T. Bowen, K. M. Wong, and J. C. Burke. 1971. Plutonium in North Atlantic Ocean Organisms; Ecological Relationships. <u>IN</u>: Nelson, D. J. (ed.). Radionuclides in Ecosystems. Proc. Third Nat. Symp. Radioecology. 2:681-688.

A considerable series of North Atlantic Ocean have been analyzed, by radiochemistry and alpha spectrometry, for fallout plutonium 239, 240, and 238. Organisms from the near-shore environment have been selected to show the effects, on plutonium uptake, of variations in feeding habits, association with sediment or with absorptive surfaces, and of trophic level. In general, plutonium concentrations are higher in organisms feeding on sediment or on surfaces than in those drawing largely on the water itself. There is some evidence that plutonium concentrations are higher in organisms of higher trophic levels. (auth)

Noshkin, V. E., Jr. and C. Gatrousis. 1974. Fallout Pu 240 and Pu 239 in Atlantic Marine Samples. Earth Planet. Sci. Lett. 22:11-117.

Mass spectrometric analyses of low levels of global fallout plutonium separated from Atlantic marine samples have differentiated fallout ^{239}Pu and ^{240}Pu in aquatic samples for the first time. The results show no single characteristic ^{240}Pu/^{239}Pu ratio in marine samples; the observed range is from 0.11 to 0.24 on an atomic basis. There are indications that differences exist in the chemical or physical form of plutonium from atmospheric fallout in Atlantic surface water and that selective concentration in surface organisms is occurring. No single ^{240}Pu/^{239}Pu value is found in pelagic sediments collected from different depths and locations. Discounting sources other than fallout, our results show that the plutonium deposited at any given time since atmospheric testing began may have carried a unique ^{240}Pu/^{239}Pu tag. This label may be extremely useful to trace fallout plutonium through biogeochemical cycles. (auth)

Noshkin, V. E., K. M. Wong, R. J. Eagle, and C. Gatrousis. 1971. Transuranics at Pacific Atolls. I. Concentrations in the Waters at Enewetak and Bikini. UCRL-51612.

This report presents the available results on the concentrations and distributions of $^{239,240}Pu$ and other transuranic radionuclides in the lagoon waters of Enewetak and Bikini Atolls. The data are derived from a series of samples collected during the period October-December 1972. The samples are being radiochemically processed and analyzed for specific radionuclides; the available results for ^{90}Sr, ^{137}Cs, ^{237}Np, ^{238}Pu, $^{239,240}Pu$, ^{241}Pu, and ^{241}Am in specific water samples are presented and discussed. The two Pacific atolls, sites of nuclear testing series in the 1940s and 1950s, act as sources of radionuclides, contributing quantities greatly exceeding the fallout deposition to the lagoon marine environments. The distributions of plutonium in the two lagoons are very heterogeneous; strong concentration gradients are evident in both lagoons, and the horizontal stratifications define areas of water renewal. The concentrations are affected by wave-driven water transported across the reefs and by flow through the main channels. Three to 90% of the $^{239,240}Pu$ in Bikini lagoon is associated with a particulate phase. $^{239,240}Pu$ concentrations associated with bottom particulates generally exceed the surface levels, suggesting that resuspension of fine material is an active mechanism for redistributing some plutonium throughout the lagoon. In the soluble phase, however, surface plutonium concentrations generally exceed bottom concentrations, indicating slow vertical mixing in the water column, and suggesting (1) that plutonium is derived from several sources, and (2) that surface and bottom currents independently redistribute different forms of the radionuclide to different areas of the lagoon. The $^{239,240}Pu/^{137}Cs$ ratios in the surface waters are not constant, indicating that different sources or mechanisms govern the redistribution of specific radionuclides in the water column of the lagoon. (auth)

Noshkin, V. E., K. M. Wong, K. Marsh, R. Eagle, G. Holladay, and R. W. Buddemeier. 1975. Plutonium Radionuclides in the Ground Waters at Enewetak Atoll. IAEA-SM-199/33.

In 1974 a groundwater program was initiated at Enewetak Atoll to study systematically the hydrology and the groundwater geochemistry on selected islands of the Atoll. The program provides chemical and radiochemical data for assessment of water quality on those islands designated for rehabilitation. These and other data are used to interpret the mechanisms by which radionuclides are cycled in the soil-groundwater system. Because of the international concern over the long-term buildup, availability, and transport of plutonium in the environment, this program emphasizes analysis of the element. The results of the study show that on all islands sampled, small quantities of plutonium radionuclides have migrated through the soil columns and are redistributed throughout the groundwater reservoirs. The observed maximum surface concentrations are less than 0.02% of the maximal recommended concentration for drinking water. Concentrations of ^{137}Cs are found to correlate with water freshness, but those of ^{239,240}Pu show no such relationship. The mecnanisms moving ^{239,240}Pu through the ground water reservoirs are independent of the processes controlling the cycling of ^{137}Cs and fresh water. A reasonable linear correlation is found between mean surface-water concentrations and soil burdens. This indicates that the quantities of ^{239,240}Pu migrating to the groundwater surface layers are, to a first approximation, independent of the physical, chemical or biological characteristics of the islands. (auth)

Novikova, S. K. and E. B. Tyuryukanova. 1968. Distribution of ^{90}Sr in the Meadow-Steppe Zone Soils. Pochvovedenie. No. 12:46-52 (in Russian).

A higher content and a more uniform distribution of ^{90}Sr were observed in the chernozem soils of the meadow-steppe zone as compared with the south taiga zone. A maximum radioactive strontium content was found in upper horizons of chernozem soils and in calcareous horizons of calcareous chernozems. Strontium-90 penetrates as deep as 100 cm. A seasonal migration of ^{90}Sr is observed in the profile of chernozems. (auth)

Nowak, Z. 1971. The radiolysis of Diluent-TBP-HNO_3 Systems. Nukleonika. 16:133-42.

The effect was studied of nitric acid on the radiolysis of n-dodecane-TBP, mepasine-TBP, and odorless kerosene-TBP systems.

It was found that the yields of nitration products increase with growing nitric acid concentration, whereas the yields of oxidation products reach a maximum for 2-3 m HNO_3.

From the results of the investigation for one and two-phase systems as well as for systems free from TBP the conclusion may be drawn that nitration proceeds chiefly at the cost of the nitric acid forming ΔTBP complex. (auth)

Nugent, L. J., R. D. Baybary, and J. L. Burnett. 1973. Standard (II-III) and (III-IV) Electrode Potentials for Each Member of the Lanthanide and Actinide Series. ORNL-4891. Chem. Div. Annual Progress Report.

Standard (II-III) and (III-IV) electrode potentials are listed and plotted versus the atomic number for the actinides and lathanides. Measurement details, discussion of result significance and theoretical developments are presented elsewhere (Jour. Phys. Chem., 77, 1528, 1973).

Nuss, M. L. and R. Wey. 1956. Sur l'Adsorption des Cation Uranyles par la Montmorillonite. Bull. Groupe Fr. Argiles. 7:15-19.

One percent uranyl nitrate or acetate solutions were equilibrated with hydrogen based montmorillonite or koalinite, and as blanks, from pH 2 to 7. Uranyl ion adsorption increases from pH 2 to 7, and is reversible in an acidic system.

Nyhan, J. W. and F. R. Miera, Jr. 1975. The Distribution of Plutonium in Trinity Site Soils After 28 Years. Agronomy Abstracts. p. 124.

The soils of four intensive study sites located along the fallout pathway of Trinity, the first nuclear detonation, were sampled to determine plutonium distributional relationships and correlations with soil physical-chemical properties. Concentrations of ^{238}Pu and $^{239,240}Pu$ were determined for whole soil samples and for soil particles with diameter ranges of

<53 μm, 53-105 μm, 105-500 μm, 0.5-1.0 mm, 1-2 mm, and 2-23 mm as a function of soil depth and distance from ground zero. The horizontal and vertical natural variation of plutonium in these soils was determined by replicated sampling of soils from nine depths (to a maximum of 47 cm) and from nine locations within each hectare-sized study area. Soil physical, chemical and morphologic properties were compared with the distribution of plutonium in these soils. The radionuclide data from this study were compared with similar data obtained at the Trinity Site nearly 20 years ago. (auth)

Nyhan, J. W. and T. E. Hakonson. 1976. A Summary of Recent Studies of Soil Plutonium in the Los Alamos and Trinity Site Environs. LA-UR-76-318.

The soils of three liquid effluent-receiving areas within the Los Alamos Scientific Laboratory and along the fallout pathway of Trinity, the first nuclear detonation, were sampled to determine plutonium distributional relationships and correlations with soil physical-chemical properties. Radionuclide concentrations were determined for whole and fractionated soil samples as a function of soil depth and distance from either the liquid effluent outfall in Los Alamos or from Ground Zero at Trinity Site. The levels of ^{238}Pu and ^{239,240}Pu found in the soils of the three liquid effluent discharge areas at Los Alamos were correlated with levels of organic carbon, carbonates, exchangeable and water-soluble cations, pH, cation exchange capacity, and geometric particle size of these soils. The hydrologic and morphologic properties of the Trinity Site soils were correlated with the distribution of plutonium in these soil samples.

Total inventories of soil plutonium were estimated for each Los Alamos effluent-receiving area and a summer runoff event was sampled and evaluated as a radionuclide transport vector in the intermittent streams of one liquid effluent-receiving area.

Temporal changes in the distribution of plutonium in the Los Alamos and Trinity Site ecosystems were also considered. The horizontal and vertical distributions of plutonium in soils were compared with the waste use histories of the three liquid effluent-receiving areas at Los Alamos:

(1) an area which had not received radioactive effluents for a decade, (2) an area which has received plutonium effluents for two decades and will not receive additional input in two years, and (3) an area which has received effluents for a decade and will receive increased use in the future. The distribution patterns of plutonium in Trinity Site soils were compared with similar data collected over two decades ago. (auth)

Ohyoshi, E., A. Ohyoshi, and M. Shinagawa. 1970. Studies on Ruthenium Chlorocomplexes by Paper Electrophoresis. Radiochimica Acta. 13:1015.

Ru(III) and Ru(IV) chlorocomplexes have been studied using high voltage paper electrophoresis. This method, by which a number of species can be evaluated individually made it possible to determine the stepwise formation constants of complexes directly. Concerning the case of Ru(III) chlorocmplexes, a discussion was made on the treatment of the data obtained in the state having not yet been equilibrium. (auth)

Ojima, T. and H. Toratani. 1965. Behavior of Water in Soil Aggregates. II. Under Unsaturated Conditions. Nippon Dojo Hiryogaka Zasshi. 36:339-42.

Tritiated water was used as a tracer to investigate the movement of water through a soil aggregate column under several unsaturated conditions in the laboratory. The content of water was controlled at a certain level during an experimental period by dropping tritiated water on to the top of the aggregate column, shorter in length than the capillary rising height. The breakthrough curves of tritiated water and the amount of immobile water were obtained. The varying shape of the curves appeared to be attributable to the differences in the distribution of microscopic flow velocities in the unsaturated column with several water contents. The amounts of immobile water ranged from 0.0 to 2.5 cm^3 while the amounts of water in the sample were from 30 to 50 cm^3.

Ojima, T., H. Toratani, and H. Fujimoto. 1965. Behavior of Radioactive Strontium, Cesium, and Coablt in Marine Water. Ann. Rep. Radiat. Center Osaka Perfect. 6:93-7.

The physiocochemical behavior of ^{89}Sr, ^{90}Sr, ^{137}Cs, and ^{60}Co ions was studied in relation to pH of marine water, trace elements dissolved in it, fragments of marine organisms living in it, and sea sediments. (auth)

Ojima. T., H. Toratani, and H. Fujimoto. 1966. Retention of ^{137}Cs by Several Clay Minerals. Ann. Rep. Radiat. Center Osaka Prefect. 7:79-85.

Cesium retention was measured by treating suspensions of several clay minerals with a ^{137}Cs-labeled solution. The amount of cesium adsorbed by clays was distributed among three phases: exchangeable, 1<u>N</u> nitric acid soluble, and insoluble fixed. The greater amount of cesium was retained by vermiculite and illite. Cesium retained by vermiculite was trapped in the lattice by ammonium or potassium ions of the extracting solution. Cesium retained by illite could substitute for interlayer potassium and was fixed tightly. Sodium salts appeared to be the most suitable extractant for the cation exchange studies with the 2:1 layered-type clay minerals. (auth)

Okazaki, E. and T. T. Chao. 1968. Boron Adsorption and Desorption by Some Hawaiian Soils. Soil Science. 105:255-259.

Boron adsorption by low humic latosols of Hawaii was studied by equilibrating soils with boric acid solutions of known concentrations (10-50 ppm. B). Boron was adsorbed by the soils in a manner conforming to the Langmuir equation. Adsorption capacities of soils calculated from the equation were related to soil pH. Boron adsorption increased as pH values of soils were increased.

Desorption of adsorbed boron showed that boron adsorption by soils was not readily reversible. This would indicate that boron probably formed more than one type of reaction products in the adsorption process. Boron extraction or desorption from soils was found to be influenced by the length of heating of soil suspensions, soil-water ratios, and the number of extractions. Longer periods of heating, wider soil-water ratios, and greater number of extractions all tended to increase the recovery of native or added boron from soils. The relationship between boron adsorption-desorption and boron availability was briefly discussed. (auth)

Okuno, H. and H. Arino. 1960. The Removal of Contaminating Nuclides in Aqueous Solutions with Bentonite and Precipitants. Radioisotopes. 9:1-5 (in Japanese).

The coagulating and precipitating power of the carbonates and chlorides of Ba, Ca, Mg, and of $Al(OH)_3$ were studied in order to get the bentonites in compact and easily filtered forms. Fairly good separations of bentonites from aqueous phases were obtained without any decrease of the decontaminating capacities of the bentonites. Whether coagulating salts were present or not, nearly the same efficiency for Ce^{144} removal was obtained. (NSA)

Olafson, J. H. and K. H. Larson. 1961. Plutonium, Its Biology and Environmental Persistence. IN: Proceedings of the First National Symposium on Radioecology held at Colorado State University September 10-15. V. S. Schultz and A. W. Klemet, Jr. (eds.). pp. 633-639.

Even a cursory review of the literature pertaining to plutonium and the manifold manifestations of its toxicity leaves little doubt that it is an extremely hazardous material. Every effort should be made to minimize the extent to which man is exposed to it. Plutonium as an environmental contaminant would not, on the basis of the evidence presently available, appear to be a serious problem. Since it decays by emission of alpha particles, it presents no hazard in terms of external whole-body radiation. It is absorbed by plants growing on contaminated soil to an infinitesimal degree, although it may be found as an external contaminant on vegetation. Ingested plutonium is absorbed and retained in animal tissues to a very small degree. Therefore, relatively high levels in dietary constituents can be tolerated without producing a ponderable tissue burden. Extremely high levels of plutonium-239 are required to produce even superficial tissue damage in the digestive tract. Inhalation of airborne particulates remains as the most effective means of entry into higher animals, including man. But for this mechanism to produce a tissue burden, there must be significant airborne concentrations. The available information indicates that, even in localized regions having very high levels of deposited plutonium-239, the levels in air are, except for occasional periods, low in comparison to what is considered as tolerable concentrations for occupational exposure. Animal tissue assays have verified that very little plutonium gains entry into mammalian systems from the contaminated environment. While no one should be alarmed about concentrations of plutonium-239 in the environment of man, or more specifically in human beings themselves, we would urge caution in drawing conclusions regarding ecological implications. Are the present concentrations only the beginning of a continuously rising trend? This is a possibility because of extremely slow turnover rate and long half-life. Will the apparent tendency for plutonium concentrations in reproductive tissue to increase in time following acute exposure continue on a chronic basis? If so, will such tissues in time have concentrations of genetic significance? These are only a few of the obvious questions to which answers are needed before a final verdict is reached. While the prognosis is encouraging, based on our present knowledge, a much greater understanding of the whole complex of environmental reactions is needed. (auth)

Olafson, J. H., H. Nishita, and K. H. Larson. 1945. The Distribution of Plutonium in the Soils of Central and Northeastern New Mexico as a Result of the Atomic Bomb Test of July 16, 1945. UCLA-406.

Soils and plants from the area of central and northeastern New Mexico, which was contaminated by fallout from the atomic bomb detonation of July 16, 1945, were analyzed for plutonium. Plutonium was found in amounts up to 0.07 micrograms per square foot of soil, one-half inch deep, at a distance of 88 miles northeast of the site of detonation. A maximum of 1.47 micrograms per square foot, one-half inch deep, was found on the Chupadera Mesa at a distance of 28 miles northeast of the detonation site. No plutonium was found in samples collected 3 miles south of the site. In assaying for plutonium, the method of Eisenacher was adapted to soil and plant samples. An estimated precision of 15% was obtained when the method was applied to field samples. A recovery of 98.0 < 3.0% was obtained when the method was applied to a "standard" soil. Uranim and thorium do not interfere in this method even when they are present in quantities much greater than the maximum amounts normally found in soils. (auth)

Ondrejcin, R. S. 1974. Chemical Compositions of Supernates Stored in SRP High Level Waste Tanks. DP-1347.

High level wastes at SRP stored in carbon steel tanks as sludge, salt cake, supernate. Results of supernate chemical analyses of 16 tanks reported along with analysis for 17 radioactive species.

Lab results on mild steel corrosion seemed to be applicable to tanks containing actual supernate.

Onishi, H. and E. B. Sandell. 1955. Notes on the Geochemistry of Antimony. Geochim. et Cosmochim. Acta. 8:213-221.

The meteoritic abundance of antimony, based on chondrites, is about 0.1 p.p.m. The metal phase of chondrites contains ∿0.5 p.p.m. Sb. Antimony shows no decided preference for silicic or subsilicic rocks. The amount in igneous rocks (and in the upper lithosphere) is estimated as 0.1-0.2 p.p.m. Shales are variable in antimony, ranging from ∿0.1 p.p.m. to several parts per million; the average may be 1 to 2 p.p.m. Limestone and sandstone normally contain less antimony than shales. Bauxite and phosphate rock may contain as much antimony as the richest shales. Oceanic red clay (Pacific) contains ∿1 p.p.m. Sb, globigerina ooze a few tenths of a part per million. A rough estimate of the weight ratio Sb/As in the upper lithosphere is 0.1, not significantly different, when the experimental error is considered, from the value 0.05 for meteorites. Because of the low concentrations of antimony in igneous rocks and meteorites and the inadequate sensitivity of the photometric method, the abundance values for these must be looked upon as tentative.(auth)

Onishi, Y., P. A. Johanson, R. G. Baca, and E. L. Hilty. 1976. Studies of Columbia River Water Quality. BNWL-B-452.

The program undertaken by PNL to study the water quality of the Columbia River consists of two separate segments:

(a) Sediment and Radionuclide Transport Program, and

(b) Columbia River Temperature Analysis.

For the Sediment and Radionuclide Transport Program, quasi-two dimensional (longitudinal and vertical directions) mathematical simulation models have been developed for determining radionuclide inventories, their variations with time, and movements of sediments and individual radionuclides in the freshwater region of the Columbia River below Priest Rapids Dam. These codes are presently being applied to the river reach between Priest Rapids and McNary Dams for the initial sensitivity analysis. In addition, true two-dimensional (longitudinal and lateral directions) models have been formulated and are presently being programmed to provide more detailed information on sediment and radionuclide behavior in the river.

For the Temperature Analysis Program, river water temperature data supplied by the U.S. Geological Survey for six ERDA-sponsored temperature recording stations have been analyzed and cataloged on storage devices associated with ERDA's CDC 6600 located at Richland, Washington. (auth)

Ooms, R., P. Schonken, D. Olieslager, W. Baetsle' and M. D'Hont. 1974. Neptunium-Plutonium Separation on In-Organic Ion Exchanger Zirconium Phosphosilicate. J. Inorg. and Nucl. Chem. 36:665-670.

The conditions for sorption and elution of neptunium(IV) from nitric acid solutions on zirconiumphosphosilicate (ZPS) have been examined in batch and column experiments. Batch experiments have indicated that the fixation depends strongly on the acid concentration. The separation of Pu and Np can be performed on ZPS by a selective reduction of Pu(III) and Np(IV), respectively, with Fe(II) sulphamate in 0.35 M HNO_3. Only Np(IV) is retained on the ZPS column and can be eluated with 8.0 M HNO_3. (auth)

Ophel, I. L. 1973. Environmental Capacity of Fresh Waters for Waste Radionuclides. IN: Environmental Behavior of Radionuclides Released in the Nuclear Industry. IAEA, Vienna, pp. 613-624.

The maximum permissible human body burden of many radionuclides can be expressed as a specific activity, i.e., the amount of a radioisotope per unit weight of its stable counterpart. A similar concept can be applied to a large body of water that is providing water and food for man. It can be thought of as a pool or reservoir of stable elements that can dilute waste radionuclides down to specific activities less than those corresponding to the body burden. It is the size and the dynamics of this stable element pool that determine the environmental capacity of an aquatic ecosystem for a radionuclide. Results from a continuing study of strontium in an experimental lake (Perch Lake, Ontario) illustrate some of the factors that must be considered. Using elevated levels of ^{90}Sr, which have been present in the lake since 1955, it has been possible to investigate the dimensions and the dynamics of the various compartments that make up the stable strontium pool. Several of these compartments, such as lake water and some biota, have a fast turnover time (i.e., they rapidly attain a uniform specific activity); but they make up only a small fraction of the stable element pool. Other compartments of interest are the marginal vegetation and the semiaquatic animals, which cause a carry-over of ^{90}Sr into terrestrial food-chains and result in further dilution of the radionuclide. Bottom sediment is important, although a considerable fraction of the stable strontium in the sediment of Perch Lake has such a slow exchange with the lake water that it limits the effective size of this compartment. However, it is the trapping action of the sediment and the consequent removal of some radionuclides from the ecosystem that provides the continuing capacity of a lake to accept such radionuclides. (auth)

Ophel, I. L. and C. D. Fraser. 1957. The Chalk River Liquid Disposal Area, 1956. CRHP-709.

Five surface pits in the Chalk River Liquid Disposal Area have been used since December 1952 for the disposal of wastes containing fission products. The liquid Disposal Area is situated on elevated ground with low-lying swampy areas to the east and south. Since November 1955 the surface water of these swamps has been contaminated by the seepage of water containing several radioisotopes. Investigations show that three of the five disposal pits are contributing to this surface contamination. The streams and a lake receiving the drainage from these swamps also show low levels of contamination. Examination of the contaminated area shows Sr^{90} to be the most important of the radioisotopes present. The amounts of Sr^{90} present in the stream draining the area are not sufficient to raise the stream water to the drinking water tolerance concentration. Present levels of Sr^{90} in the plants and animals of the area do not constitute a hazard to man, and contamination is entirely confined to the Chalk River exclusion area. (auth)

Ophel, I. L. and C. D. Fraser. 1971. Fate of Cobalt-60 in a Natural Freshwater Ecosystem. CONF-710501-P1, pp. 323-327.

Perch Lake is a small dystrophic-eutrophic lake on the property of Atomic Energy of Canada Limited at Chalk River, Ontario. For seven years it has been receiving at a relatively constant rate small amounts of ^{60}Co via its inlet stream, resulting in low, but measurable, concentrations of this radionuclide in the lake water. During this time water and food-chain components were assayed for ^{60}Co content using a large-volume counter combined with a single-channel gamma spectrometer. Concentration factors were determined for the dominant species of aquatic plants, fish, and other biota. Large differences in accumulation were found between species of plants due to morphology of the plants and their location in the lake. Differences between fish species are correlated with their feeding habits. The vertical and horizontal distribution of radiocobalt in the bottom sediments was investigated. Most of the nuclide is confined to the upper few centimeters of the organic-rich deposits. Calculations indicate that the lake sediment is an important storehouse of cobalt and that approximately 30% of the ^{60}Co that has entered the lake is now resident on the bottom. (auth)

Ophel, I. L., C. C. Fraser, and J. M. Judd. 1972. Strontium Concentration Factors in Biota and Bottom Sediments of a Freshwater Lake. EUR-4800 (Vols. 1 & 2), pp. 509-30.

Evaluation of the capacity of aquatic ecosystems to accept waste radionuclides safely requires a knowledge of concentration factors in environmental materials and of the conditions which affect the magnitude of these factors. Stable element concentrations provide the best estimate of concentration factors which would be attained by the radioisotope under conditions of chronic contamination. Over a period of years the concentration factors of both stable and radioactive strontium in bottom sediments and biota were determined in a lake chronically contaminated with low levels of ^{90}Sr from radioactive wastes. Concentration factors (on a fresh weight basis) in six species of fish range from 450 to 1250; in 22 species of aquatic plants from 30 to 1300. Each species exhibits a characteristic concentration of the element. The strontium content of bottom sediments is strongly correlated with the amount of organic matter they contain. The specific activity of the strontium (dpm ^{90}Sr/g) appears to be uniform throughout the water and the lake biota, i.e., biological availability of the stable isotope and radioisotope is the same. In the upper 10 cm of bottom sediments, however, specific activity of the exchangeable strontium and of total strontium is only half that in biota and water indicating incomplete exchange of radionuclide and stable element in this layer even after fifteen years of exposure. (auth)

Orcutt, R. G., W. J. Kaufman, and G. Klein. 1956. The Movement of Radiostrontium Through Natural Porous Media. Prog. Rpt. 2. July 1-55 to June 30, 1956. AECU-3608.

The feasibility of discharging radioactive wastes into underground formations is dependent on the predictability of the movement of certain hazardous radioisotopic components. This progress report examines several theories concerned with the equilibria and kinetics of ion-exchange as they apply to estimating the rate of underground movement of radiostrontium. Laboratory studies were conducted with the objective of testing the applicability of these theories to estimating the displacement and dispersion of radiostrontium fronts in natural media. The porous media studies with both batch and column systems included several connate-water bearing sands, an agricultural soil, and a standard halloysite clay. The parameters investigated were the exchange capacity, various expressions of equilibria, the influence of calcium, sodium, and hydrogen ions on the rate of strontium movement, the hydraulic rate of liquid application, and the rate coefficients controlling the ion-exchange reactions. The results indicate that a proper application of existing ion-exchange theory will greatly reduce the uncertainties in estimating the rate of radiocontaminant travel through natural media and may ultimately provide criteria for the design of subsurface disposal systems. (auth)

Oak Ridge Laboratory. 1953. Health Physics Division Quarterly Progress Report for Period Ending Oct. 30, 1952. ORNL-1420.

Data are tabulated on effectiveness of commercial mixed-resin water-purification devices and of shale, the latter in connection with ground-water surveys of waste-storage pits. Brief summaries are included of progress on calculations of neutron tolerances, stopping power of fission fragments in gases, and energy distribution of multiply scattered electrons in foils and on experimental studies of direct counting of α activity on particle filters, measurement of neutron and γ radiation by high-frequency variation, x-ray dosimetry, film monitoring of fast neutrons, ionization of gases by α particles, and electron-attachment coefficients for various gases. Development of a recording scintillation detector to be mounted on an automobile for U prospecting is mentioned.

[illegible]howska, I. 1964. Radiostrontium in Soil and Plants in Warsaw District. Roczniki Panstwowego Zakladu Hig. 15:323-8 (in Polish).

Studies on radiostrontium levels in soil and plants were performed in the vicinity of Warsaw during 1962. Eighteen samples of soil (sandy soil) from 12 localities and 6 samples of white clover were analyzed. Radioactive strontium levels in soil varied from 1.4 to 18.5 mC/km^2 and in clover from 0.40 to 1.83 pC/g dry matter. These values are comparable to respective values from the literature. Radiocontamination with strontium was not alarming. (auth)

Orcutt, R. G., I. Naor, G. Klein, and W. J. Kaufman. 1956. Hydraulic and Ion-Exchange Phenomena in the Underground Movement of Radiostrontium. TID-7517, Pt. 1. pp. 191-211.

The design of underground disposal facilities for radioactive wastes requires a knowledge of the hydrodynamics and chemistry controlling the movement of exchangeable cations through natural porous media. Darcy's law is not entirely adequate for delineating the velocity distribution of various portions of a liquid moving through a porous medium. Ion-exchange is shown to greatly increase the storage capacity of geological formations and to retard the rate of movement of radioisotopes through the ground. This paper reviews the physical and chemical factors influencing the rate of travel of radiostrontium and considers the application of certain principles of chemical engineering and soil chemistry to the ground disposal of radioactive wastes. (auth)

Orlova, E. I. 1965. Migration of ^{90}Sr in the Ground Waters of Various Salt Compositions. Gig. Sanit. No. 7:46-50 (in Russian).

The distribution of ^{90}Sr in a water-bearing stratum is determined to a great extent by the salt content of ground waters. The main cations that may influence the migration of ^{90}Sr are natural strontium, calcium, manganese, and sodium. Investigations, carried out under both static and kinetic conditions, showed that the natural cations in natural water may be classified according to their capacity for decreasing the sorption of

^{90}Sr by minerals in the following order: $Sr^{2+} < Ca^{2+} < Mg^{2+} < Na^{+}$. The presence in the water of the most common anions (Cl^-, NO_3^-, SO_4^{2-}) had practically no effect on the sorption of ^{90}Sr by the sand. On the other hand the anions (PO_4^{3-}, CO_3^{2-}), with which strontium and calcium form weakly soluble compounds increased the sorption of ^{90}Sr by sand and this tended to reduce the migration capacity of the isotope in the water-bearing stratum. (auth)

Orlova, E. I., V. A. Smirennoya, and R. A. Chelysheva. 1973. Conduct of Certain Long-Lived Isotopes in Rocks in Case of Their Contamination with Nontechnical Effluents of the Atomic Electric Power Stations (AES). Gig. Sanit. No. 12:65-68 (in Russian).

As a result of studying the sorption of isotopes by loose mountainous rocks, the surface-active substances were found to affect the migration of Ru^{106} and Co^{60}, while Cs^{137} and Sr^{90} contained in effluents (not generated in the reactor) were present in a cationic form, which was well sorbed by rocks. (auth)

Orlova, E. I., V. A. Smirennaya, and R. A. Chelysheva. 1974. Migration of ^{60}Co in Loose Rocks Contaminated with Effluents from an Atomic Electric Power Station (AES). Gig. Sanit. No. 3:50-53 (in Russian).

In nontechnological effluents with detergents ^{60}Co changes into a chemical state that is not sorbed by rocks. The finding is that it is due to formation of negatively charged combinations of cobalt with trilon B. In order to diminish the migrating properties of ^{60}Co it is suggested to exclude trilon B from detergents used at AES. (auth)

Orcutt, R. G., M. N. E. Rifai, G. Klein, and W. J. Kaufman. 1957. Underground Movement of Radioactive Wastes. IN: Hearings on Industrial Radioactive Waste Disposal. 2:1227-53.

Several theories are presented for describing quantitatively hydraulic dispersion, ion-exchange equilibria, and ion-exchange kinetics as they apply to the movement of radioisotopes through natural porous media. Laboratory studies were conducted with radiostrontium and several natural exchangers to determine the applicability and limitations of these theories. The laboratory results do not conclusively establish that the maximum rate of strontium movement can be readily predicted under all circumstances. However, it is believed that the theories of dispersion and ion-exchange, when used in conjunction with field-scale tests, will serve to reduce greatly the uncertainties of ground disposal operations. The salient experimental results are summarized. (auth)

Oretega, A. J. and S. L. Ramos. 1967. Use of Saccharose in the Concentration of Liquid Radioactive Residues and in the Recovery of Fission Products. An. Real Soc. Espan. Fis. Quim. Ser. B. 63:345-52 (in Spanish).

Sugar was used in removal of nitric acid from Purex liquid wastes. Vanadium salts, 10^{-3} to 10^{-2} $\underline{M}$, catalyzed this reaction. Simulated Purex wastes were concentrated by evaporation, by a factor of 100, using sugar to destroy nitric acid and ammonium vanadate. The nitric acid molarity remained below 3 during the process. The final results indicated a yield of 22 moles of HNO_3 destroyed per mole of sugar. In the presence of vanadium, the corrosion products did not affect the reaction. Since sugar reaction products (oxalic acid, tartaric acid...) are good complexing agents of fission and corrosion products, no precipitation occurred. (NSA)

Osburn, W. S. 1965. Primordial Radionuclides: Their Distribution, Movement, and Possible Effect Within Terrestrial Ecosystems. Health Physics. 11:1275-1295.

Volumes of data regarding the static and dynamic distribution of primordial radionuclides and their possible effect on biota are scattered through the literature of a number of disciplines. This paper briefly summarizes the world-wide distribution of these naturally occurring radioactive materials and provides a more detailed account of their occurrence and movement within specific ecosystems. General pathways of nuclide distribution and sites of concentration are pictured by tracing radioactive substances from the long-lived primary material to the inactive end product. This tracing includes major environmental and biological transport mechanisms to which radionuclides are subjected during the course of their life span. Thus, the biology of these naturally occurring nuclides is reviewed. The ecological life history of various plants and animals are outlined and the radiosensitivity of the various stages are considered. Where stages of high radiosensitivity are coincidental with exposure to relatively high levels of background radiation, possible biological effects are discussed. Special attention is given to the interaction of ionizing radiation with other environmental stresses. (auth)

Osmond, J. K. 1964. The Distribution of the Heavy Radioelements in the Rocks and Waters of Florida. IN: The Natural Radiation Environment. Univ. of Chicago Press. pp. 153-9.

The anomaly of low Th and U contents in sedimentary rocks as compared with igneous rocks is discusses. A program was initiated to study the distribution of the heavy radioelements in the sedimentary rocks and waters of Florida. Alpha pulse-height analysis was used, and some preliminary data are given on the distribution of Th and U in the sedimentary rocks. An attempt was made to calculate the average Th and U contents in Florida rocks; they were found to be very sensitive to the estimated abundance of phosphorite beds and black sands. Data are also presented on the Th, U, ^{224}Ra, and ^{226}Ra contents of several surface and underground waters. (NSA)

Osterberg, C., N. Cutshall, V. Johnson, J. Cronin, D. Jennings, and L. Frederick. 1966. Some Non-Biological Aspects of Columbia River Radioactivity. RLO-1750-4.

The importance of the Columbia River, its estuary, and the adjacent ocean as a radioecology laboratory is emphasized. Radioactivity measurements have been made in sediments, water, and biota of the Columbia River and Pacific Ocean. Studies of sediment and water radioactivity are reviewed. Methods for measuring ^{65}Zn and ^{51}Cr in sediments and the nature of the binding mechanisms in sediments are described. Studies of ion exchange on sediments showed that less than 5% of the ^{65}Zn on Columbia River sediments was exchangeable. Of the three parameters measured, radioactivity in water was the most difficult due to the dilution factor. Methods for removing trace metals from water are compared. Chromium-51 is regarded as a positive and sensitive tracer of Columbia River water at sea because no other source of ^{51}Cr exists in the Northeastern Pacific Ocean. Development of techniques for measuring ^{65}Zn, ^{124}Sb, ^{54}Mn, and ^{51}Cr in the Columbia River plume at sea are discussed. (NSA)

Osterberg, C., L. D. Kulm, and J. V. Byrne. 1963. Gamma Emitters in Marine Sediments Near the Columbia River. Science. 139:916-17.

Samples from sediment cores collected at 26 different locations 5 to 35 miles offshore in and around Astoria Submarine Canyon were analyzed for gamma emitters. Chromium-51 and zinc-65 were the principal radionuclides found, although several fission products and natural potassium-40 were also present. Radioactivity fell off sharply with distance from the mouth of the Columbia River, indicating that the river serves as a common source of the artificial radionuclides. (auth)

Otgonsuren, O., V. P. Perelygin, and G. N. Flerov. 1969. Search for Transuranium Elements in Iron-Manganese Nodules. Dokl. Akad. Nauk SSSR. 189:1200-3 (in Russian).

Iron-manganese nodules have a number of advantages compared to other sources in the search for superheavy elements. The nodules are selective absorbents of a number of heavy elements such as Pb, Tl, Hg, and W with enrichment coefficients of 10^5 to 10^6 as compared to ocean water. The age of the nodules varies from a few hundred thousand to millions of years. The heavy element content in the nodule is protected from fission by cosmic rays. Nodule inclusions of organic and mineral origin can serve as fission product detectors in principle. Nodules collected from the bottom of the South Pacific Ocean were examined for fission product tracks under a microscope after etching with hydrofluoric acid. The observed track density was greater than could be accounted for by the uranium content and age of the nodules estimated by various methods. This difference could be due to the absorption of heavy elements, but the evidence is not conclusive. (NSA).

Ouchi, S., I. Ogawa, S. Masuda and M. Kurabayashi. 1970. Uranium Contamination of the Shinkawa River. PNC-N-831-70-2, pp. 91-8.

Low-level uranium liquid waste, about $1 \times 10^{-7} \sim 2 \times 10^{-7}$ μCi/cm^3 in gross beta activity, was discharged from Tokai Works to the Shinkawa River downstream for about 10 years. The total amount of uranium released is estimated to be about 64 mCi. Weight of this value calculated from chemical analysis is about 6×10^2 kg. According to results of routine monitoring, no appreciable increase of uranium contamination of the river water and mud was observed. Environmental surveys of the Shinkawa River were carried out, placing emphasis on the river mud. It was found that the uranium liquid waste was diluted several times in volume in the Junichogawa, and 50 to 100 times between the junction and mouth of the Shinkawa, progressively. The radioactivity level of the Junichogawa was about 100 times as high as that of background. For biota samples, crawfishes (Cambaroides Clarkii) from benthos, cracians (Carassius Auratus) from nekton, and reed from plant, the uranium content was determined by fluorometric analysis. No appreciable contamination was found in the animal samples, while the uranium content in some plant samples was a little higher than that of other natural samples. (NSA)

Ovchenkov, V. Ya. 1972. Radium Migration from Sites of Its Concentration Under Natural Conditions. IN: Radioekologicheskie Issledovaniya v Prirodnykh Biogeotsenozakh. Verkhorskaya, I.N. (ed.). Izdatel'stvo Nauka, pp. 147-53 (in Russian).

The results of laboratory experiments are corroborating the statement that, other conditions being equal, the passage of radium from natural substrates into the liquid fraction is determined by the nature of the substrate and the form in which the radioelement occurs in it. Radioactive rocks, clays, and soils contain but small amounts of mobile forms of radium. The desorption of radium from these substratas is quite insignificant. In sand and in sand with various admixtures, radium is less solidly bound and may, under certain conditions, pass practically entirely into the liquid phase. (auth)

Ovchenkov, V. Y. and D. M. Rubstov. 1972. Content of Radioactive Isotopes of the Uranium and Thorium Series in Soils. Radioekologicheskie Issledovaniya v Priodnykh Biogeotsenozakh. Verkhovskaya, I.N. (ed.). Izdatel'stov Nauka., p. 86-94 (in Russian).

Investigations of the radioisotope composition of soils in region with a high natural radiation background showed that the soils of sites with a high radiation level differ sharply from control sites in regard to their content of radioisotopes of the uranium and thorium series. A feature common to all the soils investigated is the presence of thorium in concentrations exceeding by 1.5 to 3.5 times the mean thorium content in the soils of the Russian plain. On the basis of this character, the region investigated may be recognized as a geochemical province. A high content of radioactive isotopes (with the exception of thorium) is found mainly in the 0 to 25 cm layer. The soils of radium sites contain high (as compared with the state of radioactive equilibrium with Th) amounts of $MsTh_1$, RaTh, ThX. Uranium-radium sites have a high uranium, radium, and thorium content in the upper horizons. At a depth of 25 to 125 cm (radium sites), a radioactive equilibrium is observed in the thorium series up to RaTh. The lower radiation level in radium sites is accounted for not only by the migration of isotopes but also by the decrease of RaTh and $MsTh_1$ in the process of radioactive decay. (auth)

Pak, A. I. 1974. Epigenetic Zoning and Genesis of Uranium Deposits in Weathering Crusts of Sand-Clay Formations. Metallog. Geokhim. Uzb. p. 48-53 (in Russian).

The weathering crusts formed in the littoral-marine and continental sedimentary rocks have three zones: (a) a surface oxidation zone, (b) a stratal oxidation zone, and (c) a cementation (reduction) zone. Zone (a) has an upper gypsiferous subzone with gypsum $\leq 80\%$, Mn oxides, and carbonates and silicates of U; a middle subzone of fractured rocks with goethite, hydrogoethite, gypsum, Mn oxides, and $CaCO_3$; and a lower, mottled oxidation subzone with goethite. The rocks in zone (a) were altered by atomic agents and ground waters with positive E_H (250 mV), presence of O, and content of U ($X \times 10^6$) ($X \times 10^3$) g/l. Zone (b) had three subzones: (1) complete oxidation (of organic matter), with hydrogeothite, hematite, and various supergene minerals including kaolinite, sepiolite, halloysite, and jarosite; (2) reddish brown rock characterized by hydrohematite, goethite-hydrogoethite, and high radioactivity; and (3) mottled oxidation with Fe hydroxides, native S, uranophane, etc. Rocks of zone (b) were altered by O-containing (0.2 mg/l) formation waters containing U ($X \times 10^{-5}$), Mo ($X \times 10^{-5}$), and Se ($X \times 10^{-4}$) g/l. Zone (c) has epigene minerals of U oxides; sulfides and carbonates of Fe, Mo, and Se; quartz, calcite, dolomite, etc. and has subzones, from top to bottom, of Se, U, and Mo mineralization. The subzone of U mineralization has pitchblende and sooty uranite associated with Fe disulfides (pyrite, marcaite, and melnikovite). (CA)

Palei, P. N. (comp). 1962. Analytical Chemistry of Uranium. Translated by N. Kaner. Israel Program for Scientific Translations Ltd.

Various chapters of this book of uranium deal with general information, chemico-physical properties and compounds, detection, determination (methods of analysis), methods of separation from accompanying elements, determination in natural materials and industrial products, and determination of impurities in pure uranium preparation.

Pal'shin, E. S., B. F. Myasoedov and A. V. Davydov. 1970. Analytical Chemistry of Protactinium. Translated by J. Schmorak. Israel Program for Scientific Translations Ltd.

Various chapters of this book on protactinium deal with general properties, analytical chemistry of the element and its compounds, detection, quantitative determination, and separation from accompanying elements.

Panel on Land Burial. 1976. The Shallow Land Burial of Low-Level Radioactively Contaminated Solid Waste. National Research Council. NAS, Washington.

1. The Panel on Land Burial believes no measurable harm to human health has resulted from the past and present practices in the land burial of solid low-level radioactive waste at the sites managed by the U.S. Atomic Energy Commission (AEC) (now the U.S. Energy Research and Development Administration, or ERDA) (see Section 3.3).

2. The Panel is not satisfied that the plan to exhume and rebury the presently buried solid low-level transuranium radioactive waste can be accomplished without a measurable degree of hazard to the employees so engaged. We see no merit in the concept. As a consequence of our concern, we urge a reexamination and a reevaluation of the possible risks and possible benefits to be obtained before such a project is undertaken (see Sections 5.4.3 and 5.4.4).

3. While the Panel believes that there has been, and will be, no measurable harm to man from past and present practices of land burial of solid low-level radioactive waste, we are not convinced that current practices should be continued indefinitely into the future. As a consequence of the large volume of such waste anticipated in the near future from the commercial nuclear industry, we believe that a strong effort should be directed toward improving old, or developing new, volume reduction techniques prior to final disposal. These efforts are essential, because the amount of available land suitable for use for waste burial is limited in many parts of the United States. Otherwise, it may be impossible to meet future demands for space. Additional study and improvement of the transportation system for waste is also basic to this concept (see Section 5.2).

4. This Panel also urges that there be an economic and technical reassessment of and research into the methods for recovery of useful fissile and non-fissile materials that can be recycled into the energy chain or used otherwise (see Section 5.2.7).

5. The comments of this Panel, in accord with our charter, are primarily directed at the past and present practices of the U.S. Energy Research and Development Administration. However, they must also be construed as pertaining to other governmental agencies at all levels. These include not only federal agencies, but also those of state and local governments (see Section 6.3).

6. This Panel is seriously concerned with the land burial problem that will present itself with the dismantling of present commercial nuclear power reactors as they become obsolete and are replaced. We believe much more thought must be given to the design of the fabric or basic structure of the buildings housing future commercial power-generating reactors, in order that their useful life can be extended even though their internal operational parts are replaced.

In other words, the Panel believes that reactors and other nuclear facilities should be specifically designed so that the radioactive parts of the power plant or other functional parts of the system could be removed and replaced at the end of their useful life without having to destroy or abandon the shielding, building walls, and other portions of the total facility. In this way, the future need for the disposal of solid low-level radioactive waste may be substantially reduced. Safe dismantling of the present monolithic, nearly indestructible structures of contemporary commercial nuclear power-generating stations presents a most difficult task. The methods for separation of the radioactive fraction of the debris from these structures for disposal cannot be considered lightly. This problem includes the dismantling and decommissioning of commercial nuclear power reactors, as well as of other commercial and ERDA nuclear facilities. The problem has not been discussed or presented in the body of this report, but is a general concern of the Panel.

7. The Panel is aware of ERDA's policy of not establishing any unnecessary additional land burial sites for solid low-level radioactive waste. Because of the anticipated volume of such waste to be produced in the foreseeable future, the Panel believes that this policy should be reconsidered in connection with current and long-term needs of the nuclear industry and in view of all other recommendations of this report and other current developments (see Sections 3.3.2 and 7).

8. At present, ERDA has set an upper limit of 10 nanocuries of transuranium nuclides per gram of waste; above this level, waste cannot be buried. This limit was empirically established by referring to a range of radioactivity produced by natural radium in the earth's crust. The Panel believes that this criterion needs further careful study and evaluation, because the original assumptions may be modified by more recent data on the biological and ecological effects of low levels of radiation for occasional or long-term exposure. The Panel understands that ERDA initiated a study of this question in September 1975, which should be completed in early 1977. The results of this study should be reviewed critically by outside experts at that time (see Sections 3.3.2 and 6.3).

9. The Panel believes that a permanent final repository for solid waste contaminated with transuranium nuclides must be established without delay. This will obviate the undesirable "20-year retrievability" program for such waste and will materially reduce hazards to the handlers and operators (see Section 6.2).

10. The Panel believes that the amount of all radioactive materials that escapes from burial sites to the public domain must be monitored continually and reported periodically and frequently to the public. The Panel also believes that such reporting of leaks to the public needs to be accompanied by better public education or information on the nature of the potential hazards involved (see Section 5.8).

11. The Panel believes that a careful study should be made of the actual rate of migration of transuranium nuclides under a wide range of field conditions (e.g., humidity, soil type, concentration, type of effluent, etc.) (see Sections 5.4.4, 5.8.2, and 6.1).

12. The Panel has noted that in the past, not enough thought or study has been given to the selection of sites for the near-surface burial of solid low-level radioactive waste. It has given a list of types of information needed for complete characterization of potential sites before introduction of radioactive waste should be permitted (see Section 5.7).

13. The Panel notes that the present annual rate of production of solid low-level radioactive waste at ERDA sites (measured by volume) is approximately equivalent to the volume of solid waste produced annually by a representative town in the United States with a population of 55,000 (see Section 3.3.1). The amount of commercial solid radioactive waste now being produced (1976) is about the same, but will increase dramatically (see Section 1.2).

14. The Panel has made a series of recommended general principles for the burial of radioactively contaminated solid waste (see Section 2). (auth)

Panel on Radioactivity in the Marine Environment. 1971. Radioactivity in the Marine Environment. Committee on Oceanography, National Academy of Sciences, National Research Council.

This is a summary of what has been learned about radionuclides in the marine environment since publication of NAS-NRC Publication No. 551, The Effects of Atomic Radiation on Oceanography and Fisheries, in 1957.

Papadopulos, S. S. and I. J. Winograd. 1974. Storage of Low-Level Radioactive Wastes in the Ground: Hydrogeologic and Hydrochemical Factors with an Appendix on the Maxey Flats, Kentucky, Radioactive Waste Storage Site: Current Knowledge and Data Needs for a Quantitative Hydrogeologic Evaluation. EPA-520/3-74-009.

Hydrogeologic criteria presented by Cherry and others (1973) are adapted as a guideline to define the hydrogeologic and hydrochemical data needs for the evaluation of the suitability of proposed or existing low-level radioactive waste burial sites. Evaluation of the suitability of a site requires the prediction of flow patterns and of rates of nuclide transport in the regional hydrogeologic system. Such predictions can be made through mathematical simulation of flow and solute transport in porous media. The status of mathematical simulation techniques as they apply to radioactive waste burial sites, is briefly reviewed, and hydrogeologic and hydrochemical data needs are listed in order of increasing difficulty and cost of acquisition. Predictive modeling, monitoring, and management of radionuclides dissolved and transported by ground water can best be done for sites in relatively simple hydrogeologic settings; namely, in unfaulted relatively flat-lying strata of intermediate permeability such as silt, siltstone and silty sandstone. In contrast, dense fractured or soluble media and poorly permeable porous media (aquitards) are not suitable for use as burial sites, first, because of media heterogeneity and difficulties of sampling, and consequently of predictive modeling, and second, because in humid zones burial trenches in aquitards may overflow. A buffer zone several thousands of feet to perhaps several miles around existing or proposed sites is a mandatory consequence of the site selection criteria. As a specific example, the Maxey Flats, Kentucky low-level waste disposal site is examined. (auth)

Park, W. H., E. H. Lee, S. B. Kim, and M. U. Lee. 1965. Survey of Radioactivities in Field Water and Soil. Kisul Yon Guso Pogo. 4:57-9 (in Korean).

Radioactivities in field water and soil were measured in 1965. Results showed that: gross beta-activities in field water ranged from 19.3×10^{-5} μCi/l to 0.16×10^{-5} μCi/l and no appreciable differences from the average of $\sim 10^{-5}$ μCi/l compared with those of underground water were found; gross beta-activities of soils ranged from 25.06×10^{-4} μCi/100gr to 0.44×10^{-4} μCi/100gr and was $\sim 10^{-4}$ μCi/100gr levels on the average; and higher activities appeared in the first half year. (auth)

Parker, F. L., M. A. Churchhill, R. W. Andrew, B. J. Frederick, P. H. Carrigan, J. S. Cragwall, S. L. Jones, E. G. Struxness, and R. J. Morton. 1966. Dilution, Dispersion, and Mass Transport of Radionuclides in the Clinch-Tennessee Rivers. ORNL-P-2328.

A comprehensive cooperative study, by state and Federal agencies and the Oak Ridge National Laboratory, of the fate of nuclides discharged to the Clinch River has been successfully concluded. Analyses of water samples indicated that the major radionuclides discharged to the Clinch River in the 20 years, 1944 through 1963, were ^{90}Sr, 1110 C; ^{137}Cs, 660 C; ^{106}Ru, 6600 C; TRE, 1240 C; and ^{60}Co, 270 C. A mass-balance analysis of the ^{90}Sr, ^{137}Cs, ^{60}Co, and ^{106}Ru in Clinch and Tennessee rivers below ORNL was made, covering a period of 2 years and 160 river miles. Water samples proportional to flow were analyzed for both radioactive and stable chemical elements. A good balance was found in the Clinch River between the input and output of radionuclides, except for ^{137}Cs. Tracer tests in the river show that dispersion at all flow rates causes practically uniform distribution of the radionuclides before reaching the water intake of the Oak Ridge Gaseous Diffusion Plant. Diffusion coefficients were calculated and a mathematical model formulated for the movement of radioactive materials through the Clinch River. By theoretical analyses and field tests, it was shown that the momentary minimum dilution of ORNL wastes in the Clinch River was reduced to a dilution factor of 54 for summer conditions and 17 for winter conditions at ORGDP. These minimum dilutions persist for very short periods of time. Results of the study were compared with those for other streams receiving low-level radioactive wastes. For the rivers investigated with low organic content and comparable velocities, it can be concluded that a catastrophic large-scale release of radioactive material already stored in the river system would not occur, even as a result of major changes in flow, pH, or in oxidation-reduction potential. (auth).

Parker, F. L., B. J. Frederick, and P. H. Carrigan. 1964. Movement of Radionuclides in the Clinch River. ORNL-P-605.

The effects of temperature on the movement of radionuclides in the Clinch River, a highly regulated river with stratified flow, was studied using Rhodamine B dye as a tracer. The dispersion of the dye was followed by fluorometric measurements at various sampling stations. The effects of water released from Melton Hill Dam on water flow and mixing of radioactive waste effluents from White Oak Creek, that discharges waste from Oak Ridge National Laboratory, were determined for various temperature profiles. (NSA)

Parker, M. 1966. Studies on the Distribution of Cobalt in Lakes. COO-1281-5.

A study was made of the distribution of cobalt between the liquid and solid (suspended particles) portions in 8 lakes in Wisconsin. Samples were taken from various depths. Seasonal changes in distribution, differences in distribution in various lakes, and evaluations of the causes of various distributions are presented. (NSA)

Parsons, P. J. 1960. Movement of Radioactive Wastes Through Soil. 1. Soil and Ground-Water Investigations in Lower Perch Lake Basin. CRER-932.

An investigation of soil and ground water has been made in Perch Lake Swamp where fission products are moving through the soil away from the waste disposal area 'A' towards Perch Lake situated 2400 ft to the south.

A network of standpipes was installed to supply elevations for contouring the water table and to estimate the direction of groundwater flow.

Soil samples were collected from boreholes in the overburden and tested for permeability and porosity. Results show that the swamp lies in a bedrock depression that is lined with glacial till and silt. The principal deposits are sands (50 to 70-ft thick) that contain a continuous clay band 35 ft beneath ground level. The fission products move through the sands above this clay layer and their predicted path has been plotted.

There is no known path by which radioactive ground water can seep into the fissures of the bedrock basin.

Results from tritium-tracer experiments by the Environmental Research Branch have been used to establish a local relationship between the measured ground water velocities and those calculated from soil test results.

It is estimated that the fastest stream of ground water will take 13 years to flow from South Swamp to Perch Lake.

A soil-sampling program is in progress, using a new type of sampler, to determine the exact limits of migration of the fission products in the soil outside the disposal area. (auth)

Parsons, P. J. 1961. Movement of Radioactive Waste Through Soil. 3. Investigating the Migration of Fission Products from High-Ionic Liquids Deposited in Soil. CRER-1018.

One of the disposal areas for radioactive waste from the Chalk River Project was in use from 1946 until 1955. Although this was mainly used for the burial of solid waste, three batches of liquid were fed into the soil and these caused radionuclides to percolate away from the area by the natural movement of ground water. A soil investigation was made to find the extent of this migration and a special soils sampler was developed to carry out intensive sampling in the regions neighbouring the disposal area. The investigation is described and the results interpreted to determine the total quantity of each fission product that moved, together with the present rate of advance. The migration is delineated. Sr^{90} was the radionuclide in greatest abundance and the future pattern of its movement was predicted; it was estimated that no major release from this source to the environment will occur for 150 years, when it will have decayed sufficiently to present a negligible hazard. (auth)

Parsons, P. J. 1962. Movement of Radioactive Waste Through Soil. 4. Migration from a Single Source of Liquid Waste Deposited in Porous Media. CRER-1077.

A soil survey was carried out in a wooded region surrounding a disused plant where waste liquid fission products were concentrated. During operations in 1954 acid waste containing complexing agents and more than 1000 nominal curies of mixed fission products was poured into a pit excavated in dry sand and lined with limestone. Radionuclides migrated in the groundwater away from the disposal pit and the pattern of this movement was investigated by intensive sampling with a multiple soil sampler. Ru^{106} migrated rapidly soon after the disposal. This was followed by a slower moving Sr^{90} that developed into a continuous tongue 650 ft long, containing 800 curies. No other radionuclides were found in the tongue. It is estimated that Sr^{90} will escape into surface waters in about 30 years. However, the rate of release will not cause the concentration in a nearby drainage stream to rise above the maximum permissible concentration for occupational workers (ICRP). Figures and tables are included. (auth)

Parsons, P. J. 1962. Movement of Radioactive Waste Through Soil. 5. The Liquid Disposal Area. CRER-1089.

Two seepage pits, used for the routine disposal of water containing low-level radioactive wastes, were examined by a soil and groundwater survey. Reactor Pit 2 received 1.75×10^8 gallons and absorbed 11000 curies of soluble β-emitting radionuclides with 90 g Pu. Of these, 87 curies migrated as cations and the weak front of this movement, containing Sr^{90}, Co^{60}, Cs^{137}, and Ce^{144}, is expected to be released into the runoff of a nearby swamp in 4 years. The Chemical Pit, used for the disposal of low-level moderately acid waste accumulated 500°C of total β and 50 g Pu. It recently released Sr^{90} and Co^{60} into a nearby swamp three months after receiving a disposal containing high concentrations of complexing agents. Soil and groundwater sampling showed that the ion-exchange capacity of the soil was greatly reduced and that the escape of Co^{60} will increase to roughly three times its present value. The escape of Sr^{90} is not expected to increase. (auth)

Parsons, P. J. 1963. Migration from a Disposal of Radioactive Liquid in Sands. Health Physics. 9:333-342.

A soil survey has been carried out in a wooded region of the Chalk River Project where an isolated plant had been built to concentrate liquid fission products. During its operation in 1954 over 1000 gal of acid waste, containing complexing agents and over 1000 c of Sr^{90}, was poured into a pit lined with limestone. Intensive soil and ground water sampling have located and defined a migration pattern in the groundwater. Undisturbed samples of sand were collected from beneath the water table and a multiple sampler was used to obtain sand samples for radiochemical analysis from various depths in the same hole.

Ruthenium migrated rapidly from the disposal travelling at about the same rate as groundwater; this has been followed by slower-moving Sr^{90} that has developed into a continuous tongue 650 ft long and containing 800 c. It has been estimated that Sr^{90} will be released to the environment in about 130 years but that the rate of releas into a nearby stream will not cause the concentrations of this radionuclide to rise above drinking-water tolerance. (auth)

Parsons, P. J. 1962. Underground Movement of Radioactive Wastes at Chalk River. IN: Proc. Conf. Ground Disposal of Radioactive Wastes, 2nd, Chalk River, Canada, September 1961. J. M. Morgan, D. K. Jamison, and J. D. Stevenson (eds.) TID-7628.

One of the disposal areas for radioactive waste from the Chalk River Project was in use from 1946 until 1955. Although this was mainly used for the burial of solid waste, three batches of liquid were fed into the soil and these have caused radionuclides to percolate away from the area by the natural movement of ground water.

A soil investigation was made to find the extent of this migration and a special soil sampler was developed to carry out intensive sampling in the regions neighbouring the disposal area.

The investigation has been described and the results interpreted to determine the total quantity of each fission product that has moved, together with the present rate of advance. The migration has been successfully delineated.

Strontium-90 was the radionuclide in greatest abundance and the future pattern of its movement has been predicted; it has been estimated that no major release from this source to the environment will occur for 150 years when it will have decayed sufficiently to present a negligible hazard. (auth)

Pashneva, G. E., T. P. Slavnina, and V. V. Serebrennikov. 1965. Rare Earth and Thorium Content in Soils of Tomsk Region. Izv. Sibirsk. Otd. Akad. Nauk SSSR. No. 4 Ser. Biol.-Med. Nauk. No. 1:48-52 (in Russian).

The concentration of rare earth elements, Y, and Th in leached black earth podzolic, turf podzolic, light gray wood, dark gray wood, meta, and river alluvial soils of the tomsk region was determined. The concentration of Th and rare earth elements in the soils depend on the quantity of humus and increases with the increase of the concentration of humus in the soil. The distribution of Th in these soils depends on the development of turf and podzolic processes. The concentration of Th increases in the upper humus-accumulation horizon because of biogenesis and in the alluvial horizon because of the erosion of its eluvial horizon where the concentration of Th is lower than in the A_1, B_1, and B_2 horizons. The percent relation of rare earth elements shows that in the soils studied the rare earth elements of a cerium group predominate, with the exception of turf podzolic and light ray wood soil which have a comparatively high concentration of Er. (auth)

Pashneva, G. E., T. P. Slavnina, and V. V. Serebrennikov. 1965. Rare Earth Elements, Y, and Th in Biosphere and Soils. Tr. Tomsk. Gos. Univ., Ser. Khim. 185:44-50 (in Russian).

The rare earth (RE) elements and Th were determined in the principal soils of the Tomsk region. The soil samples were taken from genetic horizons of sections up to a depth of 2m. A total of 44 samples from 7 sections was studied. The soils were all virgin ones. In leached-out chernozem and meadow soil with high Fe content the greatest amounts of humus were found, namely, 8.43 and 10.31%, respectively. In podzol soil only 1.32% humus was found. The content of RE elements increases with humus content. An exception is meadow soil with increased Fe content. In those soils where the biogenesis plays a great role, an increased Th content is found in the upper horizons with a gradual decrease with depth. Eluvial soils which are characterized by the loss of the products of soil formation are distinguished by a reduced Th content. In the illuvial soils an accumulation of Th is found. Th accompanies mobile humus. The principal mass of the RE elements in the soils studied is made up of the Ce group. Only in some cases there is an increased Er content. The Y content in all soils is similar and varies from 2-8% of the total amount of RE elements. A comparatively high content of Sm (23.2%) is observed in Fe-enriched meadow soil and dark-gray forest soil (30.4%). The Ce content in alluvial soil is high (55%). The content of La is 15.2 and of Nd 17.1%. Leached-out chernozem is rich in Pr and Nd (36.5 and 41%, respectively). RE elements with even numbers prevail over those with odd numbers. The mother soils differ considerably in the content of the various RE elements. (CA)

Patin, S. A. and V. N. Tkachenko. 1971. Accumulation of Artifical Radionuclides in Shallow Water Deposits of the South Atlantic. At. Energ. (USSR). 31:72-4 (in Russian).

Data on the artificial radioactivity in samples of sludge deposited in the southern Atlantic Ocean (off the eastern coast of South America) in 1967 to 1968 were obtained. Concentrations of ^{95}Zr-^{95}Nb and ^{106}Ru-^{106}Rh were recorded in pCi/kg of dried sediment. A tendency was observed for activity to decrease from north to south. (NSA)

Patterson, J. H., G. M. Matlack and G. B. Nelson. 1974. The Interaction of $^{238}PuO_2$ Heat Sources with Simulated Terrestrial Environments. Am. Nucl. Soc. Trans. 19:33-34.

Environmental chamber work showed that rain on large chunks of $^{238}PuO_2$ at 200°C led to an increase of release rate of 0.04 μCi/month to 4.0 μCi/month due to spallation. Fines were at ambient temperature and actually decreased in release rate from 0.8 μCi/month to 0.4 μCi/month.

Patterson, J. H., G. B. Nelson and G. M. Matlack. 1974. The Dissolution of ^{238}Pu in Environmental and Biological Systems. LA-5624.

Results from our experiments on dissolution rates of $^{238}PuO_2$ and $^{239}PuO_2$ in distilled water and normal saline solution were compared with rates calculated from data in the literature on various PuO_2 dissolution experiments. The initial comparatively rapid dissolution rates were found to vary widely, even between experiments performed ostensibly under the same conditions. In contrast, the lower rate of dissolution, which began a few hours after contact of the oxide with the aqueous medium, was found to be constant and fell within a range of 1 to 6 ng/m^2s under widely varying conditions. (auth)

Pavlotskaya, F. I. 1970. Correlations Between Rates of Entry of ^{90}Sr from the Atmosphere, Its Content in Soil Cover and Quantity of Precipitation. AEC-tr-7128, pp. 214-34.

The effects of atmospheric precipitation on the abundance of fallout ^{90}Sr in soil surface layers were examined. Data on ^{90}Sr deposition and amounts of precipitation, measured at locations on three continents, are presented. It is concluded that dry fallout is responsible for an important addition to the total deposit of radioactive strontium on the ground, that the influence of atmospheric precipitation on the abundance of radioactive fallout must be very carefully evaluated, and that the degree of ^{90}Sr removal from the soil surface by precipitation depends on the intensity of fallout, climatic conditions, physicochemical properties of the soils, and the form of radioactive strontium in fallout and soil. (NSA).

Pavlotskaya, F. I. 1973. Relative Mobility, State and Forms of Existence of Strontium - 90, Stable Strontium, and Calcium in Soils. INIS-mf-1040 (in Russian).

The purpose of the study is to generalize the data obtained on the relative mobility, state and forms of existence of ^{90}Sr, stable strontium and calcium in soils as a function of the time of carrying out of the experimental nuclear blasts and of an ensemble of various natural factors. Observed differences in the mobility of ^{90}Sr, stable strontium and calcium in various types of soils are caused by quantitative differences in content in water-soluble, exchange and non-exchanging states, and also in the forms of existence in the water-soluble state (cationic, anionic or neutral). The form of existence in turn is determined by the physical-chemical properties of the soils and their genetic structure, by agro-meteorological conditions, by the type of plant cover, by sources of entry into the soil, and by the time of interaction with the soil. The high mobility of ^{90}Sr in comparison with stable strontium indicates that isotopic exchange requires time and that complete isotopic equilibrium has not yet been attained. This fact should be kept in view in studying the biogeochemical aspects of the behavior of these isotopes. (NSA)

Pavlotskaya, F. I. 1974. Migration of Radioactive Fallout Products in Soils. Atomizdat.

The effect of the physical and chemical properties of the main, long-lived radionuclides on their behavior in soils is considered. Particular attention is devoted to the specific behavior of the radionuclides, the role of primary soil particles (genesis, chemical and mineralogical composition, crystal structure, etc.) and of organic matter of soils in processes of absorption and the binding strength of radionuclides with soils. An attempt is made to establish the chemical composition of compounds which settle on the earth's surface and migrate into the soils. (NSA)

Pavlotskaya, F. I., G. N. Arnautov, and M. I. Blokhina. 1973. Connection Between Strontium-90 and Various Fractions of the Organic Substance of Soils. INIS-MF-1031 (in Russian).

An attempt is made to explain the character of the distribution of radioactive Sr, Ca, Fe, Al, and organic C among the individual fractions of organic substances of the soil and to explain the dependence between the results obtained. The data obtained on the character of the distribution of ^{90}Sr among different groups and fractions of organic substances of the soil and the form of occurrence in these fractions led to the conclusion that ^{90}Sr is present in soils basically not in the form of individual compounds with organic substances but in the form of complicated complexes. (NSA)

Pavlotskaya, F. I., M. I. Blokhina, and G. N. Arnautov. 1972. Distribution of ^{90}Sr into Groups and Fractions in Organic Matter of Soils. INIS-MF-887-3, pp. 77-88 (in Russian).

The nature of the distribution of ^{90}Sr, Ca, Fe, and Al into the respective groups and fractions of the organic matter of soil is explained, and the forms which they assume in the fractions concerned are listed. The tabulated results show that a considerable amount of ^{90}Sr is linked to the organic matter of soils, and after the precipitation of humus acids, another considerable part is linked to acid solutions. In the soils investigated, the principal part of ^{90}Sr was linked to the components of organic substances with lower molecular weight. ^{90}Sr can be found in soils in the form of a complex compound containing humus acids, specific organic substances, minerals, Ca, Fe, Al, and other elements. Depending on the solubility of the compounds the proportion of ^{90}Sr in mobile state increases or decreases. (NSA)

Pavlotskaya, F. I. and E. B. Tyuryukanova. 1967. The Influence of Natural Conditions on the Content and Distribution of Radioactive Strontium in the Soil Cover. A/AC.82/G/L-1175 (in Russian).

The content of radioactive strontium in the soil cover, apart from the level of its influx from the atmosphere, depends on the type of soil, the form of vegetation, the hydrometeorological conditions, the geomorphological composition of the area, and other natural factors. The latter explains to a significant degree the irregular character of the distribution in the landscape. The rate of accumulation of ^{90}Sr in the soil cover at different depths (up to 20 cm) during 1960 to 1963 was on an average 20 to 30% lower than its accumulation rate on the earth's surface, which indicates its erosion from the surface level. On an average the content of ^{90}Sr in the soil cover in 1960 to 1963 increased by 2. The latitudinal character of its distribution on the earth's surface continued to be maintained. During the selection of samples of soil cover for evaluation of its level of contamination and for investigation of the character of the distribution on and uptake by the soil, it is necessary to take into account the landscape-geochemical characteristics of the territory studied. (auth)

Pavlotskaya, F. I. and L. N. Zatsepina. 1965. Different Process of Deposition of Some Fission Products on the Ground. NP-16525 (in Russian).

The character of the distribution of the radioactive fission products between soluble and nonsoluble parts of the radioactive fallout depends on the chemical properties of the isotopes, quantity of the solid phase, type of radioactive fallout, and their physical states. The form of the occurrence of radioisotopes (cation, anion, neutral) in the soluble parts of the radioactive fallout is determined by the chemical state of the element and the chemical state of the solution. The degree of mobility of the radioactive isotopes, accumulated in the solid phase, depends on the chemical state of the solid phase, the properties of the isotope, and the time, from the moment of the nuclear explosion to the deposition of the fallout on the ground. The further behavior of the radioisotope on the ground is determined, aside from the property of the compound, by the form in which it is released from the atmosphere, combined with the natural conditions in which it falls. (auth)

Pavlov, V. V., I. E. Konstantinov, and G. A. Fedorov. 1971. Gamma Emission in Soil as a Result of Radioactive Fallout. At. Energy. (USSR) 31:639-40 (in Russian).

The gamma radiation field of a soil sample was studied on the basis of a volumetric source with sharply decreasing concentration of radioactive material according to depth. Exponential approximations were compared with accurate but complex functions of radioisotope concentration with reference to depth of penetration in the soil. (NSA)

Pazdernik, J. 1969. Radioactivity of Surface and Ground Waters. Vod. Hospod., B. 19:80-1 (in Czech).

A brief survey is given of radiochemical methods used for determining both the natural and artificial radioactivity of water in the most important waterworks and streams in Czechoslovakia. The main purpose of studying the radioactivity of waters is to determine conditions under which the quality of river and groundwaters is in accordance with act No. 34/1963 of the CSSR digest, and to ascertain and restrict the influence of radioactive pollution sources on surface and groundwaters according to the act. The following methods for determining natural radioactivity are mentioned; the extraction dithizone method for ^{210}Pb determination; the ion exchange method; the chemical precipitation and evaporation method for total beta activity measurement; fluorometric and spectrophotometric methods for Th determination; the classical emanometric method; and the scintillation method for ^{226}Ra determination. As for artificial radioactivity, a brief account is given of ^{90}Sr and ^{137}Cs determination. (NSA)

Pearce, D. W. 1957. Disposal of Radioactive Liquid Wastes to the Ground at Hanford. <u>IN</u>: Hearings on Industrial Radioactive Waste Disposal. 2:1124-71.

Low level liquid waste disposal to the ground at Hanford has been supported between a closely correlated and balanced program of theoretical study, laboratory and field experiment, and observational experience. Extensive effort in geology and hydrology, mineralogy and soil chemistry, analytical chemistry, and engineering has been applied to ground disposal problems. The more important findings from the research and development in each of these areas are outlined to show how this applies to plant practice, and indicate in general the future course of the work. (auth)

Pearce, D. W. 1957. Radioactive Waste Management Operations at the Hanford Works. Pt. 5. Disposal of Intermediate and Low-Level Wastes to the Ground. <u>IN</u>: Hearings on Industrial Radioactive Waste Disposal. 1:308-18.

Intermediate and low-level waste from Hanford is disposed to swamps, cribs, and trenches. To ensure containment of the radioisotopes on the soil column, various waste streams from the plant are kept separate. Standards on the disposal of radioactive liquids are given. (NSA)

Pearce, D. W., C. E. Linderoth, J. L. Nelson, and L. L. Ames. 1959. A Review of Radioactive Waste Disposal to the Ground at Hanford. IN: Disposal of Radioactive Wastes. IAEA, Vienna. pp. 345-63.

The disposal of radioactive wastes to the ground from the Hanford separations plants is summarized; volumes of wastes and contained curies discharged to swamps, trenches, and cribs are presented. Significant literature on ion-exchange studies using Hanford soils is reviewed. A field experiment with a model crib is described; preliminary findings indicate that spreading a waste solution below a disposal facility may be of greater benefit in disposal operations than previously assumed. Further studies with the calcite-phosphate reaction are reported; significant variables which affect Sr^{2+} removal are calcite surface area, pH of the influent, flow rate, temperature, and phosphate ion concentration. Bone-seeking radioisotopes are also removed from F^- solutions when contact is made with calcite. The zeolite clinoptilolite shows high selectivity for Cs^+ even in the presence of increased Na^+ concentration. The effect of the large-scale ground disposal operation at Hanford is described by means of a map and geological cross sections showing areas and volumes of ground and ground water contamination. (auth)

Penna-Franca, E. 1967. Radiochemical and Radioecological Studies on Brazilian Areas of High Natural Radiation. NYO-3273-9.

Studies of high natural radioactivity areas included a monazite sand region (Guarapary-Meaipe) and two volcanic regions (Araza and Morodo Ferro). Radium and thorium body burdens and somatic chromosome damage were estimated at Araza. (auth)

Pennington, W. and J. P. Lishman. 1971. Iodine in Lake Sediments in Northern England and Scotland. Biol. Rev. 46:279-313.

1. In these profiles there is no evidence for changes in iodine content due to diagenesis after burial of the source material in the sediments.

2. The iodine content shows a very close correlation with the carbon content, indicating association of iodine with organic matter in the sediments.

3. This association is not however quite complete, for some late-glacial clays of very low carbon content contain appreciable amounts of iodine. The evidence indicates that these clays originated from soils during cold periods with freeze-thaw cycles giving rise to solifluction. The iodine content can be explained by the power of clay colloids to adsorb iodine while present in soils. Varved clays, originating by fresh glacial erosion of source rock, contain only very small traces of iodine.

4. These facts can be explained by the hypothesis that lake sediments which are richer in iodine than the source rocks of the region must be derived from soils on the catchment area, where iodine from the atmosphere, washed down by rain and absorbed by plants, accumulated in association with humus and with clay colloids.

5. Differences from lake to lake in the iodine content of the sediments and in the ratio of iodine to carbon did not show any correlation with differences in the present annual rainfall-that is, with the su[illegible] of supply of iodine from rain.

6. Changes in the iodine content and in the iodine:carbon ratio from one horizon to another in the profiles, and differences between the sites in their iodine contents and in their iodine:carbon ratios, have been shown to correlate well with changes in soils on the catchments as deduced from pollen analysis and qualitative changes in the organic fraction of the sediment.

7. At sites in the Lake District where the organic fraction of the sediment shows no quantitative or qualitative changes during the post-glacial changes in rainfall that have been deduced from peat stratigraphy, by Blytt & Sernander in Sweden and by Godwin in England and Wales. These

changes have not been found in the iodine curves from any of the four Scottish sites, though at two of them the quantitative and qualitative similarity of the organic fraction of the sediment, throughout the profile, would be expected to provide the same possibility for recording changes in the rate of supply of iodine from rain as the Lake District sites. In view of the regional qualitative difference in the organic sediment fraction (which is more acid and has a higher ratio of iodine to carbon in the Scottish lakes), no claim can be made that differences in the iodine contents reflect a different pattern of rainfall in Scotland, but we consider that these differences are of interest, in view of the difficulties which have been found in applying the Blytt & Sernander climatic scheme to Scottish profiles. (auth)

Pennington, W., T. G. Tutin, R. S. Cambray, and E. M. Fisher. 1973. Observations on Lake Sediments Using Fallout ^{137}Cs as a Tracer. Nature. 242:324-326.

It would be expected that a continuously accumulating lake sediment would incorporate fallout ^{137}Cs with a distribution pattern similar to that found from regular analysis of rain and air-borne particulate matter, provided there has been no significant mixing in the sediment. In order to test this, lakes of the English Lake District were analyzed for ^{137}Cs using γ spectroscopy with Ge(Li) detectors. The distribution pattern in the top-most 25 cm. of sediment is shown for five lakes. It was found that ^{137}Cs was present in accordance with recorded annual variations in supply from rain, rather than by erosion from the cumulative deposit on the watershed, and there was strong evidence for the absence of significant vertical movement after the ^{137}Cs had reached the mud surface. Implications for sediment depth considerations and sediment accumulation rates are discussed-also the influence of eutrophication. (NSA)

Pensko, J., T. Wardaszko, and M. Wochna. 1972. Influence of Some Geophysical Factors on Gamma Background and ^{222}Rn Concentration in Soil and Atmosphere. G. Fis. Sanit. Prot. Radiaz. 16:157-167.

Observations were carried out on dependence of natural gamma radiation background and ^{222} Rn concentration on various environmental condition factors. Differences between daily mean values of radon exhalation from soil greater than one order of magnitude were noticed, which can not be explained on the basis of the instability of diffusion factor. These differences are probably caused by variation of water or ice content in the soil influencing the mechanism of radon diffusion. From observation of soil freezing effects on radon exhalation it may be supposed that the radon diffusion factor in ice is considerably greater than in water. In the period of soil water freezing the vertical distribution on radon concentration is quite different from that in normal conditions. (auth)

Peperstraete, H., J. Vos, S. Van Puymbroeck, O. Vanderborght. 1973. Physico-Chemical Characteristics of Five Ruthenium Salts During Freshwater to Marine Transition. IAEA-SM-158/52.

The changes in physico-chemical characteristics such as mobility in high-voltage electrophoresis, of different Ru-salts in solution are considered during their transition from fresh water to marine conditions. The biological availability for some indicator organisms is also assessed under the same controlled laboratory conditions.

Perkins, R. W., J. L. Nelson, and W. L. Haushild. 1966. Behavior and Transport of Radionuclides in the Columbia River Between Hanford and Vancouver, Washington. Limnol. Oceanog. 11:235-48.

A study of the behavior and transport by the Columbia River of the eleven radionuclides ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{58}Co, ^{59}Fe, ^{60}Co, ^{65}Zn, ^{95}Zr-^{95}Nb, ^{106}Ru, ^{124}Sb, and ^{140}Ba was carried out in the river reach between Pasco and Vancouver, Washington, during the period January 1964 through January 1965. This study was accomplished by direct counting of water salts and filter samples on a multidimensional gamma spectrometer and represents the first measurements of the interactions of most of these radionuclides in the river. Through this multiple tracer technique, the specific and relative behaviors of these radionuclides in regard to their sorption by and movement with suspended particulate matter in the Columbia River were determined. Depletion of these radionuclides from the river during transport and the radionuclide inventory in the stream bed for the river reach between Pasco and Vancouver were also estimated. (auth)

Pettersson, H. 1943. Red Clay and Its Manganese Concretions. Göteborgs Högskol. Arsskr. 41:1-52 (in Swedish).

The chemical and physical properties, and the biological, mineralogical and petrological composition of red clay and the Mn nodules found in it are presented. The different theories of the mode of formation of red clay are discussed with special reference to submarine volcanic eruptions, which result in the formation of HCl and the solution of Ca from the bottom sediments as chloride and bicarbonate. The Ra content of red clay, its origin, and its rate of deposition are further discussed. As an explanation of the surprisingly high Ra content in certain samples of red clay the coprecipitation of Io with Fe from sea water if thought to be most acceptable. The Ra content and rate of deposition of the Mn nodules are given. The latter varies from 0.5 to 1.3 mm in 1000 years for Central North Pacific localities. The source of Ra in the Mn nodules is found in the concentration of this element, together with Mn, Fe, and others, from surrounding sediments. The U content of red clay is found to be too low to be the source of Ra present in this sediment. The age and thickness of red-clay deposits are discussed and lines for future deep-sea research are suggested. (CA)

Pettersson, H. 1949. Exploring the Bed of the Ocean. Nature. 164:468-70.

A preliminary report is given of the extensive results obtained during a 15-month Swedish deep-sea expedition. The data taken include a continuous record of the bottom profile along a nautical course of 20,000 nautical miles and 200 long cores taken from depths between 2,000 and more than 4,000 fathoms. In addition there were obtained more than 400 oscillograms from explosions in depths between 300 and 3,500 fathoms and their echoes (taken with a special ultrasonic echograph), and approximately 4,000 samples of sea water from varying depths, some of them large volume, for uranium and radium analyses. Ten thousand temperature records by reversing thermometers or, in the surface layers, by bathythermographs, are included in the oceanographical data, which were mainly concentrated along cross sections through the equatorial current system. Observations were also made on submarine daylight, in different spectral regions, including the ultra-violet, and on the occurrence of light-scattering particles suspended in the deeper water layers. Special attention was given to the very lowest water layers down to about two fathoms from the bottom. Confirming the results previously obtained from more limited samples, it was found that the uranium content of large-volume samples of sea-water from various localities and depths is fairly constant, varying between limits of 1.0 and 1.6 μg/l. The radium content is always considerably less than the theoretical value in radioactive equilibrium with the uranium. The radium content also is found to increase with increasing depth. This deficiency in radium supports the hypothesis of a precipitation of the intervening element, ionium, (Th^{230}), to the sea bottom; this would also explain the generally high content of radium in the red clay and in radiolarian ooze. (NSA)

Phelps, P. L., L. R. Anspaugh, S. J. Roth, G. W. Huckabay, and D. L. Sawyer. 1973. Ge (Li) Low Level In-Situ Gamma-Ray Spectrometer Applications. UCRL-75325.

Currently a Ge(Li) spectrometer is being employed for in-situ measurements of radionuclides contained in soil. This is being done at nuclear reactor sites and in complex radionuclide fields at the Nevada Test Site. The methodology and precision of the in-situ spectrometric technique was previously established for analysis of radionuclides in soil. Application of the technique to gaseous and liquid effluents containing radionuclides has shown a great deal of promise. (auth)

Philips, R. E. and D. A. Brown. 1966. Counter Diffusion of ^{86}Rb and ^{89}Sr in Compacted Soil. J. Soil Sci. 17:200-11.

Counter-diffusion coefficients of ^{86}Rb and ^{89}Sr counter diffusing against H ions were measured in Dundee silt loam and Sharkey clay soils at differing soil bulk-densities. The cation exchange complex of each soil was saturated with either Rb^+, Sr^{2+}, or H^+ and washed free of salts from making diffusion measurements. The water content of the soil on an oven-dry weight basis was maintained at a constant value for all bulk-densities; 14.2 and 28.0% for the Dundee and Sharkey soils respectively. These moisture contents corresponded to a tension of 2/3 bar for sieved soil. The diffusion coefficients were dependent upon concentration. Average counter-diffusion coefficients were calculated and related to soil bulk-density. Soil compaction of Dundee silt loam had little or no effect upon the counter diffusion of ^{86}Rb. The average counter-diffusion coefficients of ^{89}Sr in Dundee silt loan had little or no effect upon the counter diffusion of ^{86}Rb. The average counter-diffusion coefficients of ^{89}Sr in Dundee silt loam and Sharkey clay were significantly and linearly related to bulk-density; as bulk-density increased the average counter-diffusion coefficients increased. The average counter-diffusion coefficients were ~0.5 to 0.75 of the corresponding self-diffusion coefficients measured previously in these soils. The applicability of counter- and self-diffusion data to practical field problems is discusses. (NSA)

Phillips, R. E. and D. A. Brown. 1968. Self-Diffusion of Tritiated Water in Montmorillonite and Kaolinite Clay. Soil Sci. Soc. Amer. Proc. 32:302-426.

The quick-freeze technique of measuring diffusion coefficients of ions in clays and soils was adapted to the measurement of self-diffusion coefficients of tritiated water in clays. The self-diffusion coefficients of tritiated water were approximately equal in the kaolinite and montmorillonite clays. The water contents, oven-dry weight basis, used for montmorillonite were 125.0, 118.5, 100.0, and 87.0%; the water contents used for kaolinite were 60.5, 55.0, 43.5, and 39.0%. The calculated average number of water layers on each mineral surface ranged from 3.5 to 5.5 for montmorillonite and from 17 to 26 for kaolinite. The self-diffusion coefficients increased in a linear manner as the average number of water layers present on each mineral surface increased; a slightly different rate of increase was obtained for each of the two clays. The lack of difference of the diffusion coefficients in the two clays could not be explained on the basis of charge density of the clays nor was a difference in viscosity a plausible explanation. A longer path length of the diffusing water molecules in the kaolinite and a smaller relative mobility of the diffusing water molecules in the montmorillonite is given as a possible explanation. (auth)

Phillips, S. J. and J. R. Raymond. 1975. Monitoring and Characterization of Radionuclide Transport in the Hydrogeologic System. BNWL-SA-5494 (Pt. 1).

The Groundwater Monitoring Program at the Hanford Reservation provides information and data on groundwater quality required to evaluate the impact of waste disposal practices on the Hanford Reservation. The program includes: (1) collection and analysis of groundwater samples on a routine basis; (2) data processing, analysis and reporting; (3) design, construction and maintenance of well sampling structures; and (4) design and implementation of supporting research studies. Within the overall framework of the Groundwater Monitoring Program, the 300 Area and Wye Burial Ground Characterization Program was initiated to evaluate transport of radionuclides in the partially saturated zone above the water table and to provide site characterization at solid waste burial locations on the Reservation. Methods for collecting and analyzing program data include (1) geophysical exploration by ground penetrating radar, refraction and reflection acoustics, magnetics, and metal detection; (2) stratigraphic investigations by drilling and sample techniques; (3) evaluation of transport phenomena by in situ psychrometric and gamma-neutron techniques; (4) laboratory characterization of fluid and vapor transport-controlling mechanisms; and (5) evaluation of biological radionuclide transport by organisms inhabiting contaminated areas. (auth)

Phillips, S. J. and J. R. Raymond. 1975. Monitoring and Characterization of Radionuclide Transport in the Hydrogeologic System. BNWL-SA-5494 (Pt.2.)

Historical records pertaining to the 300 North and Wye Burial Grounds at the Hanford Reservation were reviewed as a prerequisite to determining programs for land reclamation. All available historical documents, agency communications, and engineering drawings related to the study areas were located, reviewed, and analyzed. An inventory of recorded location, type, and quantity of radionuclides and associated materials in each burial ground was completed and distributed to cooperating investigators. A geophysical survey of the 300 North Burial Ground was conducted as a basis for detecting the composition, size, distribution, and depth of buried objects and characterizing the sediments in which they are buried. Acoustic, radar, magnetic, and metal detection surveys were completed and their applicability evaluated; drilling techniques and equipment for recovering and characterizing sediments and radioactive contaminated material were developed. Drilling will also determine the amount and dimensional extent of radionuclide migration; sediment-fluid interaction and fluid migration through the unsaturated zone at the 300 North Burial Ground were characterized. A study to determine biological transport of radionuclides at the Wye Burial Ground was also initiated. This study involved a preliminary survey of present flora and fauna inhabiting the Wye Burial Ground site. Plant tissue was chemically and radiochemically analyzed to determine radionuclide migration and possible dose effects and population dynamics of burrowing animals that could potentially be exposed to buried waste materials were investigated. (auth)

Picat, P., P. Bovard, A. Grauby, M. Ijuin, J. Reveillault, J. Faure and J. Andres. 1972. Review of the Dispersion of Radionuclides in River Basin. Perspectives in Relation to the Nuclear Activities; Processing Plants and Power Reactors. EUR-4800 (Vol. 1 & 2) pp. 139-74 (in French).

The presence of nuclear installations on the Rhone basin prompted a study on the effect of their waste on the parts of the Rhone River situated downstream of the 4 Centers of Grenoble, Pierrelatte, Marcoule, and Cadarache. Study of the Rhone River over a distance of 60 km shows that its radioactive pollution is due to the presence of ^{137}Cs (4.8 curies deposited on the bottom) and to that of ^{106}Ru and ^{90}Sr. The ^{137}Cs concentrations of the sediment of the Rhone in 1968 are comparable with those recorded in 1960 on the Tennessee River. The distribution of the radioactivity on the bottom is characterized by decreasing contents from upstream to downstream and from the banks towards the middle of the river, and the absence of a significant rise in specific activity at the mouth. (auth)

Picciotto, E. E. 1960. Geochemistry of the Radioactive Elements in the Ocean and Chronology of Ocean Sediments. Ciel et terre. No. 3-4 (in French).

A review is presented of the state of research on the radioelements in the ocean and the chronology of ocean sediments. The principles of radioactive methods of age measurement are outlined. Tables are given showing the half life, concentration, isotopic abundance, and decay rates for natural radioisotopes in the ocean. The geochemical balance of isotopes in the three radioactive families in the ocean is shown. Data on the radioisotope content of recent pelagic sediments covering great ocean depths where sedimentation is slow are presented and discussed. Finally, chronological methods are discussed including those based on decrease of a cosmogenic isotope, decrease of ionium or protactinium, or increase of ionium and protactinium. (NSA)

Picciotto, E. and S. Wilgain. 1954. Thorium Determination in Deep-Sea Sediments. Nature. 173:632-3.

Determination of Th^{227}, Th^{228}, Th^{230}, and Th^{232} in deep-sea sediments by a photographic method is discussed. Concentration of Th was calculated in samples of red clay from the Pacific Ocean from 5-branched star production, assuming Th to be in equilibrium with Th^{227} and ascribing all the 5-branched stars to Th^{227}. The chronology of deep-sea sediments by ionium-Th ratios is also discussed. (NSA)

Picer, M., N. Picer, and P. Strohal. 1973. Fixation of Manganese on Quartz, Limestone, Dolomite, and Marine Sediment Samples. Health Physics. 25:285-290.

Well-known radiotracer techniques were applied to sorption-desorption processes of manganese that were investigated in a seawater medium, in sea sediments, limestone, dolomite, and quartz. The influence of salinity and pH were also measured. Desorption processes were studied in relation to the changes of pH of the sea system. Sorption isotherms were studied in sea sediment, limestone, and quartz. The results indicate that under natural conditions in the sea environment the sorption of ^{54}Mn on marine sediment is relatively low. At lower pH values, which may be found in the guts of certain animals, strong desorption was found. (auth)

Pickering, R. J. 1969. Distribution of Radionuclides in Bottom Sediment of the Clinch River Eastern Tennessee. U.S.G.S. Professional Paper 433-H.

Radioactive bottom sediment in the Clinch River in eastern Tennessee was investigated through a study of the distribution of radioactivity in sediment cores. The cores were taken from a 21-mile-long reach of river downstream from Oak Ridge National Laboratory. Low-level-radioactive liquid wastes are released from the Laboratory to the Clinch River via Whiteoak Creek.

In the upper 8 miles of the reach, radioactive sediment is found only along the sides of the stream channel, but in the lower 13 miles of the river, it extends out into the main part of the channel as well and attains its greatest thicknesses. Several sediment cores from the lower part of the river showed the same general pattern of variation of gross gamma radioactivity with depth. This pattern resembled the pattern of annual releases of cesium-137 from the Oak Ridge National Laboratory. Statistical comparison of the patterns confirmed the similarity.

Measurements of the vertical distribution of the major gamma-ray-emitting radionuclides in nine cores showed that approximately 81 percent of the gamma radioactivity was due to cesium-137, 12 percent to cobalt-60, and 7 percent to ruthenium-106. The vertical distribution of cobalt-60 correlated strongly with that of cesium-137.

It is concluded that cesium-137 and cobalt-60 were incorporated in Clinch River bottom sediment by deposition of suspended radioactive solids which entered the river from Whiteoak Creek. The two radionuclides are not necessarily associated with the same solids, and cobalt-60 in the bottom sediment probably represents only a small fraction of that released to the river.

A study of the physical and chemical compositions of sediment samples from two cores showed that cation-exchange properties of the sediment are controlled largely by its content of mica and clay minerals. These minerals are found primarily in the finest sediment fraction, but can occur also in the coarser fractions in the form of mineral aggregates and shale particles. Calcium and magnesium are the major leachable cations in the sediment; potassium and sodium are not present in measurable quantities. The effects of chemical and physical properties of the sediment on its radionuclide content are obscured as a result of variations in annual releases of the radionuclides and as a result of dilution of radioactive sediment by non-radioactive sediment in the river. Compositional effects were discernible only after corrections were made for variations in annual releases of radionuclides. (auth)

Pickering, R. J., P. H. Carrigan, Jr., and F. L. Parker. 1964. The Clinch River Study: An Investigation of the Fate of Radionuclides Released to a Surface Stream. NY. Amer. Inst. Chem. Eng. Preprint 18e.

The Clinch River Study is a multi-agency effort to evaluate the physical, chemical, and biological effects of the release to the Clinch River of low-level radioactive wastes from the Oak Ridge National Laboratory. The major radionuclides released are ruthenium-106, cesium-137, cobalt-60, and strontium-90. Hydrologic and biologic studies indicated that radiation dosages known to result or assumed to result from direct and indirect means of exposure are below maximum permissible levels. Radionuclide concentrations in river water were measured at seven sampling stations on the Clinch and Tennessee Rivers. Mass balance calculations for 44 weeks of sampling indicate that losses of radionuclides from the water phase to river bottom sediments represent only a very small portion of the total radioactivity released to the river. A study of Clinch River bottom sediment cores collected in 1962 disclosed a recurring pattern of variation in radioactivity with depth, which may reflect past events in waste disposal operations at the laboratory. Current investigations are expected to provide information about the chemical forms in which the major radionuclides exist and the mechanisms by which they were incorporated in the sediments. (auth)

Pickering, R. J., P. H. Carrigan, T. Tamura, H. H. Abee, J. W. Beverage, and R. W. Andrew. 1966. Radioactivity in Bottom Sediments of the Clinch-Tennessee Rivers. IAEA-SM-72/4.

Low-activity wastes are released from the Oak Ridge National Laboratory to the Clinch River via White Oak Creek. Part of the released nuclides eventually settle downstream in the bottom sediments in the Clinch-Tennessee Rivers. Analyses of sediment cores from a 21-mile reach of the 1 July, 1962, 154.6 curies of ^{137}Cs, 17.5 curies of ^{60}Co, 15.5 curies of ^{106}Ru, at least 10.2 curies of rare earths, and 2 9 curies of ^{90}Sr. These quantities (decay taken into account) represent 21% of the ^{137}Cs, 9% of the ^{60}Co, 0.4% of the ^{106}Ru, possibly 25% or more of the rare earths, and 0.2% of the ^{90}Sr released to the river during the 20 years of laboratory operations. The total volume of radioactive sediment in the 21-mile reach was 84.8 million cubic feet. Approximately 95% of the identified radioactivity in the sediment occurs in the most-downstream 15 miles of the Clinch River in the backwaters of Watts Bar Dam. In the upstream, swifter-flowing portion of the reach, radioactive sediment was detected along the sides of the stream channel. The maximum concentration of radionuclides was found near the mouth of White Oak Creek, the point at which the wastes enter the river. Several sediment cores from the downstream section of the river showed the same general pattern of variation of gross gamma radioactivity with depth. This pattern resembled the pattern of annual laboratory releases of ^{137}Cs, the most abundant radionuclide in the sediment. The vertical distribution of ^{60}Co correlated strongly with that of ^{137}Cs. It was concluded that ^{137}Cs and ^{60}Co were incorporated in the sediment by deposition of suspended radioactive solids which entered the river from White Oak Creek. Cation exchange properties of the sediment are largely controlled by its content of mica and clay minerals. Radioactive nuclides can be released from the sediments only with difficulty under atypical conditions. (auth)

Piggot, C. S. and W. D. Urry. 1942. Radioactivity of Ocean Sediments. IV. The Radium Concent of Sediments of the Cayman Trough. Am. J. Sci. 240:1-12.

The radioelements are not in equilibrium in the uppermost layers of the sediments at the bottom of the ocean. Of these elements U, ionium and Ra have a sufficiently long half life to be of importance. A history of these three elements is reflected in the variation of the Ra content of ocean sediments with the depth below the ocean floor. Measurements of this variation demonstrate that the concentrations of U, ionium and Ra at any time are established by the usual laws of radioactivity governing the growth and decay of radioelements in a system that is not in radioactive equilibrium. The experimental results must be adjusted to the conditions that pertained to the undisturbed sediments. This requires a knowledge of the history of the specimens between sampling and analysis. The relation between Ra content and depth in an ocean sediment promises a method of determining the rate of accumulation of the deposit at that place. (CA)

Pillai, K. C. and E. Mathew. 1975. Plutonium in Aquatic Environment--Its Behavior, Distribution and Significance. IAEA-SM-199/27.

Plutonium as a contaminate appeared in the human environment as a result of nuclear weapon testing. In view of the accelerated growth of nuclear power reactors and subsequent establishment of many irradiated fuel reprocessing facilities and increasing use of plutonium, the possibility of more plutonium entering the environment has increased. Plutonium being long-lived and being one of the most toxic radionuclides, its environmental behavior answers significance.

The inventory of fallout plutonium in the environment is discussed. The fallout levels of plutonium in sea woods, rain water, soils and aquatic separation using ^{236}Pu as an internal tracer and alpha spectrometry.

The behavior of trace amounts of plutonium discharged from fuel reprocessing operations into the aquatic environment of Bombay Harbour Bay is investigated in detail and the distribution of this radionuclide in different matrices of the marine environment -- seawater, silt sediments, organism and solar salt -- were studied. The suspended silt and bottom sediments of coastal waters have been found to have high capacity for removal of plutonium from seawater. Kd factors of about 10^5 were obtained in silt. Build-up of plutonium with time in sediments of the aquatic environment has been studied. Nearly 99 percent of the plutonium gets removed by sediments from silt laden coastal water. The preferential uptake of plutonium by benthic organisms was observed.

The interaction of plutonium solutions and also trace plutonium present in the fuel reprocessing effluents with seawater were studied and the formation of ionic as well as non-ionic species of plutonium were investigated. Organic matter added to seawater was found to inhibit hydrolysis and precipitation of added Pu and the anionic species formed increased with time. Further investigations are made on the interaction of plutonium directly with organic matter extracted from sediments and the ionic nature of the complexes formed. The extraction of organic matter from coastal sediments contaminated with plutonium showed the presence of the element in the purified organic fraction.

The average concentration of Pu in benthic organisms from discharge locale is only 0.01 percent of the limiting values. Biological uptake and transport of Pu might be insignificant in coastal areas. Sediments being the major depository of all released Pu, needs further study to understand its biological and geochemical significance.

Pillai, K. C., R. C. Smith and T. R. Folsom. 1964. Plutonium in the Marine Environment. Nature. 201:568-71.

Plutonium-239 and 240 were separated from seawater by radiochemical techniques and measured with an alpha spectrometer. ^{239,240}Pu were found to be highly concentrated in marine organisms including phytoplankton, dinoflagellates, green algae, palm kelp, mussels and fish. (auth)

Pinder, J. E., M. H. Smith, H. R. McLendon, A. L. Boni, J. H. Horton, and J. C. Corey. 1975. Field Study to Obtain Plutonium Contents of Old Field Vegetation and Soil Under Humid Climatic Conditions. DP-MS-74-65.

Soil and vegetation at the Savannah River Plant were analysed for plutonium. The data indicate that vacuumed samples have the greatest concentration of plutonium, that resuspension and fallout of plutonium is a principal contributor to the plutonium concentration of vegetation because the ^{238}Pu concentrations are more closely aligned to source term values than soil values under field conditions, and that laboratory uptake studies may underestimate the plutonium content of vegetation growing under field conditions adjacent to a fuel reprocessing facility. (NSA)

Pirs, M. 1974. Sorption-Desorption of Radioactive Caesium, Strontium, and Cerium on Earth Components. IN: Population Dose Evaluation and Standards for Man and His Environment. IAEA, Vienna, pp. 539-551.

The sorption capacity on humus material, calcite and dolomite for cesium, strontium, and cerium was determined by static and dynamic measurements. The dependence of the equilibrium concentration on the solution, pH, the presence of foreign salts and the stability of the fixation of the above-mentioned ions has been investigated. The elution curves for Cs, Sr, and Ce from the humus material, sand, calcite and dolomite with water, salt solutions and acids were calculated. (auth)

Pisarev, V. V., L. A. Koloskov, V. M. Kuznetsova, and I. S. Tsybizov. 1972. Leaching of Strontium-90 from Soil by Surface Water. Sov. Soil Sci. 4:193-201.

The results of studies on the leaching rate of strontium-90 from soil by meltwater, rainwater, and ephemeral streams are analyzed. Experiments were performed under natural conditions on plots measuring 1 x 1 m to whose surface soluble strontium-90 compounds were applied previously. The coefficients of decontamination of the soil by surface water (ratio of the amount of strontium removed to the amount before leaching) were found to be close for the different kinds of surface water, averaging 0.62% a yr for soils contaminated 2 yrs and 0.16% a yr for soils contaminated 10 yrs. (auth)

Pisarev, V. V. and I. S. Tsybizov. 1973. Effect of Some Natural Factors on Transition of ^{90}Sr from Soil Surface to Open Waters. IN: Radioekologiya Vodngkh Organizmov, II. pp. 36-43 (in Russian).

The results of experiments on the leaching of soils contaminated with soluble ^{90}Sr compounds are reported. It was established that the leaching out of this isotope depends mainly on environmental contamination and the volume of surface water. (auth)

Pitkyanen, G. B. and N. G. Safronova. 1973. Distribution and Migration of ^{90}Sr in Experimental Still-Water Reservoir. IN: Radicekologiya Vodnykh Organizmov, II. pp. 140-6 (in Russian).

The distribution and migration of ^{90}Sr between the components of experimental freshwater lake were studied. In 10 years after the equilibrium had occurred, the concentration of ^{90}Sr in the water decreased twice. Migration of radiostrontium through the vertical profile of lake sediments was observed. The content of ^{90}Sr in the free swimming green alga Cladophora fructs decreased as well. As for deeprooted Phragmites communis and carp, there were no significant changes in ^{90}Sr concentration. (auth)

Plamondon, J. 1968. Rapid Determination of Uranium in Geochemical Samples by Paper Chromatography. Economic Geology. 63:76-79.

Concentrations of uranium as low as 1 ppm are determined in soils and sediments by ascending paper chromatography, subsequent to a hot nitric acid attack of the samples. The reagent 1-(2-pyridylazo)-2-naphthol (PAN), which is used to develop the chromatograms, is capable of detecting 0.05 gamma of uranium. The method is rapid and inexpensive. (auth)

Plato, P. A. 1968. Predicting the Movement of a Radionuclide Through Soil. Thesis. Iowa State University.

A method for predicting the rate of movement of a simple waste through soil was developed. The waste material selected was strontium, an important constituent of many radioactive liquid wastes because of its chemical similarity to calcium which is an element that is used in the synthesis of teeth and bones. Soil columns were used in which flow moved in one direction, and a soil tank was used in which flow moved in the horizontal and vertical directions away from a modeled waste seepage pit. In an attempt to obtain more reproducible results in examining the mechanisms responsible for the movement of strontium through soil, a cation exchange resin was used to simulate the soil. Stable calcium was substituted for radiostrontium which resulted in an analytical technique for measuring cationic concentrations which was faster than determining the concentrations radiochemically. An equation, which accurately predicted the movement of calcium through the ion exchange resin was developed, and incorporated the flow rate through the resin, the concentration of the influent solution, and the resin bed depth. However, the equation did not prove to be applicable in predicting the movement of cations through soil due to the relatively large time required for the cations to diffuse into the soil particles. An empirical equation was developed which tended to describe the results obtained when calcium solutions were passed through soil columns. A design of a field study based on the empirical equation was suggested.

Plato, P. A. 1972. Distribution of ^{137}Cs and Naturally Occurring Radionuclides in Sediments of Lake Michigan. Radiat. Data Rep. 13:181-7.

Measurements of radioactivity in bottom sediments of Lake Michigan were made during 1969 and 1970. The only man-made radionuclide found was cesium-137 which originated from over two decades of atmospheric testing of nuclear weapons. A correlation was observed between accumulation of cesium-137 in sediments and water current patterns in Lake Michigan. Concentrations of naturally-occurring potassium-40 and radium-226 were found to correlate with the type of sediment present. (auth)

Plato, P. 1974. Use of Rivers to Predict Accumulation in Sediment of Radionuclides Discharged from Nuclear Power Stations. Health Physics. 26:489-496.

The liquid discharge characteristics, which include flow rate, suspended solids content, and radioactivity of the Donald C. Cook and Palisades nuclear power plants are similar to those from the St. Joseph and Black rivers, respectively, in southern Lake Michigan. The areas of influence of the rivers on Lake Michigan are defined by direct measurement of the accumulation of fallout ^{137}Cs in the sediments near the mouths of the rivers. The areas of influence of the rivers are used to predict the areas of influence expected near the two nuclear power plants after two decades of discharging radioactive wastes into Lake Michigan. (auth)

Plato, P. 1975. ^{137}Cs in Lake Michigan Sediments. Health Physics. 28:635-636.

The author responds to a letter by Edgington and Ritchie which commented on his paper concerning ^{137}Cs in Lake Michigan sediments (Health

Phys; 26:489 (1974)). The criticism of the use of grab samples to measure the ^{137}Cs content in sediment and the concern expressed about the calculation that a maximum of 20% of the ^{137}Cs that has entered the St. Joseph River watershed is now in the sediments of Lake Michigan near Benton Harbor are discussed. It is agreed that the direct atmospheric contribution of ^{137}Cs should have been discussed as a source of sediments in the lake shown in the paper. (NSA)

Platt, A. M. (comp). 1976. Nuclear Waste Management and Transportation Quarterly Progress Report January Through March 1976. BNWL-2029. The Reconcentration Phenomenon of Radionuclide Chain Migration, H.C. Burkholder, p. 1.8-1.16.

^{230}Th decays to ^{226}Ra as it moves through the geologic medium. ^{226}Ra has a lower sorption constant (K) value than ^{230}Th and moves increasingly ahead of its parent. The net effect is a tendency to build up the faster moving ^{226}Ra. Decreasing the sorption constant of the second chain member increases both the magnitude and range of the phenomenon.

Pliler, R. and J. A. S. Adams. 1962. The Distribution of Thorium and Uranium in a Pennsylvanian Weathering Profile. Geochim. et Cosmochim. Acta. 26:1137-46.

Eleven samples representing a pre-Pennsylvanian weathering profile on the Boulder Creek granodiorite near Boulder, Colorado, were analyzed for thorium and uranium by γ-ray spectrometric and chemical methods. In an effort to determine the possible sites of thorium and uranium in the samples, a study of their leachability in hot 2<u>N</u> hydrochloric acid was undertaken. Fresh granodiorite was found to contain 9.3 ppm thorium and 2.5 ppm uranium. The first stages of weathering resulted in an apparent removal of 25% of the thorium and 60% of the uranium present in the original granidiorite. The leaching study of the fresh granidiorite demonstrated that as much as 90% of the thorium and 60% of the uranium could be removed by an acid leach solution. This seems to indicate that most of the thorium and uranium in the fresh rock is situated in acid soluble minerals or in interstitial materials. After the initial drop of the concentration in the lowest part of the weathered mantle, the total uranium and thorium content of the weathered rock increased by a factor of at least 4 in the uppermost, most-weathered rock material. Leaching studies of the weathered rock indicated that uranium is present largely in the primary resistates, such as zircon, xenotime, and apatite, and thorium occurs mainly in or on clays or in the secondary resistates--minerals formed during weathering. (auth)

Pluman, I. I. 1971. Uranium Content in Black Argillites of the Volga Stage of the West Siberian Platform as Criterion of Geochemical Conditions of Sedimentation. Geokhimiya. No. 9:1138-43 (in Russian).

A similarity of geochemical peculiarities and in particular of uranium content has been established between recent deposits of seas with hydrosulfuric contamination (Black Sea, and others) and bituminiferous black argillites of the Upper Jurassic Volga stage of the West-Siberian platform. On this basis it was concluded that the geochemical sedimentation medium is identical with that of the Black Sea, i.e., it is hydrosulfuric in the above-bottom part of the sedimentation basin. (auth)

Poelstra, P. and M. J. Frissel. 1967. Migration of Water and Ions in Undisturbed Soil Columns and Its Description by Simulation Models. IN: Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. IAEA, Vienna, pp. 203-10.

A description is given of the technique of taking 100-cm-high and 12-cm-dia soil columns without disturbing the natural build-up of the profile, the rain installation, controlled by an automatic device, that enables fluxes from 0.05 ml cm^{-2} d^{-1} to 20 ml cm^{-2} d^{-1}, and supplies the water in drops of about 0.04 ml. In this installation 25 columns can be handled simultaneously at five different flow-rates while 10 different solutions can be used for leaching; the column scanner specifically developed for measuring the distribution pattern of the labeled compound in the column; and the results of several leaching experiments in a podsolic soil with tritiated water and solutions of strontium- and calcium- labeled $CaCl_2$ at different flow-rates and concentrations. As soil is a heterogeneous system it is not possible to describe the migration by the usual chromatographic theories such as those of Glueckauf or Hiester and Vermeulen. The mathematical description, therefore, is done by simulation models. In these models the calculation is carried out step by step by a computer whereby the conditions are varied as necessary after each step. Several models that have been tested are described and compared with experimental results. (auth)

Poet, S. E. and E. A. Martell. 1972. Plutonium 239 and Americium 241 Contamination in the Denver Area. Health Physics. 23:537-548.

Procedures and results of an experimental investigation of Pu 239 and Am 241 contamination in the environs of the Rocky Flats plutonium plant and elsewhere in the greater Denver area are presented and discussed. Measurements of Pu 239 and Sr 90 in the top 1 cm surface layer of soils show that in this layer the Pu 239 contamination in offsite areas just east of the Rocky Flats plant ranges up to hundreds of times that from nuclear tests. In the more densely populated areas of Denver, the Pu contamination level in surface soils is several times fallout. The depth distribution of Pu 239 in undisturbed soils in the more heavily contaminated areas show that the contaminant is concentrated largely in a thin surface layer. Results for soils of known last date of disturbance make it evident that most of the offsite Pu accumulated between 1966 and 1969. This corresponds to the period in which Pu in an oil spill area on the plant site was exposed and subjected to wind reentrainment. Am 241, which grows in from Pu 241 present in the contaminant, now contributes between 3 and 15% as much alpha activity as Pu 239 and ultimately will approach comparable levels. The important unknowns and uncertainties involved in the estimation of inhalation exposures and the carcinogenic risks from the Pu 239 contamination in the environs of Rocky Flats are briefly reviewed. (auth)

Poet, S. E. and E. A. Martell. 1974. Reply to Plutonium-239 Contamination in the Denver Area by P. W. Krey. Health Physics. 26:120-22.

Reference is made to the letter of Krey (Health Phys. 26:117 (1974)) in which he spoke of "omissions, errors, and misconceptions" in the present author's previous paper (Health Phys. 23:537 (1972)). Such allegations of this author's work covering the spatial distribution of ^{239}Pu contamination, the sampling and analysis techniques used, and the ^{239}Pu distribution with depth, are argued. (NSA)

Pokidin, V. K., Y. V. Kuznetov, E. A. Prozorovich, and F. A. Asadullaeva. 1972. Radioactivity and Rate of Sediment Formation in the Caspian Sea. Geokhimiya. No. 7:834-43 (in Russian).

On the basis of data on the vertical distribution of ^{226}Ra, ^{230}Th, ^{232}Th, and ^{238}U in sediments of the Caspian Sea and with the aid of the radiumionic method the formation rates of deep-sea and shallow water sediments have been determined, which equal respectively: 6.0 to 26.0 and 100 cm for 1000 years. The difference of vertical sections of ^{230}Th and ^{232}Th distribution in deep-sea sediments of the Caspian Sea is shown, which confirms the hypothesis about different forms of supply to these isotopes to the sea bottom. A close direct connection between the distribution of ^{230}Th and calcium carbonate in deep-sea sediments was established, which bears witness of the sorption character of the ^{230}Th withdrawal from water by chemogenic calcite. (auth)

Polyakov, Yu. A., V. F. Gol'tsov, and V. G. Grakovskii. 1969. Diffusion of ^{90}Sr in Soils. AEC-tr-7030, pp. 14-25.

The diffusion of ^{90}Sr was studied in several varieties of black earth and forested-steppe soils found within the arid steppe zone of Russia. Both field and laboratory observations were made. The physicochemical properties of these soils which were determined included the organic content, the pH of aqueous suspension, absorption capacity, and the composition of the absorbed bases. The laboratory methods used and the theoretical method for computing soil diffusion characteristics based on Fink's equation are explained. The ^{90}Sr studies showed that: the diffusion coefficients for the soils studied ranged from 0.6×10^{-7} to 20×10^{-7} cm^2/sec depending on the properties of the soil; the diffusion coefficient was constant only for homogeneously prepared soil samples, and, under natural soil conditions, the diffusion coefficient must be considered as variable; and, the methods developed for preparing soil samples and for solving Fink's equation could be used for studying the diffusion of ions other than ^{90}Sr. (NSA)

Polyakov, Yu. A., G. M. Kader, and V. V. Krinitskii. 1973. Behavior of Strontium-90 and Cesium-137 in Soils. IN: Radioecology. V. M. Klechkovskii (ed.) pp. 78-102.

The forms of ^{90}Sr and ^{137}Cs compounds in soils and the impact on the behavior of these nuclides of the water factor, absorption capacity, complex formers, diffusion, and ion exchange are reviewed. Other topics discussed are energy characteristics of ion exchange reactions of the analog element, ^{90}Sr and ^{137}Cs discrimination in different stages of the ecological cycle, effects of various cations, significance of complexants, field determination of diffusion coefficients, exchange of Sr and Ca ions in soils and clays, and exchange sorption of Cs^+ and Sr^{2+} ions on resins. (NSA)

Polzer, W. R. 1971. Solubility of Plutonium in Soil/Water Environments. IN: Proceedings of Rocky Flats Symposium on Safety in Plutonium. CONF-710401, p. 411-430.

Thermodynamic data was used to construct Eh-pH diagrams for plutonium oxides, plutonium hydroxides, and some solution species of plutonium. These diagrams show that at equilibrium PuO_2 would control the solution levels of plutonium.

Polzer, W. L. and F. J. Miner. 1977. Plutonium and Americium Behavior in the Soil/Water Environment. II. The Effect of Selected Chemical and Physical Characteristics of Aqueous Plutonium and Americium on their Sorption by Soils. BNWL-2117, pp. 255-290.

Sorption of plutonium by seventeen soils, as measured by distribution coefficients, was observed in most cases to be dependent on the initial plutonium concentration which ranged from 10^{-8} to 10^{-6} M. Several trends were observed with respect to changes in sorption. A decrease in sorption occurred in the presence of polymers compared to the absence of polymers. Polymers are likely to have a lower positive charge density than the nonpolymerized species. The presence of polymers was assumed when the ratio of measured plutonium to that calculated to be in equilibrium with plutonium hydroxide exceeded unity.

In acid solutions and in the presence of polymers a decrease in sorption occurred with an increase in pH. This decrease is attributed to a lower positive charge density at the higher pH value. A decrease in sorption also occurred in the absence of polymers with an increase in pH at values of approximately eight or greater. This decrease is attributed to the reaction of plutonium with hydroxyl and carbonate ions to form a negatively charged complex. At pH values of eight or greater its concentration is likely to exceed the concentration of the predominant noncomplexed species; thus reducing the sorption of plutonium. The sorption data for americium is also discussed. (auth)

Pomeroy, L. R. and E. P. Odum. 1975. Flux of Radionuclides Through A Salt Marsh. SR-639-15.

Progress is reported on studies of exchange processes of radionuclides in salt marshes and microbial community processes on the continental shelf. Work on the exchange of phosphate between salt marsh sediments and estuarine water was also carried out on a seasonal basis. Instrumentation was developed for studies of the microbial and planktonic community of continental shelf waters, and some preliminary shake-down cruises were made in the Georgia bight. Work also was begun on a scanning electron micrographic study of the microorganisms and ultraplankton of the continental shelf. (auth)

Poole, J. H. H. and J. W. Bremner. 1948. Investigation of the Radioactivity of Rocks by the Photographic Method. Nature. 161:884-5.

The method employed is to place an Ilford Nuclear Research plate at a distance of about 0.1 mm from a flat surface of the specimen cut with a diamond saw, and expose it for one to three weeks, depending on the probable activity of the specimen. In more recent experiments the plate has been placed in contact with the cut surface, as this makes easier the identification of α-rays tracks, which all originate from one nucleus. Theoretically, from the frequencies of two-, three-, four- and five-ray stars, it should be possible to estimate the separate amounts of uranium and thorium present.

Enough data have not yet been obtained to determine whether this method will prove possible. The results of some experiments are reviewed briefly. (NSA)

Poole, J. H. H. and J. W. Bremner. 1949. Investigation of the Distribution of the Radioactive Elements in Rocks by the Photographic Method. Nature. 163:130-1

A method is described for the microscopic study of the distrubution of radioactive elements in rocks. A standard microscope slide of the rock to be examined is made, but the cover glass is omitted, so that the α-rays from the rock can affect a nuclear plate placed in contact with the slide. Both slide and plate are placed in a specially constructed brass frame, in which they are held against three definite contacts, so that either slide or plate can be removed from the frame and replaced in the same position. The distribution of the tracks on the developed plate can be correlated with the rock minerals by replacing the rock slide on top of the plate. Polarized light can be used for the identification of the minerals in the usual manner. A composite photomicrograph of a Finland granite is given, showing numerous α-ray tracks originating from some of the crystals. The nuclear plate was exposed to the rock slide for about 10 days. The absolute radioactivity of a crystal may be roughly estimated from the number of α-particles emitted. (NSA)

Potter, R. W. 1976. Some Geochemical Parameters Effecting the In-Situ Leaching of Uranium. U.S.G.S. Open File No. 76-835.

There are many lixiviant-rock interactions which can lead to the reduction of the porosity-permeability of the ore-bearing formation. These include reaction involving phase changes such as clay transformations, zeolite transformations, feldspar alteration to zeolites, feldspar alteration to clays, and alteration of various accessory minerals. There are a plethora of phases which can precipitate from solution as a result of lixiviant-formation interactions, but in general the most common phases are Ca-carbonates, Fe-oxyhydroxides, Al-oxyhydroxides, and silicates.

Poulaert, G. and S. Zmyslowska. 1958. Application of γ-Spectrometry for the Measurement of Natural Soil Radioactivity. Roczniki Nauk. Rolniczych. Ser. A. 78:539-51.

The average values for the soils investigated are 10^{-6} g U and 10^{-5} g Th/g of soil. K^{40}, U, and Th were determined by using an MBLE γ spectrometer of the type PN 2.4.3/A, which contains a NaI (Tl) crystal. K is present in soils and rocks in average concentrations of 10^{-1} g/g; the average error of the determinations for U and Th is of the order of 10%, for K, 20%. This rather large error does not preclude the use of the method for scanning and prospecting purposes, as the results are obtained so rapidly. (CA)

Price, K. R. 1971. A Critical Review of Biological Accumulation, Discrimination and Uptake of Radionuclides Important to Waste Management Practices. BNWL-B-148.

The objective of this survey is to screen the world literature for data on biological uptake and accumulation or the discrimination against uptake of certain radionuclides associated with nuclear waste management. Historical aspects based on the publication sequence of biological research are briefly considered, and relevant research findings are discussed under several categories. One category is devoted to transuranic elements and is accompanied by a special bibliography. The application of research findings to the Hanford situation is discussed and projects for future study are recommended. An annotated list of 119 references is presented. (auth)

Price, K. R. 1972. Uptake of Neptunium 237, Plutonium 239, Americium 241, and Curium 244 from Soil by Tumbleweed and Cheatgrass. BNWL-1688.

Tumbleweed (Salsola Kali) and cheatgrass (Bromus Tectorum) were grown under controlled conditions in pots containing surface soil common to radioactive waste disposal sites at Hanford. The soil was spiked with Np 237 Np $(NO_3)_5$, Pu 239 Pu $(NO_3)_4$, Am 241 Am $(NO_3)_3$, or Cm 244 Cm $(NO_3)_3$ solutions, and all radionuclides were absorbed by the test plants. Large amounts of neptunium were taken up (>2% dose), with smaller amounts of americium and curium. Plutonium uptake was only slight. Critical levels of detection (L sub C) are calculated, and the term Minimum Soil Detection

Level (L sub MSD) is introduced. The application of results to waste management is discussed. (auth)

Price, K. R. 1973. A Review of Transuranic Elements in Soils, Plants, and Animals. J. Environ. Quality. 2:62-66.

Published information concerning the distribution and fate of neptunium, plutonium, americium, and curium in terrestrial ecosystems is reviewed and areas needing further study are identified. In the final analysis of environmental quality, radionuclides with very long half lives will become increasingly important to man as they continually constitute a greater proportion of environmental radioactivity. The transuranic elements have been identified as the most hazardous radionuclide by-products of nuclear reactor operations. The relatively few studies conducted indicate that transuranic elements do not remain in solution in soils, plants, or animals but organic complexes and chelation greatly enhance mobility. The elucidation of natural organic complexes and chelating agents has not been attempted. Oxidation state also influences mobility, but possible biological mechanisms permitting exodation or reduction remain uninvestigated. Ingestion is the most important transfer mechanism in ecosystems, but assimilation of transuranics from natural food sources is mostly unknown. Evidence in the literature suggests three possible mechanisms leading to the observed increase in plant uptake with time: the formation of organic complexes or chelates, a buildup of radionuclide concentration at root surface, or the slow but continual uptake by perennial plants. Each of these mechanisms deserves further study. (auth)

Price, K. R. 1973. Tumbleweed and Cheatgrass Uptake of Transuranium Elements Applied to Soil as Organic Acid Complexes. BNWL-1775.

Plant uptake of radioactive waste materials is a biological interaction important to the environmental management of waste storage sites. This study on the uptake of ^{241}Am, ^{244}Cm, ^{237}Np, and ^{239}Pu from soil by plants demonstrates that shoot uptake is clearly influenced by the chemical form of the transuranic. It is unclear at this time whether soil or plant mechanisms, or both, are responsible. Future studies are planned to investigate these aspects. The observation that some organic acids suppress plant uptake of americium and curium will be investigated further to evaluate the use of soil additives to suppress plant uptake of transuranics. Test results indicate that organic acid complexes of plutonium such as oxalate or citrate can increase plant uptake when added to soil as compared to uptake from dilute nitric acid solutions. (auth)

Price, K. R. 1974. The Behavior of Waste Radionuclides in Soil-Plant Systems. IN: Pacific Northwest Laboratory Annual Report for 1973 to the USAEC Division of Biomedical and Environmental Research, Part 2, Ecological Sciences. BNWL-1850 Pt. 2, pp. 38-40.

Np 237, Pu 239, Am 241, and Cm 244 were added to soils as nitrates and chelates of EDTA and DTPA. Tumbleweed (Salsola Kali) and cheatgrass (Bromus tectorum) were grown in soils for two months and the shoot uptake of radionuclides from chelates was compared with uptake from nitrate solutions. EDTA increased the uptake of Pu (about 10 fold) and of Am and Cm only slightly, whereas, reduced the uptake of Np. DTPA increased the uptake of Pu(more than 800 fold) and of Am and Cm (about 100 fold), whereas, reduced the uptake of Np. (auth)

Price, N. B., S. E. Calvert, and P. G. W. Jones. 1970. The Distribution of Iodine and Bromine in the Sediments of the Southwestern Barents Sea. J. Marine Res. 28:22-34.

In 42 surface sediments from the southwestern Barents Sea, iodine and bromine ranged from 60 to 828 p.p.m. and 12 to 257 p.p.m., respectively. In the surface environment, both I and Br are related to organic matter; the dependence of halogens on the grain size of the sediment is small. With depth, all sediments showed a marked decrease in I and Br and in I/C and Br/C ratios; the ratios often reach a constant value. This decrease in I concentration per unit length, in the cores has provided a means of estimating the accumulation rates in the sediments. (auth)

Price, S. M. and L. L. Ames. 1975. Characterization of Actinide-Bearing Sediments Underlying Liquid Waste Disposal Facilities at Hanford. IAEA-SM-199/87.

Past liquid waste disposal practices at the U. S. Energy Research and Development Administration's Hanford Reservation have included the discharges of solutions containing trace quantities of actinides directly into the ground via structures collectively termed "trenches". Characterization of samples from two of these trenches, the 216-Z-9 and the 216-Z-1A(a), has been initiated to determine the present form and migration potential of plutonium stored in sediments which received high salt, acidic waste liquids.

Analysis of samples acquired by drilling has revealed that the greatest measured concentration of Pu, $\sim 10^5$ μCi ^{239}Pu/liter of sediment, occurs in both facilities just below the points of release of the waste liquids. This concentration decreases to $\sim 10^3$ μCi ^{239}Pu/liter of sediment within the first 2 meters of the underlying sediment columns and to ~ 10 μCi ^{239}Pu/liter of sediment at the maximum depth sampled (9 meters). Examination of relatively undisturbed sediment cores illustrated two types of Pu occurrence responsible for this distribution. One of these types if composed of Pu particles (>70 wt% PuO_2) added to the disposal site in the same form. This "particulate" type was "filtered out" within the upper 1 meter of the sediment column, accounting for the high concentration of Pu/liter of sediment in this region. The second type of Pu (<0.5 wt% PuO_2) was originally disposed of as soluble Pu (IV). This "nonparticulate" type penetrated deeper within the sediment profile and was deposited in association with silicate hydrolysis of the sediment fragments. (autn)

Prister, B. S. 1970. Behavior of Uranium in the Biologic Chain. AEC-tr-7128. pp. 194-27.

Field experiments on the accumulation of uranium in basic crops were carried out for three years on a large tract of land. Crops included grains, legumes, root crops, and vegetables. Measurements of the uranium content of the soil were made by extracting uranium with nitric solutions.

A formula is presented for determining the coefficient of accumulations, or relative capacity of plants to accumulate uranium. Values for these coefficients are tabulated for grains, legumes, root plants, and vegetables. Data on accumulation of uranium in tissues of chickens and swine are tabulated. Studies on concentration of uranium in dairy products showed that the content of butter and cheese was eight times as great as that of milk. Data on uranium content of the human diet showed that more than half the uranium reached man through products of vegetable origin. Food products of animal origin contributed 28 percent of uranium to man. (NSA)

Prister, B. S. and S. S. Prister. 1970. Effects of Uranium on the Growth and Development of Plants and Its Accumulation as a Function of the Content in the Germination Medium. Radiobiologiya. 10:138-40.

It was found in greenhouse experiments that U at a dose of 200 mg/kg of sand was nontoxic for plants. For a water culture a 50 mg/liter dose of U results in death of corn plants and its content in the medium was a decreasing exponential function. With increasing U concentration in the roots, intake into the aboveground portion of the plants decreased. (auth)

Proctor, J. F. and I. W. Marine. 1965. Geologic, Hydrologic, and Safety Considerations in the Storage of Radioactive Wastes in a Vault Excavated in Crystalline Rock. Nuclear Science and Engineering. 22:350-365.

A recent investigation established the technical feasibility and indicated the high degree of safeth that could be afforded by the storage of high-level radioactive wastes in unlined vaults excavated in crystalline rock 1500 feet beneath the surface of the Savannah River Plant near Aiken, SC. The crystalline rock at the proposed site is covered by 1000 feet of unconsolidated sediments consisting predominantly of sand and clay. A virtually impermeable layer of clay separates the rock from the overlying sediments in which several prolific water-bearing zones occur. The separation of the waters above and below this clay layer is confirmed by their different chemical composition and by the presence of dissolved helium-bearing gas only in the water in the rocks beneath the clay. Based on geologic and hydrologic information obtained in an intense drilling and testing program, upper limits on the rates of water movement through the crystalline rock are calculated to be 1.5 to 7 ft/yr, depending upon the degree of fracturing of the rock. Comparable data on the unconsolidated sediments lead to a calculated maximum rate of water movement of 350 ft/yr. The most significant driving force for the migration of radionuclides from the storage site is derived from the natural water movement coupled with effects due to dispersion and ion exchange. Characteristics of the waste, heat generation, and radiolysis have, by contrast, only small effects on migration. Three barriers prevent migration of the radionuclides: the very low permeability of the rock in which the storage vault is located, the virtually impermeable clay layer separating the rock and sediments, and the ion exchange properties of the sediments. Any one of these barriers is capable of confining the radionuclides well within the plant boundaries for a time much greater than the 600-year period required to render the wastes innocuous. (auth)

Prokhorov, V. M. 1970. Calculation of the Reduction of ^{90}Sr Content in Lake and Pond Water as a result of Bottom Absorption. AEC-tr-7128, pp. 254-62.

The concentration of soluble radioactive fission products in the fall-out on lakes, reservoirs and other stationary bodies of water decreases slowly with time as a result of the absorption of the radioisotopes by the bottom and to a much lesser extent by the biomass. The concentration of the isotopes is different at various depths of the bottom sediment. A method was developed to calculate these changes of the ^{90}Sr concentration in stationary bodies of water as a function of time. It was assumed that the adsorptive ion-exchange kinetics by the soil, although much weaker than adsorption on ion exchangers, follows the same general rules. It was found that with the exception of a short initial period, the adsorption kinetics of ^{90}Sr is controlled by the diffusion rate of this isotope into the bottom sediment. In principle, no equilibrium is established between the water and the bottom; however, the adsorption rate is decreased until the concentration of the isotope appears to remain constant for a certain period. A formula was derived to predict the ^{90}Sr concentration in the water and in the sediment at a given time from the previous concentration. For a sufficiently long period, the concentration decreases inversely with the square root of the time. The removal half-life is not a constant but increases with time. (NSA)

Prokhorov, V. M. 1962 Diffusion of Strontium-90 in Soil and Sand. Radiokhimiya. 4:205-21..

1. A differential equation was derived for diffusion in a polyphase adsorbing medium. It was shown that in the case of a linear adsorption isotherm, the diffusion coefficient does not actually depend on concentration.

2. The numerical values for the diffusion coefficient of Sr^{90} in a strongly sorbing soil and in quartz sand were found at various moisture contents and it was established that the experimental data agree with the theoretical equation derived.

3. The possibility of investigating the adsorption properties of media by measuring diffusion rates was demonstrated.

4. It was found that the distribution coefficient of Sr^{90} was considerably less in moist soil than in an aqueous suspension of the same soil. (auth)

Prokhorov, V. M. 1969. Kinetics of Adsorption of ^{90}Sr on the Bottom of Confined Water Basins. Radiokhimiya. 11:317-25 (in Russian).

It is shown that the kinetics of adsorption of ^{90}Sr from water confined in a basin is determined (with the exception of a small initial period) by the actual rate of diffusion of ^{90}Sr in thick bottom deposits. Adsorptive equilibrium of ^{90}Sr between water and the bottom of the reservoir could not be proved. Formulas were developed that permit, without the utilization of empirical magnitudes, the forecasting of the concentration of ^{90}Sr in water and in the bottom deposits for any moment from known concentrations for other times. (auth)

Prokhorov, V. M. 1972. Mathematical Modelling of Radionuclide Migration in Certain Regions of Biosphere. INIS-mf-887, pp. 252-265 (in Russian).

Mathematical relationships are derived and the models are elaborated for the radionuclide absorption by the bottoms of water basins, for the vertical migration of radionuclides in soils, for the root absorption of radionuclides by plants from soils, and for the migration of radionuclides in forest flora. ^{90}Sr was taken as a typical representative of the radionuclides. (NSA)

Prokhorov, V. M. 1973. Ion Diffusion in Soils and Its Role in Radionuclide Migration. IN: Radioecology. V. M. Klechkovskii (ed.), pp. 103-125.

The role of ion diffusion in radionuclide migration in soils is reviewed. The complex nature of migration in soils is emphasized and the effects of biological transport processes, climatic factors, and human economic activities are dicussed. Special features of radionuclide diffusion in soil, such as the inhomogeneous properties of soil, are discussed. The migration of nuclides over the soil profile is reviewed with regard to type of soil, climatic zones, isotope composition of nuclides, conditions of their deposition on soil surface, and migration time. The fixation of nuclides, particularly ^{137}Cs, by clay minerals is discussed. Root nutrition of plants is discussed with emphasis on absorption of ^{90}Sr and ^{137}Cs and other radionuclides. (NSA)

Prokhorov, V. M. and T. Chai. 1963. Diffusion of Cesium^{137} in Soil. Radiokhimiya. 5:639-42 (in Russian).

The distribution coefficient of Cs^{137} in humid soil is 20 and 250 fold as high as the distribution coefficient of Sr^{90} under identical conditions. The rate of Cs^{137} diffusion into light arrillaceous soils was abnormally high and under humid conditions practically identical to that of Sr^{90}. (NSA)

Prokhorov, V. M. and A. S. Frid. 1966. Relation Between the Adsorption and Diffusion Rate of Microquantities of Strontium in the Soil. Radiokhimiya. 8:695-6 (in Russian).

The distribution factor for ^{90}Sr in humid soils is a function of concentration of soil solutions; with an increase of Ca^{2+} from 4×10^{-3} to 0.58N, the coefficient of distribution is reduced 68 times. The relation of the ^{90}Sr diffusion factor to the distribution coefficient for the investigated soil on the logarithmic scale is linear in character. (NSA)

Prokhorov, B. M. and A. S. Frid. 1972. Contribution of Adsorbed Ions to the Diffusion of ^{90}Sr in Soils. Sov. Radiochem. 14:536-542.

It was shown that the change in the actual rate of diffusion of ^{90}Sr in soil is caused by a change not only in the value of the adsorption, but also in the rate of diffusion of ions both in the pore solution and in the adsorbed state. The contribution of adsorbed ions to the total diffusion transport of ^{90}Sr in unsalted soil exceeds the contribution of ions of the soil solution and in many cases is more than 90%. The rate of diffusion of ^{90}Sr in the adsorbed state is 0.2 to 3.3% of the corresponding values for the pore solution. The contribution of adsorbed ions of ^{90}Sr decreases with increasing concentration of the soil solution, while at higher concentrations (0.5 N and higher) it again increases. The diffusion coefficient of adsorbed ^{90}Sr ions increases with increasing concentration of the soil solution, reaching values corresponding to the diffusion of Sr^{2+} in solution at very high concentrations. (auth)

Prokhorov, V. M. and A. S. Frid. 1972. Effects of Humus Content and Composition on Strontium-90 Mobility in Soil. Sov. Soil Sci. 4:333-340.

Actual diffusivity (D) can be used as a measure of the mobility of an element in soil. An increase in the content of humic substances was found to reduce the D of strontium-90. Humic and fulvic acid salts have a greater effect on this parameter than do the acids themselves; the effect of humic acids and their salts is greater than that of fulvic acids and their salts. In natural soils, the D of strontium-90 may differ more than 70 times, depending on the composition and content of humic substances. (auth)

Prokhorov, V. M., A. S. Frid, and M. V. Ryzhinskii. 1968. The Effect of Salts on ^{90}Sr Adsorption by Soils. A-AC-82/G/L-1305 (in Russian).

Different kinds of soil (chernozem, podzolic, etc.) were ground and sieved, and then contacted with a ^{90}Sr solution or with distilled water to give the soil a moisture content of 42 wt%. The soil was allowed to contact the tracer solution for 40 to 54 days in order to attain equilibrium. The soil was separated from the solution by centrifugation, and allowed to stand for two weeks before counting in order to attain equilibrium between ^{90}Sr and its daughter ^{90}Y. Salt solutions of $MgCl_2$-Mg_2SO_4, NaCl-Na_2SO_4, $Mg(NO_3)_2$, and EDTA were used at various concentrations. High salt concentrations tended to displace ^{90}Sr from the soil. However in the presence of sulfate, ^{90}Sr could be carried down by insoluble alkaline earth precipitates to give anomalous results. EDTA tends to complex ^{90}Sr from the soil especially if the soil is wet with water and not with a concentrated salt solution. An electrophoretic experiment showed that the strontium was in the form of positive ions. (NSA)

Prokhorov, V. M., A. S. Frid, and M. V. Ryzhinskii. 1970. Effect of Liming of Soil on the Diffusion Rate of ^{90}Sr. Agrokhimiya. 7:40-8 (in Russian).

Samples of soil from the Leningrad area were acidified with HCl, washed with distilled water, and treated with various ratios of CaO. It was found that with amounts of CaO up to 80% of the hydrolytic acidity the coefficient of diffusion of ^{90}Sr decreased by a factor of 5. For CaO doses greater than 90% of the hydrolytic acidity the ^{90}Sr coefficient increased. (auth)

Prokhorov, V. M. and N. G. Safronova. 1974. Kinetics of the Self-Purification of a Body of Water Containing Strontium-90 as a Result of Absorption of the Radionuclide by the Bottom Deposits. Sov. J. Ecol. 4:101-105.

The previously proposed diffusion model of the self-purification of natural water as a result of the absorption of ^{90}Sr by the bottom deposits agrees with the experimental data on the kinetics of the change in the concentration of ^{90}Sr in the water of the experimental lake. Together with the diffusion mechanism of self-purification, there operates additionally in the investigated lake a factor of self-purification that can be considered within the framework of the model. Simple computational formulas for the dependence of the concentration of ^{90}Sr in the water on the time were obtained, permitting a long-range prognosis for the experimental lake. (auth)

Prokhorov, V. M. and C. Tien-ying. 1963. Diffusion of Ce^{144} in Soil. Pochvovedenie. No. 7:107-8 (in Russian).

The relation between the diffusion coefficient of ^{144}Ce and moisture was investigated for a light loamy soil. It was revealed that the relation is not linear, ^{144}Ce diffuses much slower than ^{90}Sr and ^{137}Cs due to a high degree of adsorption and a low mobility of adsorbed ions. (auth)

Prout, W. E. 1958. Adsorption of Radioactive Wastes by Savannah River Plant Soil. Soil Science. 86:13-17.

The adsorption of radioisotopes on soil was investigated in the laboratory to determine the behavior of low-level radioactive waste solutions discharged to the ground. Strontium, cesium, and plutonium distributions between soil and waste solutions were studied. The effects of cation concentration and acidity were determined. The results of the distribution experiments, and material balance considerations, permit prediction of the behavior of activity in beds of soil. Laboratory tests with beds of soil gave results that agreed with these predictions. These results can be applied to the disposal of radioactive solutions to the ground. A typical application is discussed. (auth)

Prout, W. E. 1959. Adsorption of Fission Products by Savannah River Plant Soil. DP-394.

Data are presented for the equilibrium distribution of cesium, strontium, plutonium, ruthenium, and zirconium-niobium between soil of the Savannah River plant and various aqueous solutions. Low cation concentration and a pH range of 7 to 9 were most favorable for absorption of these elements on the soil. (auth)

Prout, W. E. 1962. Studies of the Containment of Radioactive Wastes in the Underground Mined Caverns at the Savannah River Plant. IN: Morgan, J. M., D. K. Jamison, and J. D. Stevenson (eds.). Ground Disposal of Radioactive Wastes. Second Conference Proceedings. TID-7628, pp. 380-393.

The DuPont Company is coordinating an exploratory drilling program, to determine the feasibility of mining caverns for the storage of radioactive wastes in the basement rock underlying the Savannah River Plant. Other groups participating in the study include the U.S. Corps of Engineers and the U.S. Geological Survey. At the Savannah River Plant the problem of waste management has been handled satisfactorily by a policy of containment within the environs of the plant proper. Low level waste is released to seepage basins at controlled rates. All other liquid wastes are stored in underground steel tanks contained in concrete vaults or in steel-lined concrete tanks. Containment in these vessels has been satisfactory from the standpoint that there has been no loss of stored wastes to the natural environment. However, the tanks have a relatively short life as compared to the radioactive life of the stored material . Unless a more permanent disposal scheme is developed, new tanks may be required from time to time, and the presently stored liquid may have to be transferred if continuing safe containment is to be assured. Following the drilling of a test hole at the Savannah River Plant in 1952, consideration was given to the use of caverns mined in bedrock for the ultimate storage of radioactive wastes. Active investigation was postponed, however, since satisfactory interim storage could be obtained in tanks and since the heat generated from the fission products dictated that considerable aging would be required before permanent storage would be practical. It is our current opinion that the bedrock that underlies the plant site has a good potential for containing radioactive wastes. A study of the feasibility of cavern storage is currently underway. A total of 10 test holes are to be drilled to a depth of 1000 feet into the basement rock. The rock cores are to be tested to determine compressive strength, modulus of elasticity, water permeability, coefficient of expansion, specific heat, diffusivity, conductivity, and chemical compatibility of the rock with synthetic and actual wastes. Testing of the rock core from the first hole is complete. Drilling of holes 2, 3, and 4 is more than 75% complete. (auth)

Purtymun, W. D. 1971. Plutonium in Stream Channel Alluvium in the Los Alamos Area, New Mexico. LA-4561.

A survey of plutonium isotopes Plutonium 238 and Plutonium 239 in the alluvium of major canyons in the Los Alamos Area was made to determine concentrations and movement of soil-bound plutonium. Trace concentrations of plutonium were found in alluvium in those canyons which have received or are receiving treated effluents from operations of the Laboratory. The concentrations of plutonium in the alluvium of the remainder of the canyons were no greater than those concentrations attributed to world-wide fallout from atmospheric tests. (auth)

Purtymun, W. D. 1973. Underground Movement of Tritium from Solid-Waste Storage Shafts. LA-5286-MS.

Tritium from contaminated wastes placed in storage shafts has been transported by moisture into the adjacent tuff. A study made to determine the extent and geologic factors governing this movement indicates that 100 pCi/ml levels have moved westward a distance of 105 ft in 4 yr. Major movement has been along the contact between the two ashflows penetrated by the shafts, with secondary transport through open joints and through the tuff matrix. Evaporation from surface soil and tuff and transpiration from plants has been a contributing factor in the release of tritium to the atmosphere. (auth)

Purtymun, W. D. 1974. Storm Runoff and Transport of Radionuclides in DP Canyon, Los Alamos County, New Mexico. LA-5744, pp. 1-7.

Study determined runoff volume, suspended sediment load and amount of radioactivity carried out of DP Canyon by storm runoff. During summer of 1967, 23 runoff events carried $\sim$88,000 kg of suspended sediments in $\sim$36,800 m^3 of water. Sediments carried out $\sim$70 µCi of gross alpha, $\sim$11,300 µCi gross beta. About 31,000 µCi ^{90}Sr left canyon in solution as did traces of ^{238}Pu, ^{239}Pu, ^{241}Am. (auth)

Purtymun, W. D. and W. R. Kennedy. 1971. Geology and Hydrology of Mesita del Buey. LA-4660.

Mesita del Buey is used for the disposal of wastes contaminated by radionuclides, of toxic or explosive chemicals, and of classified materials. These are buried in pits or shafts dug into the mesa surface. The mesa, covered by a clay-like soil, is underlain by a series of ashfalls of rhyolite tuffs from 240 to 590 ft thick. The tuffs are above the main aquifer of the Los Alamos area which lies at a depth of about 1,000 ft. Stream flow in adjacent canyons is intermittent. Water in the alluvium of the stream-connected aquifer in the canyon south of the mesa is recharged by storm runoff. The hydrologic characteristics and conditions of the soil, tuff, and seal material used to cover the wastes indicate no recharge to the stream-connected aquifer or main aquifer through the soil, buried wastes, or tuff at Mesita del Buey.

Purushothaman, K. 1968. Transport of ^{85}Sr and ^{137}Cs Under Induced Clay Suspensions. Thesis. Univ. of Tex.

The effects of induced clay suspensions on the transport of ^{85}Sr and ^{137}Cs in an aqueous environment were studied. An instrumented flume was used as a model river to simulate an environment typical of a slow-moving, unpolluted, turbid stream. Modified longitudinal dispersion relationships were used to describe the transport of radionuclides in turbid streams. Data were derived from instantaneous release of ^{85}Sr and ^{137}Cs with suspended Attapulgite and Kaolinite clays. Continuous release of ^{137}Cs with an Attapulgite clay suspension helped to establish uptake and transport characteristics for one environmental condition. Aquaria and laboratory studies preceded the model river experiments to define more specifically some of the physical and chemical characteristics. Suspended clay in the model river system produced a significant reduction in the transport of ^{137}Cs. Conversely, the transport of ^{85}Sr was not affected appreciably since most of the ^{85}Sr remained in solution. (NSA)

Purushothaman, K. 1971. Radionuclide Transport in an Aquatic Model System. IN: Trace Substances in Environmental Health. IV/Hemphill, D. D. (ed.). Univ. of Missouri, pp. 174-85.

The radioactive wastes at very low concentrations as released by the nuclear power facilities into an aquatic system pose complex problems such as the transport of the radionuclides for further dilution downstream, simple and complex chemical changes of the radionuclide, and the concentration and subsequent release of the radioactive materials in the aquatic biota and sediments depending upon the nature and condition of the environment. A study conducted to evaluate the effects of selected clay suspensions on the transport of ^{85}Sr and ^{137}Cs in a model river is described. An instrumented flume was used to simulate a slow-moving, turbid stream which did not receive any extraneous biodegradable organic pollutant. Modified longitudinal dispersion relationships were used to describe the transport of radionuclides in the turbid stream. Data were obtained from instantaneous release of ^{85}Sr and ^{137}Cs with suspended Attapulgite and Kaolinite clays. Results showed that suspended clays in the model river system produced a significant reduction in the transport of ^{137}Cs. The transport of ^{85}Sr is not affected to a considerable degree since most of the ^{85}Sr remained in solution. (auth)

Purushothaman, K. and E. F. Gloyna. 1968. Radioactivity Transport in Water: Transport of ^{85}Sr and ^{137}Cs Under Induced Clay Suspensions. ORO-490-13.

The effects of induced clay suspensions on the transport of ^{85}Sr and ^{137}Cs in aqueous environments are described. An instrumented flume was used as a model river to simulate an environment typical of a slow-moving, unpolluted, turbid stream. Modified longitudinal dispersion relationships were used to describe the transport of radionuclides in turbid streams. Data were derived from instantaneous release of ^{85}Sr and ^{137}Cs with suspended Attapulgite and Kaolinite clays. Continuous release of ^{137}Cs with an Attapulgite clay suspension helped to establish uptake and transport characteristics for one environmental condition. Aquaria and laboratory studies preceded the model river experiments to define more specifically some of the physical and chemical characteristics. Suspended clay in the model river system produced a significant reduction in the transport of ^{137}Cs. Conversely, the transport of ^{85}Sr was not affected appreciably since most of the ^{85}Sr remained in solution. (auth)

Puschmann, H. 1970. Research on Sorption of the Radionuclides ^{85}Sr, ^{137}Cs, and ^{131}I by Unconsolidated Sediments. Sands from the Low-Terraces of the Rivers Weser, Donau, Elbe/Germany. Deut. Gewaesserk, Mitt. 14:63-72 (in German).

Fine-grained sediments from the Weser, Donau, and Elbe rivers were examined for their sorption behavior in respect to ^{85}Sr, ^{137}Cs, and ^{131}I. The experiments with closed systems give the course of the sorption and the possible sorption rate after the equilibrium has been established. The sorption rates are converted to grams of the element used per m^3 sand as used in the laboratory experiment. The results are compared with the sorption rates dealt with by Weisflog (1968), which were made with low-terrace sediments from the river Rhine. (auth)

Pyalling, A. O. 1970. Effect of Physiochemical Conditions of the Medium on the Leaching of Uranium from Natural Dahllite. Probl. Regional Geol. Petrogr. Sibiri Metedy Geokhim. Geofiz. Issled. No. 2:88-91 (in Russian).

The U from natural dahllite was leached in various media under normal conditions (1 atm, 19-20°). The pH and E_h of solutions were measured. The U was determined by the luminescence-bead and phosphor-hydroquinone methods. The leaching of U from phosphates in a carbonate medium

(4.2×10^{-4} and 9.43×10^{-2}M Na_2CO_3) did not depend on the E_h of the system within the range from +0.74 to -0.27V. A small amount of U was transferred into solution during a change of Na_2CO_3 concentration from 4.2×10^{-4} to 9.43×10^{-2}M. A decrease of pH to 4.5 resulted in decomposition of the dahllite lattice and in an increase in the U content to 120 ppm. At pH 2.1, the solution contained 2400 ppm U. (CA)

Raats, P. A. C. 1967. Kinematics of Soil Water. IN: Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. IAEA, Vienna, pp. 191-200.

Relatively simply physical-mathematical models have been quite successful in describing the flow of water in saturated and in partially saturated soils. The main features in these models are, (1) a balance of mass for the water, (2) a dynamic statement relating the velocity of the water relative to the solid phase, to the forces causing the movement of the water, and (3) a capacity relation, e.g., for a partially saturated soil the relationship between the water content and the pressure head. These models treat the soil water in a macroscopic sense as a continuous medium. Kinematics deal with concepts that are useful in characterizing the motion of a continuous medium. Regarding the soil water as a continuous medium leads naturally to a discussion of the kinematics of soil water. Among the kinematic concepts considered are: velocity, vorticity, stream line, path line, streak line, and collections of particles forming a surface. The main purpose is to describe the restrictions imposed upon the kinematics of the soil-water movement by conservation of mass, the dynamic law, and the capacity relation. Several special cases are discussed. The soil may be saturated; the solid phase may be homogeneous or not homogeneous; and the flow of the water may be steady or unsteady. The nature of the velocity field of the water in the various cases is discussed. The relationship between the kinematics of the motion and surfaces of equal total potential, of equal pressure potential, and, in the case of a partially saturated soil, of equal water content, is described. Radioactive tracers are very useful in studying the kinematics of soil water. The aims and limitations of several tracer techniques will be interpreted in terms of kinematic concepts. (auth)

Rabinowitz, D. 1970. Forced Exchange of Tritiated Water with Clays. EOS, Transactions American Geophysical Union. 51:287.

Isotopic fractionation of tritium under selective sorption by standard clays from tritiated water in contact with the clay surface shows a strong dependence on the acidity of the clay-water mixture. Under forced exchange of ions between tritiated water and clays, the rate of exchange is shown to depend on the type of clay and the hydrogen ion concentration in the sample. Ion exchange between tritiated water and the clay sample was stimulated by a process of electrodialysis under constant ambient conditions. No significant exchange between solution and clay is found under electrodialysis for an illite clay. Similar experiments on kaolinite clay samples show a constant rate of exchange between sample and solution. With the illite clay the pH in the clay-water mixture remained basic during most of the experiment, but with the kaolinite clays, the pH changed from neutral to acidic after equilibrium in tritium concentration was reached. The constant rate of loss of tritium to the kaolinite clays begins in coincidence with the change in pH of the solution. A fraction of the tritium lost was recovered in the hydroxyl water of all the clays. The amount of tritium recovered in the hydroxyl water of each clay is proportional to the cation exchange capacity of the clay.

Rabinowitz, D. D., C. R. Holmes, and G. W. Gross. 1973. Forced Exchange of Tritiated Water with Clays. IN: Tritium. A. A. Moghissi, and M. W. Carter (eds.). Messenger Graphics.

This report describes the isotope exchange and "fixation" of tritium on clay minerals (kaolinite and illite) under a mild form of electrodialysis (2V/cm). Aluminum and other basing cations were determined after each experiment to be certain that a major movement of aluminum out of the octahedral position had not occurred. A mass balance on the tritium was also determined for each experiment. The analytical data for tritium facilitated the differentiation of both isotopic exchange and fixation of tritium by the clays. The presence of exchangeable aluminum correlated with the tritium loss from the water.

Rackley, R. I. 1971. Environment of Wyoming Tertiary Uranium Deposits. American Assn. Petroleum Geologists Bull. 56:755-74.

Four major uranium districts in Tertiary rocks of central Wyoming are in fluvial sandstones derived from the granitic rock of the ancestral Sweetwater arch and deposited in adjacent intermountain basins. Sediment transported southward into the Great Divide basin was deposited on an apron of alluvial fans. Sedimentation in the Gas Hills area of the Wind River basin was on the alluvial fan in which ridges of older rock disrupted the normal development of the fan. Sediment in west Shirley basin was deposited on an alluvial fan, but in east Shirley basin and in the Powder River basin sedimentation was channel and flood-basin deposits of a meandering stream. The sandstones are subarkosic to arkosic, medium grained to conglomeratic, angular and poorly sorted. Sandstones intertongue with green or carbonaceous shales. Sedimentation was in a warm, humid climate with abundant vegetation. Decay of the organic material created reducing conditions in the sediment which caused partial carbonization of some of the plant debris, formation of pyrite, and precipitation of uranium minerals. Following burial, uplift-induced changes in the hydrodynamic system caused an invasion of the reduced sediment by oxygenated water far below the static water table. This caused destruction of carbonaceous material, oxidation of pyrite, and accumulation of uranium and other susceptible metals in a wave or front just ahead of the invading oxidizing environment. The invading oxidation was a dynamic, expanding process which moved through the permeable zones of the fluvial sequence until its dimensions measured miles in areal extent and hundreds of feet in thickness. This geochemical cell had a sharply defined boundary produced by biochemically controlled changes in physical and chemical conditions. Oxygenated waters, aided by Thiobacillus ferrooxidans, oxidized pyrite to produce sulfuric acid and ferric sulfate, a strong oxidizer, which leached uranium and other susceptible elements. In the reducing part of the cell, anaerobic bacteria, including the sulfate reducer Desulfovibrio, consumed the organic material in the sediments and the sulfide, and a mildly alkaline, strongly reducing environment which precipitated pyrite, uranium, and other metals on the front. Migration of the cell was controlled by the permeability of the sandstone and by availability of carbon and pyrite. The cell advanced faster in the more permeable zones and was retarded in zones of reduced permeability and areas of greater pyrite and carbon content. The position of the mineral front was a function of the initial sedimentary pattern. Sedimentation, alteration, and mineralization in the Gas Hills and Shirley basin districts illustrated these conditions and processes. (auth)

Radosavljevic, R. and T. Tasovac. 1970. Capture of ^{60}Co by Suspended Particles in the Danube. IN: Symposium International de Radioecologie. Vol. I. Fontenay-aux-Roses, France. pp. 83-92.

As a part of the program for the control of the radioactivity of the Danube, the behavior of different radionuclides is studied and the fixation of cobalt-60 by suspensions is investigated. The influence of different parameters on fixation is determined. (auth)

Rafal'skii, R. P. 1963. Physico-chemical Investigation of Conditions Conducive to Formation of Uranium Ores. Gosatomizdat (in Russian).

Physiochemical studies were made of the primary mineralization of uranium-bearing deposits. The crystallization of amorphous silica and the mechanism of hydrothermal transformation of silica glass to quartz under isothermal conditions are analyzed. The solubility of U(IV) and U(VI) compounds in aqueous solutions and the reduction of U(IV) and U(VI) by divalent iron, sulfur, sulfur compounds, and other reducing agents are discussed as well as the reduction and precipitation of uranium by minerals. The hydrothermal transport and deposition of uranium are also discussed. (NSA)

Rafal'skii, R. P. and K. F. Kudinova. 1959. Conditions for the Reduction and Precipitation of Uranium by Minerals. Atomniya Energ. 7:333-7 (in Russian).

It is postulated that primary uranium minerals were precipitated by iron, sulfur, and arsenic reduction of U(VI) present in hydrothermal solutions. Experiments produced crystalline pitchblende, collomorphic uranium powder, and sooty uranium black formed by reduction of U(VI) to U(IV) by acid solutions at 100 to 135°C. The character of the formation depends upon the precipitator mineral, interaction temperature, and in some cases on the concentration of uranium in solution. (NSA)

Ragland, P. G. 1964. Autoradiographic Investigations of Naturally Occurring Materials. IN: Natural Radiation Environment. J. A. Adams and W. M. Lowder (eds.). University of Chicago Press. pp. 129-51.

An analysis of information obtained by autoradiography of rocks is presented. Suggestions concerning applications of radiographic methods are included. Discussions of distribution of α emitters in constituent minerals are also included along with data on α activity in various rocks. (NSA)

Ragsdale, H. L. and D. J. Shure. 1973. Flood Plain Transfer and Accumulation of ^{137}Cs from a Reactor Effluent Stream. IN: Environmental Behavior of Radionuclides Released [illegible] the Nuclear Industry. IAEA, Vienna. pp. 243-53.

Analysis of the flood [illegible] in swamp forest ecosystem of a reactor effluent stream in South Carolina revealed significant lateral transport of ^{137}Cs from the stream channel to the flood plain. Six flood plain transects, representing 13 miles of the stream, were extended from the stream bank into the swamp forests. Soil, root, litter, branch and leaf samples were collected at 100-ft intervals up to a distance of 300 ft along each transect. Upstream burdens of ^{137}Cs reached mean values of 225 pCi/g-d (g dry wt.) in soil and 100 pCi/g-d in vegetation, while downstream burdens were found to be 100 pCi/g-d in soil and 15 pCi/g-d in vegetation. The upstream-downstream differences indicate that significant biological cycling of radiocesium occurs upstream, while downstream there is accumulation through immobilization in the soil. Levels of ^{137}Cs in the flood plain were variable with soils, litter and vegetation ranging from near-background to 100 pCi/g-d and roots ranging up to 340 pCi/g-d. Flood plain distribution of radiocesium correlated with topographic relief resulting in non-uniform levels of ^{137}Cs where flood plain depressions allowed for physical accumulation of radioactivity. These results lead to a rejection of the commonly assumed hypothesis of stream containment of radionuclides for streams in coastal plain areas. A new model of the fate of reactor effluents discharged to a coastal plain stream must account for discreet flooding over low banks, physical movement of suspended and soluble forms of radionuclides in terrestrial habitats, biological cycling and accumulation in the flood plain, redistribution of biologically incorporated radionuclides back to the stream, and long-term erosional movement of sedimentary radionuclear materials due to stream bed movements. (auth)

Rai, D. and W. L. Lindsay. 1975. A Thermodynamic Model for Predicting the Formation, Stability, and Weathering of Common Soil Minerals. Soil Sci. Soc. Amer. Proc. 39:991-996.

Numerous workers have examined the weathering products of soil minerals and have proposed empirical weathering sequences. The present paper outlines the development of a thermodynamic model that predicts in a systematic way several mineral transformations that can occur in soils.

According to this model, the stability of primary minerals increases in the order: Na-glass, K-glass, pyroxene, analcime, anorthite, low albite, microcline and quartz. The stability of secondary clay minerals depends on soluble silica. At pH 6 with high silica ($\approx 10^{-3}$M) the order of increasing stability is: chlorite, halloysite, gibbsite, illite, dickite, beidellite, kaolinite, and montmorillonite; at low silica ($\approx 10^{-5}$M) the order is: chlorite, hallosyte, illite, beidellite, montmorillonite, dickite, kaolinite and gibbsite. The stability of both primary and secondary minerals increases with pH.

The observed weathering of volcanic ash agrees well with the predictions of this model. The model makes use of important thermodynamic data accumulated for soil minerals and helps to pinpoint deficiencies in these data. The need to examine the kinetics of mineral transformations in soils in greater detail also becomes obvious from this model. (auth)

Rai, D. and R.J. Serne. 1976. Removal of ^{239}Pu and ^{241}Am from Contaminated Sediments with Various Extracting Solutions. Agronomy Abstracts, 131.

The use of intrinsic Ge diodes to detect low energy x-rays and gamma rays as a means of determining ^{239}Pu and ^{241}Am in sediments and solutions was investigated and found to be rapid, reliable, and inexpensive compared with the conventional method of wet chemical extraction of sediments followed by α analyses. This method was applied to the study of contaminated sediments from 216 area of Hanford Reservation where acidic and alkaline radioactive wastes were disposed to the sediments of Z-9 and Z-12 cribs, respectively.

Plutonium-239 and ^{241}Am forms such as water soluble, exchangeable, organic matter and iron oxide bound, present in the sediments were studied. In general, ^{241}Am was slightly more mobile than the ^{239}Pu. However, only a few percent of the total ^{239}Pu (<2.6%) and ^{241}Am (<6.5%) was readily mobile (water soluble and exchangeable). The concentration of ^{239}Pu in water extracts of contaminated sediments decreased with the increase in pH from 3 to 7. The variation in ^{241}Am concentration with changes in pH was similar to ^{239}Pu variations. The variation of ^{239}Pu with the changes in pH was very similar to the variations predicted from the thermodynamic data. Further data on pH and other factors could result in a valuable tool for predicting the fate of Pu and Am in geologic environments.

The acidic contaminated sediments differed considerably from the basic sediments in ^{239}Pu and ^{241}Am forms. A higher percentage of total ^{239}Pu and ^{241}Am in acidic sediments compared with the basic sediments seems to be associated with the organic matter, iron oxides, and that can be extracted in organic chelates. At the end of sequential extractions with H_2O, $MgCl_2$, DTPA, H_2O_2, and acid ammonium oxalate, the sediment was treated with 8N HNO_3. Only a small percentage of total ^{239}Pu (<1%) and ^{241}Am (<7.5%) in acidic sediments was extractable in 8N HNO_3, whereas approximately 71% of total ^{239}Pu and ^{241}Am was extracted from basic sediments with 8N HNO_3. When contaminated sediments without any pretreatments were contacted with 8N HNO_3, the percentage extraction was considerably higher than reported above. However, the relative degree of extraction of Pu and Am from acidic and basic sediments did not change considerably. The results on forms of ^{239}Pu and ^{241}Am in contaminated sediments lend themselves to prediction of relative pollution potential of Z-9 and Z-12 sediments under various weathering environments. (auth)

Rai, D. and R.J. Serne. 1977. Plutonium Activities in Soil Solutions and the Stability and Formation of Selected Plutonium Minerals. J. Environ. Qual. 6:89-95.

Selected thermodynamic data was used to develop solid phase-soil solution equilibria diagrams which are used to predict and understand plutonium behavior in terrestrial environments.

The plutonium mineral transformations in soils are highly dependent upon the pH, Eh, and the soil solution composition. The predictions of weathering and formation sequences of $Pu(OH)_3$, $Pu(OH)_4$, $PuO_2(OH)$, $PuO_2(OH)_2$, PuO_2, βPu_2O_3, PuF_3, PuF_4, PuO_2CO_3, and $Pu(HPO_4)_2$ at pH values from 3 to 11 at pO_2 from 0.68 to 80, and in an assumed weathering environment are given. The study shows that the PuO_2 is the most stable mineral in the pH and pO_2 ranges found in the terrestrial environments.

The nature and activity of ions and ion-complexs and, hence, the total plutonium in solution is a function of the stable phase, pH, Eh, and complexing anions: for example, (i) in a reducing environment ($pO_2 80$) at pH 8 and in equilibrium with $PuO_2(s)$, the predominant solution species are Pu^{3+} and its complexes, and (ii) in an oxidizing environment (pO_2 16) at pH 8 and in equilibrium with $PuO_2(s)$, the predominant solution specie is $PuO_2CO_3OH^-$.

Empirical predictions regarding the plutonium sorption by soils are outlined and verified by experimental results reported in the literature. The deficiencies in the present thermodynamic data and future research needs are outlined. (auth)

Raikov, L. 1965. Natural Radioactivity of Bulgarian Soils. Rast. Nauki. 2:31-36.

Total Beta-radioactivity of various soil types and paternal rocks was measured by means of STS-6 counter. Measurements were made with two cylinders, an outside and inside one. A tritiated soil sample of 150 g shifted through a 1 mm mesh sieve, was put in the outside cylinder and in the inside cylinder, the wall of which is a thin paper, and placed in the cylindrical counter. Radioactivity of various soils is expressed in impulses per minute and it varies greatly. Cinnamon forest soils, developed over calcareous rocks, have a radioactivity of about ten impulses per minute, while the radioactivity of brown forest soils, underlain with rhyolites and alluvial and diluvial soils developed over materials originating in acid eruptive rocks attains ten times higher values. Chernozem soils, grey forest, chernosem-smolnitza and podzolic cinnamon soils take a medium position within the extremes pointed out. The radioactivity of nearly all soils investigated was due (in two thirds of the cases) to radioactive potassium. Uranium, thorium and other element groups have a greater participation in the peat-bog and solonetz soils in the region of Plovdiv. Considerably increased radioactivity (2 to 3 times) of the 0 to 6 cm top soil layer was observed in virgin soils of certain mountain areas due to radioactive elements deposited by precipitation. (auth)

Raikov, L., Z. Naumov, M. Milchev, and E. Dimitrova. 1970. Total β-Radioactivity and ^{40}K Content in Brown Forest Soils of the Central Balkans and the Northwestern Rhodopes. Gorskostop. Nauka. 7:27-35 (in Bulgarian).

Studies on the total β-radioactivity and ^{40}K content in brown forest soils in the central Balkan Mountains showed that of the total β-radioactivity the greater part came from ^{40}K. The total β-radioactivity of these soils ranged from 8 to 21 pCi/g soil, in the soils of northwestern Rhodopes from 2 to 29 pCi/g. The higher total β-radioactivity in most of the soil types studied in the northwestern Rhodopes was related to the higher content of K in the granite-gneiss parent rock and to the higher altitude above sealevel. (NSA)

Raikov, L. and S. Sapundzhiev. 1966. Natural Radioactivity and Chemical Composition of Iron-Manganese Concretions in Saline and Podzolized Soils. Pochvozn. Agrokhim. 1:327-30 (in Bulgarian).

Concretions in saline soils have a much higher radioactivity than concretions in podzolic, 6-8 times higher than in zonal soils. The radioactivity is due mainly to U; its contents are determined in 0-20 cm meadow-solonchak-solonets soils with 5.9 ppm, in its concretions >3 mm 62 ppm and <3 mm 46 ppm the contents in cinnamon-podzolic soil are in concretions >3 mm 9.2, <3 mm 6.7, in such of light-gray mountain soil 4.7 ppm. The concretions in solonets contain 10.28-12.59 percent MnO vs 0.15-0.16 percent in soil; moreover, 3-4 times more Fe_2O_3, and much less SiO_3. (CA)

Raja, M.E. and K.L. Babcock. 1961. On the Soil Chemistry of Radio-Iodine. Soil Science. 91:1-5.

The behavior of carrier-free I-131 in two California soils in two clay minerals, and in peat has been studied. The results of pretreatment by autoclaving, oxidation with peroxide and digestion with alcohol, as well as extraction of I-131 with various salt solutions, all indicate that the large fraction of I-131 retained by the soils is due to reaction with organic matter. (auth)

Rajkov, L. 1972. Test for Limiting the Penetration of ^{90}Sr from the Soil into Plants. INIS-mf-715 (in Bulgarian).

The assimilation of ^{90}Sr introduced in the soil by the plants is studied in pot experiments. A total of 15 soils, including the basic soil varieties in this country were tested. Significant differences were established in the desorption of ^{90}Sr of the separate soils. With five widely distributed soils (carbonate chernozem, smolnitza, bleached chernozem, podzolized cinnamon forest soil, and brown forest soil) tests are carried out with chemicals and fertilizers for blocking the assimilation of ^{90}Sr by plants. Tests were conducted with $Ca(H_2PO_4)_2$, K_2PHO_4, $CaCO_3$, and manure in growing oats, peas, and alfalfa. As a result of investigations it was established that plants grown on brown forest soil, podzolized cinnamon forest soil, and on alluvial soils assimilate many times more ^{90}Sr than plants grown on chernozem soil and particularly on smolnitza soil. This is related to differences in the mechanical composition, the sorption capacity, pH of the soil, and other factors. Most strong and permanent is the blocking effect of K_2HPO_4. Significant blocking effect was also obtained by $Ca(H_2PO_4)_2$ while such effect by $CaCO_3$ and manure was observed only in acid soils. The dependences established were observed in cereals and leguminous plants but certain differences exist in their absolute values as well as in the straw and grain of the separate crops. (auth)

Rajkov, L., M. Najdenov, and St. Darkova. 1972. Pollution of Mountain Soils with Radioactive Strontium and Cesium. INIS-mf-716 (in Bulgarian).

During investigations of the mountain soils in this country (brown forest soils and mountain-meadow soils) a considerably higher accumulation of fallout products was established as compared to soils in the plains. Studies were conducted on the ^{90}Sr and ^{137}Cs content in soils of different altitude as well as on the ^{90}Sr content in the natural vegetation of separate regions. The ^{90}Sr content was determined radiochemically and that of ^{137}Cs radiometrically with a gamma analyser and specially constructed camera. It was established that from 80 to 90% of the Sr accumulated in the soil was absorbed comparatively firmly by the surface layers from 0 to 3 cm deep. The penetration of this element in the layers from 3 to 10 cm deep is in small amounts and in the layers from 10 to 20 cm is encountered only as an exception. The picture of ^{137}Cs content and distribution in the same soils is similar. Expressed in absolute units (pCi/g soil) the content of ^{137}Cs is higher than that of ^{90}Sr. The increase of the beta activity in the surface layers of virgin soils investigated as a result of deposition of fallout products exceeds 5 to 6 times the natural beta activity of the same soils (for the period 1964-1970). (NSA)

Ralkova, J. and J. Saidl. 1969. Solidification of High Level Wastes. Part 3. Diffusion and Elution Rates of Radionuclides Incorporated in Basalts. Kernenergie. 10:161-164.

Elution data for cesium and strontium incorporated into basalt glasses are given. The diffusion coefficients for cesium and strontium were 4.0×10^{-13} and 1.9×10^{-13} cm^2/sec, respectively, at 350°C and at 550°C, 2.5×10^{-11} and 1.8×10^{-11} cm^2/sec, respectively.

Rancon, D. 1967. Mechanism of Radioactive Contamination in Consolidated Impermeable Rocks or Rocks of Very Low Permeability. IN: Disposal of Radioactive Wastes into the Ground. IAEA-SM-93/14 (in French).

The geochemical studies of radioactive contamination carried out so far have been mainly concerned with granular rocks (clay and soil) in which, owing to the infiltration of water, the radioisotopes are retained by micrograins or microcrystals of clay. But a circulation of radioactive effluents can also affect consolidated rocks which are impermeable or of very low permeability. The retention phenomena are then different, since they occur mainly on the surface.

In order to determine the capacity of a body to retain a given radioisotope, use is made of the distribution coefficient of Kd. This value, which is characteristic of a granular rock for a given radioisotope, is not characteristic of a consolidated rock. We have, however, devised a law expressing the variation of this Kd measured as a function of the thickness of penetration (e) of the liquid and of the dimension of the rock, which was experimentally verified by measuring the Kd as a function of the diameter x of the grains in the rock. Similarly it has been found that this measured Kd increases linearly with the specific surface of the rock.

Thus, the Kd does not represent a physico-chemical characteristic when applied to rocks of very low permeability, since it is dependent upon grain size and the specific surface. Accordingly, an alternative concept has been defined for uptake by rocks of this nature, i.e. the surface distribution coefficient, of Kd(S). Experience has shown that this value of Kd(S) was constant and characteristic of a rock and a radioisotope for a specific contact time.

The author describes the methods used to ascertain the retention stability of the radioisotope on the rock and the kinetic study of its diffusion. (auth)

Rancon, D. 1971. Study and Demarcation of Pollution in Non-saturated Soils. IN: Nuclear Techniques in Environmental Pollution. IAEA, Vienna. pp. 551-63 (in French).

A method was developed for evaluating the intensity and determining the extent of pollution in non-saturated soils and for following its progress, with a view to preventing the pollution of aquifers in particular. A simple device is described which can be rapidly inserted to a depth of 3 to 4 m in loose soils. A neutron moisture gauge is introduced into borehole tubes in order to measure variations in the moisture content of the ground and thereby give warning of any movement of pollutants associated with water movement. A focalized probe specially designed for the purpose is then inserted into the same tubes and measures movement of the activity front of radioactive tracers or of various radioactive pollutants. The greater the number of access tubes the more accurate is the demarcation of the polluted zone. Numerous experimental releases of radioactive liquids have been carried out to test this device, the liquids being labeled with ^{85}Sr to simulate those elements retained by minerals and with ^{131}I to simulate those hardly retained. It was thus possible to measure the relative velocities of the activity and moisture fronts, determine the boundaries of the polluted zone and evaluate the volume of soil polluted. A study has also been made of the behavior of already polluted soil when it is traversed by non-contaminated seepage waters discharged at the surface, the risks of spreading and the possibility of confinement of the pollutants being assessed. The method is ready for use in the field. (auth)

Rancon, D. 1972. Practical Use of the Distribution Coefficient in Measuring the Radioactive Contamination of Minerals, Rocks, Soils, and Underground Water. ANL-Trans-931.

The uptake of radioisotopes by soils or the diffusion in subterranean waters is often estimated with the distribution coefficient (Kd) of the radioisotope between the solution and the solid. In practice, many precautions have to be taken so that the Kd measurements will be representative of natural media. As a matter of fact, the Kd depends on the chemical form of the radioisotope, on the nature and composition of the solution and on the nature of the minerals constituting the rocks. But it is also necessary to take into account the texture and the grain size of the material. The Kd does not represent a physicochemical characteristic when applied to consolidated rocks of very low permeability, since it is dependent upon specific surfaces according to a determined law. Accordingly, an alternative concept has been defined for uptake by rocks of this nature, i.e. the surface distribution coefficient or Kd(S). Experience has shown that the value of Kd(S) was constant and characteristic of a consolidated rock and a radioisotope for a specific contact time. (auth)

Rancon, D. 1973. The Behavior in Underground Environments of Uranium and Thorium Discharged by the Nuclear Industry. IN: Environmental Behavior of Radionuclides Released in the Nuclear Industry. IAEA-SM-172/55, pp. 333-346 (in French).

Following various studies on the radioactive contamination of soil by fission products from a variety of effluents, it has been found necessary also to establish in what way long-lived heavy radionuclides could be diffused in underground environments. A proposal is made for the study of the behavior in the soil of uranium and thorium originating from outside, as compared with the uranium and thorium existing as natural constituents of the soil. Use was made of various types of soil (acid and alkaline) and of various minerals (argillaceous minerals, calcite and quartz). Uranium in solution, or uranyl ion to be more precise, has a certain degree of mobility in soils. The coefficient for the distribution of uranyl ion between the solution and the mineral was measured at various concentrations. The influence of the pH of the soil-water solution is very considerable; the retention of uranium by the soil shows a marked increase within certain narrow pH ranges. Thorium is subject to high retention by argillaceous and calcareous soils, some of the latter strongly fixing the whole amount. The influence of various parameters (pH, concentration, soil composition) is also substantial, as retention can be very much reduced under certain extreme conditions. The risk of the spread of thorium in dilute solution over long distances is negligible in most soils. On the other hand, a certain degree of uranium diffusion under the influence of ground-water movements is to be anticipated; diffusion evaluations are presented. (auth)

Rancon, D. 1973. Soil Contamination. Part 2. Movements of Radioactive Ions in Nonsaturated Soils After Reject in a Limited Space. CEA-R-3635(2) (in French).

Water movements in non-saturated soils after reject on a limited space were measured using the radioactive ions ^{131} and ^{85}Sr (an anion and a cation). The experimental method is based on the simultaneous measurements of moisture and radioactivity by means of a neutron moisturemeter and an especially designed radioactivity probe. It was possible to measure: the relative velocities of moisture and radioactivity fronts; the contaminated soil volume inside the moistened soil volume; the concentration gradients; the contamination changes on watering; the effect of chemical composition of water on ion movements; and the effect of soil moisture on the counting rate of radioactivity. This method can be generalized to other radioisotopes and other soils. They are applicable to radiological safety monitoring of sites; testing storage facilities; estimates of accidents hazards; and protection of subterranean waters. (auth)

Rao, V. K., C. J. Shahani, and C. L. Rao. 1970. Studies on the Phosphate Complexes of Actinium and Lanthanum. Radiochimica Acta. 14:31-34.

The stability constants for the formation of $Ac\text{-}H_2PO_4^{2+}$ and $La\text{-}H_2PO_4^{2+}$ have been determined at ionic strength 0.5M using the liquid cation exchanger, dinonyl naphthalene sulphonic acid (NH_4 + form). It has been found that in acid phosphate solutions (at pH 2.0 and 3.0), complexation occurs mainly with $H_2PO_4^-$ ion while complex formation due to HPO_4^{2-} and PO_4^{3-} ions is negligible. (auth)

Raymond, J. R. 1964. Investigation of the Disposition and Migration of Gross Gamma Emitters Beneath Liquid Waste Disposal Sites. HW-81746, pp. 4.32-4.36.

Wells immediately adjacent to liquid waste disposal sites were logged with a gamma scintillation probe to determine the penetration depth of radionuclides. Information is presented to show contamination magnitude and migration changes at several "typical" sites. Well scintillation logs are shown to illustrate changes in waste penetration at three waste disposal facilities that have different operational histories. (auth)

Raymond, J. R., D. A. Myers, J. J. Fix, V. L. McGhan, and P. M. Schrotke. 1976. Environmental Monitoring Report on Radiological Status of the Ground Water Beneath the Hanford Site, January-December 1974. BNWL-1970.

Evaluation of β/sub t/, ^3H and NO_3/sup -/ concentrations measured in well water sampled near the surface of the unconfined ground water during

1974 shows that zones of contamination extend in an easterly to southeasterly direction from 200-E Area, as has been observed in the past. Tritium and NO_3^- ion concentrations above background were found along the Columbia River in the vicinity of the 100 Areas. A low ground-water mound showing uranium and nitrate ion concentrations above background continues to be observed in the 300 Area. Gross beta activity in the ground water beneath the 100 Areas was detectable only at the 100-N Area from effluent discharged to the 1301-N crib. A number of radionuclides, such as ^{106}Ru, ^{60}Co, ^{129}I, ^{137}Cs and ^{90}Sr, occur at various locations and are detectable in very low concentrations in the unconfined ground water external to the 200 Areas. In most cases, concentrations are several orders of magnitude below applicable CG's and are so close to the detection limit as to cast doubt of their existence based on a single analysis. Only in and adjacent to the 200 Areas does any radionuclide that was analyzed in CY-1974 occur in concentrations greater than 10 percent of the applicable CG for uncontrolled water use. Nitrate ion concentrations greater than 100 percent of the Public Health Service (PHS) recommended drinking water standard of 45 mg/l continued to be observed in the ground water adjacent to the 200 Areas: in the vicinity of the 100-F and 300 Areas, and in the east-central part of the Hanford site (Wells 20-20, 26-15, and 32-22). Ground water from these zones is not consumed by human beings or other animals. (A)

Razin, L. V., V. P. Khvostov, and V. A. Novikov. 1965. Platinum Metals in the Essential and Accessory Minerals of Ultramafic Rocks. Geokhimiya. No. 2:159-174.

Purified mineral fractions were prepared from samples of ultramafic rocks from a Urals-type intrusive and were analyzed for the Pt-group metals. It was found that most of the platinum metals in chrome-spinel-containing dunite were present as independent Pt minerals, and that most of the Pt metals in altered dunite of pyroxenitic composition were dispersed in the rock-forming minerals. The concentration of dispersed Pt metals in mafic silicates of ultra-mafic rocks decreases with progressive crystallization, while the spinels of the dunites become progressively richer in Pt metals with time. Most of the dispersed Pt is incorporated in the structures of the rock minerals, but some is adsorbed on the hydrous iron oxides accompanying serpentine. (Auth)

Recht, P. and M. Collet. 1968. Systematic Study of the Radioactivity of a Drainage Waterway Organized on an International Plan. IN: Radiation Protection. Pt. 2. Snyder, W. S. (et al) (eds.). Pergamon Press (in French).

In order to perfect the systematic study of the radioactivity of the whole of a river basin, the Euratom Commission, Director of Health Protection, has undertaken in the past few years a complete study of the proper methods and means to obtain the most representative results possible with respect to the radioactive pollution of the water course on the whole of a river basin. After establishment of a detailed program of research, the Rhine basin was selected because it interested the largest number of member states and because of its extent which makes it possible to take into consideration very diverse geological, climatic, industrial, and social elements. In order to make the general study of the radioactivity of the mud on the bottoms of the river and its principal affluences and at numerous points, a detailed study was made of the radioactivity of the waters, of the material in suspension, and of muds for a complete year; then for 42 points selected in an appropriate manner, the fixation capacity of the muds with respect to various radioelements was studied. This study of the total muds showed the necessity of investigating the fixation capacities for the various fractions of the mud with respect to the radioelements. The systematic studies of Ra and Sr were made on all the basin as well as in the waters and in the different components of the river mud. Parallel with this systematic study, which was carried out for several years, there was a general theoretical study which contributed to a better knowledge of the natural and artificial factors capable of affecting the contamination of the Rhine basin. All the data on the precipitation and radioactive fallout on the Rhine basin was collected in order to establish as exact a balance as possible for the period from 1962 to 1965, the years during which the study was carried out. The measurements and determinations were ended the first of March 1966. There is still the task of compiling and analyzing the numerous data collected and of presenting the results. It appears at present that the principles and methods adopted have resulted in valid results and can be applied to the study of other river basins.

Reeves, M. and J. O. Duguid. 1975. Application of a Soil and Ground-Water Pollutant-Transport Model. CONF-750530-1.

A general two-dimensional model was developed for simulation of saturated-unsaturated transport of radionuclides in ground water. This model is being applied to the transport of radionuclides from waste-disposal sites, where field investigations are currently under way to obtain the necessary parameters. A zero-order simulation of a waste-disposal trench is presented. Estimated values of the soil properties have been used since very limited experimental information is available at the present time. However, as more measured values become available from field studies, the simulation will be updated. The end product of this research will be a reliable computer model useful both in predicting future transport of radionuclides from buried waste and in examining control measures if they are shown to be necessary. (auth)

Reichert, S. O. 1962. Disposal of Radioactive Wastes to the Ground at the Savannah River Plant. IN: Ground Disposal of Radioactive Wastes. TID-7628, pp. 462-468.

The complex consists of fuel preparation, five reactors, two radiochemical separations plants and a heavy water plant. The soil is sandy with cation exchange capacities of 0.1 meq/100 g soil at pH 5 and 1.2 meq/100 g soil at pH 10. The high level waste is tanked. The ^{90}Sr, the fastest traveling isotope with the exception of tritium and anions, is within 500 feet of seepage basins. (auth)

Reichert, S. O. 1962. Radionuclides in Groundwater at the Savannah River Plant Waste Disposal Facilities. J. Geophys. Res. 67:4363-74.

At the Savannah River Plant, disposal of radioactivity to the ground has been limited to the burial of solid waste and the discharge of very-low-level waste to open seepage basins. Although solid wastes have been subjected to leaching by an annual rainfall of 45 to 50 inches since 1953, no radionuclides have been detected in groundwater from this source. Seepage basin retention of radionuclides has been less satisfactory. All of the radionuclides released to the seepage basins, except plutonium, have been detected in the surrounding groundwater. Fission-product tritium, present in water, is not adsorbed and thus serves as a useful groundwater tracer. Strontium 90 is poorly adsorbed on local soil (under the acidic conditions usually present in seepage basins), and is detectable in sand layers, at concentrations less than the Radioactivity Concentration Guide, as far as 500 feet from the basins. The radionuclides of cerium, cesium, ruthenium, zirconium, and niobium do not migrate as far as those of strontium. The path of radionuclide migration from seepage basins is determined by the geology and hydrology of each area. Most of the migration of radionuclides has been through sandy strata or sand-filled clastic dikes. Wherever the soils do not contain these imperfections, migration has been slow. (auth)

Reichle, D. E., E. A. Bondietti and R. D. Dahlman. 1974. Plutonium Research and Applied Studies. ORNL-4935, pp. 61-65.

This is a new project this year, designed to explore the behavior of plutonium on mesic and humid environments of the eastern United States. Most existing knowledge on the environmental fate of plutonium has been derived from releases in sparsely populated arid environments. However, future uses of plutonium will occur in closer proximity to larger human populations and cultivated land. Intention to locate the first liquid metal fast breeder reactor (LMFBR) in the eastern United States (Tennessee), and locating a waste processing facility (Barnwell, South Carolina) in the

Southeast, are examples of the expansion of plutonium facilities into new and different environments. Knowledge on plutonium behavior in these different environments will be needed because new sites of plutonium technology eventually will be located in mesic, sub-humid regions of the eastern United States. Physical characteristics of these environments and related biotic behavior are significantly different from those of arid regions. (auth)

Reiniger, P., M. J. Frissel, and P. Poelstra. 1970. Calculation by Digital Computer of the Migration Rate of ^{90}Sr in the Soil. IN: Symposium International de Radioecologie. Vol. I. Fontenay-aux-Roses. pp. 589-609 (in French).

A mathematical model of strontium-90 transport in the soil is presented. The total transport rate is calculated by addition of the component rates, these being the rates of chromatographic transport, biological transport, and displacement by ploughing. The climatological parameters used in these calculations may be time variables. The biological parameters and those of the soil may be variables of time, of position in the soil profile or of both. The mathematical model uses the CSMP (continuous system modeling program) for the IBM 360/50 digital computer. The results of calculations for an experimental field with three pH levels and for a muddy soil are compared to the strontium-90 values measured over a period of eight years. (auth)

Reisenauer, A. E. 1959. A Procedure for Estimating Capacity of a Ground Disposal Facility for Radioactive Waste. HW-57897.

Intermediate level radioactive wastes from chemical processing plants have been disposed to the ground at Hanford for several years. The disposal facilities are called cribs. These cribs vary in size from several feet square to a rectangular shape several hundred feet in length. The present method used for predicting crib life is described. Laboratory procedures for the preparation of soil and for the preparation and operation of soil columns in the laboratory are reported. (NSA)

Reisenauer, A. E. 1959. 216-Z-9 Core Sampling Data. HW-61787-RD.

Four one-inch diameter core samples taken from the soil beneath the Hanford 216-Z-9 Recuplex waste storage crib at Hanford during 1959 were examined for Pu content to collect data to permit evaluation of the life of the crib. Concentrations as high as 1.5 mg Pu/cm^3 of soil were found in one of the cores. Results of the analyses indicated that approximately 8 kg of the 13 kg of Pu disposed to this crib might be located within the upper few cm of soil beneath the crib. (NSA)

Reisenauer, A. E. 1959. Laboratory Studies of Hanford Waste Cribs. HW-63121.

Laboratory research on the fixation and retention of radioactive materials on soils was undertaken for application to the ground disposal of low- and intermediate-level waste solutions from Hanford chemical separations plants. Tabulation of pertinent laboratory data on Hanford waste cribs is presented. The results of the research permit the estimation of waste volumes which would produce a limited breakthrough of long-lived nuclides into the ground water for a given crib and type of waste. (NSA)

Reisenauer, A. E. and P. P. Rowe. 1961. Density Effect on Two-Fluid Flow. A Factor in Ground Disposal of Aqueous Waste. HW-69627.

The influence of the density and viscosity differences between radioactive liquid wastes and natural ground water on the movement and dispersion of contaminants was investigated. Experimental equipment and techniques are described which were used to study a two-fluid flow system in porous media with miscible fluids of different densities when the more dense overlies the one of lesser density. A mathematical model was developed using the concepts of velocity potential and a salt potential as a function of density differences which permitted a numerical solution of the flow system. Results are reported from experiments using deaerated water and sodium nitrate solutions with densities of 1.03, 1.06, and 1.10, with a sodium salt of bromthymol blue used as a visible tracer in the salt solution. Density measurements were made at specific points in the flow system. The mathematical model predicted that an increase of potential difference of 0.5 cm across the flow system described would prevent the reverse flow of the salt solution. Experiments with the flow system confirmed the prediction. (NSA)

Reissig, H. 1965. The ^{90}Sr Contents of Soils and Plants on the Territory of the G. D. R. in 1963. Kernenergie. 8:364-78 (in German).

The ^{90}Sr contamination of soils and plants in the German Democratic Republic in 1963 is considered. From 1962 to 1963, the ^{90}Sr content of pasture grounds and fields increased significantly. This increase agreed with ^{90}Sr total fallout in this period. Simultaneously, the ^{90}Sr concentration of plants increased in 1963 in comparison with 1962 (except potato bulbs) by a factor of 1.5 to 3. A comparably high increase of ^{90}Sr was observed in rye grain, which was also in good agreement with fallout conditions. The fraction of ^{90}Sr surface contamination in total contamination was higher in 1963 than in 1962 in plants with large specific surface. Its estimation was carried out in 1963 by regression analysis, by determining the ratio of ^{90}Sr contents to residual beta activity, and by determining the ^{137}Cs to ^{90}Sr ratio. The values calculated varied from 40 to 90% in dependence on the plant species. The development of ^{90}Sr contamination of soils and plants is shown for the period from 1960 to 1963. (auth)

Reissig, H. 1966. Investigations on ^{90}Sr Wash-out in Soils. Chem. Erde. 25:204-29 (in German).

The sorption, distribution and migration of ^{90}Sr are discussed on the basis of literature data. A mathematical model proposed by Thornthwaite et al. was applied to the results of lysimeter studies on ^{90}Sr leaching by precipitation (carried out from 1959 to 1965). The migration of ^{90}Sr in soils with average to high cation exchange capacity shows a close agreement with the mathematical model. The deviations occurring in soils with low cation exchange capacity can probably be traced back to the relatively fast ground water flow through these soils so that the interaction of ^{90}Sr

ions with the soil sorption complex was sharply limited. A negative relation exists between the cation exchange capacity of the soil and the ^{90}Sr migration rate. Some vertical profiles were reported and discussed on the distribution of ^{90}Sr in a contaminated field. Fallout of ^{90}Sr in cultivated meadows and waste lands was also discussed. Both the lysimeter studies and investigations on naturally layered soils show that the ^{90}Sr migration rate is below 1 cm/700 mm precipitation in most soils. (auth)

Reitemeier, R. F. 1959. Soil and Plant Relationships of Fission Products. TID-5558.

The fission products contained in fall-out particles enter the food chain of man primarily through plants and soils. Some particles are deposited initially on the plants, the remainder on the soil. Mechanisms of intake of fission products by plants, reactions with soils, and land reclamation and decontamination measures are discussed. (auth)

Rekharskdya, V. M. 1971. Uranium Distribution in Clay Minerals in an Oxidation Zone. Atomic Energy (USSR). 31:61-3 (in Russian).

Argillaceous minerals with an increased U content in the zone of oxidation were examined chemically and physically. The data show that kaolinite and similar minerals collected U in the oxidation zone, and in such zones the most favored areas are those in which iron sulfide has been retained. (NSA)

Relyea, J. F. and D. A. Brown. 1975. The Diffusion of Pu 238 in Aqueous and Soil Systems. Agronomy Abstracts, p. 124.

Movement of Pu 238 in aqueous salt solutions and soil systems was studied by measuring the diffusion coefficients in both phases and the absorption-desorption relationship between the phases. Aqueous diffusion coefficients were measured using the capillary tube technique. The diffusion coefficient in soils was determined by the quick-freeze method. Adsorption-desorption relations were studied by adding Pu 238 as the nitrate of 5 ml of H_2O at a pH of 2.0 and allowing it to equilibrate with one gram of soil. The effectiveness of Ca and Ce in replacing Pu 238 from the soil were subsequently studied. Aqueous diffusion coefficients of Pu 238 were several times lower than the values found for exchangeable soil cations (order of 5×10^{-6} cm^2/sec). The ratio of Pu 238 adsorbed by the soil to that in the equilibrium solution was greater than 99.1. Diffusion of Pu 238 in four different soils was also found to be much slower than for exchangeable soil cations as would be predicted from aqueous diffusion and adsorption data. (auth)

Relyea, J. F. and D. A. Brown. 1976. The Adsorption and Diffusion of Pu 238 in Soil. A paper presented at Mineral Cycling Symposium of U. S. ERDA at Augusta, GA, April 1976.

The behavior of Pu 238 in soil-water systems was studied by measuring its apparent diffusion coefficient in both phases and finding the adsorption-desorption relationships between soil and solution. Apparent diffusion coefficients of plutonium in soil were measured using a quick freeze method. Aqueous diffusion was studied in a capillary tube diffusion cell. Adsorption studies were done by allowing a tagged soil-water mixture to equilibrate on a rotary shaker before centrifuging and sampling. Apparent diffusion coefficients found were low compared to normal soil cations (1.4×10^{-9} cm^2/sec in a sandy soil to less than 5×10^{-11} cm^2/sec in a silt loam). These were expected from the high Kd values (300 to 500 in a sandy soil to 10^4 in a silt loam). Chelating agents (EDTA, DTPA) reduced most Kd's by a factor of up to 100. The aqueous diffusion coefficients varied widely from 3.1×10^{-7} cm^2/sec in solution extracted from the silt loam up to 2.7×10^{-5} cm^2/sec in a solution extracted from the sandy soil. (auth)

Renfro, W. C. 1971. Seasonal Radionuclide Inventories in Alder Slough, an Ecosystem in the Columbia River Estuary. CONF-710501-P 2, pp. 738-746.

Neutron activation products from the Hanford plutonium production reactors are present in all components of the Columbia River Estuary. Total amounts of the most abundant gamma emitters (^{65}Zn, ^{51}Cr, and ^{46}Sc) in Alder Slough water, sediments, plants, and animals were periodically estimated during 1968 to 1970. Inventories were made during winter, spring, and summer. Total amounts of the radionuclides in the ecosystem declined as Hanford reactors were shut down. By far, the greatest amounts of radionuclides were associated with the sediments. The biota accounted for only a small fraction of the total radioactivity present. Large seasonal fluctuations were noted in the total levels of the radionuclides in plants, animals, and detritus. (auth)

Renfro, W. C. 1972. Radioecology of ^{65}Zn in Alder Slough, an Arm of the Columbia River Estuary. IN: Columbia River Estuary and Adjacent Ocean Waters. A. T. Pruter. (ed.). U of W Press. pp. 755-76.

The results are reported of an investigation of the transfer of ^{65}Zn through Alder Slough, a small, discrete segment of the Columbia River estuary located some 600 km downstream from Hanford, WA. Zinc 65 activity levels were measured in water, sediments, algae, emergent vegetation, and in animals. The activity level increased in the spring, fell in midsummer, and continued at low level throughout the remainder of the year, even when concentrations of radionuclides in Columbia River organisms near Hanford were increasing. Organisms in the lowest trophic levels had the shortest ecological half-life, and each succeeding trophic level showed a longer ecological half-life, (i.e., time required to reduce radionuclide specific activity by one-half by radioactive decay and biological turnover in spite of continued uptake of the radionuclide through the food web). (auth)

Reynolds Electrical and Engineering Co., Inc. 1971. Environmental Surveillance Sampling Results at the Nevada Test Site, July 1968-June 1969. NVO-410-16.

This report summarizes the data obtained from periodic environmental surveys at the Nevada Test Site (NTS) from July 1968 through June 1969. The Environmental Surveillance group performed routine and special surveys of the NTS. Samples of potable water were collected for laboratory analysis from living quarters, administrative facilities, and cafeterias. Additionally, samples of water from waste ponds, sewage basins, reservoirs, springs, and wells were collected on a routine basis to determine ambient levels of radioactivity or any changes of radioactivity. Air samples were also routinely collected at selected locations throughout NTS for the same purpose as for water samples. Soil and vegetation samples were collected to provide information for assessing trends in the distribution of fallout radioactivity levels. All environmental samples, except soil and vegetation, were analyzed routinely for gross beta radioactivity, and selected samples were additionally analyzed for plutonium alpha activity. Soil and vegetation samples were routinely analyzed for gross gamma radioactivity. Significant increases or changes in the radioactivity levels of these samples were reported to the appropriate field monitoring groups for investigation and remedial action. All sample results are permanently maintained by the Environmental Surveillance group for record purposes and for comparison with previous results to determine trends and correlations where feasible. (auth)

Reynolds, R. C., Jr. 1971. Cobalt Sorption on Surface Reactive Minerals in the Glacial Environment. NYO-3912-3.

Progress is reported on a study of the distribution and compositions of natural waters in the South Cascade Glacier region, and on the regosols and stream and lake sediments in this alpine environment. New analytical techniques were developed for the analysis of Ca + Mg, K, Na, Cl^-, and SO_4^{-2} by means of ion sensitive electrodes. Work was performed in the laboratory that provides data on the cobalt and cesium sorption characteristics of natural silts in natural waters. Finally, progress was made toward the development of a quantitative model for cobalt sorption on vermiculite in the presence of interfering ions. (auth)

Reynolds, R. C. 1971. Cobalt Sorption on Surface Reactive Minerals in the Glacial Environment. Three-year Summary Report, August, 1967 - February, 1971. NYO-3912-4.

Progress is reported covering the three year period of August, 1967 to February, 1971 on a study of the cobalt sorption on surface reactive minerals in a glacial environment. Results reported are: cationic denudation in the South Cascade Glacier Region is presently occurring at rates that are approximately three times the world average; the dominant driving force for chemical weathering consists of continuous carbonation of surface waters during their transit of the watershed; dominant clay mineral in the area is vermiculite, and it forms by the alteration of biotite; clays are sufficiently abundant to provide high cation exchange capacities in local sediments; ion sensitive electrodes can be used for the analysis of Ca + Mg, K, Na, Cl^-, and SO_4^{-2}. Preliminary data on cobalt and cesium sorption and the development of a quantitative model for cobalt sorption on vermiculite are also presented. (NSA)

Reynolds, T. D. 1963. Transport of Strontium and Cesium by Stream and Estuarine Sediments. Thesis. Univ. of Texas.

Factors involved in the transport of radiostrontium and radiocesium by suspended and bottom sediments frequently found in fresh water streams, lakes, and brackish waters were investigated. An evaluation of the distribution coefficients and mass action constants for these two radionuclides is based on the observed data. In support of these basic studies, uptake and release data were collected for a series of other radionuclides. Laboratory and field studies showed that the concentrations of radiostrontium and radiocesium in the sediment and water were represented by mass action equations. Also, equilibrium computations and radiochemical analyses showed that the concentrations of these two radionuclides in the sediments were fairly uniform throughout the fresh water section of the Guadalupe River although the river passed through various geologic formations. As the ionic concentration increased in the lower reaches of the Guadalupe River, there was a notable change in the distribution of radiostrontium and radiocesium between the sediment and the water. As the river water mixed with the brackish San Antonio Bay water, some of the radionuclides were transferred from the sediments and suspensoids to the saline water. It was also shown that sediments present in marine waters sorbed less strontium and cesium than sediments in fresh water. The amount of radionuclide release which occurred when fresh water sediments were deposited in marine water was dependent upon the particular radionuclide under consideration. The distribution of strontium 90 and radiocesium in the lake sediments was dependent upon the grain size. The smaller the grain size the greater the radionuclide content. (NSA)

Reynolds, T. D. and E. F. Gloyna. 1963. Radioactivity Transport in Water-Transport of Strontium and Cesium by Stream and Estuarine Sediments. Tech. Rpt. No. 1. TID-19559.

Factors involved in the transport of radioisotopes of Sr and Cs by suspended and bottom sediments in fresh water streams, lakes, and estuaries were investigated in watersheds of Texas and San Antonio Bay. An evaluation of the distribution coefficients and mass action constants for Cs^{137} and Sr^{89} was based on observed data from laboratory and field studies. Uptake and release data for Ru^{103}, Cr^{51}, Fe^{59}, and I^{131} were also collected. The bodies of water selected were the Guadalupe River, Lake Austin on the Colorado River, Lake Falcon on the Rio Grande River, and San Antonio Bay. These sampling areas provided a variety of geographical and environmental factors. Although some uranium deposits are found in the watershed, the major portion of the radioactivity in the surface waters resulted from fallout and washout of radionuclides after nuclear detonations. Results showed that the transport of Sr^{89} and Cs^{137} in fresh water systems can be predicted, that their uptake by river and lake sediments is primarily an ion exchange process, that the mass action coefficients are relatively constant provided the K concentration in the solution did not vary appreciably, that the concentration of Sr^{89} and Cs^{137} in the sediments were relatively uniform throughout the fresh water reaches of the Guadalupe River, that sediments from San Antonio Bay contain lesser concentrations of Sr^{89} and Cs^{137} than the river sediments, that monovalent cations were more inhibitive to Cs^{137} uptake while divalent cations were inhibitive to Sr^{89} uptake, and the coarse-grained materials were significant in the uptake of Cs^{137} and Sr^{89} because of incrusted clay particles on the surface of of the sand or gravel materials. (NSA)

Rhodes, D. W. 1952. Preliminary Studies of Plutonium Adsorption in Hanford Soil. HW-24548.

Some preliminary studies of the adsorption of plutonium by soil indicate that at concentrations <100,000 d/m/ml and a neutral or slightly acid pH, plutonium is adsorbed very effectively (>99%) from an aqueous solution. The greater portion of the plutonium is adsorbed almost instantaneously and seems to be adsorbed just as effectively from a solution containing as much as 82 mg/l of salts as from distilled water. Plutonium is adsorbed most effectively by the soil constituents having a high specific surface and a high cation exchange capacity. The results in general indicate that an exchange reaction is probably the predominate mechanism involved in the removal of plutonium from solution by soil. (auth)

Rhodes, D. W. 1956. Adsorption by Soil of Strontium from 216-S Crib Waste. HW-42699.

Soil equilibrium adsorption experiments with D-1 waste (cell drainage) and D-2 waste (process condensate) from Redox Plant indicated that >90% of the cesium was readily adsorbed by soil from these wastes, but that <10% of the strontium was adsorbed under present disposal conditions. The data further indicated that the relatively poor adsorption of strontium was due to the low pH of both the D-1 and D-2 wastes, and also was affected by the dissolved salts in the D-1 waste. The addition of a base to raise the pH to approximately pH 8 to 10 increased the adsorption of strontium to >90% from the D-2 and from a 1:60 mixture of the D-1-D-2 wastes. The addition of a phosphate salt as well as a base was necessary to obtain a similar increase in the adsorption of strontium from the D-1 waste alone. (auth)

Rhodes, D. W. 1957. The Adsorption of Plutonium by Soil. Soil Science. 84:465-471.

The experimental data suggest the definite existence of a polymer or radiocolloid for tracer concentrations of plutonium in solution at pH >2 with the possible exception of the pH range 9 to 12. Apparently the polymer formed carries a positive charge that enables it to be taken up rapidly by the soil. The rather complex chemistry of plutonium suggests that the polymer probably has a composition approximately that of a plutonium hydroxide although the exact composition of the polymer undoubtedly changes as the conditions of the solution are changed. The desorption of plutonium from soil is difficult to accomplish with aqueous solutions of inorganic salts, but may be accomplished readily by solutions containing organic anions which complex the plutonium. (auth)

Rhodes, D. W. 1957. The Effect of pH on the Uptake of Radioactive Isotopes from Solution by a Soil. Soil Sci. Soc. of Am. Proc. 21:389-392.

The reactions with natural earth materials of fission products and plutonium are of current interest in the field of atomic energy waste disposal and soil chemistry. Solutions containing less than 1×10^{-9} ml/l of selected radioisotopes were equilibrated with samples of a calcareous subsoil. The uptake of these radioactive isotopes by the soil was measured as a function of pH. The uptake of Cs^{137} was not affected appreciably by varying the pH between 4 and 10. The maximum uptake of Sr^{90} occurred at about pH 10 and decreased rapidly as the pH was lowered. The radioisotopes Pu^{239}, Ce^{144}, Zr^{95}, -Nb^{95}, Y^{91} and Ru^{106} exhibited a maximum uptake between approximately pH 4 and pH 8. Above pH 8 a region of reduced uptake occurred and persisted up to at least pH 11 for most of the polyvalent radioisotopes. The addition of high concentrations of sodium salts to the solution inhibited the uptake of both Cs^{137} and Sr^{90} by soil. A relatively small concentration of phosphate (0.01 M) added to the system was found, in effect, to nullify the interference of sodium ion with the uptake of Sr^{90}, but the phosphate ions had no apparent influence on the uptake of Cs^{137}. (auth)

Rhodes, D. W., K. R. Holtzinger, and J. R. McHenry. 1954. Adsorption of Radioactive Isotopes by Soil from a Bismuth Phosphate Waste. HW-32978.

Data obtained from laboratory experiments indicated that Ru from the 112-T bismuth phosphate waste solution penetrated to a greater depth in soil than any of the other radioactive isotopes. Cesium penetrated to a lesser depth than Ru, and the other radioactive isotopes followed some distance behind Cs. Application of the laboratory results to the 241-T crib area indicated that Cs probably penetrated to a depth slightly greater than 80 ft and that Ru should have moved beyond this point, possibly to ground water. Analyses of water samples from wells near the crib area indicated that the depth of penetration of the radioactive isotopes was approximately as predicted on the basis of the experimental results. (auth)

Rhodes, D. W. and J. L. Nelson. 1957. Disposal of Radioactive Liquid Wastes from the Uranium Recovery Plant. HW-54721.

A series of laboratory experiments was conducted to estimate disposal volumes for Uranium Recovery Plant (URP) scavenged wastes. The disposal volume was considered to be the maximum volume of waste that could be discharged to a specific disposal site such that no radioisotope with a half-life greater than three years reached the ground water in concentrations greater than one-tenth of the maximum permissible concentration for that radioisotope in drinking water. The results of laboratory equilibrium and soil column tests with synthetic and actual process wastes are presented. Methods used to estimate disposal volumes from the experimental data are largely empirical and in many cases were influenced by operational experiences in the past. The data are considered applicable only to the particular soil-waste liquid system studied in this investigation. (auth)

Rhodes, D. W., J. R. Raymond, and H. V. Clukey. 19- . Operational Experience in Hanford Liquid Waste Disposal. IN: Sanitary Engineering Aspects of the Atomic Energy Industry. pp. 5-22.

The operational experience with ground disposal of low level radioactive liquid wastes at Hanford has been generally favorable over a period of approximately 10 years. Disposal units are placed underground to avoid radiation and contamination hazards and the liquid wastes are allowed to percolate through at least 200 feet of sediments which adsorb the long-lived radioisotopes. In more recent years, the application of laboratory findings and field observations together with chemical scavenging to reduce the concentrations of Cs^{137} and Sr^{90} has resulted in the disposal of other wastes containing 1 to 50 μc/ml of total beta-emitters and 0.02 μc/ml of both Cs^{137} and Sr^{90}. Continual observation of the location and movement of the radioisotopes discharged to ground has been maintained by routine sampling of monitoring wells extending to ground water in the near vicinity of the disposal sites. No ground water contamination of objectionable concentrations has resulted from ground disposal. (auth)

Richardson, K. A. 1963. The Radioactivity, Sites of Alpha Emitters and Radioactive Disequilibrium in the Conway Granite of New Hampshire. Thesis. Rice University.

The radioactivity of the Conway granite of New Hampshire was studied by γ-ray spectrometry, autoradiography, and α-particle pulse-height analysis, as part of an investigation of the possibility of recovering Th from common rocks. It was concluded that the Conway granite is homogeneous with respect to Th, and the mean Th concentration in the Conway granite of the White Mountain batholith is 56 ± 6 ppm. On this basis, the Conway granite in the White Mountain batholith is considered a low-grade Th resource containing three million tons of Th per hundred feet of depth. Comparison of Th and U concentrations in drill-core samples and in samples taken from outcrops indicates an average U loss of 35% from surface samples of Conway granite. Autoradiographic results show that ∿ 2/3 of the α emitters in the Conway granite are concentrated in accessory mineral grains identified as thorite, huttonite, allanite, and zircon. The wide ranges of α activity and the estimated Th concentrations in zircon, thorite, and huttonite suggests that extensive isomorphism exists between zircon and thorite, and that the mineral identified as huttonite is isomorphous between monazite and huttonite. Radioactive disequilibrium in the U-238 series was found in extremely weathered rock, with a U-234 deficiency of about 50%. Other samples taken from deeper in the drill core and from other outcrops showed an equilibrium ratio between U-238 and U-234. (NSA)

Richardson, K. A. and J. A. S. Adams. 1963. Effect of Weathering on Radioactive Elements in the Conway Granite of New Hampshire. CONF-498-3.

Studies were made on the effects of weathering on thorium and uranium in the Conway granite of New Hampshire. The results showed that weathering processes have leached and isotopically fractionated uranium to a depth of 30 to 40 feet below the surface, and leaching of uranium has occurred at greater depths in the vicinity of joints. This chemical alteration has occurred in rock that does not optically show evidence of weathering. (NSA)

Richmond, C. R. and E. M. Sullivan. 1974. Annual Report of Biomedical and Environmental Research Program of the LASL Health Division, January-December 1973. LA-5633-PR.

Characterization of Los Alamos canyon soils - Eroded soils contained 1-2% silt and clay in top 2.5 cm, 3-4% silt and clay in remainder of profile with CEC 2-10 meq/100 g. Noneroded soils contained up to 54% silt and clay with CEC 11-21 meq/100 g. Honey bees can be used as ^{3}H contamination indicators. Radiation Ecology Studies of Liquid Waste Disposal Sites - ^{137}Cs, ^{238,239}Pu - Cs^{137} in soils of discharge area-depth sampling-log normal distribution. Radiation Ecology Studies at Trinity Site - 260 PCi/g ^{239}Pu at Gr. Zero. Pu has penetrated 7.5 cm into soil in 20 years. Hydrological Characterization of Soils at the Trinity Site.

Richter, D. 1965. On the Localization of ^{90}Sr Fallout in Soils. Chem. Eree. 24:67-76 (in German).

Five soils typical of central Germany, including black soil from loess, variegated sandstone, bottomland, and shell lime were examined in 1961 for their ^{90}Sr content at levels of 0 to 20 and 20 to 40 cm depth. In the upper layers, the average decay rate/200 g soil was 37 cpm of ^{90}Sr. In the 20 to 40 cm level the average was 5 cpm/200 g of soil. These values were remeasured in 1963 and almost identical results were obtained for the soil at the 0 to 20 cm depth. These results indicate that there had been very little movement of ^{90}Sr during the 2-yr period, taking into account the fallout measurements that also had been made in this interval. Some of the physicochemical factors that may affect movement of ^{90}Sr in soils are discussed. (NSA)

Rigg, T. and W. Wild. 1958. Radiation Effects in Solvent Extraction Processes. <u>IN</u>: Progress in Nuclear Energy - Series III. Volume 2. Process Chemistry. pp. 320-331.

The yields of gaseous products from the irradiation of solvents are given together with the yields of acid phosphates from the irradiation of tributyl and other trialkyl phosphates. For tributyl phosphate, the influence on these products of dilution with kerosene, water, nitric acid and uranyl nitrate are described and results on the retention of plutonium, uranium and fission products, applicable to extraction processes are given. (auth)

Rima, D. R., E. B. Chase, and B. M. Myers. 1971. Subsurface Waste Disposal by Means of Wells - A Selective Annotated Bibliography. U.S.G.S. Water Supply Paper - 2020.

The bibliography contains 692 abstracted references compiled from a selective review through 1969. About one-third of the abstracts pertain to the disposal of oil-field brines and deal mainly with the engineering problems of injection wells. An additional third of the abstracts pertain to the research that has been done to find satisfactory methods for the disposal of radioactive wastes. The major emphasis of this research is on the interaction of radioactive materials with the natural environment. It deals chiefly with the natural processes and mechanisms of transport, retention and dispersal of radioactive materials in the subsurface. Most of the remaining abstracts describe actual case histories of various industries that are using one or more injection wells. (0-21)

Rimshaw, S. J. and D. C. Winkley. 1960. Removal of Cs^{137}, Sr^{90}, and Ru^{106} from ORNL Plant Wastes by Sorption on Various Minerals. CF-60-4-17.

A series of minerals (120) were tested as to their efficiency in removing Cs^{137}, Sr^{90}, and Ru^{106} from dilute alkaline wastes prior to ground disposal. Strontium-90 exchanged rapidly with calcium in Florida pebble phosphate. The best results were obtained with Tennessee phosphate heated to 600°C for one hour, but part of the increase in sorption of strontium was due to ion exchange. Heating Tennessee phosphate resulted in a material with excellent hydraulic properties that sorbed Cs^{137} and Sr^{90} from dilute alkaline solutions. Other calcium minerals such as calcite or dolomite were activated to adsorb Sr^{90} by heating or by treating with caustic or phosphate solutions. Cesium-137 in dilute alkaline solutions exchanged preferentially with the potassium present in a number of mica schists and mica minerals which possess a layer lattice type of structure. The high selectivity for cesium of Tennessee phosphate heated to 600°C for one hour is ascribed to the presence of bentonitic impurities present in this material. The kinetics and adsorption of Ru^{106} are shown to be complex and slow due to the large number of chemical forms and complexes of ruthenium which can exist under varying conditions. Copper in conglomerate, various sulfide minerals containing copper, cuprite (cuprous oxide), and descloizite (basic zinc lead vanadate) removed 90% of the ruthenium under reducing conditions at a pH of 7 when heated at 60°C for 16 hours. At lower temperatures (25°C) the removal of ruthenium from aged solutions took days or even weeks. (auth)

Ritchie, J. E., E. E. C. Clebsch, W. K. Rudolph. 1970. Distribution of Fallout and Natural Gamma Radionuclides in Litter, Humus, and Surface Mineral Soil Layers Under Natural Vegetation in the Great Smoky Mountains, North Carolina-Tennessee. Health Physics. 18:479-89.

The bulk density, pH, and weight of unincorporated organic matter were determined in soils at four sites of contrasting exposure and vegetation cover at different elevations. Total ^{137}Cs, ^{106}Ru, ^{144}Ce, and ^{40}K in the organic matter and first 11.4 cm of mineral soil were determined by gamma spectrometry from samples taken in early September, 1961. Totals of these fallout nuclides ranged from 95.6 to 144.5, 81 to 137, and 88 to near 418 uCi/m^2, respectively. The pattern of distribution of nuclides is related to precipitation, vegetation cover, and layer in the soil, with ^{137}Cs showing the most consistent pattern. (auth)

Ritchie, J. C., P. H. Hawks, and J. R. McHenry. 1972. Thorium, Uranium, and Potassium in Upper Cretaceous, Pateocene, and Eocene Sediments of the Little Tallahatchie River Watershed in Northern Mississippi. Southeast. Geol. 14:221-31.

Size analyses and γ-ray spectrometric analyses were made of 129 outcrop samples that contained: Th 0.9-29.9, average 8.4 ppm; U 0.3-10.9 average 2.2 ppm; K 0-2.43, average 0.86%; Th/U average 3.8. The contents of U, Th, and K in the sediments increase with decreasing particle size. (CA)

Ritchie, J. C. and J. R. McHenry. 1973. Vertical Distribution of Fallout Cesium-137 in Cultivated Soils. Radiat. Data Rep. 14:727-728.

Fallout ^{137}Cs was found to be evenly distributed in the upper 15 to 20 cm of cultivated soils of five watersheds in the mid-United States.

This distribution pattern is markedly different from the vertical distribution of ^{137}Cs in noncultivated soils. (auth)

Ritchie, J. C., J. R. McHenry, and A. C. Gill. 1972. Distribution of ^{137}Cs in the Litter and Upper 10 cm of Soil Under Different Cover Types in Northern Mississippi. Health Physics. 22:197-8.

Three each of litter and soil samples were collected in 2.5 cm or 5.0 cm increments, to depths of 10 cm, from oak-hickory and pine woodland, pasture and eroded sites in northern Mississippi. Gamma ray spectra of the soil layers are presented. The concentration and redistribution of fallout ^{137}Cs appeared to be related to the vegetative cover and amount of erosion, the highest concentrations being found in the surface 2.5 cm soil layer under oak-hickory and the next highest in the surface 2.5 soil layer under pine and grass. The total ^{137}Cs concentration measured in the eroded sites was less than 4% of that measured at other sites. (NSA)

Ritchie, J. C., J. R. McHenry, and A. C. Gill. 1973. Dating Recent Reservoir Sediments. Limnol. Oceanogr. 18:254-263.

Radioactive fallout ^{137}Cs can be used to date sediment deposited in lakes and reservoirs since 1959. Within small regional watersheds, fallout ^{137}Cs is assumed to be uniformly distributed on the surface soil and is tightly adsorbed to surface soil particles. Some of these soil particles naturally labeled with ^{137}Cs then move through the sedimentation cycle and can be used to date sediment profiles. Two distinct periods of erosion and sedimentation (1959 to 1960 and 1963 to 1964) can be associated with periods of maximum atmospheric fallout. Data from other reservoirs illustrate the utility of this method. (auth)

Ritchie, J. C., J. R. McHenry, A. C. Gill, and P. H. Hawks. 1971. Distribution of Cesium-137 in a Small Watershed in Northern Mississippi. CONF-710501-P1, pp. 129-132.

Concentration of fallout ^{137}Cs in soils and sediments of a small watershed in north Mississippi was measured to determine the redistribution of fallout ^{137}Cs. Measured concentration of ^{137}Cs ranged from 8.9 nCi/m^2

in soils from actively eroding areas to 412.2 nCi/m^2 in conservation pool sediments. A model was constructed for the distribution of ^{137}Cs in the watershed. Sixty-one % of the ^{137}Cs in the conservation pool sediments was derived from the movement of ^{137}Cs from the contributing watershed. Of the ^{137}Cs moved from the watershed, 53% was contributed from the eroded areas that presently occupy 4% of the contributing watershed area. The efficiency of the reservoir for trapping or retaining ^{137}Cs carried into it from runoff was 57%. Of the total ^{137}Cs deposited in the watershed, less than 7% moved from the contributing watershed and only 3% of the ^{137}Cs deposited in the watershed moved through the reservoir outlets. (auth)

Ritchie, J. C., J. R. McHenry, A. C. Gill, and P. H. Hawks. 1972. Fallout ^{137}Cs in Reservoir Sediment. Health Physics. 22:95-8.

In 1969, five reservoirs and their contributing watersheds were sampled in Mississippi, New Mexico, and Arizona. Soil samples were collected in the upland part of the watersheds in 5 cm increments to a depth of 10 cm. Samples of sediment deposited in the reservoirs were collected in 2.5, 5, or 10 cm increments from the sedimentation profile. Determinations of ^{137}Cs were subsequently made by γ spectrometry. Highest concentrations of fallout ^{137}Cs were usually below the sediment surface and some attempt was made to associate concentrations of fallout ^{137}Cs with various years of fallout, and to link sediment concentrations with various types of erosion. In all cases, the concentration of ^{137}Cs per unit area in the reservoir was greater than the average concentration of ^{137}Cs per unit area in the watershed. (NSA)

Ritchie, J. C. and G. L. Plummer. 1969. Natural Gamma Radiation in Northeast and East-Central Georgia. Bull. Ga. Acad. Sci. 27:173-194.

Thorium, uranium and potassium (all naturally occurring), and beryllium 7, cesium 137, ruthenium 106, cerium 144, antimony 125, zirconium-niobium-95 and manganese 54 (all from fallout) were found in soil samples collected in northeastern and east-central Georgia. Thorium concentrations ranged from 3 to 70 ppm with an average concentration of 15.8 ppm. Uranium concentrations varied from 1 to 10 ppm with an average of 3.7 ppm. The average thorium to uranium ratio was 4.3:1. Total potassium ranged from nondetectable levels to 4.8% with an average of 1.08%. Concentrations of thorium and uranium in granitic outcrop soils were the same as non-outcrop soils. Potassium concentrations in granitic outcrop soils were three times that of non-outcrop soils. Cesium 137 concentrations in outcrop soils were ten times greater than that in nonoutcrop soils. Although concentrations given in this report cannot be considered as absolute values, they are good estimates of the thorium, uranium and potassium at the particular locations samples and are probably representative of concentrations elsewhere in northeastern and east-central Georgia. Average concentrations of thorium and uranium were higher in the study area than those reportedly found in the worldwide lithosphere and soil. One probable cause for higher concentrations is the occurrence of monozite in the Georgia Piedmont. Commercially mineable uranium ores are usually at least 100 times more concentrated than any concentrations found in the study area. Neither uranium nor thorium is an active metabolite in plants or animals. Although uranium is more mobile than thorium in soils, neither uranium nor thorium concentrations are high in plant or animal tissues, therefore, they cannot be considered of great importance in ecological food chains. Potassium, on the other hand, is mobile in the soil, and is an active metabolic. Total gamma radiation (0-2.70 MeV) ranged from 560 to 8900 CPM/Kg or an 18-fold range in activity. Calculated dose rates ranged from 2.25 to 38.30 uR/hr or a 17-fold range. The average dose rate for the 132 soils was 10.65 uR/hr. Distribution of thorium, uranium and potassium followed broad geologic patterns. Concentrations of these elements were lowest in the sandy materials of the Coastal Plain and highest in the basic igneous-metamorphic material of the Piedmont. Distribution of thorium, uranium and potassium in four soil series was best related to geologic parent material. The Piedmont soils, Appling, Madison and Cecil, had higher concentrations than sandy Norfolk soils of the Coastal

Plain. A high correlation (r=0.88) was found between aerial gamma radioactivity and dose rates indicating that gamma aeroradioactivity maps can be used to delineate areas with different background radiation. (auth)

Ritchie, J. C., J. A. Spraberry, and J. R. McHenry. 1974. Estimating Soil Erosion from the Redistribution of Fallout ^{137}Cs. Soil Sci. Soc. Amer. Proc. 38:137-139.

The movement of fallout ^{137}Cs from soils in three north Mississippi watersheds was found to be logarithmically (r=0.89) related to potential soil loss. Analysis of published data on ^{137}Cs as well as the north Mississippi data also showed a significant (r-0.95) logarithmic relation existing between soil loss and ^{137}Cs loss from soils. This study indicates that it may be possible to calculate soil loss from the movement of fallout ^{137}Cs in watersheds. Also it may be possible to calculate the movement of surface adsorbed nutrients like ^{137}Cs in watersheds from soil erosion data. (auth)

Roberts, W. N. 1957. Radioisotope Adsorption on Minerals. NP-6636.

A study has been made of the adsorption of radioisotopes on zinc mineral concentrates as a function of pH and concentration. Of the isotopes tested, Cu^{64} and Ag^{110} showed better adsorption and retention by sphalerite particles than other radioisotopes. Fe^{59}, Co^{60}, Zn^{65}, Cd^{115}, and Hg^{203} were not appreciably adsorbed by sphalerite at the concentrations employed. Possible correlation between tracer adsorption and effectiveness as a flotation activator is discussed as a guide in choosing suitable isotopes. (auth)

Robertson, D. E. and R. W. Perkins. 1974. Radioisotope Ratios in Characterizing the Movement of Different Physical and Chemical Species Through Natural Soils. BNWL-SA-5024.

Physicochemical characterization studies of reactor effluent water radionuclides at the Hanford N-Reactor provided important information describing the mobility of radionuclides in freshwater environments. At N-Reactor, cooling water containing a wide spectrum of radionuclides in various physicochemical forms is discharged to a seepage trench located near the reactor. The effluent water migrates through a soil bank between the trench and the Columbia River, and a portion of the water emerges as seepage springs along the bank of the Columbia River near the reactor. The mobility of effluent water radionuclides during transport through the soil is greatly dependent upon the physicochemical forms of the radionuclides. Radionuclides in particulate and cationic forms are nearly quantitatively retained in the soil bank by sorption onto mineral phases, whereas radionuclides in anionic and soluble nonionic forms are relatively mobile and and are retained by the soil to a much lesser degree. Several radionuclides such as ^{58}Co, ^{60}Co, $^{103\text{-}106}$Ru, and $^{122\text{-}124\text{-}125}$Sb, ^{131}I, and ^{133}I are present in reactor effluent water partitioned among particulate, cationic, anionic and nonionic species. However, as these radionuclides migrate through the soil bank their particulate and cationic forms are retained, and predominantly anionic and nonionic forms emerge in the seepage springs. Studies of the behavior of these radionuclides provide data for assessing present rad-waste treatment processes and in improving future processes for reducing environmental releases of radionuclides from nuclear installations. (auth)

Robertson, D. E. 1974. Physiochemical Characterization of N-Reactor Effluent Radionuclides in Soil and Water Systems. BNWL-1950, Pt. 2, pp. 82-85.

The study of the fate of introduced chemical and particulate matter in freshwater ecosystems is fundamental to our understanding of the structure and function of these water bodies. These inputs can be in a variety of forms and need not be solely related to the movement of radioactive materials despite the inherent emphasis in our programs on these isotopes. · Intrinsic to investigations of this nature is understanding not only where and in what quantities these materials appear in various ecosystem components, but also knowing what chemical, physical, and biological processes mediate their movement. Our studies in this field have emphasized the Columbia River and its associated ecosystems for several years, and work on the chemical characterization of reactor effluents before and after their passage through the soil before reaching the Columbia is continuing. Emphasis in this program, however, has shifted to more detailed studies of lentic habitats receiving low-level radioactive effluents. Our goal is to provide basic data on the cycling of radionuclides within these ponds which will be useful to both ecologists and waste management personnel. (auth)

Robertson, D. E. and W. O. Forster. 1969. Radionuclide Concentrations in Northeast Pacific Ocean Sediments in the Vicinity of the Columbia River Estuary. BNWL-1051, Pt. 2, pp. 40-3.

The radionuclides ^{40}K, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{60}Co, ^{65}Zn, ^{124}Sb, ^{140}Ba-La, ^{226}Ra, and ^{228}Th were measured in 15 Columbia River estuarine and adjacent Pacific Ocean sediments. Potassium-40, ^{46}Sc, ^{60}Co, ^{65}Zn, ^{226}Ra, and ^{228}Th were present in all samples, while ^{51}Cr, ^{124}Sb, and ^{140}Ba-La were present in only one atypical sample collected about five miles straight out from the mouth of the river. Concentration gradients of the radionuclides ^{46}Sc, ^{60}Co, and ^{65}Zn and the activity ratios of ^{46}Sc/^{65}Zn and ^{65}Zn/^{60}Co indicated that sedimentary material had moved mainly northward at a velocity of 0.1 to 0.5 cm/sec. The naturally occurring radionuclide ^{228}Th appeared to be a potentially valuable tracer of the distribution and movement of the suspended load of the Columbia River as it enters the ocean. (auth)

Robertson, D. E., W. B. Silker, J. C. Langford, M. R. Petersen, and R. W. Perkins. 1973. Transport and Depletion of Radionuclides in the Columbia River. IN: Radioactive Contamination of the Marine Environment. IAEA, Vienna. pp. 141-155.

The radionuclide transport and depletion processes in the Columbia River are being characterized following the closure of the last of the Hanford plutonium production reactors in January 1971. Radionuclide concentrations are periodically being measured in river water, sediments and biota between Hanford and Bonneville Dam to determine the rates and mechanisms of the processes which govern the distribution and behavior of the radionuclides in the Columbia River system. All the short-lived radionuclides in the river have now decayed, but some residual long-lived radionuclides have remained, being associated mainly with sedimentary deposits in the reservoir behind McNary Dam. The most abundant radionuclides remaining in the river are Fe 55, Zn 65, Eu 155, Co 60, Eu 152, Eu 154, Mn 54, and Sc 46. Also present in much lower concentrations are Sb 125, Cs 137, Ce 144, and Pu 239. These radionuclides are tightly bound to the sediments and enter the river mainly by resuspension, especially during the high river flow in the spring and early summer. The depth distributions of radionuclides in sediment cores collected at various locations in the reservoirs behind McNary, The Dalles, and Bonneville Dams are being measured to estimate radionuclide inventories, sediment resuspension and transport, and sedimentation rates in the river system. Because present concentrations of radionuclides in the river water are low, large volume water sampling (up to 1000 liters) is required and is being done at the four dam sites downstream from Hanford to determine radionuclide concentrations, physicochemical forms and transport in the river. Over 95% of the Columbia River radionuclides of Hanford origin which enter the river from bottom sediments are in particulate forms. The main mechanisms for removing radioactivity from the river system, other than by radioactive decay, is by scouring of surface sediment during high river flow, and their subsequent transport into the Pacific Ocean. The dissolution of sediment attached Columbia River radionuclides upon their entry into the marine environment is being studied by leaching Columbia River sediments with seawater. Since the net sediment deposition rate in the reservoir behind McNary Dam has, in the past, been greater than the scouring rate, it appears that eventually the major radioactive sediment deposits in the McNary reservoir will become covered by new, uncontaminated silt deposits. (auth)

Robertson, J. B. 1974. Digital Modeling of Radioactive and Chemical Waste Transport in the Snake River Plain Aquifer at the National Reactor Testing Station, Idaho. IDO-22054.

Industrial and low-level radioactive liquid wastes at the National Reactor Testing Station (NRTS) in Idaho have been disposed to the Snake River Plain aquifer since 1952. Monitoring studies have indicated that tritium and chloride have dispersed over a 15-square mile (39 square kilometer) area of the aquifer in low but detectable concentrations and have migrated only as far as 5 miles (8 kilometers) downgradient from discharge points. The movement of cationic waste solutes, particularly ^{90}Sr and ^{137}Cs, has been significantly retarded due to sorption phenomena, principally ion exchange. ^{137}Cs has shown no detectable migration in the aquifer and ^{90}Sr has migrated about only 1.5 miles (2 kilometers) from the Idaho Chemical Processing Plant (ICPP) discharge well, and is detectable over an area of only 1.5 square miles (4 square kilometers) of the aquifer.

Digital modeling techniques have been applied successfully to the analysis of the complex waste-transport system by utilizing numerical solution of the coupled equations of groundwater motion and mass transport. The model includes the effects of convective transport, flow divergence, two-dimensional hydraulic dispersion, radioactive decay, and reversible linear sorption. The hydraulic phase of the model uses the iterative, alternating-direction, implicit finite-difference scheme to solve the groundwater flow equations, while the waste-transport phase uses a modified method of characteristics to solve the solute transport equations simulated by the model. The modeling results indicate that hydraulic dispersion (especially transverse) is a much more significant influence than previously suggested by earlier studies. The model has been used to estimate future waste migration patterns for varied assumed hydrological and waste conditions up through the year 2000. The hydraulic effects of recharge from the Big Lost River have an important (but not predominant) influence on the simulated future migration patterns. For the assumed conditions, the model indicates that detectable concentrations of waste chloride and tritium could move as much as 15 miles (24 kilometers) downgradient from the original discharge points by the year 2000. However, the model shows ^{90}Sr moving only 2 to 3 miles (3 to 5 kilometers) downgradient in the same time. The model may also be used to estimate the effects of the various future waste disposal practices and hydrologic conditions on subsequent migration of waste products. (auth)

Robertson, J. B., R. Schoen, and J. T. Barraclough. 1974. Influence of Liquid Waste Disposal on the Geochemistry of Water at the National Reactor Testing Station, Idaho: 1952-1970. IDO-22053.

Studies at the National Reactor Testing Station (NRTS), Idaho by the U. S. Geological Survey are described. A summarized evaluation of the geology, hydrology, and water geochemistry of the NRTS and the associated influences of subsurface liquid-waste products discharged from the NRTS facilities are presented. The progressive buildup, distribution, and changes of both radioactive and chemical wastes are analyzed for the total disposal period from 1952 to 1970. Of principal concern is the fate of wastes discharged from the NRTS in the Snake River Plain aquifer, an extremely large and productive groundwater system underlying the vast eastern Snake River Plain. Since 1952, the NRTS facilities (primarily the Test Reactors Area--TRA, Idaho Chemical Processing Plant--ICPP, and the Naval Reactor Facility--NRF) have discharged 1.6×10^{10} gallons of liquid waste containing 7×10^{4} curies of radioactivity and about 1×10^{8} pounds of chemicals to the subsurface. The discharge has been disposed in wells and seepage ponds. The principal waste products include triated water, ^{90}Sr, ^{137}Cs, ^{60}Co, sodium chloride, chromates, and heat. Wastes at the NRTS have been distributed in the Snake River Plain aquifer and overlying bodies of perched groundwater according to hydrologic and geochemical controls. Expansion of the plume of waste products in the aquifer from the ICPP disposal well has been traced over the years. Chloride and tritium in this plume are most widely distributed, detectable over about 15 miles of the aquifer. Migration of cationic waste products, especially ^{90}Sr and ^{137}Cs, has been greatly retarded by sorption. Radioactive decay is a significant influence on the spreading and dilution of wastes as they move down-gradient in the aquifer. No detectable wastes have been found close to or beyond the southern boundary of the NRTS. Materials and heat balances calculated for the ICPP wastes indicate that the interpretive subsurface distributions are valid and that the wastes generally remain in the upper 250 ft of the aquifer. The balances indicate that heat and tritium are maintaining an equilibrium (nearly constant) inventory. Waste plumes from TRA and NRF are poorly defined because of insufficient observation wells. (auth)

Robinson, A. V., T. R. Garland, H. Drucker, and R. E. Wildung. 1974. Plutonium-Resistant Fungi and Actinomycetes in Soil. II. Alteration of Plutonium Form. BNWL-1950, Pt. 2, pp. 21-30.

After several day incubation exocellular media analyzed by TLC, TLE to see if other than Pu DTPA present. Found a few as yet unidentified Pu compounds, possible metabolites. (auth)

Robinson, B. P. 1962. Ion Exchange Minerals and Disposal of Radioactive Wastes - A Survey of Literature. U.S.G.S. Water Supply Paper 1616.

A review of the literature on ion-exchange theory, naturally occurring ion-exchange minerals, and the role of ion exchange in the disposal of radioactive wastes is presented. Ion-exchange theory is discussed in terms of colloid science, thermodynamics, reaction kinetics, reaction mechanisms, and adsorption equations.

Ion exchange may be defined as the exchange of an ion held by an electrical charge near the surface of an exchange mineral with an ion present in a solution in which the exchange mineral is immersed. Ion-exchange reactions follow the law of mass action with the reactions being restricted by the number of exchange sites on the mineral and by the bond strength between the exchangeable cations and the mineral surface. Crystalline structure of the exchange minerals and the chemical composition of the solution in contact with the mineral influence the ion-exchange reaction.

Clay minerals and other ion-exchange minerals, including glauconite, ultramarines, and zeolites are discussed in terms of origin, nomenclature, composition, structure, and exchange capacities. The origin of clay minerals is explained by various factors. These include leaching of certain elements from older minerals, complete replacement of a mineral, devitrification of a volcanic glass, crystallization of colloid material, direct precipitation from solutions, and reactions between older minerals and solutions. Older literature on clay minerals includes some misnomers of nomenclature. The modern student, having the advantages of better instruments and improved analytical techniques, has made progress in correcting this situation.

Structurally the clay minerals are considered to consist of a collodial, silicate-layer lattice in which the layers are composed of planes of silica-oxygen tetrahedrons and planes of aluminum, iron, or magnesium atoms surrounded by six oxygen atoms or hydroxyl groups arranged as octahedrons.

Ion-exchange capacities generally are measured in chemical equivalents adsorbed per 100 grams of exchange mineral at pH 7. Because of differences in structure and in chemical composition of clay minerals, their exchange capacities are reported over a range. Some of the exchange capacities reported in the literature are kaolinite, 3-15; halloysite ($2H_2O$), 5-10; hakloysite ($4H_2O$), 40-50; montmorillonite, 70-100; illite, 10-40; vermiculite, 100-150; glauconite, 11-20; and attapulgite, 20-30.

The control of radioactive wastes has been described as adequate but expensive at the present time. However, the condition of adequacy could change in the foreseeable future unless additional means of disposal become available. Some of the major technical considerations associated with the radioactive waste disposal problem include the following (Wolman and others, 1956):

1. Nuclear fuel characteristics and processing associated with them.
2. Recovery of specific isotopes from wastes and use of them to help defray disposal costs. (auth)

Robinson, C. S. and J. N. Rosholt. 1961. Uranium Migration and Geochemistry of Uranium Deposits in Sandstone Above, At, and Below the Water Table. Part II. Relationship of Uranium Migration Dates, Geology, and Chemistry of the Uranium Deposits. Econ. Geol. 56:1404-20.

Data were obtained from uranium ore samples representing deposits above the water table, deposits just above and below perched water tables, and deposits at least 250 feet below the water table in the Hulett Creek area, Wyoming. The first uranium deposition occurred more than 250,000 years ago for the deposits now at or above the water table. Approximately 60,000 to 80,000 years ago these deposits were oxidized, leached, and locally enriched. Accumulation of uranium in the deposits below the water table probably did not start before 180,000 years ago and has continued to the present. (auth)

Robertson, J. B. 1974. Application of Digital Modelling to the Prediction of Radioisotope Migration in Ground Water. IAEA-SM-182/50.

Recently developed numerical techniques have been adapted to the solution of transient radioactive solute migration problems in groundwater. The differential equations of groundwater movement are first solved by standard finite difference methods, then the differential equations of solute transport are solved by the method of characteristics. Validity of the simulation techniques is demonstrated for real examples of tritium, chloride and ^{90}Sr migration in groundwater at the National Reactor Testing Station, Idaho. This is probably the first documented field-verification of such a model that includes the effects of convective transport, two-dimensional dispersion, radioactive decay and ion exchange. Model results demonstrate the relative sensitivity of groundwater transport systems to various parameters, such as dispersion coefficients and ion-exchange distribution coefficients. The models can be very useful in predicting how the behavior of natural isotopes, artificial tracers or waste in groundwater. The models allow variable hydraulic parameters in space and time, as well as variable chemical parameters. Predictive use of such models is demonstrated for several different conditions in a heterogeneous basaltic aquifer. Thirty-year predictions of tritium and ^{90}Sr migrations are shown with variable hydraulic and chemical influences. Additional methods and potential applications of modelling are suggested, including tracer migration studies and natural isotope distributions in groundwater. (auth)

Robinson, S. C. 1952. Autoradiographs as a Means of Studying Distribution of Radioactive Minerals in Thin Section. Am. Mineral. 37:544-7.

A simple method is described of recognizing those grains in a thin section of rock that contribute to its radioactivity. Thin sections are made without a cover glass and the surface is placed against the emulsion and are held there under light pressure for exposure. The specimen and emulsion are then remounted back-to-back to interpose the glass slide between them. The mount is studied under a medium power objective such that the tracks are out of focus when the microscope is focused on the rock slice and vice versa. When the centers of tracks are found, it is only necessary to focus down to the rock slice to identify the mineral that has caused them. (NSA)

Robinson, W. O. 1943. The Occurrence of Rare Earths in Plants and Soils. Soil Science. 56:1-6.

Rare earths were found in all of the plants and soils examined, and exchangeable rare earths were found in the 12 soils examined. The hickory tree absorbs relatively large quantities of rare earths from the soil, and hickory leaf analyses may serve as an indication of soil areas high or low in available rare earths. (auth)

Robinson, W. O., H. Bastron, and K. J. Murata. 1958. Biogeochemistry of the Rare Earth Elements with Particular Reference to Hickory Trees. Geochim. et Cosmochim. Acta. 14:55-67.

Hickory trees concentrate the rare-earth elements in their leaves to a phenomenal degree and may contain as much as 2300 ppm of total rare earths based on the dry weight of the leaves. The average proportions of the individual elements (atomic percent of the total rare-earth elements) in the leaves are: Y 36, La 16, Ce 14, Pr 2, Nd 20, Sm 1, Eu 0.7, Gd 3, Tb 0.6, Dy 3, Ho 0.7, Er 2, Tm 0.2, Yb 1, and Lu 0.2. The similarity in the proportions of the rare-earth elements in the leaves and in the exchange complex of the soil on which the hickory trees grow indicates that the trees do not fractionate the rare earths appreciably.

The variation of the rare-earth elements in the leaves and soils can be explained generally in terms of the relative abundance of the cerium group and the yttrium group, except for the element cerium. The large fluctuations in the proportion of cerium [Ce/(La + Nd) atomic ratios of 0.16 to 0.86] correlate with oxidation-reduction conditions in the soil profile. The substitution of dilute H_2SO_3 for dilute HCl in the determination of available rare-earth elements brings about a large increase in the proportion of cerium that is extracted from an oxygenated subsoil. These relationships strongly suggest that quadrivalent cerium is present in oxygenated subsoil and is less available to plants than the other rare-earth elements that do not undergo such a change in valence.

A few parts per billion of rare-earth elements have been detected in two samples of ground water. (auth)

Rodliffe, R. S. 1974. Transport of Adsorbing Radioactive Species in a Non-Isothermal Porous Medium. RD/B/N-2931.

The simple parallel circular pore model is used to derive the equation describing the transport of an adsorbing, radioactive species in a non-isothermal porous medium. A temperature gradient is established along the pore axes and the gas and pore surface at any given axial location are assumed to be at the same temperature. The problem is formulated for a single pore and considers the following transport mechanisms: diffusion in the gas in the pore; convective flow of gas in the pore; diffusion along the surface of the pore; adsorption and desorption at the pore surface described by a Henry's Law adsorption isotherm. The surface diffusion and convective terms in the transport equation take the form which would be expected for position dependent diffusion coefficient and velocity. The gaseous diffusion term is significantly different from the form which might be expected from a superficial modification of the relevant equation for an isothermal medium. Under some circumstances the evaluation of experimental concentration profiles using solutions to the isothermal equation will be significantly in error. (auth)

Roessler, C. E. 1967. ^{137}Cs and Other Gamma Radioactivity in the Florida Environment. Thesis. Univ. of Florida.

Kinds, levels, and distribution of gamma-emitting radionuclides in the Florida environment were investigated because of the unusual levels and characteristic geographical patterns of cesium-137 found in Florida milk and forage in earlier studies. Beef and vegetables were selected as the most important media for sampling in May and June, 1966, and during January through July, 1967. Analyses were performed by gamma spectroscopy on triturated whole samples and gamma spectra were interpreted in terms of the individual contributing components by use of the simultaneous equations method. The most significant gamma-emitting radionuclide present was ^{137}Cs, and the evaluation of the data was concentrated on this nuclide. Levels of ^{137}Cs in both beef and vegetables showed geographical patterns of variation similar to those reported earlier by others in Florida milk. Maximum levels were found in the central and southern parts of the State, with intermediate levels in the northeastern and north central parts of the State, and the lowest levels in the northwestern part of the State. In addition, vegetable samples showed a marked difference from southeast to southwest, with average levels in the southeastern part of the State as low as in the northwestern part. Levels of ^{137}Cs in lower-quality meat from animals that had fed primarily on grass were much higher than those in high-quality meat from feed-lot animals. These levels were higher than any other levels reported in beef in the conterminous United States. There was no apparent difference in ^{137}Cs concentrations between leafy, fruit, and root categories of vegetables; although certain crops in each category did exhibit consistently higher levels than the other crops in the same category. Cesium-137 concentrations found in this study were compared to literature values, both to those reported for years previous to this study and to 1966 to 1967 values obtained by extrapolating published values to that time. The significance of the observed ^{137}Cs levels was evaluated in terms of the human intake of this nuclide. It was estimated that radioactivity intakes from locally produced food in northwestern Florida would be similar to the national average. It was concluded that unusual environmental factors or mechanisms are involved in the levels of ^{137}Cs found in the Florida environment. The possibility of such mechanisms has important implications to waste disposal, hazard evaluation, and nuclear facility operation. The mechanisms were not identified but there is increasing evidence that the role of uptake from the soil is greater than that reported for most areas of the country. (NSA)

Rogers, D. R. 1975. Mound Laboratory Environmental Plutonium Study. MLM-2249.

In 1974, Mound Laboratory found that the sediment in certain waterways near the laboratory site appeared to exhibit plutonium-238 concentrations higher than the expected baseline levels. As a result, Mound Laboratory initiated a comprehensive environmental plutonium-238 study to determine the full extent of the contamination, the cause and mechanisms of the release, and the health and safety impact of these deposits on the public.

During the plutonium-238 environmental survey program, over 1750 soil, sediment, biota, water, and air samples were collected in the off-site areas and analyzed for plutonium-238. From these data, it was determined that about 5.2 curies of plutonium-238 are deposited in these waterways, mostly buried under up to 3 ft of sediment.

The plutonium-238 was found to be strongly sorbed and fixed onto the sediment. Autoradiographic analysis indicated very little, if any, particulate forms of plutonium. The solubility of the plutonium/sediment in the natural surface water is very low; only about one part per one hundred thousand parts of the plutonium is soluble in canal water. The maximum concentration in the water sampled from the waterways is about 0.00001 nCi/g. The highest subsurface sediment concentration is 4.56 nCi/g at a 3 or 4 ft depth in a localized area. The plutonium-238 concentration in samples of the biota was found to be very low.

The plutonium-238 concentrations in land areas contiguous to the waterways are at or below baseline levels (<0.0004 nCi/g).

An intensive investigation identified the cause of the plutonium-238 deposits and the mechanisms of the release, transport and deposition into these off-site waterways. Experimental laboratory studies and field observations were used to verify these mechanisms.

In January, 1969, an underground pipeline carrying plutonium-238 waste solution from the Plutonium Processing (PP) Building to the Waste Disposal Facility (WD) ruptured. Acidic waste solution containing plutonium-238 was released to the soil adjacent to the pipe. The plutonium was quickly and strongly sorbed by the soil where it was immobilized. During the excavation and repair operations, when the contaminated soil was most susceptible to erosion, the weather warmed, and intense rain was experienced for two days. This heavy rain eroded the exposed surface of the contaminated soil, causing the soil particles to be carried off-site. These erosion products, suspended in the moving water, settled according to normal sedimentation processes in the waterways adjacent to Mound Laboratory. Water sampling performed during this occurrence failed to detect this movement because the plutonium was in the sediment.

The health and safety aspects of the plutonium-238 sediment deposits were evaluated under the prevailing conditions and under credible worst-case future conditions.

The evaluation under prevailing conditions was performed considering the measured concentrations of plutonium-238 in air, water, vegetation, fish, soil and sediment and the physical conditions and circumstances prevalent in this specific area. The air and water data were compared with existing Radioactivity Concentration Guides (RCG) for plutonium-238. The biota was evaluated by determining the amount of each of the materials which would have to be ingested to receive 1/70 of a permissible body burden per year. It was concluded that the air and water concentrations are at safe levels (substantially below RCG). Due to the physical and chemical properties of the area and the sediment, the present air and water concentrations are not likely to be significantly higher in the future under prevalent conditions. The amount of the other materials which would have to be ingested to lead to a potential uptake of 1/70 of a permissible body burden per year is too large to be of concern. Overall, these plutonium-238 deposits, therefore, were evaluated and found to present no hazard to the public under the prevalent conditions which presently existed in this area.

Anticipating that future conditions may change, comprehensive pathway analyses were performed, assuming credible worst-case conditions associated with each of the several ingestion, absorption, and inhalation pathways considered. From these pathway analyses, *Sediment Concentration Decision Guides* were estimated using methods and philosophies similar to those used for RCG deviations. The maximum available, potentially available, and worst-case credible plutonium-238 sediment/soil concentrations found in and around these waterways were compared with these decision guides.

On the basis of this analysis, the concentrations of plutonium in the sediment are not expected to present a hazard to the public in the future. (auth)

Rogers, V. C., G. M. Sandquist, J. Byrne. Leaching of Radioactive Materials at the Salt Lake City Uranium Mill Tailings Site. Transactions of the American Nuclear Society. 1975 Annual Meeting, June 9-13, 1975, New Orleans, LA. p. 94.

Core samples from the old Vitro Mill site at Salt Lake City show ^{226}Ra and at least one of its daughters have leached significantly to a depth of 5 feet. (auth)

Rogowski, A. S. and T. Tamura. 1970. Erosional Behavior of ^{137}Cs. Health Physics. 18:467-77.

Movement of ^{137}Cs by runoff, erosion, and infiltration on a silt-loam soil in Tennessee is reported. A summary of a 2-yr study is given, and a model for the nuclide erosional loss is suggested. It was found that, although an empirical parabolic equation adequately describe the radionuclide loss, an exponential model, based on the nuclide distribution in a soil profile, appears to give more general results. The results show that a 60% reduction in the radiation dose due to surface-deposited ^{137}Cs occurred during the first 7 months following the application. Most of the applied radiocesium was found in the 0- to 3-cm layer or had been eroded away. It appears that the specific loss of ^{137}Cs reflects the seasonal variation in the magnitude of the erosion index and the extent of vegetative cover for a particular location. (auth)

Rohleder, K. 1973. Model Experiments on the Downward Migration of Artificial Radioactive Materials in Soils. Kerntechnik. 15:301-305 (in German).

The distribution of various nuclides in certain types of soil and the dependence of this distribution on the distribution coefficients of the nuclides, the exchange capabilities of the soils, the percolation time, the pH of the percolating water, and the vegetation cover are reported. Estimates are presented of the reduction of the dose rate on the soil surface with time, taking into account the nuclide distribution, the radiation absorption and nuclide decay. (auth)

Romney, E. M. and J. J. Davis. 1972. Ecological Aspects of Plutonium Dissemination in Terrestrial Environments. Health Physics. 22:551-557.

The technology of plutonium production and processing is already established, but the realization of its peaceful applications depends largely upon the development of methods for preventing its distribution in the environment. Because of safeguards and effective control measures, no accidental plutonium contamination of the public domain has imposed serious risks to a population group. Trace amounts of plutonium from above-ground nuclear detonations are contained in world-wide fallout; however, the levels of plutonium in foodstuffs and other components of the environment are insignificant compared to the amounts known to be hazardous. There has thus been very little interest in the study of ecological aspects of plutonium contamination. The result is a paucity of information on the behavior of plutonium in ecosystems and its radiological effects on natural fauna and flora. The Nevada Applied Ecology Group is embarked upon a program at the Nevada Test Site to investigate the long-range effects of plutonium disseminated into the desert ecosystem. Emphasis has been placed upon standardization of analytical methods, delineation of contaminated areas, problems of resuspension and redistribution, food chain transport and ecological effects. (auth)

Romney, E. M., V. Q. Hale, A. Wallace, O. R. Lunt, J. D. Childress, H. Kaaz, G. V. Alexander, J. E. Kinnear and T. L. Ackerman. 1973. Some Characteristics of Soil and Perennial Vegetation in Northern Mojave Desert Areas of the Nevada Test Site. UCLA-12-916.

Data were compiled from several interrelated projects conducted at the Nevada Test Site as part of a team effort to obtain more information on soil and plant relationships in the desert ecosystem in order to better understand the impact of nuclear testing on the environment. It ties together the masses of acquired data into one convenient volume for use by the funding agency and also to serve as a basis for the continuing systems analysis work involved with these projects. Included are results from the chemical and physical characterization of soil profiles at 79 study sites located in some northern Mojave Desert areas of the Nevada Test Site. These profiles were characterized under clumps of perennial vegetation and under bare desert pavement in order to determine the modifying influence of shrubs on desert soil. Ecological attributes of perennial vegetation determined by nondestructive, dimensional analysis are reported in terms of density, area, volume, and biomass according to the existence of shrubs as solitary plants or as members of a shrub clump. Mineral element compositions of leaves and stems are reported for the most common plant species at each study site. Also included are the concentrations of ^{137}Cs, and the natural ^{40}K (as total K), uranium, and thorium found in the surface fractions of the soil profile. Abiotic data compiled during a five year period from nine sampling stations are reported for rainfall, air temperature, soil temperature and soil moisture. (auth)

Romney, E. M., H. M. Mork, and K. H. Larson. 1970. Persistence of Plutonium in Soil, Plants and Small Mammals. Health Physics. 19:487-491.

Periodic surveys during a 10 year period were made of the persistence of residual ^{239}Pu in soil, plants and small mammals indigenous to fallout areas contaminated with ^{239}Pu dispersed by high explosive detonations. Downward migration of fallout particles occurred in undisturbed soil profiles, and wind and water erosion accounted for some redistribution of the initial ^{239}Pu contamination. Long-term cropping experiments showed a relatively low degree of ^{239}Pu transfer from soil to plants, but there was a consistent increase in its accumulation in plant tissue during a five year cropping sequence. Plant uptake of ^{239}Pu from soil was enhanced by DTPA chelating agent. Qualitative trends from these surveys indicate that the accumulation of residual ^{239}Pu in kangaroo rats and jackrabbits was highest in bone tissue; considerable amounts also were found in lung tissue. Inhalation is known to be the major pathway for plutonium deposition in lung and bone, but the high levels found in the gastrointestinal tracts indicate that ingestion is also an important route through which these small mammals maintained contact with the residual ^{239}Pu contamination in the environment. (auth)

Romney, E. M., A. Wallace, R. O. Gilbert, S. A. Bamberg, J. D. Childress, J. E. Kinnear, and T. L. Ackerman. 1973. Some Ecological Attributes and Plutonium Contents of Perennial Vegetation in Area 13. UCLA-12-937.

Progress is reported on work conducted at the Nevada Test Site under the auspices of the Nevada Applied Ecology Group, Office of Effects Evaluation, USAEC Nevada Operations Office, Las Vegas, Nevada. Included are data on some ecological attributes of the vegetation within the fenced portion of the Project 57 fallout pattern in Area 13. Also included are some preliminary data on the $^{239-240}$Am in samples of vegetation collected in conjunction with the soil sampling program. Prominent shrub and grass species in the fallout pattern of Area 13 include Artemisia spinescens, Atriplex canescens, Atriplex confertifolia, Eurotia lanata, Grayia spinosa, Kochia americana, Lycium andersonii, and Oryzopsis hymenoides. Individual or codominant species distinguished local association patterns of varied size within the fenced study area. Vegetation cover estimates in sample study plots ranged from 12.8 to 28.3%. Shrub densities ranged from 1.2×10^3 to 17.9×10^3 plants per hectare, and the standing shrub biomass ranged from 1592 to 4285 kilograms per hectare (0.7 to 1.9 tons per acre). Preliminary results showed rather uniform distributions of $^{239-240}$Pu and ^{241}Am among individual samples of the same plant species collected within an intensive study plot. However, there was considerable variation in the contamination levels between different species, presumably from superficial entrapment of resuspended particulate material. Concentrations in Eurotia lanata were three to five times higher than in other species sampled from the same study site. The $^{239-240}$Pu and ^{241}Am generally tended to decrease in samples of vegetation collected at increasing distances from ground zero, but there were poor correlations between vegetation and soil $^{239-240}$Pu concentrations in isopleth strata within the fenced grazing area. Results showed inconsistencies in the Pu/Am ratios for vegetation and soil. Lower ratios found in vegetation samples indicate that preferential uptake and concentration of ^{241}Am through plant roots might have occurred in the Project 57 fallout area. (auth)

Romney, E. M., A. Wallace, R. O. Gilbert, and J. E. Kinnear. 1975. 239-240Pu and 241Am Contamination of Vegetation in Aged Plutonium Fallout Areas. IAEA-SM-199/75.

Data are presented on the $^{239-240}$Pu and ^{241}Am contents of vegetation samples collected in conjunction with the soil sampling program in aged plutonium fallout areas on the Nevada Test Site (NTS) and the Tonopah Test

Range (TTR). Radiochemical analyses indicate definite variations in the contamination levels from sample to sample collected within a given activity stratum. Variations also occur in the contamination levels on different plant species, which can be attributed to differences in the amounts of resuspendable particulate material superficially entrapped upon plant foliage. In spite of these variations, there were some indications of reasonable agreement between the mean activity levels of $^{239-240}$Pu in vegetation and soil samples. (NSA)

Rona, E. 1967. Natural Radioactive Elements in Marine Environment. Final Report. ORO-2411-8.

A resume of research carried out at the Institute of Marine Sciences from 1960 to 1967 is presented. Before this project started, work on the problem of natural radioactive elements in marine environments was pursued in a somewhat haphazard fashion; it was not until the past decade that concentrated efforts were made to thoroughly study all aspects of the problem. Among the problems given particular emphasis were: chemical balance in the sea; inflow from rivers and deposition into sediments; mechanisms for the removal of the radioactive nuclides and stable trace elements; and determination of sedimentation rates of large areas. The study of the radium distribution in the oceans led to the conclusion that the sediments must be its principal source; emphasizing the importance of the sediment-water to oceanographic problems. One of the foremost interests was the dating of the Pleistocene epoch; theoretical considerations and critical discussions open the way for the successful dating of Caribbean cores to 200,000 years. The enclosed list of papers gives a more comprehensive understanding of the work carried out during this period. (auth)

Rona, E. 1970. Absolute Dating of Ocean Sediments by Use of ^{230}Th/^{321}Pa Ratio and Geochemical Studies of Limiting Boundary Conditions with Special Attention to Exotic Environments. Annual Progress Report. ORO-3622-9.

One deep sea core from the central Caribbean was dated by ^{14}C and ^{231}Pa/^{230}Th methods. The ages obtained were in good agreement with the ages previously obtained for other cores. Sediment cores from the Cariaco

Trench were analyzed, and a high U concentration was found. Fossil marine carbonates for the Afar depression between Ethiopia and the Red Sea were studied to develop a geochronology of the region. Tentative ages of the deposits are given. (NSA)

Rona, E., L. Muse, and B. L. Brandau. 1966. Protactinium in Deep Sea Sediments. IN: Physico-Chemie du Protactinium. Centre National de la Recherche Scientifique. pp. 333-8.

A method is presented utilizing protactinium to determine absolute ages of marine sediments. This method necessitates the separation of submicrogram quantities of protactinium in pure form from other elements which are present in the sediments in much higher quantities. The method is given and ages, calculated for a sediment core taken from the Gulf of Mexico, are presented as an example. (auth)

Ronov, A. B., Yu. A. Balashov, and A. A. Migdisov. 1967 Geochemistry of the Rare Earths in the Sedimentary Cycle. Geokhimiya. No. 1:3-19.

Behavior of RE was studied in all stages of the sedimentary cycle including weathering of parent crystalline rocks and sedimentation. The work is based on analyses of more than 30,000 samples from the Russian Platform. (auth)

Rose, D. A. 1973. Some Aspects of the Hydrodynamic Dispersion of Solutes in Porous Materials. Journal of Soil Science. 24:284-295.

The paper reviews some quantitative aspects of the hydrodynamic dispersion of solute that occurs under the combined influence of molecular diffusion and convection when a solution flows through a porous material. In particular, the paper: (i) describes several methods of analysing the breakthrough curve of one solution as it displaces another from a column of porous material to yield a coefficient of hydrodynamic dispersion (κ); (ii) discusses the form of κ as a function of particle size and fluid velocity in granular beds composed of solid particles or of aggregates; (iii) discusses the effect of κ on the dispersion observed in a column of porous material, as fluid velocity and particle size vary, as an aid in assessing the efficiency of leaching. (auth)

Rosholt, J. N. 1961. Late Pleistocene and Recent Accumulation of Uranium in Groundwater Saturated Sandstone Deposits. Econ. Geol. 56:423-30.

Protactinium-231 and thorium-230 relations in several groundwater saturated sandstone containing uranium ore indicate that much of the uranium has been accumulating in very recent times. Samples from the Hauber mine, Crook County, Wyoming, were selected to illustrate the concept of recent accumulation and the methods of calculation of the estimated minimum and maximum dates of the start of the uranium accumulation. The radiochemical results of eight samples from this mine show extremely consistent radioactive daughter product distribution, and a close correlation between the estimated dates of the start of uranium accumulation and the uranium content of the ore. The results for mill pulp samples, representing large tonnages of ore, indicate that the major part of uranium deposition started between 40,000 and 130,000 years ago and the rate of deposition has increased approaching the present time. (auth)

Rosholt, J. N. 1961. Uranium Migration and Geochemistry of Uranium Deposits in Sandstone Above, At, and Below the Water Table. Part I. Calculation of Apparent Dates of Uranium Migration in Deposits Above and At the Water Table. Econ. Geol. 56:1392-1403.

The distribution of the daughter products is determined by radiochemical analyses of samples from ore deposits in sandstone, and the apparent minimum and maximum dates of uranium introduction or redistribution may be calculated from the Pa^{231}/Th^{230} ratio. The primary assumption required is that the protactinium and thorium do not migrate in measurable quantities from the place where they were produced by the decay of the parent uranium isotopes. The upper limit of age determination is about 250,000 years, based on the half lives of Pa^{231} and Th^{230}. The difference in the half lives of these isotopes is reflected in their differential rates of growth and decay corresponding to migrations of the parent uranium during the time range considered. The growth and decay patterns, analyzed mathematically, are used to determine the apparent date of uranium migration. Calculations based on analyses of samples from the Hulett Creek area, Wyoming, illustrate the results for typical sandstone ore deposits that are above and at the water table. (auth)

Rosholt, J. N. 1963. Uranium in Sediments. Thesis. University of Miami.

An oceanographic approach is used to study the distribution of abnormal occurrences of uranium in sediments. These occurrences predominate in marine phosphorites, black marine shales, and deposits in terrestrial-fluvial sandstones and ancient conglomerites. In early Paleozoic times, marine shales accounted for the majority of uranium deposition. By the beginning of tertiary time, the balance had shifted to predominant deposition in marine phosphorites, which continued to the present. Much smaller total quantities of uranium are associated with terrestrial sandstones and ancient conglomerates, although its concentration is greater and its economic recovery is more feasible. All the abnormal occurrences fit into a unique niche in the hydrologic cycle, and emplacement was largely controlled by cycles of organic substances in water. Radiochemical analyses of ^{231}Pa, ^{230}Th, and ^{226}Ra were made on a few hundred samples from sandstone-type uranium deposits. These results, in comparison to the uranium content of samples, indicate that much of the uranium in terrestrial sediments is presently in a slow, continual state of migration toward the ocean. (NSA)

Rosholt, J. N. 1970. Nuclear Methods Applied to Uranium Geochemistry.
Trans. Nucl. Sci. NS-17. 1:173-6.

Stable and radioactive daughter products produced from nuclear disintegrations of uranium have proved useful in fundamental studies of the geochemistry of uranium in igneous rock and sedimentary environments and in ore deposits. Information gained from geochemical studies or uranium migration has been used to develop models for attempts to date archeological, geological, and oceanographic environments represented by samples of bone, wood, charcoal, continental and marine carbonates, marine sediments, and glacially derived soils. Recent improvements of nuclear instrumentation and techniques allowed accurate measurements of natural radioactive isotopes, and it is now believed that radioactive equilibrium between the long-lived isotopes of the two uranium decay series is more the exception than the rule in nature. It was assumed that the ^{234}U and ^{238}U isotopes were in equilibrium until Thurber confirmed that considerable separation between ^{234}U daughter and ^{238}U parent exists in nature. It now has been documented that the ^{234}U content may range from 60% deficient to 500% in excess relative to ^{238}U. An excess of 15% of ^{234}U isotope in seawater is well documented. A summary of previous work has shown that geochemical fractionation of the radioactive nuclides in ^{238}U and ^{235}U decay series takes place in the hydrologic environment, resulting in depletion of ^{230}Th and ^{231}Pa with respect to their parents, ^{238}U, ^{234}U, and ^{235}U, in water and a complementary enrichment of these daughter nuclides in some sediments. Subsequent assimilation of uranium, essentially free of radioactive daughters, occurs in some specific types of deposits such as carbonates and phosphates. In the study of the geochemical processes involved in the migration of uranium and its isotopes (^{234}U, ^{235}U, ^{238}U) in the hydrologic cycle, radioactive tracers produced by nuclear processes in nature (^{230}Th as tracer of ^{234}U and ^{231}Pa as tracer of ^{235}U and ^{238}U) have proved useful in studies of the Pleistocene. This tracer technique is a powerful tool when applied to pleistocene chronology, and possibly to the correlation of glacial deposits in their respective stages of glacial deposition. Natural tracer studies have been initiated to investigate the process of uranium removal from Precambrian granitic rocks by comparison of the concentrations of radiogenic lead isotopes (^{206}Pb, ^{207}Pb, ^{208}Pb) to the concentrations of uranium and thorium in total rock samples. Initial results indicate the large volumes of uranium have been removed from the Granite Mountains in Wyoming and may have provided a major source for the uranium deposits in the central Wyoming basins. (auth)

Rosholt, J. N., E. L. Garner, and W. R. Shields. 1964. Fractionation of Uranium Isotopes and Daughter Products in Weathered Granite and Uranium-Bearing Sandstone, Wind River Basin Region, Wyoming. U.S.G.S. Professional Paper No. 501, B84-7.

Isotopic ratios of $^{235}U/^{234}U$ for three samples representing different stages of weathering of granite show 7 to 23% deficient ^{234}U. The slightly weathered rock is most deficient, suggesting major ^{234}U leaching at an early stage in the decomposition. Isotopic ratios in samples from a uranium deposit in sandstone showed slight excess ^{234}U in parts of the adjoining oxidized sandstone characterized by relatively high uranium content. $^{230}Th/^{234}U$ ratios indicate relatively recent deposition of redistributed uranium in parts of the oxidized sandstone where the $^{234}U/^{235}U$ ratio is high. The low $^{234}U/^{235}U$ ratios prevailing in uranium-poor parts of the oxidized sandstone are believed to have resulted from preferential leaching of ^{234}U in these places and over a considerable time. (auth)

Rosholt, J. N. and D. C. Noble. 1969. Loss of Uranium from Crystallized Silicic Volcanic Rocks. Earth Planet. Sci. Lett. 6:268-270.

Dense primarily crystallized silicic groundmass material from two welded ash-flow units and one lava flow of Tertiary age from the Western United States contain only 20 to 60% of the uranium present in nonhydrated glass from the rock units. These differences reflect loss of uranium from the crystallized specimens, probably as a result of ground water leaching. It appears likely that most crystallized silicic volcanic rocks have lost comparable amounts of uranium. (auth)

Rosholt, J. N., Prijana, and D. C. Noble. 1971. Mobility of Uranium and Thorium in Glassy and Crystallized Silicic Volcanic Rocks. Econ. Geol. 66:1061-1069.

Analyses of hydrated and nonhydrated glass pairs from three welded ash-flow units and four lava flows of Tertiary age from the Western United States showed that the uranium and thorium contents of hydrated glass, when corrected for water hydration, were nearly identical to those of the parent nonhydrated glass. This indicates that no measurable quantities of uranium or thorium were removed from or added to the glass during or after hydration. The uranium content of nine crystallized specimens, however, was only 20 to 70% of that in the glasses from the same unit. These differences reflect a loss of uranium from the crystallized material by some combination of distillation as the volatile fluoride during cooling and crystallization and ground water leaching after cooling. The thorium content of primarily crystallized groundmass material was nearly the same as that in glasses from the same unit. The possibility appears remote that volcanic ash layers that have simply undergone hydration without devitrification have provided a large source of uranium in ore deposits in stratigraphically underlying sediments, such as in the intermountain basins in Wyoming. Comparison of the potential source of uranium available from granites in this area suggests that approximately 20 grams uranium per 1,000 kilograms of granitic rock may have been available, whereas, a maximum of about 5 grams uranium per 1,000 kilograms of original volcanic material could have been available if the volcanic ash devitrified. (auth)

Rosholt, J. N., W. R. Shields, and E. L. Garner. 1963. Isotopic Fractionation of Uranium in Sandstone. Science. 139:224-6.

Relatively unoxidized black uranium ores from sandstone deposits in the western United States show deviations in the uranium-235 to uranium-234 ratio throughout a range from 40% excess uranium-234 to 40% deficient uranium-234 with respect to a reference uranium-235 to uranium-234 ratio. The deficient uranium-234 is leached preferentially to uranium-238 and the excess uranium-234 is believed to result from deposition of uranium-234 enriched in solutions from leached deposits. (auth)

Rosyanov, S. P., V. K. Vinogradova, L. I. Gustova, and L. I. Gedeonov. 1965 Distribution of ^{90}Sr and ^{137}Cs in the Profile of Soils Under Natural Conditions in 1964. AEC-tr-7214., pp. 82-6.

Data are presented on the vertical distribution of ^{137}Cs and ^{90}Sr in various soils in the USSR during 1964. Soil samples were taken to depths up to 30 cm. Determination of the ^{90}Sr content was carried out by radiochemical analysis, while the ^{137}Cs content was determined by the gamma spectrometric method. It was concluded that the vertical distribution of radioactive fission products in soils is determined by the chemical and physical properties of the radioisotopes and the occurrence of numerous migration processes. The efficiency of these processes depends primarily on the basic factors of soil formation such as the source rock, climate, topography, vegetation, etc. (NSA)

Routson, R. C. 1969. An Evaluation of Predictive Methods of Determining the Effects of Solid-Liquid Phase Interactions on the Movement of Solutes in Soils. BNWL-1196.

An evaluation was made of the available methods, theories, and models which have been used to describe solid-liquid phase interactions that take place in porous media. Only the discontinuous-fixed plate model of Dutt was found to be a multiion approach which prior work on the Hanford project has shown to be necessary for a successful sorption description. The combination of Dutt's macroion approach and an empirical-statistical method of measuring trace radionuclide sorption was deemed to be the most fruitful approach for describing radionuclide concentration as a function of position and time. A computer program has been written and experiments have been designed to measure model parameters for testing the aforementioned approach. (auth)

Routson, R. C. 1969. Effect of the Prior Disposal of Uncontaminated Solution on the Waste Retention Capacity of a Hanford Crib. BNWL-1163.

An empirical method, suggested by constant head and moisture redistribution studies, was developed to predict the movement of a wetting front and a waste front in homogeneous sand columns due to pulse solution additions. The movements of wetting fronts and waste fronts were initiated by additions of equal pulses of aqueous solution. Movement of the wetting front was initiated prior to the initiation of the movement of the waste front. Log-log plots of the frontal position versus elapsed time were found to be linear for both wetting fronts and waste fronts for elapsed times up to 5000 hours. This demonstrates that the position of a front at time T can be empirically predicted by equations of the form $S = ET^F$. Parameters E and F can be evaluated from laboratory measurements. Parameter E was found to be an extensive variable which increased with an increase in the amount of solution added as a pulse. Parameter F was found to be constant for a range of solution additions from 2.5 to 10% of the column volumes, suggesting that it may be an intensive variable. The position of the wetting front was found to move at a faster rate than the position of the waste front. Initiation of the waste front was found to increase the rate of movement of the wetting front. The observed decreased rate of movement of the waste front relative to the wetting front was interpreted as being equivalent to an increase in the waste retention capacity of the soil due to an initial addition of uncontaminated solution to the soil. In addition, moisture initially present in a soil need not be subtracted from the waste retention capacity because it will be displaced into the ground-water ahead of any disposed aqueous waste. (auth)

Routson, R. C. 1973. Review of Studies on Soil-Waste Relationships on the Hanford Reservation from 1944-1967. BNWL-1464.

Hanford chemical processing plants have been in operation for more than twenty years, and during this period have disposed large volumes of waste liquids to the Hanford sediments. Because the ground water and sediments at this major nuclear facility have been closely monitored and investigated a unique opportunity exists to assess the effects of these disposal operations at Hanford on the soil environment. The literature regarding effects of the liquid waste disposal operations at Hanford on the soil environment is summarized. This summary is divided into studies pertaining to: the vadose zone below a depth of twenty feet (lower vadose zone); the saturated zone; and the vadose zone above twenty feet (upper vadose zone). The division is based upon the relative desirability of these three zones for nuclear waste disposal (storage). Liquid nuclear wastes have been safely discharged to the lower vadose zone for over twenty years. Migration of these wastes from the lower vadose zone by the mechanisms of diffusion, leaching, and particulate transport is discussed. It is concluded that little movement of sorbed radionuclides by the above mechanisms within ten half-lives of even the long-lived radionuclides occurs; the sorbed radionuclides can be removed from this zone only by a cataclysmic occurrence in which the sediment in the zone and the entrained wastes are both physically removed. Field studies show that essentially all of the long-lived radionuclides disposed to the ground have been sorbed and remain in the upper levels of the lower vadose zone. Radionuclides which normally need to be considered in waste disposal include strontium-90, cesium-137, plutonium, cobalt-60, ruthenium-106 transition metals, rare earths, and hydrogen-3. In many wastes strontium-90 is the radionuclide which limits ground disposal to Hanford sediments due to its long radioactive and biological half-lives and resulting low maximum permissible concentrations. In sediments containing small amounts of mica, cesium-137 could become the limiting nuclide; however, cesium-137 has a much shorter biological half-life than strontium-90, and therefore, a higher maximum permissible concentration. Much of the sediment of the Hanford project has a moderate mica content and exhibits high cesium-137 sorption. Due to the likelihood of strontium-90 and cesium-137 limiting the disposal of most wastes, a more detailed review of the sorption of these nuclides is included. (NSA)

Routson, R. C. 1975. Effect of Soil Concentration on the Tumbleweed Uptake of ^{90}Sr and ^{137}Cs from a Burbank Sand. BNWL-1905.

Concentration factors (CF values) for tumbleweed shoots have been measured as a function of soil radionuclide concentration and plant age. CF values were constant in totally mixed Burbank sand soil for Sr over five orders of magnitude and for Cs over three orders of magnitude of soil radionuclide concentration. CF values for 8- and 12-week-old plants were 9.6 and 19 for Sr and 0.033 and 0.053 for Cs, respectively. CF values measured in totally mixed and layered systems were compared. (auth)

Routson, R. C., G. Jansen and A. V. Robinson. 1975. Sorption of ^{99}Tc, ^{237}Np and ^{241}Am on Two Subsoils from Differing Weathering Intensity Areas. BNWL-1889.

Distribution coefficients (Kd values) were determined on subsoils from Washington and South Carolina for ^{241}Am, ^{237}Np, and ^{99}Tc as a function of equilibrium solution concentration of calcium (Ca^{+2}) and of sodium (Na^{+}). Kd values decreased in all cases with increasing solution concentrations of Ca^{+2} and Na^{+}. For the South Carolina subsoil Kd values ranged from 1.0 to 67 for ^{241}Am as a function of Ca^{+2}, 1.6 to 280 for ^{241}Am as a function of Na^{+}, 0.43 to 0.66 for ^{237}Np as a function of Ca^{+2}, and 0.16 to 0.25 for ^{237}Np as a function of Na^{+}. For the Washington soil Kd values were greater than 1200 for ^{241}Am and ranged from 0.36 to 2.37 as a function of Ca^{+2} and from 3.19 to 3.90 for ^{237}Np as a function of Na^{+}. Kd values for ^{99}Tc were essentially 0 at all $NaHCO_3$ concentrations on the South Carolina subsoil. (auth)

Routson, R. C. and R. J. Serne. 1972. Experimental Support Studies for the Percol and Transport Models. BNWL-1719.

A group of support studies conducted during development of a transport model for the Radionuclides in Soils Program is described. Measurement studies for sorption parameters concluded that: small calcium experiments are more useful than batch experiments for measuring the Kd of trace solutes which are sorbed by ion-exchange, unless the batch system is prewashed several times with influent prior to measuring the Kd; the decrease in Kd often reported with an increasing soil-to-solution ratio is the result of the reaction of the soil solid phase with the influent solution; batch and small column Kds will agree if the equilibrium chemical environment is equivalent; and the number of regression equations required to adequately define sorption in soil column work is a determinable function for each soil. The sorption of Eu was found to depend upon both ion exchange and the filtration of radiocolloids formed by solution hydrolysis in the soil. Either centrifugation or filtration was capable of removing radiocolloidal

Eu from solution. Formation of radiocolloidal Eu is a predictable function of pH and solution concentration of Ca (Ca). It is independent of the solution concentration of Na. Multiple regression analysis was used to develop regression equations for predicting Eu hydrolysis as a function of equilibrium pH and (Ca) over 3 pH ranges. Regression coefficients (r) for the 3 ranges were 0.96, 0.95, and 0.54, showing the high correlation of hydrolysis with pH and (Ca). Once radiocolloidal Eu was removed by centrifugation or filtration, Kd values could be determined for the balance of the Eu. In further study a method was developed for calculating activity coefficients for solutions with ionic strengths greater than 0.5. This method allows extension of the PERCOL model to high ionic strength solutions. A method was developed to estimate the KdSr in Hanford groundwater as a function of the soil's transmissivity. KdSr was found to be a linear function of the log of the permeability and the regression coefficient for the equation was found to be 0.799. Unsorbed solute was measured through soil columns using Cl^- and ^3H. The effective porosity was found to be 7.7 ± 2% smaller than the calculated porosity. These data were also used to calculate dispersion for the soil columns. (auth)

Routson, R. C. and R. J. Serne. 1972. One-Dimensional Model of the Movement of Trace Radioactive Solute Through Soil Columns: The Percol Model. BNWL-1718.

A one-dimensional mathematical model, PERCOL, has been developed to predict the movement of radionuclides through porous media as a function of measurable chemical parameters of the media. Laboratory column studies were conducted to verify the model. System parameters considered include soil type, radionuclide type, waste composition, flow rate, column length, and soil saturation. The agreement between measured radionuclide movement and that predicted by the model is considered good. (auth)

Routson, R. C. and R. E. Wildung. 1969. Ultimate Disposal of Wastes to Soil. Water - 1969. Chem. Eng. Prog. Sym. Ser. 65:19-25.

Soil is a dynamic system which is capable of reacting with a broad spectrum of extraneous components. The nature of these reactions is such that soil may function as a medium for either waste storage or for ultimate waste disposal. This paper will elaborate upon those aspects of the soil system which are relevant to the problems of ultimate waste disposal.

In the strictest sense, ultimate disposal of waste products may be accomplished by permanent removal from the environment, dilution to innocuous levels, transformation to innocuous forms, or recyclization and reuse. Since soil represents a relatively thin surface layer and is generally an integral part of man's environment, soil disposal alone should not be considered permanent. Furthermore, concentration mechanisms in the soil often negate the usefulness of soil as a medium for disposal by dispersion or dilution. However, both transformational and recyclization and reuse mechanisms occur as normal functions of most soil systems. Thus, the latter two ultimate disposal methods will be emphasized in the following discussion of nature of the soil, soil properties amenable to waste disposal, and general soil waste interactions. (auth)

Routson, R. C., R. E. Wildung, and T. R. Garland. 1976. Characterization of Surface Soils for Plutonium Studies. BNWL-2000, Pt. 2, pp. 21-29.

Thirty-five soil types from Oregon, Washington, Minnesota, Tennessee, North Carolina and Colorado were collected and characterized as to sand, silt and clay contents, cation exchange capacity, pH in 0.01 M $CaCl_2$ solution, principal primary and secondary minerals in individual size fractions, calcite content, ash content, organic carbon content, hydrous oxides of Al, Fe and Mn and water content. Water and 0.01 M $CaCl_2$ solution extractions of Pu amended as $Pa(NO_3)_4$ to Ritzville, Muscatine and Hesson soils were reported. Some work with ultrafiltration techniques was done to help determine the size of the Pu molecules in the soil extracts.

Rovinskii, F. Ya. 1967. Migration of ^{90}Sr in Stagnant Waters. Radiokhimiya. 9:80-4 (in Russian).

The migration of ^{90}Sr in lake waters was studied by determining the content of ^{90}Sr, stable Sr^{2+}, Na^+, K^+, Mg^{2+}, and Ca^{2+} ions both in waters of 13 lakes and in the lake bed grounds. The migration of ^{90}Sr in stagnant waters is attributed to the ion-exchange reaction between the water and the lake bed ground. The redistribution of ^{90}Sr in the lakes proceeds mainly by ion-exchange reactions with Ca^{2+}. Equations for prediction the level of contamination of lake waters by ^{90}Sr were derived. Comparable results were also obtained under laboratory conditions using synthetic lake water samples. (NSA)

Rowe, P. P. 1959. Flow Rate Distribution Beneath a Waste Disposal Site. HW-61475.

Two methods of calculating flow-rate distributions beneath a waste disposal site are presented. Data obtained from a two-dimensional percolation model were used to evaluate the two methods. (NSA)

Rozhkova, E. V., E. G. Razumnaya, et al. Sorption in Concentration of Uranium in Sedimentary Rocks. A/CONF 15/P/2059 (in Russian).

The results of a study of the role of sorption processes in accumulating uranium in sedimentary deposits are discussed. A number of uranium-bearing sedimentary rocks were investigated. It was found that uranium is connected only with certain components of these rocks which proved to contain no uranium minerals. Assumptions were made as to the possibility of accumulation of uranium in these components as a result of sorption processes. At the second stage of investigation experiments were carried out with the sorption of uranium from the solutions of its salts. Experiments were made with the rock components under conditions which made it possible to determine the sorption capacity of these components and to establish the basic regularities of the sorption process. The comparison of the results of the first and second stages of the investigation indicates the possibility of uranium being accumulated in sedimentary rocks by sorption at various periods of their formation as well as in the process of epigenetic ore formation in sedimentary deposits. (auth)

Rozzell, T. C. and J. B. Andelman. 1971. Plutonium in the Water Environment. Part II. Sorption of Aqueous Plutonium on Silica Surfaces. Advances in Chemistry Series. 106:280-298.

The sorption and desorption of aqueous plutonium in the range of 10^{-7} to 10^{-8}M was studied on quartz and other silica surfaces. Sorption continued typically for 12 to 15 days before apparent equilibrium was reached, and the distribution of plutonium particle sizes sorbed on the silica was different from that in solution. At pH 7, sorption increased with increasing ionic strength, but decreased when bicarbonate was added. The amount of sorption varied at pH 5 and 7, but differently at high and low ionic strengths, as well as with the age of the solution. Plutonium desorption indicated that there were two basically different sorbed species, and the rate and quantity of desorbed material increased at pH 5 compared with 7 and 9. (auth)

Rubtsov, D. M. 1966. Distribution of Thorium in Various Soils. Pochvovedenie. No. 3:55-67 (in Russian).

Different concentrations of thorium and its decay products in soils cause different levels of γ radiation output above the surface of the soil mantle. The concentration of thorium in fine grain soil, that is, products of weathering and soil formation, is higher than in basement rock-schists with layers of quartzite. Increased concentration of thorium in the fine grain soil is related to processes of weathering and soil formation. The fluctuating concentration of thorium in the soil determines basically the concentration of thorium in the air near the ground. The presence of thorium in vegetable objects indicates that it is in the biological cycle of nature. The uptake of thorium in vegetative objects is determined not only by the concentration of thorium in the fine grained soil, but is also regulated by the species of vegetative association and by the trend in the soil-making process. The processes of soil formation, characteristic of a bioclimatic zone, appear as the basic source of the transdistribution on thorium in the soil profile. (auth)

Rubtsov, D. M. 1971. Soils of Separate Biogeocoenoses Containing
Increased Amounts of Natural Radioactive Elements. Metody Radioekol.
Issled. pp. 24-34 (in Russian).

A technique is described of the study of the effect of increased natural soil radioactivity on the content and elemental composition of radioactive isotopes in soil. Increased content of U, R, and Th is expressed as absent amount in soil or in arbitrary units. An important part of the accumulation of radioactive isotopes is played by soil organic matter and by colloidal soil fractions. In the latter, particle dimensions have considerable influence. In fine-dispersion fractions of mountain forest soil, there is a direct correlation between the content of Th and the amount of organic matter. (CA)

Rubtsov, D. M. 1972. Distribution of Uranium and Radium in the Podzolic
Mountain Soils of Thin Forests. Radioekologicheskie Issledovaniya v
Prirodnykh Biogeotsenozakh. Izdatel'strvo Nauka./Verkhovskaya,
I. N. (ed.) pp. 42-53 (in Russian).

The content and distribution of uranium and radium in the profiles of podzolic mountain soils of thin forests were undetermined A tendency was discovered to a preferential accumulation of uranium and radium in the products of soil formation (aleurite as compared with base rocks) by sericitic shists with quartzite intercalations. The presence of uranium and radium in the vegetative objects of forest litters confirms the already established fact that uranium and radium are involved in the biological cycle of matter exchange in nature. The distribution of radium and uranium in soil profiles reflects the zonal features inherent in the given bioclimatic zone. In base rocks and soils, the equilibrium between radium and uranium is disturbed in favor of radium. In the order of decreasing energy of their absorption by vegetative objects, radioactive elements form the series: radium > uranium > thorium. (auth)

Rubtsov, D. M. 1972. Thorium and Radium Content in the Silt Fraction of the Podzolic Mountain Soils of Thin Forests. Radioekologicheskie. Issledavaniya V Prirodnykh Biogeotsenozakh. IN: Verkhovskaya (ed.) Izdatel'stov Nauka. pp. 42-53.

Investigations have shown that in zones of ore manifestation, thorium is associated with the coarse dispersed part of aleurite. In the zone of the halo of dispersion and the zone of background areas, thorium represented by the fine dispersed fraction is prevailing. The distribution of the silty thorium fraction in different soil profiles is determined by the nature of soil forming processes and the thorium content of aleurite and correlates in a certain measure with the composition of the plant association. The presence of thorium in separate fractions of organic matter was ascertained. The amount of uranium in the soils considered varies with the range of the geochemical background of uranium content in the soils of the Russian plain. Uranium is confined mainly to the fraction > 0.001 mm. The distribution of the uranium of the silty fraction along soil profiles is determined, like that of thorium, by the nature and trend of the process of soil formation. Uranium enters the vegetative objects of forest litters far more intensely than thorium. (auth)

Rubtsov, D. M. 1972. Thorium and Uranium Content in the Clay Fraction of Podzolic Mountain Soils of Thin Forests. Radioekol. Issled. Prir. Biogeotsenozakh. pp. 53-66 (in Russian).

Th and U were quantities determined in clay fractions of individual genetic horizons of thin forest podzolid mountain soils from localities with significantly different levels of γ-radiation above the soil surface. Th in the <0.001 mm fraction appears to be the primary source of Th accumulation in soil. This fraction can be involved in the soil-plant biological cycle and it is capable of forming organo-mineral complexes. The maximum content of Th was in the A_2 and BC horizons. The soil fractions >0.001 mm contained 57-96% of total U in the soil; this is explained by the high minerizing capacity of U compounds. A relatively high level of U was found in the >0.001 mm fractions of the podzolic A_2 horizon. Th was found in some organic matter fractions. Forest litter contained more U than Th. (CA)

Rubstov, D. M. and E. J. Pravdina. 1972. Content and Distribution of Uranium, Radium, and Thorium in Mountain Tundra Soils. Radioekologicheskie Issledovaniya v. Prirodnykh Biogeotsenozakh. I. N. Verkhovskaga. (ed.) Izdatel'stvo Nauka, pp. 67-86 (in Russian)

Investigations of the content and distribution of thorium, uranium, and radium in mountain tundra soils showed a differentiation of their content according to genetic soil horizons, determined by the nature of the processes of formation. The absolute biological accumulation of thorium and uranium was found to be lower in the soils of mountain tundras as compared with the more southern mountain tundra soils of thin forests. Against a background of a reduced absolute biological accumulation of thorium and uranium in mountain tundra soils, an increase is observed of the relative coefficient of the participation of thorium and uranium in the biological cycle of matter exchange. (auth)

Rudolph, A. W., T. E. Carroll, and R. S. Davidson. 1971. Plutonium and Its Effects in the Environment. TID-26130.

Approximately 325 references on effects of Pu on the environment with emphasis on man are given to journals, reports, and conferences for the period 1948 through 1971. Separate author, subject, and report number indexes are included. (NSA)

Ruf, M. 1968. Contamination of Fresh Water with Radioactive Material with Special Attention to Sludge of River Dams. Wasserwirtschaft. 58:16-22 (in German).

The artificial radioactivity of freshwater in Bavaria differed in the years between 1957 and 1966 within a range of less than one μμCi/l up to 140 μμCi/l. The water activity showed a direct dependence on the activity of rain, and the effects of nuclear power plants. Radioactivity in surface waters was caused by typical fallout products such as: ^{90}Sr, ^{89}Sr, ^{137}Cs,

^{103}Ru, ^{106}Ru, ^{141}Ce, ^{144}Ce, ^{95}Zr, ^{95}Nb, ^{54}Mn, ^{125}Sb. Since the 237-MW-KRB-reactor Gundremmingen reached its full capacity in November, 1966, more waste has been passed into the river Danube. So radioactive corrosion products (Co-, Fe-, Mn- and Cr-isotopes) of low concentrations could be analyzed besides fission products (especially I-131). Radioactive substances were, to a large extent, concentrated in the sludge of river dams, in consequence of the increased sedimentation of seston particles. In this case the ^{137}Cs and ^{144}Ce-activity reached a 12- to 15,000 fold concentration of the water activity. In different fish of the river Isar and Danube a ^{137}Cs-activity 3,000 times higher than water activity was found. (auth)

Runnells, D. D. 1976. Wastewaters in the Vadose Zone of Arid Regions: Geochemical Interactions. Ground Water. 14:374-384.

Because of increasingly stringent laws governing discharge of fluid wastes to surface waters, the alternative of discharge to the subsurface has become attractive. The physical-chemical processes that prevail in the subsurface are not well understood, but they are clearly not identical to processes of purification in surface waters. For example, in the subsurface the process of oxidation may be of little value in significantly reducing the concentration of discharged contaminants; in contrast, oxidation plays an important role in purifying surface waters. Eleven physical-chemical processes can be identified as having potential value for purifying wastes discharged to the subsurface, as follow: dilution, buffering of pH, precipitation by reaction, hydrolysis, oxidation or reduction, filtration, volatilization, biological assimilation, radioactive decay, membrane filtration, and sorption.

Discharge to the vadose zone may be a safe means of disposal of wastes in arid regions. But it is necessary to carefully test the suitability of a particular site for a particular waste. Processes of purification in the vadose zone can be incorporated into a workable plan of discharge if adequate studies and safeguards are employed. Regulations governing subsurface discharge should take into account the physical-chemical processes that may act to purify the waste fluids. In one set of experiments, a soil from Sulfur Springs, New Mexico was capable of removing large quantities of dissolved molybdenum and copper from a synthetic mill water, and the soil was able to quantitatively retain the copper during subsequent leaching by fresh and metal-free mill waters. Such studies permit rational plans of discharge to be developed. (auth)

Rusanova, G. V. 1972. Radium Content of Soils in Regions with a High Radiation Background and the Effect of Fertilizers on Radium Mobility. IN: Radioekologicheskie Issledovaniya v Prirodnykh Biogeotsenozakh./ Verkhovskaya, I. N. (ed.). Moscow; Izdatel'stvo Nauka. pp. 22-23 (in Russian).

It was established that the radium content of gleystrongly-podzolic soils in regions with a high radiation level is equal to $10^{-7\%}$, that is by 4 orders higher than its clark content in the soil. A certain part of the radium in the soil is in a mobile state and is carried with the downward water flow into the lower horizons. Experimental investigations in cultivated soddy-meadow soil have shown that radium mobility and its entry into plants are reduced by the application of organic fertilizers and lime. Superphosphate on the contrary enhances the mobility of radium. (auth)

Ryabchikov, D. I. and E. K. Gol'braikh. 1960. Analytical Chemistry of Thorium. Trans. by A. Aladjem. Israel Program for Scientific Translations Ltd.

This book gives details of thorium occurrence in nature and its properties, chemical and physicochemical methods for determination, methods for separation from accompanying elements, determination in natural materials and in industrial products, and determination of impurities in metallic thorium.

Rydell, H. S. 1971. U, Th, and Pa Isotopes as Indicators of Geologic Processes in Marine Environments. ORO-3622-12.

From August 1970 to August 1971, several geochemical studies were initiated using Th and U isotopes as indicators of geological processes in the marine environment. Summaries are presented of the following investigations: the postdepositional mobility of some transition elements, P, U, and Th in deep-sea sediments; the final desiccation of the Afar Rift, Ethiopia; U content of Caribbean cores; mineralogy of Afar Rift, Ethiopia; Pa, Th, and U content in atmospheric dust; mineralogy and petrology of rock samples from fractured zones of the Equatorial Mid-Atlantic Ridge; and the Th and U isotope contents in marine ferromanganese deposits. (NSA)

Rydell, H. S. and E. Bonatti. 1973. Uranium in Sub-Marine Metalliferous Deposits. Geochim. et Cosmochim. Acta. 37:2557-65.

Hydrothermal submarine metalliferous deposits, common in areas of the ocean floor with a high heat flow containing ∿ 10 ppm U. The ratio is close to that of seawater. These data are explained by a model where thermal water (essentially heated seawater) in its sub bottom circulation often is unable to leach U from the basaltic oceanic crust; in fact, these thermal waters may in some cases lose U. When leaching of U from the basalt does take place, probably during shallow stages of the sub bottom circulation, the resulting anomalous $^{234}U/^{238}U$ ratio can be preserved in the hydrothermal deposit only if mixing with "seawater" U is prevented. (CA)

Rydell, H. S. and J. M. Prospero. 1972. Uranium and Thorium Concentrations in Wind-Borne Saharan Dust Over the Western Equatorial North Atlantic Ocean. Earth Planet. Sci. Lett. 14:397-402.

The average uranium and thorium concentration in 15 samples of wind-borne Saharan dust collected at Barbados, West Indies, is 3.6 and 12.4 ppm, respectively; these values are approximately one-third greater than that of average crustal material. The thorium-uranium weight ratio of the dust is 3.5, about the same as that of the crust; the $^{234}U/^{238}U$ activity ratio is 1.08 and the $^{230}Th/^{234}U$ activity ratio, 0.97. It is concluded that the presence of large amounts of African dust in Atlantic sediments would not significantly affect the validity of the assumptions inherent in the $^{231}Pa/^{230}Th$ and $^{230}Th/^{232}Th$ dating methods. (auth)

Ryzhinskii, M. V. 1974. Convective Diffusion of Strontium Ions in Quartz Sand. Russ. J. Phys. Chem. 48:1362-1364.

The quasi-diffusion coefficient of Sr^{2+} in quartz sand increases substantially when the flow rate of the eluent is increased from 0 to 0.8×10^{-3} cm s^{-1}. At low velocities of the Sr^{2+} ion ($\sim 10^{-6}$ cm s^{-1})D^* is independent of flow rate, and the diffuseness of the Sr^{2+} band is due entirely to the ionic diffusion of Sr^{2+}. At flow rates of $\sim 10^{-3}$ cm s^{-1} (with distilled water or 0.005 N $CaCl_2$ solution as the eluent) the main contribution to band spreading comes from sorption kinetics. However, with 0.05 and 1 N solutions of $CaCl_2$ as the eluent the process goes effectively to equilibrium, and band spreading arises from ionic diffusion and from the granularity effect. (auth)

Saas, A. 1973. Contamination of Soils by Industrial Radioactive Wastes, Mechanisms and Factors of Migration and Evaluation. Sci. Sol. No. 4: 255-64 (in French).

A number of examples are given illustrating the investigations on soil protection carried out by the laboratory of continental radioecology. The techniques of soil and radionuclide migration are first reviewed: the main trends of investigations are then developed: role of the radionuclide vector in the soils, influence of the mode of entry of the radionuclide in the biological cycles, influence of some specific soils compounds, in particular organic matter. The aim of these applied investigations is to demonstrate the main mechanisms involved in the transfer of radionuclides to the soils and their uptake by plants. (NSA)

Saas, A. and A. Grauby. 1976. An Approach to Investigations of the Behavior of Iodine-129 in the Atmosphere - Soil - Plant System. Health Physics. 31:21-26.

Iodine-129 is presently one of the chief contributors to air pollution around nuclear installations because of its radioactive half-life (1.72×10^7 yr) rather than on account of the amounts released. Just as with iodine-131, it is released into the atmosphere under many chemical forms (Ta71). However ^{129}I reaches man through several food chains and not only through the air-grass-cow-milk food chain. The values of its deposition rate on soil and plants are fairly dispersed because of its changing reactivity due to its chemical instability (1h68; Co64; St66). On account of this chemical complexity, the transfer of iodine along the air-soil-plant system was studied using ^{125}I. (auth)

Saas, A. and A. Grauby. 1973. Mechanisms for the Transfer to Cultivated Soils of Radionuclides Discharged by Nuclear Power Stations into the System: River--Irrigated Soil--Ground Water. In: Environmental behavior Radionuclides Released in the Nuclear Industry. IAEA-SM-172/57, pp 255-269.

The siting of nuclear power stations on the banks of rivers whose water is used for irrigation and industrial and domestic consumption must be proceeded by a study in depth of the mechanisms of transfer in the system comprising the river, irrigated soil and groundwater. The mechanism of transfer to cultivated soils are considered basically from three viewpoints: the influence of the quality of the river water, irrigation channel water and groundwater on radionuclide mobility in soils; the influence of the type of soil (four types have been considered: brown acid soil, brown calcic soil, brown calcareous soil, and alluvial calcareous soil) and the development and distribution of radionuclides in the soil (water-soluble forms liable to contaminate the groundwater and the more labile forms available to plants). The study described relates to the following radionuclides: ^{22}Na, ^{137}Cs, ^{85}Sr, ^{54}Mn, ^{59}Fe, ^{60}Co, ^{65}Zn, ^{124}Sb, ^{141}Ce, and ^{131}I. Knowledge of the transfer mechanisms in cultivated soils permits an evaluation of the risks of contamination of the food chain and the groundwater. This study also demonstrates new aspects of the behavior of radionuclides as a function of the organomineral pollution by industrial and domestic waste of the water into which they are discharged. This pollution has a considerable effect on the formation of stable complexes transferred by the river to irrigated soils. The quality of the water determines the distribution of the radionuclides in the profile. The water-soluble complexes persist in the soil and migrate towards the groundwater if they are not biodegradable or are only slightly so. The stability of these complexes as a function of the pH of the soil and its physico-chemical characteristics and the radionuclides concerned can be used as a basis for drawing up a new balance of the radiological capacity of soils and for formulating new proposals for regulating nuclear power station siting. (autn)

Saas, A. and A. Grauby. 1974. Radionuclide Migration as a Function of the Quality of Irrigation Water. C. R. Hebd. Seances Acad. Agric. Fr. 60:1181-1192 (in French).

The depth migration of radionuclides (^{137}Cs, ^{54}Mn, ^{60}Co) and their different chemical forms available as a function of the quality of the irrigation water were investigated in two types of soils. The notion of irrigation water quality should be introduced in order to assess the potential radioactive contamination of soils. (NSA)

Saas, A., A. Grauby, and J. Andres. 1972. Cycle of Some Radioelements in Natural Soils. Main Data for the Control of a Site. EUR-4800 (Vol. 1&2), pp. 381-93.

Results of studies of the decomposition of litter and the manner of introduction of radioelements into soil were used to show the role of these two factors in the development of contamination. Leaching by rain and foliar absorption by shrubby plants complete the cycle of development of radioelements and the data on the fixation and migration in the soil. Using these methods the cycle of manganese, cobalt, and cesium was studied. The integration of radioelements in the biological cycle depends on the manner of introduction. Leaching of radioelements by rain represents: 10% for cesium, 8% for manganese, and 4% for cobalt. These forms can be assimilated directly and are very mobile. The decomposition of plant debris progressively releases the mineral and organic elements in the course of the year. The migration in depth takes place according to the season and the elements released; this is also represented by a variation of the chemical forms present in the soil and the possibilities of absorption via the roots. These correlations including development of soils, age and distance of samples taken and access route are the basis for directives for rational control. (auth)

Sachse, G. 1962. Investigation of the Applicability of an Albanian Clay for Purification of Radioactive Waste Solutions. Kernenergie. 5:554-8 (in German).

In the purification of radioactive waste solutions clays offer special advantages as natural cheap ion-exchange materials. A gabbro mixture of Albanian origin was investigated as a clay exchanger. In addition to a survey on the mineralogical characterization of the material studied by element analysis, Debye-Scherrer diagrams, electron microscopic investigations, and differential thermal analysis were used to determine the exchange behavior for cesium, strontium, and cerium ions. The exchange capacity of the clays lies between 0.5 and 0.8 mval/g, depending on the type of exchanging cations. Investigations on the fixation of the exchanged ions on clay samples were described in conclusion. (auth)

Sachse, G., G. Anders, H. Puehrer, W. Stohn. 1975. Investigation of Counter-Measures in the Case of Radioactive Materials Penetration in Soils and Ground Water. Zfk-285.

Proceeding from the methods known from hydraulic engineering for the protection of ground waters from penetrating noxious substances, suitable measures for preventing the contamination of ground waters and soils are discussed. Since preventive measures are always of priority, a facility using concrete containers with double walls is considered to be an appropriate method for temporary storage of low and medium activity waste waters. (auth)

Sachse, G. and E. Leibnitz. 1961. Purification of Radioactive Waste Solutions With Natural Inorganic Ion Exchangers. I. The Application of Silicate Clays as Ion Exchangers. Kernenergie. 4:633-6 (in German).

After establishment of the advantages which are obtained in the utilization of inorganic exchangers to processing of radioactive waste solutions, it is shown which silicate clay minerals are suitable for this purpose. The clay material used for the investigations was approximately characterized by Debye-Scherrer diagrams, electron optical formations, differential thermal analysis, and elementary analysis. A brief survey on the stabilization of clays with polyelectrolytes, which is necessary for their use in columns as exchange materials, is given in conclusion. (auth)

Sachse, G. and E. Leibnitz. 1961. Purification of Radioactive Waste Solutions With Natural Inorganic Ion Exchangers. II. The Exchange of Cesium and Strontium Ions on Radgendorf Clay. Kernenergie. 4:697-700 (in German).

The research and measurement methods used in the determination of the exchange properties are described. For characterization of the applicability of Radgendorf clay as an ion exchanger, the results are given for exchange velocity, effect of pH, grain size influence, and temperature dependence for cesium and strontium. The exchange capacity of the clay can be determined with the help of agitation and column studies. For the column research a stabilization of the clay was necessary. In order to obtain a survey on the changes in the exchange capacity caused by inactive salts such as $NaNO_3$, $Ca(NO_3)_2$, and $Al(NO_3)_3$, comparative studies were made. The cesium selectivity of the clay was established. On the basis of this selectivity, samples of

Radgendorf clay are suitable for the separation of Cs^{137} and Sr^{90}. The possibility of separating Cs^{137} from fission product mixtures for the preparation of radioactive sources is shown. (auth)

Sachse, G. and E. Leibnitz. 1962. Purification of Radioactive Waste Solutions With Natural Inorganic Ion Exchangers. III. The Exchange Adsorption of Cerium Ions and Ruthenium and Zirconium Complexes on Radgendorf Clay. Kernenergie. 5:114-17 (in German).

The results of the investigation of the exchange adsorption of cerium ions as a function of exchange velocity, pH value, and the concentration of the solution are described. Corresponding to the given maximum capacity of the clay for cerium ion, cerium activities of 185 c/g clay would be extracted. After a brief survey of the possible purification method for waste solutions containing Ru^{106} and Zr^{95}, the adsorption of Ru nitrosyl and Zr hydrolysis complexes on Radgendorf bentonites is reported. A complete removal of Ru(NO) complexes using cation exchanging clay is not possible on the basis of the simultaneous presence of neutral and anionic complex forms in addition to colloidal compounds. Zr hydrolysis complexes were, however, well adsorbed in nitric acid solution. (auth)

Sackett, W. M. 1960. Protactinium-231 Content of Ocean Water and Sediments. Science. 132:1761-2.

By means of a direct method for determining Pa^{231}, a deficiency in ocean water was found to be accompanied by unsupported Pa^{231} in ocean sediments. Protactinium-ionium ratios obtained for a surface and a deep section in the same equatorial core yielded apparent ages which were in agreement with predicted ages. (auth)

Sackett, W. M. 1963. Evaluation of the Pa^{231}/Th^{230} Method as a Geochronological Tool for the Study of Pelagic Sediments. TID-19555.

An evaluation of the Pa^{231}/Th^{230} method is being made. Preliminary data indicate that absolute ages for various levels of pelagic sediments are obtained only in rare instances. However, accumulation rates based on the slope of the curve of the exponential change in Th^{230}/Pa^{231} ratio with depth apparently agree with radiocarbon based accumulation rates. Various assumptions of the method are being tested. Eleven samples of seawater are being processed for their protactinium and isotopic thorium composition. (auth)

Sackett, W. M. 1972. Geochemical Behavior of Uranium and Thorium Series Nuclides. Annual Progress Report. 1971-1972. ORO-3852-7.

Developments are reported for studies on: removal of Th from seawater and contemporary geochemistry of uranium. Previous studies on Th in seawater are reviewed, particularly in regard to depth. A new geochemical balance for U in the Gulf of Mexico (GOM) is in the process of the final stages of computation. Input from over 22 rivers entering the GOM was analyzed. The results indicated that the GOM receives some of the highest U input concentration of any known basin. (NSA)

Sackett, W. M. 1974. Geochemical Behavior of Uranium and Thorium Series Nuclides. Annual Progress Report 1973-1974. ORO-3852-15.

Samples were collected to measure ^{228}Ra and ^{228}Th distributions in the Gulf of Mexico. Summary profiles of the ^{228}Ra/^{226}Ra activity ratio, salinity, temperature, and dissolved oxygen are given for three stations to study mixing dynamics in the Gulf. Studies are also being made of radium and uranium in livestock feed additives. (NSA)

Sackett, W. M., W. S. Broecker, and D. L. Thurber. 1965. The Geochemistry of Protactinium - 231 and the Dating of Pelagic Sediments. Annual Report. TID-21522.

Papers are included on sediment deposition rate determination by the protactinium method and on measured rates of marine sediment deposition and implications for accumulation rates of extraterrestrial dust. Separate abstracts were prepared for these papers. (NSA)

Sackett, W. M. and G. B. Cook. 1969. Uranium Geochemistry of the Gulf of of Mexico. Gulf Coast Ass. Geol. Soc. 19:233-8.

U concentrations (10^{-6} g/l) and the ratio ^{234}U/^{238}U were determined: Gulf of Mexico, 3.4-3.6, 1.14-1.18; estuaries and bays along the Gulf, 2.1-17.3, 1.12-1.54; four rivers in Texas and Oklahoma, 0.6-3.0, 1.01-1.44.

The high U concentrations in U.S. rivers are considered to be due to the dissolution of U from phosphate fertilizers. Determinations of U, Th, and the ratio $^{234}U/^{238}U$ are given for sediments of the Gulf and of Rivers. (CA)

Sackett, W. M., T. Mo, R. F. Spalding and M. E. Exner. 1973. A Revaluation of the Marine Geochemistry of Uranium. IN: Radioactive Contamination of the Marine Environment. IAEA-SM-158/51, pp. 757-769.

Approximately 10^{15} μg/yr of dissolved uranium are being removed from the ocean by each of the generally accepted signifcant sinks for uranium-carbonate deposits and deep anoxic basin sediments. However, these sinks account for only 10% of the estimated present-day input of uranium. Possible explanations for this discrepancy are: 1) contemporary input values are too high owing to a significant contribution from man's effects, or 2) there are other important uranium sinks such as the abundant siliceous oozes or continental shelf anoxic sediments. (auth)

Safronova, N. G. 1974. Kinetics of the Self-Purification of a Body of Water Containing Strontium-90 as a Result of Absorption of the Radionuclide by the Bottom Deposits. Sov. J. Ecol. 4:101-105.

A previously proposed diffusion model of the self-purification of natural water as a result of the absorption of ^{90}Sr by the bottom deposits agrees with the experimental data on the kinetics of the change in the concentration of ^{90}Sr in the water of an experimental lake. Together with the diffusion mechanism of self-purification, a factor of self-purification that can be considered within the framework of the model operates in the lake. Simple computational formulas for the dependence of the concentration of ^{90}Sr in the water on the time were obtained, permitting a long-range prognosis for the experimental lake. (NSA)

Saidl, J. 1962. The Disposal of High Specific Activity Wastes. II. Waste Fixation into Clay Minerals. Jaderna Energie. 8:314-18 (in Czech).

The use of clay minerals of Czechoslovak provenience for the fixation of radioactive cesium and strontium is discussed. A survey of research work is given. (auth)

Saiki, M., T. Koyanagi, Y. Ohmomo, and M. Ihikawa (et al.) 1971. Recent Waste Management Programme in Japan and the Studies on the Behavior of Radionuclides in the Marine Environment for Hazard Evaluation of Sea Waste Disposal. A/CONF. 49/P-850.

In order to cope with the rapid increase in the number of nuclear power stations to be expected in the near future in Japan, the establishment of a reprocessing plant for spent nuclear fuel has been planned with a target date for operation in 1973. Some of the low-level radioactive liquid wastes may be discharged into the sea. To clarify the various factors necessary for evaluating the hazard associated with the discharge of radioactive wastes into the sea, research was conducted on the following subjects: the behavior of radionuclides in the sea; sorption of radionuclides by marine sediments; investigation on biological concentration; and survey of the actual status of food consumption. The results of these investigations are introduced, together with a brief introduction of the recent status on the waste management program in Japan. (auth)

Sakanoue, M. 1960. Geochemical Studies on the Radioactive Sediments. II. Uranium Content of Natural Waters from the Ningyo-Pass Mining Area. Nippon Kagakii Zasshi. 81:896-8.

In order to find the amounts of U leached from the U-bearing sedimentary bed by the action of natural waters, U was determined paper chromatographically in water samples collected inside the drift of the Ningyo-Pass mine and from the rivulets and streams near the mine. Waters that have passed through the unoxidized zone tend to contain higher concentrations of U (80 and 250 γ/l.) than that passed through the oxidized zone (21-33 γ 1). This tendency was confirmed by a model experiment; 2 ore samples obtained from the two zones were treated with water of different pH values, and the supernatant liquids were analyzed for U. (CA)

Sakanoue, M. 1960. Geochemical Studies on the Radioactive Sediments. III. Uranium, Phosphorus, and Arsenic in the Sedimentary Bed at Ningyo Pass. Nippon Kagaku Zasshi. 81:898-902.

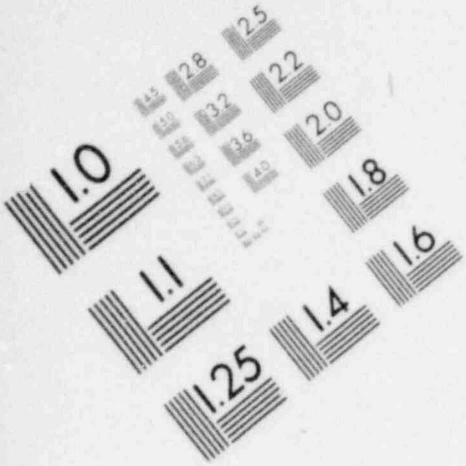
U, P, and As were determined in core samples taken from the unoxidized zone where ningyoite occurred, oxidized zone where autunite occurred, mixed zone, and shale beds containing fairly large amounts of U. Arsenic was determined by a modified Gutzeit method, and P by the molybdenum blue method after evolution of arsine. In the unoxidized zone correlation is highly positive between U and P, suggesting that the U in these sediments was deposited mainly as a compound whose composition corresponds to that of ningyoite, a $Ca^{++}U^{4+}$ phosphate mineral. In the unoxidized zone U also shows a positive correlation with As, and the presence of As-bearing pyrite (as high as 0.76% As) was confirmed. It is pointed out that pyrite is related to the deposition of U. (CA)

Sakanoue, M. and K. Komura. 1971. Anomalously High $^{234}U/^{238}U$ Ratio in a Natural Sample. Phys. Sci. 232:80-1.

Following the discovery of the radioactive disequilibrium of the $^{234}U/^{238}U$ anomaly has been shown to occur commonly in nature. This ratio is available for dating quaternary samples back to about one million years, because of the relatively long half life of ^{234}U (2.48×10^5 yr). The dating aspects and the geochemistry of the U and Ac series disequilibrium were studied, and some data are given for a maghemite sample collected in northeast Japan. The chemical and radiometric procedures are described in detail; an abnormally high $^{234}U/^{238}U$ ratio of about 15 was found. An abnormality was also found in the ^{230}Th activity, which was about nine times larger than the equilibrium value with the parent ^{234}U. The history of the sample is discussed and mechanisms are suggested for the ^{234}U enrichment. (NSA)

Sakanoue, M., M. Nakaura, and T. Imai. 1971. Determination of Plutonium in Environmental Samples. IAEA-SM-148/54, pp. 171-181.

Instead of the time-consuming method using ion-exchange resins separation, a simple solvent extraction method for determining plutonium in environmental samples has been developed and applied for various samples, for example, soil from the Nagasaki area subjected to the first plutonium atomic bomb explosion in 1945, corals from the east Pacific Ocean coast, and seawater from the Pacific Ocean. As yield tracer, the alpha emitter Pu 236 (5.75 MeV) was first spiked into the sample, and the sample solution was prepared



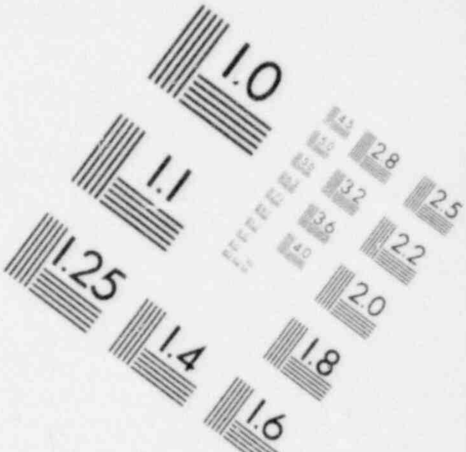
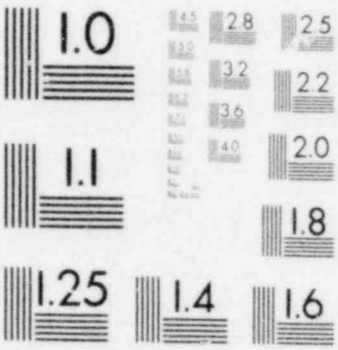
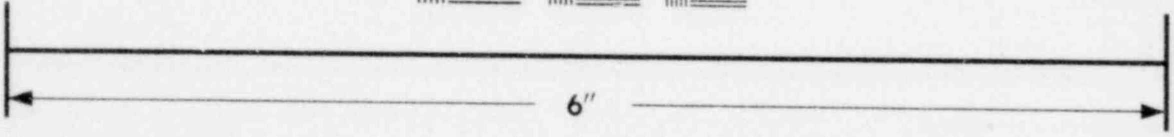
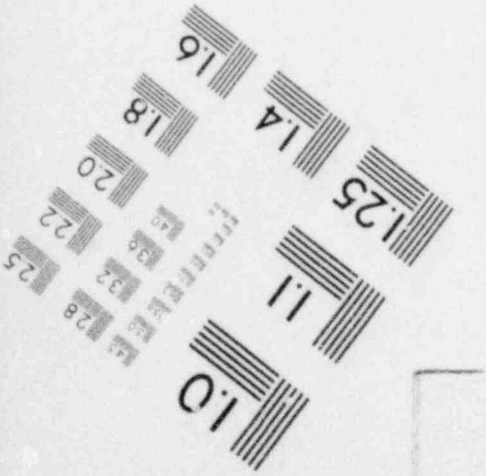


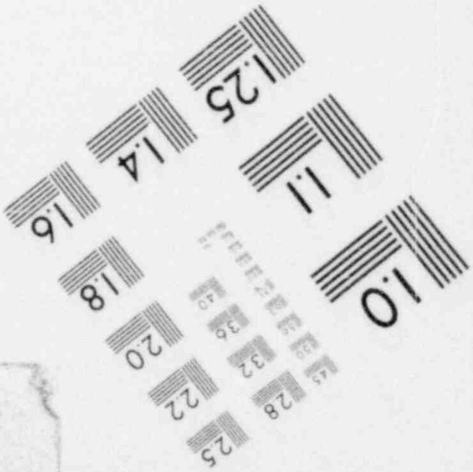
IMAGE EVALUATION TEST TARGET (MT-3)





MICROCOPY RESOLUTION TEST CHART





in 8M nitric solution either by direct leaching of the sample with nitric acid or by dissolving the ferric hydroxide precipitate made from the acidic solution of solid samples or natural water. Solvent extraction with trioxtylamine was applied to this aqueous solution and followed by the scrubbing of uranium and thorium with 8M HNO_3 and 10M HCl, respectively. Finally plutonium was stripped with 8M HCl + 0.2M HF, and determined by alpha spectrometry using a counting source prepared by electrode position on either a stainless steel plate or nickel foil. In addition to a gross alpha-track counting on cellulose nitrate, the very sensitive fission track method was also examined for determining Pu 239 and the evaluation of the interference from the contaminating uranium was studied. Contamination of the natural environment with plutonium isotopes was found in various samples and the contents of each isotope were determined. (auth)

Sakanoue, M. and T. Tsuji. 1971. Plutonium Content of Soil at Nagasaki. Nature. 234:92-93.

Determination of the plutonium content of the soil at Nagasaki, Japan, was made 24 years after the detonation of the atomic bomb. Samples were taken from less disturbed surfaces of the ground, and assays were made for Pu 238, P 239, and Sr 90. Powdered dry soil samples were treated with 8M nitric acid after adding Pu 236 tracer. Ferric hydroxide coprecipitation was then indiced from this sample solution in the presence of carbonate ions, and dissolved in 8M nitric acid and extraction of the solvent with tricylamine. The plutonium content was ten times higher at the Nishiyama location than at other areas tested although the strontium level was comparable. Results indicate that plutonium contaminants in soil are not easily removed naturally. (auth)

Sakanoue, M., S. Yoneda, K. Onishi, K. Koyama, K. Komura and T. Nakanishi. 1968. α-Radioactive Nuclides of Uranium, Protactinium, and Thorium in Uranium Deposits. Geochim. J. (Nagoya). 2:71-86.

Radiochemistry separations were made on many samples, and determinations by α-spectrometry were made of ^{238}U, ^{234}U, ^{231}Pa, ^{232}Th, and ^{230}Th. Analyses of ore samples from the Ningyo-Toge Mine, Okayama, had isotopic ratios indicating extensive preferential leaching of U. A Mu nodule (Mn 20.1% from a montmorillonite bed, Katama district, was enriched in both Ra and Pa. Secondary U minerals from the Tono district, Gifu, gave ages of about 5,000 and 34,000 years. U in phosphorite from Oyaemondani, Noto district, was apparently not syngenetic with the phosphate, but was introduced into it later. (CA)

Sallach, R. A. 1967. Model for Estimating the Distribution of Cations in Multicomponent Ion Exchange Reactions. SC-RR-67-861.

The model developed by Langmuir for the adsorption of gases on solids was adapted and applied to cation-exchange phenomena. The relationship between the amount exchanged on the surface and its concentration in solution is expressed in terms of mass-action-type equilibrium constants. After considering all possible exchange reactions and their mutual effects, an analytic expression was deduced describing the experimentally defined distribution coefficient in terms of the equilibrium constants and concentrations of the various cations, and of the cation-exchange capacity of the mineral. Good qualitative agreement with experimental results was found for those minerals in which exchange is truly a surface phenomenon. Quantitative comparisons are difficult because a reference ion common to all experiments is lacking. (auth)

Salmon, L. 1962. The Caesium-137 Content of Soil in the United Kingdom--1960. AERE-R-4018.

The amount of Cs^{137} deposited on the soil in the U.K. was determined from measurements of soil samples by gamma-ray spectrometry. The relation between Cs^{137} in soil and rainfall was examined, good correlation being found with results from other workers. An estimate of the external dose rate from Cs^{137} was also made. At the end of 1960, the amount of Cs^{137} deposited in any locality was approximately proportional to mean annual rainfall (1 mC/km^2/inch) and the external dose rate in a region of high rainfall (123 inches per year) was 1.1 μr/hr. An estimate of the amount of dry deposition is uncertain but it is unlikely to have exceeded 8 mC/km^2 anywhere as compared with the observed average deposit of 44 mC/km^2. (auth)

Salo, A. and R. Saxen. 1974. Role of Humic Substances in the Transport of Radionuclides. SFL-A-20.

The present study was undertaken in order to elucidate the possible role of humic substances in the transport of radionuclides in water. The first task was to find suitable methods to characterize humic substances from different sources and to find analytical methods sensitive enough for the determination of metals bound to humic substances of different molecular size groups. From the methodological point of view the use of the Pt standard as a measure of the humus concentration is discussed, as are the fractionation of humic substances into different molecular size groups, the atomic absorption and X-ray fluorescence methods to determine the stable elements bound to these fractions, and the use of radionuclides as tracers for organic bound metals. The molecular size distribution of humic substances in some surface water samples and samples from Bothnian Bay, Finland, and the use of distribution coefficients (K_d) to characterize water samples containing humic substances were studied by gel chromatography. The effect of salinity on distribution coefficients, the seasonal variation of the K_d values, and the distribution of iron, manganese, zinc, copper, strontium, and cesium into different molecular size groups of the humic substances are discussed. (auth)

Salo, A. and A. Voipio. 1973. Transport of Radionuclides in Lake and River Systems Flowing Through Areas Characterized by Precambrian Bedrock and Peat-Bogs. IN: Radioactive Contamination of the Marine Environment. IAEA, Vienna. pp. 195-217.

Strontium-90 and cesium-137 were determined together with the discharge (m^3/s) and the following stable chemical components: conductivity, pH, color, turbidity, HCO_3^-, PO_4-P, total-P, NO_3-N, NH_3-N, total-N, SiO_3-Si, SO_4-S, chloride, iron, aluminium, manganese, copper, zinc, sodium, potassium, magnesium, and calcium in two lake and river systems discharging into the Bothnian Bay (Baltic Sea) in 1965 to 1970. The water samples were taken monthly at one sampling station in the smaller (1330 km^2) and at five stations in the larger (14,315 km^2) lake and river system. Deposition was collected at three stations. The ratio was calculated of the deposited amounts to the amounts that are transported concerning the above-mentioned radionuclides nd some stable components in both the catchment areas and the sub-regions of the lake and river systems. A factor analysis was used in an attempt to find the main factors affecting the behavior of the different chemical components, especially that of the radionuclides strontium-90 and cesium-137. When interpreting the results of the factor analysis, the chemical factors, the quality of the ground, hydrological features, and other possible environmental factors were taken into consideration. The regional differences are discussed. Special attention was paid to the annual changes in the factors affecting the behavior of strontium-90 and cesium-137. The most obvious factors determining the systems are those determining the behavior of the main electrolytes (Mg^{2+}, Na^+, K^+, Ca^{2+}, SiO_3-Si, HCO_3^-, Cl^-). All these components have good correlations to the discharge (contact time with the ground?). The factor common to those variables showed annual variations in their deposition in the catchment areas of strontium-90. A group of factors reflecting the quality of the soil, eventually characterized by the organic (younger) and inorganic (older) constituents of the soil also showed an effect. (auth)

Sappok, M. 1973. Concentration of Radon 222. Its Short-Lived Daughter Products and Some Other Atmospheric Spurious Materials in the Ground Stratum and in the Lower Troposphere. Thesis. University of Heidelberg (in German).

A report is given on the activity concentration of radon 222 and its short-lived daughter products in the first 3,000 m of the atmosphere. An apparatus has been developed which enables the simultaneous determination of the activity of radon 222, polonium 218, lead 214, and of bismuth 214 during a measuring period of 30 minutes. The determination of radon takes place by adsorption on active coal at -78°C, desorption at +450°C and counting of the decays in a scintillation chamber, while the daughter products are determined by collecting on filters and discrimination between α- and β- radiation as well as delayed coincidence between bismuth 214 and polonium 214. (NSA)

Sarma, T. P. 1964. Dating of Marine Sediments by Ionium and Protatinum Methods. NYO-8925.

It is the objective of this investigation to find reliable methods for dating marine sediments based on non-equilibrium secondary natural radioactivity, and to apply these dating methods to determine the times at which geologically significant events in the past have taken place. Radiochemical procedures are developed to isolate thorium, protactinium and uranium from sedimentary materials following complete decomposition of the samples with HF plus H_2SO_4. ^{238}U, ^{228}Th, and ^{233}Pa are used as tracers for the chemical yields of uranium, thorium, and protactinium, respectively. The thorium and uranium samples were counted by surface-barrier solid-state alpha detectors. The ^{231}Pa activities were measured in a Frisch-grid ionization chamber. Multichannel pulse analyzer is used with both detectors. The absolute specific activities of ^{238}U, ^{234}U, ^{232}Th, ^{230}Th, and ^{231}Pa were determined in various sections of four different areas from the Pacific, Atlantic, and Indian Oceans. The ^{230}U and ^{234}U specific activities observed ranged from 0.6 to 2.3 dpm g^{-1}, whereas the ^{232}Th specific activities showed greater variations, of the order of 0.08 to 4 dpm g^{-1}. The ^{235}U/^{238}U activity ratios are close to unity within the experimental uncertainty of about 5-10%. The variations in the ^{230}Th specific activities are considerable and they fluctuate between 0.6 and 55 dpm g^{-1}, depending on the location of the core and the depth at which the sample was taken. The ^{231}Pa specific activities are lower than those of ^{232}Pa by a factor of about 10 in the top layers of the sediments, and by a factor of about 20 in the deep sections of the core. The excess ^{230}Th specific activities are calculated subtracting the ^{234}U specific activities from the total ^{230}Th specific activities in the same sections of the core. Similarly, the excess ^{231}Pa specific activities are gained by subtacting the ^{235}U specific activities (0.046 times the ^{238}U specific activities) from the ^{231}Pa specific activities. In three of the cores analyzed, the excess ^{230}Th and ^{231}Pa specific activities decreased fairly steadily and nearly exponentially, especially below about 20 to 30 cm. From the slope of the semi-log plot of specific activity vs depth, the mean sedimentation rate at each location was calculated. In the Pacific core (Scripps MSN-2G), an average age sedimentation rate of 0.86 x 10^{-4} cm year^{-1} was obtained, whereas in the Indian Ocean core (Goteborg SDSE-137) the value of 3.3 x 10^{-4} cm $year^{-1}$ was obtained. In the Mid-Atlantic core (Lamont V16-21), the average rate was about 3.7 10^{-4} cm $year^{-1}$ which is unexpectedly small for an Atlantic core. In the North Atlantic core (Lamont A179-15), a deficiency of ^{230}Th and ^{234}U is present in some sections of the column. A geochemical model is constructed to calculate the ^{230}Th and ^{231}Pa specific activities in freshly deposited sediments, and thereby ascertain under what circumstances one can expect excesses and deficiencies of ^{230}Th with respect to ^{234}U and of ^{231}Pa with respect to ^{235}U. The ^{230}Th and ^{231}Pa deficiencies can be explained by high sedimentation rates of biogenic calcite, exceeding about 8 x 10^{-3} cm $year^{-1}$. Because of the complications due to several components always present in sediments, it is evident that complete dissolution rather than partial leaching is necessary to obtain meaningful specific activities of the various radionuclides. Theoretical calculations were made to account for the diffusion-like mixing by sub-surface organisms, underwater currents, or both. The effect of this pseudo-diffusion on the depth distribution has been calculated for ^{14}C, ^{231}Pa, and ^{230}Th activities, and for the $^{231}Pa/^{230}Th$ ratio. Of the four indices which might be used for dating sediments, 1) excess ^{230}Th specific activity, 2) ^{232}Th-normalized excess ^{230}activity, 3) excess ^{231}Pa specific activity, 4) excess ^{231}Pa/excess ^{230}Th activity ratio, the first seems to be of greatest utility for determining ages and sedimentation rates. The second quantity fluctuates as a result of rather large ^{232}Th variations. The last two indices are less precise and their applicability is limited to about 200,000 years; besides, they are more affected by pseudo-diffusion. ^{14}C is affected even more by pseudodiffusion, leading to erroneously high previous estimates of sedimentation rates. For reliable ^{14}C dating, one must determine the activity of many points and also correct for pseudodiffusion. The ^{230}Th measurements are good for this. The ^{231}Pa excess and $^{231}Pa/^{230}Th$ ratio can also help to indicate the conditions of deposition. The core V16-21 is one of eight cores in which the Pliocene-Pleistocene boundary is believed to be present, according to Ericson, Ewing and Wollin (1963). The boundary is at a depth of close to 165 cm in this locality. According to the ionium measurements made on this core, the apparent age of the boundary is close to (503 ± 20) x 10^3 year.

A more probable age, $(525 \pm 20) \times 10^3$ year, results from making a correction for assumed and indicated mixing in the top layers. The ages of the uppermost sections of the core V16-21 calculated from the decay of excess ^{231}Pa and the excess ^{231}Pa/excess ^{230}Th ratio are in good agreement with the excess ^{230}Th ages. The dating of the Ericson-Ewing-Wollin boundary is the first time a geologically significant event has been dated by the ^{230}Th dating method, although it cannot be considered definitely established on the basis of this single core that this event is actually the beginning of the Pleistocene epoch. 500,000 years is about the practical dating limit of the ^{230}Th method for such sediments, but in favorable cases (such as deep Pacific cores, this might be extended to 600,000 or 700,000 years. For longer times a method based on the growth of the spontaneous fission product ^{129}I might be useful. (auth)

Sasscer, D. S., C. F. Jordan, and J. R. Kline. 1971. Mathematical Model of Tritiated and Stable Water Movement in an Old-Field Ecosystem. IN: Radionuclides in Ecosystems. CONF-710501-P1, pp. 915-923.

Water and tritium movement in an old-field ecosystem was simulated by means of a kinetic equation model utilizing data obtained from field measurements of stable and/or tritiated water.

The ecosystem was assumed to consist of 49 layers of 1-cm-thick soil and one plant compartment. The water content of the soil and plants was described by a system of 50 simultaneous, first-order, linear, differential equations with discontinuous, variable coefficients. The coefficients were assumed to be functions of the evapotranspiration, soil-water diffusion, gravity flow of soil water, and the previous 48-hr history of rainfall. A solution for the water content in each compartment as a function of time was arrived at by obtaining successive solutions of the system of differential equations for arbitrarily small periods of time during which the coefficients were assumed to be constant.

A pulse of tritium deposited on or near the surface in the spring of the year is predicted to move downward in the soil to a depth of approximately 30 cm and remain there throughout the summer. Rainfall and transpiration rates were found to have a greater effect on water concentration in the soil than diffusion.

The predictions made by the model are validated by Jordan et al. (this symposium) by comparison to experimentally determined data. (auth)

Savannah River Laboratory. 1967. Excerpts from SRL Monthly Reports on Waste Management. TID-26517.

Miscellaneous data on environmental radiation monitoring near waste storage areas at the Savannah River Plant are presented. Information is included on: soil and water contamination at the waste storage site; ^{137}Cs content in waters and sediments of the Savannah River and Four Mile Creek as the result of a high-level liquid waste spill; and the contamination problems which resulted from the railway shipment of irradiated electrical cables from hot cells to a burial ground. (NSA)

Savannah River Laboratory. 1972. Distribution and Cycling of Radioactive Isotopes Released into the Savannah River Swamp Forest: Environmental Implications. Progress Report, November 1, 1971--August 1, 1972. SRO-708-1.

The distribution and cycling of radioisotopes released into the Savannah River swamp forest are being studied by reviewing literature on the subject, sampling the soil and vegetation of the area, measuring the ^{137}Cs content of these samples, and finally, determining the body burden of ^{137}Cs in biological specimens. Progress in each of these areas is reported. Data are presented on the animal, amphibian, bird, dragonfly, fish, plant, and reptile species of the area and the ^{137}Cs content or distribution in soils, plants, sagittaria roots, cotton rats, and snakes. (NSA)

Savannah River Laboratory. 1975. Savannah River Laboratory Quarterly Report. Waste Management. April-June, 1975. DPST-75-125-2.

Tests showed that dry (ground-surface) soil effectively sorbs and immobilizes small volumes of postulated leaking solvent-complexed plutonium, but moist (subsurface) soil would permit extensive migration of postulated large volumes.

Sawhney, B. L. 1964. Sorption and Fixation of Microquantities of Cesium by Clay Minerals: Effect of Saturating Cations. Soil Sci. Soc. Am. Proc. 28:183-186.

Sorption and fixation of microquanties of Cs by six minerals, as affected by the saturating cations, were studied. Micas and vermiculite sorbed more Cs in the presence of Ca and similar divalent cations than in the presence of K and similar monovalent cations. Montmorillonite and kaolinite, on the other hand, sorbed more Cs in the presence of K than in the presence of Ca. While micas and vermiculite fixed large proportion of the Cs sorbed, montmorillonite and kaolinite did not fix significant amounts of Cs against replacement by neutral salts. Thus, whereas Cs-sorption by montmorillonite and kaolinite appeared to be largely electrostatic, the sorption and fixation of Cs by micas and vermiculite was governed by the size and hydration, rather than valence, of the competing cation. Micas particularly exhibited a large fixation of Cs. It is suggested that the fixation of Cs by micas occurs at the crystal edges where Cs may replace K and thus become a part of the stable mica structure. (auth)

Sawhney, B. L. 1966. Kinetics of Cesium Sorption by Clay Minerals. Soil Sci. Soc. Amer. Proc. 30:565-9.

Time course and the processes in the sorption of ^{137}Cs from dilute solutions by illite, montmorillonite, and vermiculite saturated with Ca or K and in the absence of excess saturating cation were investigated. Cesium sorbed by illite and montmorillonite quickly reached an approximate equilibrium: the ^{137}Cs sorbed by montmorillonite did not change with time while the ^{137}Cs sorbed by illite changed only slightly. On the other hand, the ^{137}Cs sorbed by vermiculite did not reach an equilibrium even after 500 hr. Cesium sorbed by Ca-vermiculite continued to increase while the ^{137}Cs sorbed by K-vermiculite decreased. Since the sorption of ^{137}Cs by illite is limited to the external planar surfaces and interlattice edges only, equilibrium is quickly reached. Equilibrium in montmorillonite is attributed to its expanded lattice which makes all exchange sites equally available and permits exchange readily. The increased ^{137}Cs sorption by Ca-vermiculite, on the other hand, is attributed to the different sorption rates by different exchange sites: initial fast sorption on external surfaces and edges followed by slow diffusion into the interlayers. The decreased ^{137}Cs by K-vermiculite is perhaps associated with the collapse of the partially hydrated vermiculite in suspension to 10 Å. (NSA)

Sawhney, B. L. 1968. Fixation of ^{137}Cs by Soil Clays. Progress Report, 1962-1968. NYO-2955-15.

The sorption and fixation of Cs by different minerals in soil clays wrre established. In addition, it was demonstrated that in the absence of Al-interlayers, the sorption of Cs by soil clays was governed by the dominant clay mineral. Studies were also made on the time course of the sorption of Cs by illite, montmorillonite, and vermiculite saturated with Ca or K. Investigations on Cs sorption by biotite and vermiculite mixtures and the manner in which Cs collapsed vermiculite interlayers showed that the greater the amount of vermiculite, the greater was the Cs sorbed. Thus, the contention that the selective sorption of Cs was associated with a 10Å spacing was found to be incorrect. Also, the selective sorption of illite and other weathered micas was found to be associated with their frayed edges rather than the 10Å spacing. (NSA)

Sax, N. I., J. J. Gabay, D. Revinson, and B. Keisch. 1954. Analysis for Long-Lived Products in Soil. NYO-4604.

Results are reported from an analysis for long-lived fission products in a sample of Marshall Islands soil contaminated by heavy fall-out following the March 1, 1954, nuclear tests. An attempt was made to account for the total activity of the sample. Chemical procedures for the separation of the Sr, Ru, rare earth, and Zr groups are given in an appendix. (NSA)

Saxena, S. K., F. T. Lindstrom and L. Boersma. 1974. Experimental Evaluation of Chemical Transport in Water Saturated Porous Media 1. Non Sorbing Media. Soil Science. 118:120-126.

Dispersion profiles of 2,4-dichlorophenoxyacetic acid were measured experimentally to evaluate a theoretical dispersion model previously developed by the investigators and to evaluate the effect of pore size on dispersion. The chemical being dispersed along a column made up of glass beads was initially present only in the pore water of a 1 cm long section at the front of the column. After leaching for a period of time, the column was sectioned and the concentration in each section was obtained and compared with a predicted concentration.

Four porous media systems consisting of glass beads with particle diameters of <30, 28-53, 105-149, and 149-210 μm obtained by dry sieving were used. Corresponding predominant pore radii were 4.5, 8.2, 19.5, and 36.2 μm. The corresponding dispersion coefficients were found to be 0.53, 0.69, 1.41, and 2.05 cm^2/day, respectively. Using these values, theoretical dispersion profiles were calculated. The theoretical distributions of the chemical in the columns were found to be in good agreement with the experimentally determined distributions. The values of the dispersion coefficients were in agreement with values reported in the literature and could be related to pore size, diffusion coefficient, and flow rate. (auth)

Saxena, S. K., F. T. Lindstrom and L. Boersma. 1974. Experimental Evaluation of Chemical Transport in Water-Saturated Porous Media: 2. Sorbing Media. Soil Science. 118:238-242.

Dispersion profiles of 2,4-dichlorophenoxyacetic acid in sorbing porous media were measured experimentally to evaluate a theoretical dispersion model previously developed by the investigators. The chemical being dispersed along a column made up of glass beads was initially present only in the pore water of a 1 cm long section at the front of the column. After leaching for a period of time the column was sectioned and the concentration in each section was obtained and compared with a predicted concentration.

Four porous media systems consisting of glass beads with particle diameters of <30, 28-53, 105-149, and 149-210 μm obtained by dry sieving were used. Corresponding predominant pore radii were 4.5, 8.2, 19.5, and 36.2 μm. Sorption sites were established on the glass beads by coating them with an ion exchange resin.

Experimental results were in good agreement with theoretical predictions. (auth)

Scargill, D. and C. E. Lyon. 1963. The Estimation by Paper Chromatography of Nitro- and Nitrato-Complexes of Nitrosylruthenium in Process Solutions. AERE-R-4292.

The parameters affecting the separation of nitrosylruthenium nitrato- and nitro-complexes by paper chromatography have been studied, and a comparatively labile species is postulated to account for some anomalous behaviour. The former paper chromatographic method for the estimation of the proportions of nitro- and nitrato-complexes has been found to be sensitive to the precise conditions used. For process solutions containing uranyl nitrate, a modified procedure is given which uses the results from elution with dibutyl cellosolve. This method indicates a higher proportion of nitro-complexes in process solutions than was found previously. (auth)

Schales, F., R. Keil, and T. Franke. 1973. Sources of Terrestrial Radiation. Natural Radionuclides in the Soil. IN: Symposium on Natural Radiation Exposure of Man: Basis for Judging the Radiation Risk. Frankfurt am Main, Germany (in German).

Reviewed are the discovery, the origin, and significance of the soil's natural radioactivity and radionuclides, respectively, followed by a table of the most important long-lived radionuclides of the soil along with their modes of decay, their half-life periods and average concentration in soil. Because of the short range of α and β radiation in soil, air, and tissue, only the gamma-emitting radionuclides are of biophysical relevance, particularly the most frequent nuclides of the $^{238}U/^{226}Ra$ and ^{232}Th radioactive decay series, along with ^{40}K. A table is presented of the soil's most important natural gamma-emitting nuclides, their main spectral lines, and decay coefficients. The biologically significant total gamma dose rates above various geological formations are compared to each other. The percentage of ^{226}Ra, ^{232}Th, and ^{40}K in several kinds of stone is compiled, along with the concentrations of ^{222}Rn, ^{220}Rn, and ^{219}Rn as a function of the depth in soil. The dependence of the isotope exhalation on porosity and humidity of the soil, on pressure and humidity of the air, on soil and air temperature, and on direction and velocity of the wind is reviewed. An extensive bibliography is given, dating up to 1965. (NSA)

Scharpenseel, H. W. 1972. Measurement of Natural ^{14}C Concentrations in the Organic Matter Soils. Intermediary Summarising Report. Z. Pflanzenernaehr. Bodenk. 133:241-263 (in German).

Radiocarbon dating of soil based on charcoal in autochthonous position produces the true age (TA) of soil formation; humus-C in recent profiles reveals the apparent mean residence time (AMRT), buried humus-C in fossil soils shows the AMRT of the sample-C till the event of burial plus the time lapsed since then. Among a greater number of natural radiocarbon measurements on soil samples, all profiles from Spodosols, Udalfs, Udolls, Plaggepts, and Vertisols are subjected to correlation analysis with regard to the AMRT profile depth interdependence. Comparison of methods, used for pretreatment of soil samples prior to benzene synthesis and C^{14} counting procedure, motivates the use of the method. Only the clay-humus is decanted from a soil suspension and its carbon is enriched by a centrifugal method. Measurements of the AMRT of the humus-C in soils within the rooted zone, and comparison with C^{14} dates of the same soil material, but under enough cover to be outside the rooted zone, further with estimates by other dating procedures, give a first hint regarding the extent of rejuvenation of some carbon samples, derived from recent soil profiles within the rooted zone. More parallel measurements on humus-C and charcoal-C originating from the same soil horizons, are of key importance for adequate informaton about the extent of rejuvenation in recent soils. Besides limited potentialities in pedochronology, natural radiocarbon measurements find a domaine in pedogenetic and soil systematic, further humus-kinetic questions. Their value for soil organic matter transformation and carbon cycle studies is evident. Some examples are presented. (auth)

Scharpenseel, H. W. and W. Kerpen. 1967. Studies on Tagged Clay Migration Due to Water Movement. <u>IN</u>: Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. IAEA, Vienna. pp. 279-87.

^{55}Fe-tagged clay minerals, produced by hydrothermal synthesis, serve to clarify the question whether clay migration or clay formation in situ is the predominating mechanism in the B_t-development of Parabraunerde (sol brun lessivé, grey brown podsolic, hapludalf, dernopodsol). They further indicate the possibilities of clay transportation caused by water percolation. Suitable experimental approaches, such as thin-layer chromatography and autoradiography, translocation tests in columns filled with monotypical textural fractions or with undisturbed soil profiles, and synchronous hydrothermal treatment of ^{55}Fe-containing material from different horizons of Parabraunerde, to reveal the specific readiness of the different profile zones for ^{55}Fe-clay production, are described. The possibilities of clay percolation are discussed. (auth)

Schell, W. R. 1974. Sedimentation Rates and Mean Residence Times of Stable Pb and ^{210}Pb in Lake Washington, Puget Sound Estuaries, and a Coastal Region. RLO-2225-T14-6.

Core and water samples from Lake Washington and the marine environment of Puget Sound were analyzed for ^{210}Pb and Pb. A systematic evaluation of geochemical processes was made by measuring the sedimentation rates, the density, and the water concentration to evaluate the atmospheric and water contributions of ^{210}Pb and Pb to sediments. The mean residence time was evaluated in the several systems. In Lake Washington the mean residence time of Pb and ^{210}Pb was 70 to 80 days; in the dynamic system of Bellingham Bay the mean residence time was 10 days; in the coastal station the mean residence time was 75 days; at the mouth of the Frazer River the mean residence time was estimated at 80 to 113 days. The sediments reflect the total input from aeolean and pluvial sources. In Lake Washington, the time history is shown by the three sedimentation rates measured: 0.58 mm/year before 1870, 4.5 mm/yr between 1890 to 1916, and 3.1 mm between 1916 and 1972. The stable lead concentrations in the sediments give information on the anthropogenic input to Lake Washington which correlates well with the time history determined by sediment dating. (auth)

Schell, W. R. and R. L. Walters. 1975. Plutonium in Aqueous Systems. Health Physics. 29:589-597.

A review was made of the available information concerning Pu in the aquatic environment. The levels are low and the data on the environmental concentrations in lake and marine environments are very limited. Of particular relevance to biological accumulation processes is the physical-chemical state of Pu. Limited information is available in natural environmental waters. Indications are that the plankton has the highest concentration factors and that the concentration factors decrease with increasing complexity of the organisms. Results of recent studies of ^{239}Pu, ^{240}Pu, and ^{241}Am concentrations in water, sediment, and biota at Bikini and Eniwetok Atolls are given. The water samples measured indicate that Pu exists in the particulate, soluble and colloidal physical-chemical states. The plutonium is being injected into the water column from the sediments and has not been removed from the biogeochemical cycle after 16 years. Concentrations of Pu in vertebrates and invertebrates measured at Eniwetok were low and ranged from .001 to .2 pCi/g wet in fish muscle. Additional data are required to better evaluate the potential hazards to man of Pu in the aquatic environment. A computer program was developed to estimate the final forms of soluble Pu in natural waters under certain conditions of acidity, oxidation potential, and complexing factors. (NSA)

Schilling, G. and D. Richter. 1964. On the Content of ^{90}Sr and ^{90}Y in Soil in Central Germany. Albrecht-Thaer-Arch. 8:107-25 (in German).

Solutions of carrier-free mixtures of $^{90}SrCl_2$ and $^{90}YCl_3$ were added to soils and to model substances (ferric hydroxide, $Al(OH)_3$, quartz sand, silicic acid, kaolin, and bentonite) to study the binding of the two radionuclides to soil constituents on the basis of their extractability. The various soils and the model substances tested adsorbed ^{90}Sr and ^{90}Y to an extent whereby it was almost impossible to extract them with distilled water at neutral pH. Adsorbed ^{90}Y could only be displaced by saline solutions in the acid range, and only up to pH 5.0. It was tightly bound to the carrier as a colloid and could not be exchanged if the pH value was higher than 5. In contrast to ^{90}Y, ^{90}Sr was found to be exchangeable in all experiments performed, but was slightly more difficult to displace with cations than calcium. Oat plants absorbed ^{90}Sr and Ca in the ratio to be expected from these interchangeability differences. Wash-out experiments that were performed in soil in situ indicated that the depths to which ^{90}Sr penetrates into the soil and the extent to which it is washed out depend on the exchange capacity of the soil and on the electrolyte content of the soil solution. The results are discussed in relation to radioactive fallout contamination of soil. (NSA)

Schmalz, B. L. (comp.) 1972. Radionuclide Distribution in Soil Mantle of the Lithosphere as a Consequence of Waste Disposal at the National Reactor Testing Station. IDO-10049.

A study of the distribution of radionuclides in the soil resulting from disposal of liquid and solid waste at the National Reactor Testing Station (NRTS) is reported. The situation involving liquid waste was appraised by mathematical models using parameter determined in the laboratory; physical models using soil samples and simulated waste solution; and sampling of soil and water where waste is being discharged. In the case of ^{90}Sr, the data obtained indicate that the sorption capacity of the alluvial deposits between the disposal pond bottoms and the basalt bedrock has been reached. The data for cesium were erratic but the most pessimistic interpretation indicates that the capacity of the alluvium has not been reached. The amount of ^{60}Co estimated to be in the alluvium is greater than that reported to have been discharged. The discharge estimates do not take into account the more frequent usage of unsheathed cobalt wires for neutron flux measurements during the early history of the reactors. ^{60}Co retention in the soil is attributed to reactions other than ion-exchange. A theoretical appraisal of the migration of radionuclides at the burial ground indicates that the potential hazard is small under well-drained circumstances. Leaching of waste and the migration of some fission products as well as plutonium isotopes and daughter products is shown to have occurred to a very limited extent. This is inferred to have resulted from inundation of waste as a result of poor drainage of snow-melt runoff. The concentrations and distances are small and are not interpreted as a cause of concern in regard to insulting the regional aquifer system. A hypothetical evaluation is included of the environmental problems remaining after active operation of a disposal site has been discontinued. It is concluded that disposal sites can be used for other purposes with certain restrictions. (auth)

Schmalz, B. L. and W. S. Keys. 1963. Retention and Migration of Radioactive Isotopes in the Lithosphere at the National Reactor Testing Station-Idaho. Colloq. Intern. Retention Migration Ions Radioactifs. Sols. Saclay. pp. 243-56.

Aqueous liquids containing mixed fission and activation products in a concentraton of the order of 10^3 µC/ml, plus tritium in a concentration of 10^3 µC/ml, are routinely discharged to ponds excavated in the alluvial regolith. Migration of radioisotopes through the regolith and basalt is delineated by samples from drill holes. The water and isotopes have been detected in the regolith at distances of 150 meters from the MTR-ETR disposal pond. The waste has been detected in perched water in the basalt at distance up to 1.5 kilometers. Migrating isotopes that have been identified are; tritium, chromium-51, cobalt-60, iodine-131, cerium-144, ruthenium-106, silver-110. Tritium, chromium-51, and cobalt-60 have been observed to be particularly migratory. The migration of cobalt-60 and cesium-137 has also been observed at other plant areas. The concentration of tritium diminishes with distance from the disposal pond. Because disposal is to the zone of aeration this cannot be explained on the basis of dilution. Ion exchange has been substantiated by laboratory studies. Columns filled with natural earth materials have shown that significant attenuation of tritium does occur despite relatively small column capacities. Migration of contaminated ground water resulting from disposal of waste at the NRTS is most extensively mapped on the basis of tritium analyses. Concentrations of 10^6 tritium units (T.U.) have been discovered at distances of 210 meters from a disposal well. Attenuation of the concentration to 1,200 T.U. at distances of 5 kilometers from the disposal point is observed. Attempts to trace contamination in ground water beyond 400 meters on the basis of isotopes other than tritium have been unsuccessful. Chemically contaminated wastes have also been traced to a distance of 5 kilometers. (auth)

Schmalz, B. and W. L. Polzer. 1969. Tritiated Water Distribution in Unsaturated Soil. Soil Science. 108:43-7.

On the basis of tritium concentration measurements in soil water, it was concluded that approximately 3.5% of the tritium which occurred at the Southeastern Idaho location during a 15-year period remained in the top 200 centimeters of the soil profile while the rest was lost by evaporation or transpiration. The observed distribution compared with that calculated by a mathematical model based on diffusivity and convective processes. Diffusivity values acceptable by the model varied within a range of 0.9×10^{-6} to 9×10^{-6} cm^2/sec. Acceptable values for velocity varied within a smaller range of 8 to 10.4 cm per three-month period. (auth)

Schmidt-Collerus, J. J. 1969. Research in Uranium Geochemistry. Investigation of the Relationship between Organic Matter and Uranium Deposits. Part II. Experimental Investigations. Final Report. GJO-933-2.

The feasibility of the micropyrolysis-gas chromatography-mass spectrometry (MPGM) method for the characterization of the organic matter associated with uranium in fluviatile ore deposits was investigated. The role of biogenically generated hydrogen sulfide in the reduction and precipitation of uranium in particular in the roll-type deposits was also investigated. It was found that the MPGM method, applied successfully to the characterization ("fingerprinting") of various intractable natural bioliths, can equally well be applied to the characterization of the organic matter in uranium ore deposits and to the study of the nature of this association. The enrichment of uranium in the roll-type deposits appears to be associated principally with the organic matter present and caused by specific ligating moieties in it, the role of hydrogen sulfide is probably of a secondary nature. Nonetheless, if hydrogen sulfide was synergistically involved in the reduction and precipitation of uranium together with the organic matter it is more likely that its origin was mainly biogenic in nature because of the facile availability of organic matter as energy source for the H_2S producing microorganisms. This mechanism for the H_2S production appears also the less complicated one than that assumed for the inorganic mechanisms, involving oxidation of sulfides to sulfites and disproportionation of the latter to form H_2S and sulfates -- although the possible simultaneous partial formation by the latter reaction mechanism cannot be excluded. (NSA)

Schneider, H. 1970. To the Question of the Loading Capacity of the Rhine for Radioactive Nuclides. 6. Sorption of Radionuclides on Selected Minerals. Gas-Wasserfach, Wasser-Abwasser. III:21-6 (in German).

The sorptive properties of artificial mono-mineralic fine sands of uniform grain size is investigated. Montmorillonite, kaolinite, muscovite, and biotite have a high sorptive power. The sorptive power of quartz oxides and magnetite and of microcline and albite is low. Hornblende and augite occupy a medium position. The highest affinity for the minerals show the cations ^{137}Cs, ^{90}Sr, and ^{65}Zn. Phosphorus-32, as complex phosphate anion, is less highly absorbed. The sorption of ^{131}I is negligible. (NSA)

Schneider, H. and W. Block. 1968. On the Question of the Capacity of the Rhine for Radioactive Nuclides. Sorption of Radionuclides by Sediments of the Rhine. Gas Wasserfach. 109:1410-15 (in German).

For estimation of the action of decontaminating sediments and suspended material in rivers charged with radionuclides, the sorbability of deposits of the Rhine for several nuclides was determined; the sorbability increases in the following order: I^-, Sr(II), Pu(IV), Zn(II), Cs(I). Saturation was reached by sediments after 24 hours at the latest for all nuclides. The sediment samples were taken from Oehningen (Upper Rhine), Koblenz (Middle Rhine), and Wesel (Lower Rhine). Data were compared with the organic content for each sample. The sorption of ^{137}Cs is dependent on grain size but not on organic material. A sudden release by living or dead organic material of radionuclides is not possible, though desorption from mineral suspended material is more rapid, often occurring within a few hours. Less than 1% of transported nuclides in the Rhine under any conceivable conditions would be bound to suspended material or sediments. (NSA)

Schneider, P. 1974. Radionuclide Content of Vegetation and Soil on an Integrated Nuclear Complex. DP-MS-75-65.

Samples of soil and vegetation collected at the Savannah River Plant in July 1974 were analyzed for plutonium, using different procedures. The method of choice for soil analysis involved a leach procedure followed by separation using an ion exchange column. The elute was finally adjusted to the proper pH and electroplated to platinum. Counting was done on a solid state alpha spectrometer to resolve ^{236}Pu, ^{238}Pu, and $^{239-240}$Pu. An internal spike of ^{236}Pu is used to calculate percent recovery. The method of plutonium analysis for vegetation involved dissolution of the ashed plant material and then double separation. The first separation was with TIOA-xylene, and the second used HCl. The organic residue was then destroyed using nitric acid and hydrogen peroxide. Finally, the solution was mounted on a planchet and counted in an alpha spectrometer. Data are included on the content of ^{137}Cs and ^{90}Sr in the samples. (NSA)

Schnetzler, C. C. and J. A. Philpotts. 1968. Partition Coefficients of Rare-Earth Elements and Barium Between Igneous Matrix Material and Rock-Forming Mineral Phenocrysts-I. Origin and Distribution of the Elements. IN: L. H. Ahrens (ed.). Intern. Ser. Monographs Earth Science. 30:929-938.

Partition coefficients between natural melts, as represented by igneous matrix material, and amphibole, augite, olivine and plagioclase phenocrysts have been determined for eight rare-earth elements and barium by a mass-spectrometric stable-isotope-dilution technique. Peridotite nodules, crystallization of plagioclase and relationships between basalts are briefly discussed in terms of the partition coefficient data. (auth)

Schoenfeld, I. 1961. Soil Analyses in Connection with Contamination Problems. IA-524.

In connection with a study of the ^{90}Sr contamination of natural media, the properties of typical Israeli soils were examined. The characteristic calcium-rich nature of the majority of these soils was taken into account in the development of suitable methods of analysis. Standard methods are evaluated and adaptations of them suitable for the local conditions are described. Determinations described include mechanical analysis, moisture, pH, $CaCO_3$, exchangeable calcium and total cation exchange capacity of the soils. Calculated and experimental values for cation exchange capacity are compared and seasonal changes in the various soil parameters are noted. (auth)

Schoenfeld, T., K. Liebscher, and F. Karl. 1962. Factors Controlling the Distribution of Fission Products in the Biosphere. IAEA-R-1.

Progress is reported in studies on factors controlling the distribution of fission products in the biosphere with emphasis on the behavior of fission products in surface waters and the deposition of inhaled fission products in human lungs. Measurement techniques used for the determination of fission products in samples of dust, rain water, surface waters, and vegetation are described, with emphasis on applications of gamma scintillation spectrometry. Radiochemical separation techniques are described. Procedures used for the β-counting of separated fission products are also described. Results are reported from experiments on the influence of various complexing agents on the uptake of radioisotopes by ion exchange resins and laboratory experiments on the adsorption of ^{89}Sr and ^{137}Cs by clays and other soil components. Procedures used in obtaining and evaluating the γ spectra of a number of fission products in samples form the biosphere are discussed. Data are included on on the content of ^{89}Sr, ^{90}Sr, ^{141}Ce, ^{144}Ce, ^{137}Cs, ^{131}I, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{106}Ru, ^{106}Rh, ^{137}Ba, ^{140}Ba, ^{140}La, and ^{144}Pr in samples of dust, precipitation, surface water, drinking waters, lungs, and pulmonary lymph nodes analyzed during 1959, 1960, 1961 and 1962. The influence of the origin of air masses in atmospheric transport phenomena on the composition of the fission product mixture was demonstrated by determination of the relative amounts of ^{103}Ru, ^{95}Zr, and ^{95}Nb in rain water samples. The results show that atmospheric mixing was far from complete in 1962. The observed fission product concentrations are compared with the maximum permissible concentration values for radioisotopes established by the International Commission on Radiological Protection. Values for lung burdens of various fission products were plotted as a function of the date of death with emphasis on ^{144}Ce, ^{95}Zr, and ^{95}Nb. The data show that a steady rise in lung burden took place between September 1961 and February 1962. The data also indicate that considerable translocation of ^{144}Ce from lungs to pulmonary lymph nodes takes place and results in an increase in concentration in lymph nodes. (NSA)

Schofield, J. C. 1967. Origin of Radioactivity at Niue Island. N.Z.J. Geol. Geophys. 10:1362-1371.

Origin of the high soil radioactivity on Niue, an isolated island in the South Pacific, is discussed. The high radioactivity of the Niuean soils is similar to that found in deep sea sediments. Ionium and ^{226}Ra are the source of the bulk of the radioactivity on Niue. Because of the greater solubility of U, separation from the daughter products occurs in seawater, the high radioactive content in deep sea sediments being due to a slow rate of clastic deposition compared with the deposition of shelf sediments. The rate of sedimentation in deep sea areas is unlikely to have been as rapid as in the now dry lagoon at Niue; hence, a seawater origin for the abnormally high radioactivity at Niue is unlikely. A separation from U of the daughter products also takes place in hydrothermal solutions which could have come from the volcanic substructure at Niue, possibly phonolite, one of the most radioactive igneous rocks. The anomalous distribution of radioactive soil values at Niue favors a volcanic origin rather than a seawater orgin. Evidence is also presented that radioactivity in the limestone was derived from groundwater and not percolating rainwater. Groundwater is the main source of freshwater at Niue and if hydrothermal activity is still present, the groundwater may be injurious to health and should be tested for radioactivity. (NSA)

Schoolmeester, J. E. and J. J. Martin. 1957. Preparation of Radiation Sources from Fission Products by the Clay Process. AECU-3618.

This study was made to determine the feasibility of producing usable radiation sources by the montmorillonite clay process. The clay process was developed at Brookhaven National Laboratory primarily to solve the problem of ultimately disposing of waste fission products. After reviewing the process in detail, it is shown that radiation sources may be prepared with specific activity as high as 4.5 curies of ^{137}Ce per gram of clay. Sources of this strength would be entirely suitable for such processing applications as promotion of chemical reactions, preservation of foods, or sterilization of drugs. Furthermore, the operations involved in the clay process are simpler and more straightforward than those of any other process for making radiation sources from fission products. It is concluded from this study that some clay sources should be prepared to demonstrate the actual process. (auth)

Schopf, J. M. and R. J. Gray. 1954. Microscopic Studies of Uraniferous Coal Deposits. U.S.G.S. Circular 343.

Quantitative coal petrologic studies have been completed on 4 beds of uranium-bearing lignite from the Slim Buttes area of Harding County, South Dakota. Comparison of analyses of these deposits with analyses of lignite from commercial deposits suggests that the Slim Buttes coal deposits are highly diverse in composition. Relative to most coal deposits, however, all of the Slim Buttes coal that was studied has an unusually high uranium content. The studies show that no quantitative correlation exists between uranium content and the coal petrologic constituents that are normally determined for coal-type classification and for prediction of coal behavior in utilization. As the coal constituents normally determined are to some extent heterogeneous, a further study was made of subordinate components. The components of translucent attritus were studied particularly, not only for selected layers of Slim Buttes lignite, but also for layers of coal from the Goose Creek field in Southern Idaho. These data are presented for 11 layers of relatively high uranium content and for 8 associated layers that are much less radioactive and approach values that are about normal for coal. The results of this comparison cast doubt on direct correlation of uranium content with the amount of any single microscopic component of coal. A more complex control of uranium occurrence in coal is indicated. It may be significant that the samples richest in uranium contain relatively large amounts of humic attrital matter resulting from decomposition and microbial decay. One may tentatively conclude that this type of organic material is most favorable to uranium emplacement. (auth)

Schreiber, B. 1968. Method of Absolute Dating of the Coastal Marine Sediments by Means of the Vertical Distribution of the Fallout Radionuclides. Atti. Accad. Naz. Lincei, Red., Cl. Sci. Fis., Mat. Natur. 44:515-21.

Studies were made on the vertical distributions of gross beta radioactivity in cores collected from the continental shelf of the Ligurian and North Adriatic Seas. The gross beta radioactivity in the coastal marine sediment was relative to the fallout from nuclear tests and coeval sedimentation of clays. Graphic comparisons were made between known beta fallout values in some areas and core sampling beta values from the marine coastal areas in Italy. (NSA)

Schreiber, B., E. Cerrai, C. Triulzi, P. Tassi, and M. G. Mezzadri. 1969. Research on the Vertical Distribution of Radioactivity in the Sediment of the Ligurian Sea. G. Fis. Sanit. Prot. Radiaz. 13:1-19 (in Italian).

The vertical distribution of the total β radioactivity of cores taken from the Ligurian Sea from 1963 to 1968 was reported. The radiochemical analysis for the determination of the principal natural and artificial radionuclides in these core samples was given. The results showed that the maximum radioactivity was measured in the first layers of the core of 1963. The surface activity then progressively decreased. Stratification of the sediments and subsequent sinking of the more radioactive layers were confirmed. The characteristic pattern of the radioactivity of the cores can be determined by four factors: sedimentation and encirclement of the artificial fallout radionuclides in the sand of the sea bottom; variations of the quantity of radionuclides with time, and the diffusion of the radionuclides in the sediments. (NSA)

Schroeder, D. and G. Freiherr von Dem Bussche. 1962. [illegible] and [illegible] Ions in Adsorption on Active and Inactive Soil [illegible]. Landwirt. Forsch. [illegible] (in German).

The relative uptake and exchange values of Ca and Sr in socalled Ca-type and Sr-type soils were examined in relation to changes in pH. Within a concentration range of 100 m equiv inactive Sr to 0.5 μCi radioactive carrier-free Sr per 100 g soil, adsorption of both macro and micro quantities follows the same general laws. When Sr is adsorbed by a Ca-type soil, its greater affinity for the exchange sites relative to Ca (due to its greater ionic dia and lower degree of hydration) is masked by a hysteresis effect, this effect inhibits the exchange of the ions already adsorbed; hence the weaker adsorption of Sr ions as compared with Ca ions, in Ca soils. Given a constant metal ion and a decreasing H ion concentration, adsorption of Sr increases over the entire pH scale. If the concentration of metal ions is low and increases with the pH, Sr adsorption increases only within the very acid pH range (up to about pH 5). The influence of pH between pH 5 and 8 is slight, while above pH 8, in the presence of a high concentration of alkaline earth ions, the adsorption of Sr again declines. (NSA)

Schroeder, M. C. and A. R. Jennings. 1963. Laboratory Studies of the Radioactive Contamination of Aquifers. UCRL-13074.

Exchange column experiments and batch determinations of the distribution coefficient were utilized in studying the migration of radioactive cesium and strontium through earth materials. The studies indicate that the prediction of the rate of movement of these two radioisotopes in relation to the rate of grou water movement can be made with reasonable accuracy. Several factors affect the transport of radioactive substances by water through granular earth materials. The distribution coefficient is probably the single-most important factor. The distribution coefficient for a mineral or material is a measure of the adsorption of an ionic species. This coefficient is dependent on the ion concentration, the chemical nature of the material, the surface area of the material, the nature of the competing ions in the water, their concentration, and the pH of the solution. Other factors affecting the movement of radioactivity through granular material are the rate of uptake of the activity by the mineral, the rate of elution of the adsorbed radioactivity, the velocity of the water, hydraulic dispersion in a longitudinal direction, and the dispersion in a lateral direction. The latter, however, is not of importance in column experiments. Distribution coefficients were determined by the batch method for cesium and strontium for the 20-30 and 50-60 mesh sizes of quartz sand, crushed quartz, and crushed microcline for several concentrations of either sodium, potassium, or calcium. Coefficients were determined for some other minerals such as calcite, soda feldspar, and limestone. Exchange column experiments were done using the previously stated two sizes of quartz sand, crushed quartz, and crushed microcline. These experiments have used various concentrations of calcium, potassium, and sodium as the competing or eluting cation. An isotope pulse was placed on the minerals in the columns and eluted at flow rates of 10 cm or 1 cm per hour. The distribution coefficient can be determined from the column elution history by the Mayer and Tompkins equations. However, this calculation was made using the position of 50% elution of the activity from the column instead of the peak position of the radioactivity. Discrepancies between the batch and column coefficients for the same materials and solutions are of small magnitude. Therefore, the equation derived by Higgins in 1959 can be used to determine the rate of migration of tracer concentrations of radioisotopes. This states that the average velocity of a radioactive ion is equal to the velocity of the transporting water divided by the sum of one plus the product of the distribution coefficient (batch) and the exchange ratio, which is defined as the bulk density divided by the porosity. Batch distribution coefficient determinations can be used to predict with reasonable accuracy the migration of radioactivity from the site of a nuclear explosion used for excavation or other purposes. The coefficient must be for the material through which the transporting water is moving. The flow rate of ground-water in the aquifer and its physical properties such as bulk density and porosity must be known. The nature of the hypothetical average aquifer and the pre-explosion site investigation will insure that there will be no hazards related to radiological contamination of ground water. (auth)

Schroeder, J. H., D. S. Miller and G. M. Friedman. 1970. Uranium Distributions in Recent Skeletal Carbonates. J. Sediment Petrology. 40:672-81.

Fission track analysis which was used to map U distributions in sections at the ppb to ppm level, showed considerable intraskeletal heterogeneities in coral and mollusks. In the corals, a zone next to the internal surface of the corallite U is enriched with respect to the inner portions of the skeleton; configuration and the factor of relative enrichment of this zone vary between coral species. The branching coral Oculina diffusa, exhibits alternating bands of relatively high and low U contents arranged subparallel to the external surface. In the mollusk shells studied, U concentrations vary between different layers of a given shell; further variations exist within a given layer perpendicular to the direction of accretion. Trace element distribution in carbonate skeletons is determined primarily by biological processes and can be expected to change when affected by physiochemical diagenetic influences. The patterns of U distribution presented are potential indicators of U mobility during diagenesis and potential checks on the closed system requirement for U series dating of biogenic carbonates. (CA)

Schuettelkopf, H. 1974. Environmental Surveillance for Plutonium at the Karlsruhe Nuclear Research Center from 1969 Until 1973. IN: Environmental Surveillance Around Nuclear Installations. IAEA, Vienna. II:327-344.

Several nuclear research reactors, a fuel reprocessing plant, an incinerator for radioactive burnable waste and a laboratory for ^{238}Pu production have been operated on the site of the Karlsruhe Nuclear Research Center, and several institutes there have been concerned with research on transuranium elements. The necessary surveillance of the environment is carried out by analysis for plutonium in plants, precipitation, sediment, plankton and special materials. Nearly 100 samples are collected and analyzed each year. The objectives and structure of the surveillance program are described. The analytical results of the last 4 years are reported. The results of environmental surveillance performed with plants and precipitation, and the different annual variations of plutonium concentrations in these sample materials are compared. The effectiveness of the surveillance system is discussed critically, taking as an example some unplanned releases of plutonium to the environment. (auth)

Schulz, R. K. 1965. Soil Chemistry of Radionuclides. Health Physics. 11:1317-24.

The naturally occurring radionuclides found in the soil in significant amounts include ^{14}C, ^{40}K, ^{87}Rb, and members of the U, Ac, and Th series. More than 300 radioisotopes will be undetectable, because of their short half-lives

Y, Pr, Pm, Th, Pa, Zr, and Nb occur in soils, but are either very strongly adsorbed by the clay particles or are present as insoluble oxides or hydroxides. In either of these states, these elements will be immobile in the soil and largely unavailable to plants. The elements which have a greater degree of mobility include Sr, Ba, U, Ra, Pb, Mn, Co, Zn, Fe, Ru, Cr, K, Rb, Ca, and C. In considering the mobility of any ion, all others have to be taken into account. The amount and species of the complementary ions will have a strong influence on the redistribution of these isotopes in the soil profile and will affect plant uptake. (CA)

Schulz, R. K., R. Overstreet, and I. Barshad. 1960. On the Soil Chemistry of Cesium-137. Soil Science. 89:16-27.

The nonexchangeable fixation of macro amounts of cesium in the five soils investigated appeared to be different in character from the corresponding fixation of potassium and ammonium. Only vermiculite could account for the magnitude of the fixation in soils such as Vina, Yorkville and Yolo, and for the behavior of the soils towards extraction with Cs^+ and Ca^{++}. Cesium may be fixed on the surfaces of micaeous minerals, with alteration of the mica basal spacing to incorporate Cs.

Schulz, R. K. and H. H. Riedel. 1961. Effect of Aging on Fixation of Strontium-90 by Soils. Soil Science. 91:262-4.

With the passage of several years a small fixation of ^{90}Sr was found to exist in a nonexchangeable form in soils. This fixation probably takes place, in part, by incorporation in $CaCO_3$ crystals when soils contain this material. In all soils studied, fixation appears to be caused by entry of the ^{90}Sr into such solid phases as Sr or Ca phosphates or other crystals containing Sr or Ca. (auth)

Schultz, R. K., G. A. Tompkins and K. L. Babcock. 1974. Uptake of Plutonium and Americium by Plants from Soils: Uptake by Wheat from Various Soils and Effects of Oxidation State of Plutonium Added to Soil. IAEA-SM-199/92.

The uptake of $^{239,240}Pu$ and ^{241}Am by wheat (*Triticum aestivum L.*) from three California soils was studied. A forest soil (slightly acid), a fertile alluvial soil (neutral) and a calcareous soil (alkaline) were used. Prior to the uptake studies the Pu was added to the soils in the Pu^{3+} state in chloride solution and also as the disproportionate Pu^{3+}, Pu^{4+}, Pu^{5+}, Pu^{6+} in nitrate solution. Americium was added as $AmCl_3$ or $Am(NO_3)_3$ solutions. The highest concentration of Pu in the wheat grain was found when Pu was added as nitrate to the alkaline, calcareous soil. The greatest concentration of Am in the grain was found when Am was added as the chloride to a neutral soil. The plutonium distribution ratios

$$(\text{D.R.} = \frac{\text{nuclide concentration in plant, dpm/g of air dry plant material}}{\text{nuclide concentration in soil, dpm/g of air dry soil}})$$

for the grain ranged from 4.4×10^{-8} to 3.8×10^{-6} and the americium D.R.'s ranged from 2.6×10^{-7} to 3.0×10^{-5}. (auth)

Schulz, W. W. 1968. Effects of Some Synergistic and Antagonistic Agents on HDEHP Extraction of Strontium. BNWL-759.

Extraction of strontium by a HDEHP-kerosene solvent is significantly altered when certain other organic reagents are present in the extractant. Distribution ratio data for extraction and stripping of cerium (III) and (IV), as well as for those of strontium, demonstrate the substitution of 0.2M DBBP for the 0.2M TBP in the present plant solvent to be technically feasible.

The deleterious effects of small concentrations of H_2MEHP on HDEHP strontium extraction is ascribed to strong intermolecular hydrogen bonding between H_2MEHP and HDEHP. The antagonistic effect of H_2MEHP is particularly important to B-plant operation because H_2MEHP is a primary radiolysis product of HDEHP and, unless periodically removed, can reach a concentration as high as 0.05M upon even modest (10^8 rad) solvent exposure. The antagonistic effects of the alcohol and acid are not considered of importance to B-plant operation. (auth)

Schulz, W. W. 1972. Radiolysis of Hanford B Plant HDEHP Extractant. Nucl. Tech. 13:159-67.

Irradiation (^{60}Co source) tests were performed to determine effects of radiolysis of HDEHP [bis(2-ethylhexyl)phosphoric acid] solvents. (An HDEHP-TBP-kerosene extractant is used in the Hanford B Plant to extract ^{90}Sr from Purex process high-level waste.) Irradiation to 230 to 350 Wh/liter destroys only small (~6%) amounts of HDEHP; the principal radiolytic effect is a two- to threefold decrease in strontium extraction capacity. This effect is ascribed to polymerization of HDEHP with itself and/or with H_2MEHP [mono (2-ethylhexyl)phosphoric acid], a primary radiolysis product. Dilute NaOH and Na_2CO_3 solutions wash H_2MEHP from irradiated HDEHP extractants; however, only with solvents irradiated in the absence of any aqueous phase do such washes improve strontium extraction properties. Addition of unirradiated HDEHP to irradiated HDEHP solvents increases their ability to extract strontium; this simple procedure is used to maintain the strontium extraction capacity of the B Plant solvent at a suitable level. Performance and properties of plant solvent are in general agreement with those anticipated from ^{60}Co irradiation tests. (auth)

Schulz, W. W. 1976. Headend/Tailend Ozonation Procedures. IN: ARHCO Quarterly Report. Process Technology and Process Development. ARH-LD-149B, pp. 58-61.

Use of ozonation to destroy typical complexing agents (citrate, tartrate, hydroxyacetic acid, EDTA, DTPA, HEDTA) was studied. In an alkaline solution, the ozonation also readily oxidized nitrite to nitrate ion. (auth)

Schwartz, F. W. 1975. On Radioactive Waste Management. An Analysis of the Parameters Controlling Subsurface Contaminant Transfer. J. of Hydrology. 27:51-71.

The problem of subsurface, radioactive-contaminant transfer is investigated theoretically through the development of a two-dimensional model which considers the simultaneous flow of water and mass. In addition to the well-known physical transport processes, convection and dispersion, the model treats radioactive decay and cation exchange which are two of the most important concentration attenuation processes. The influence of factors, which control the transport processes, on subsurface contaminant distributions is demonstrated through the simulation and analysis of a series of hypothetical cases. With respect to the physical transport processes, hydraulic conductivity, porous medium dispersivity and the location of the contaminant inflow zone are considered as controlling parameters. The attenuation processes are controlled by the following parameters, radioactive half-life, selectivity coefficients, cation-exchange capacity, ion charge and weathering rate.

The maximum extent of subsurface contamination in all cases is determined by the physical transport processes. Chemical and nuclear attenuation simply reduces the size of the contaminated region to some fraction of that which could be attributed to physical transport alone. The complexity of the transport process suggests that empirical evaluations of site behaviour which are based on rigid guidelines are inadequate for siting and designing waste management sites, and for insuring the safety of potable water supplies. (auth)

Schwille, F., W. Lippok, and D. Weisflog. 1967. Model Experiments on Fluid Flow in the Transition Zone from Unsaturated to Saturated Soil. IN: Disposal of Radioactive Wastes into the Ground. IAEA-SM-93/11, pp. 151-160.

Since central water supply systems were established in Germany, ground water has been preferred as a water source and will undoubtedly continue to be so. More than four-fifths of the necessary drinking water is extracted from the sub-soil either as genuine ground water or as bank-filtered river water. The most important aquifers in the Federal Republic of Germany are fluviatile and fluvioglacial Pleistocene sand and gravel deposits, situated in the valleys of the large rivers. The ground-water level is generally from 3 to 15 m below ground surface Depending on the permeability of the substrata, about 100 to 300 mm of precipitation water probably infiltrates. Therefore, the possibility of ground-water contamination by dissolved products is always present.

These alluvial plains are suitable locations for radionuclide-producing plants. However, because of the intensive exploitation of the aquifers, it is hard to find any locality where such plants would not have a marked effect on the water supply system. If ground water is to be protected effectively and at reasonable cost against radionuclide contamination, a detailed knowledge is first necessary of the migration mechanisms of radionuclide-containing solutions both into the unsaturated zone, i.e. the aerated zone, and the saturated zone, since the migration of radionuclide depends on the static and dynamic behavior of fluids in porous media. Infiltration in the unsaturated zone and spreading in the saturated zone were analysed with sand models scaled to resemble the natural conditions as closely as possible. Large special glass lysimeters, experimental troughs with glass walls and small diameter copper and glass segment-tubes were used as models. The liquid fronts were traced mainly with ultra-violet light. The result shows that it is not yet possible to treat the flow of liquid analytically in every case, even in homogeneous media. (auth)

Scott, M. R. 1968. Thorium and Uranium Concentrations and Isotope Ratios in River Sediments. Earth Planet. Sci. Lett. 4:245-52.

Sediments from five rivers in the eastern and southern United States have been divided into several size fractions and analyzed for thorium and uranium isotope concentrations. The ^{238}U decay series exhibits disequilibrium as a result of weathering. The ^{234}U/^{238}U activity ratio is less than unit in sediment derived from well-leached soils and greater than unity in sediment containing relatively large amounts of organic material from organic-rich surface layers of soil profiles. Thorium-230 exists in excess of equilibrium amounts relative to its parent ^{234}U in the fine fraction of most of the sediments analyzed. The thorium concentration and ^{230}Th excess are significantly higher in the 2 to 0.2 μ and less than 0.2 μ size fractions than in the 2 to 20 μ fractions, indicating adsorption by clays, complexing with sesquioxides, or possible concentration in resistates. Unsupported ^{230}Th is being added to deep-sea sediments at a maximum rate of 0.5 dpm/cm^2/1000 years; therefore, detrital material is not a significant source of excess ^{230}Th in deep-sea sediments. (auth)

Scrudato, R. J. and L. D. Ramspott. 1973. ^{85}Kr Sorption on Tuff Samples from NTS. UOPKB73-51 (unpublished).

Very little, if any, adsorption of ^{85}Kr on NTS tuff occurred at 300 to 500 psig.

Seaborg, G. T. and J. J. Katz (eds.). 1954. The Actinide Elements. McGraw Hill Book Company, Inc. New York.

This book is a compilation of chapters written by various authorities on actinide chemistry. In order to indicate the contents of this book, the chapters are listed below: Introduction; the chemistry of actinium; nuclear properties of uranium; protactinium, and thorium isotopes; the chemistry of thorium; the chemistry of protactinium; the chemistry of uranium; nuclear properties of the plutonium isotopes; oxidation states, potentials, equilibria, and oxidation-reduction reactions of plutonium; ionic and molecular species of plutonium in solution; preparation and properties of the neptunium isotopes; the chemistry of neptunium; nuclear properties of transplutonium nuclides (Am, Cm, Bk, Cf); the chemistry of transplutonium elements (Am, Cm, Bk, Cf); radiochemical separations of the actinide elements; radiochemical assay by alpha and fission measurements; correlation of properties as actinide transition series; crystal chemistry of the 5 f elements; optical properties of some compounds of uranium, plutonium, and related elements; and slow-neutron and spontaneous-fission properties of heavy nuclei.

Sedlet, J., N. W. Golchert, and T. L. Duffy. 1975. Environmental Monitoring at Argonne National Laboratory. ANL-75-18.

The results of the environmental monitoring program at Argonne National Laboratory for 1974 are presented and discussed. To evaluate the effect of Argonne operations on the environment, measurements were made for a variety of radionuclides in air, surface water, Argonne effluent water, soil, grass, benthos, and milk; for a variety of chemical constituents in surface and Argonne effluent water; and of the environmental penetrating radiation dose. Sample collections and measurements were made at the site boundary and off the Argonne site for comparison purposes. Some on-site measurements were made to aid in the interpretation of the boundary and off-site data. The results of the program are interpreted in terms of the sources and origin of the radioactive and chemical substances (natural, fallout, Argonne, and other) and are compared with accepted environmental quality standards. The potential radiation dose to off-site population groups is also estimated. (auth)

Sedlet, J. and F. S. Iwami. 1965. Environmental Radioactivity at Argonne National Laboratory Report for 1962 and 1963. ANL-6945.

This report presents the results of the environmental monitoring program at Argonne National Laboratory during 1962 and 1963. The purposes of the program are to measure the natural radioactive content of the ANL site and its surroundings, and to determine the origin, identity, and magnitude of any radioactivity not naturally present. Of primary interest is the detection of radioactive materials released to the environment as a result of Argonne operations. (auth)

Sehmel, G. A. and F. D. Lloyd. 1974. Resuspension by Wind at Rocky Flats. BNWL-1850, Pt. 3, pp. 204-211.

A field experiment at Rocky Flats was conducted to initially determine plutonium air concentration dependency on wind speed and sampling height and to determine the respirable particle size distribution and subsequently to determine plutonium resuspension rates from ground source samples concurrently collected by HASL. Radiochemical plutonium analyses for filter samples are awaited from DOW at Rocky Flats. Airborne soil size distributions indicate that airborne concentrations of respirable soil particles increase proportionately with the wind speed to the 4th and 6th power.

Sehmel, G. A. and F. D. Lloyd. 1974. Resuspension of Plutonium at Rocky Flats. BNWL-SA-5085.

In a July 1973 field experiment at Rocky Flats, vertical airborne plutonium concentrations were determined as a function of respirable particle size. The principal sampling site was a 100-ft meteorological tower which was instrumented at several heights with self-orienting, high volume cascade impactor-cowl systems. Wind speed instrumentation activated selected impactors as a function of wind speed. Airborne plutonium concentrations and concentrations on airborne soil were measured as a function of both height and wind speed. Below 10 m concentrations decreased with height. Above this height to 30 m, an increase suggested that an elevated upwind source could be contributing. The maximum airborne concentration measured was 3.7×10^{-15} Ci/m^3. The maximum concentration per gram of gross airborne soil was 50 pCi/g. Somewhat higher concentration was found on the ~2 μm airborne soil fraction. All concentrations were significantly less than maximum permissible concentrations. (auth)

Senin, Yu. M. and A. I. Sherstnev. 1967. Total β Activity of Recent Bottom Sediments. Okeanologiya. 7:628-32 (in Russian).

The total β activity of the bottom sediments from the northwest African shelf made by the Atlantic Research Institute of Fisheries and Ocenaography was determined. The β activity was determined in 96 grab samples, and granulometric composition and $CaCO_3$ and organic carbon content determinations were made. The distribution of sediments of different activity over the shelf is presented schematically. Variation in sediment radioactivity was considered in relation to changes of lithological characteristics of the sediments and physical-geographical conditions of sedimentation. The studies described provided background characteristics of the shelf sediments, confirmed the regularity of an increase in activity with a decrease of sediment granularity, showed an insignificant effect of $CaCO_3$ content on β activity in sands, and the absence of such an effect in coarse aleurites and oozes. In sands and coarse aleurities a direct relation was found to exist between the value of β activity and organic carbon content; this relation was not marked in oozes. It was concluded that the mechanism of supply and accumulation of radioactive matter is closely related to the general process of sedimentation, and that variations of sediment radioactivity are due to their granulometric composition and peculiarities of both terrigenous and biogenic sedimentation on the northwest African shelf. (NSA)

Senin, Yu. M. and A. I. Sherstnev. 1967. Total β-Activity of Recent Bottom Sediments of the Northwest African Shelf. Oceanology. 7:487-91.

Total β-activity was determined in 96 bottom grab samples from fisheries areas on the northwest African shelf between 28 and 8°N and in the Gulf of Guinea around Takoradi. In addition to β-activity, the particle-size composition of the sediments was investigated, and the amounts of calcium carbonate, organic C, P, authigenous Si, Fe, and Mn were determined in some samples. The shelf sediments from regions of sedimentary rocks (between Cape Hubi and the port of Freetown) have lesser indices of activity than the shelf sediments of regions of metamorphic and igneous rocks (Gulf of Guinea). The main explanation for this difference is the different activity of the sedimentary and igneous rocks of the coast, and also that the igneous rocks occur in the humid tropical zone. The relation between the β-activity of the sediments and their particle-size composition and the increase in this relation as the dispersion of the sediments decreases are indicated: sand, 3.06 pCi/kg; fine silt, 7.60 pCi/kg (mean values). The increase of β-activity from sand to silt is related to a rise in the adsorption capacity of sediments of this series and to the increased content of fine particles. The increase may also be caused by changes in the mineralogical and general composition of the sediments. The relation between the activity of sediments and their chemical compositon is considered taking as an example $CaCO_3$ and C_{org}. In fact, β-activity does not vary in the sequence: terrigenous--heavily calcareous sediments; some difference is to be noted only in sand. Within each particle-size type of bottom sediment radioactivity values are dependent on C_{org} content. Calcareous sands have higher indices of activity than terrigenous sands. Moreover, particles of organic origin contain more than ^{40}K. A different pattern is to be noted in fine silt and ooze; there is no evident dependence of β-activity on C_{org} content. (NSA)

Sereda, G. A. and F. Ya. Rovinskii. 1963. Shift in the Radioactive Equilibrium ^{90}Sr and ^{90}Y in Lake Waters. MLM-1470 (tr).

The effect of ^{90}Y absorption by lake silts on the equilibrium of ^{90}Sr and ^{90}Y in lake waters was examined. The factors which affect the ^{90}Y absorption are noted and calculations are made for the rate of removal of ^{90}Y from the water. (NSA)

Serne, R. J. and Dhanpat Rai. 1976. Adsorption-Precipitation Behavior of Eu in Soils and Standard Clays. Agronomy Abstracts. p. 132.

The influence of type of soil mineral, pH, composition of bulk solution and Eu concentration in solutions was investigated in order to determine the environmental consequences of Eu disposal to soils. Europium forms an insoluble hydroxide at relatively low concentrations under moderately acidic and alkaline conditions. The pH values at which one to 1000 ppm Eu solutions precipitate as $Eu(OH)_3$ were determined by Tyndall beam techniques and found to agree quite favorably with the theoretical values. (auth)

Serne, R. J. and R. C. Routson. 1973. Percol Users Manual. BNWL-1720.

Research being conducted under the Radionuclides in Soils Program is attempting to predict the distribution and movement of liquid wastes in the heterogeneous subsurface environment of the Hanford Reservation. As part of this program, a transport model is being developed to predict chemical phenomena in soil-waste reactions. This document describes the use of the PERCOL model, which was developed as a simplified one-dimensional precursor to the transport model. PERCOL numerically describes the complex chemical reactions which occur during percolation of a waste solution through a porous media.

This User's Manual describes the main program (PERCOL) and two subroutines (NEWTIT and DIST) and gives procedures for accessing these programs, inputting data to them and interpreting the output. (auth)

Serne, R. J., R. C. Routson, and D. A. Cochran. 1973. Experimental Methods for Obtaining PERCOL Model Input and Verification Data. BNWL-1721.

A soil-waste chemical equilibrium model, PERCOL, was developed to numerically simulate the complex chemical reactions that occur while a solution is percolating through porous media. Experimental procedures for measuring PERCOL model input verification parameters are described, including procedures for preparing both saturated and unsaturated experimental soil columns. Two methods of determining the soil-cation-exchange, capacity and soil exchange selectivity constants are presented. Methods for determining the initial soil conditions, a procedure for measuring the apparent porosity of a soil column and an empirical determination of trace ion sorption are also described. (auth)

Shade, J. W. 1974. Reaction of Hanford Sediments with Synthetic Waste, A Reconnaissance Study. ARH-CD-176.

Modified high salt-high caustic synthetic tank wastes were recirculated through columns of sediment from the SY Tank Farm and crushed anorthite ($NaAlSi_3O_8$). After 26 days of recylcing, the wastes in the sediment column contained up to 1200 parts per million elemental Si and 200 ppm elemental Al. Similar data from the anorthite column suggests that solution of SiO_2 and Al_2O_3 in synthetic wastes is in direct proportion to their mole ratios. Neither column reached equilibrium. After 26 days, about 2 weight percent of the sediment column dissolved (in terms of SiO_2), corresponding to a volume of about 0.03 cubic inches per gallon of waste throughout. No evidence of a reduction in permeability was observed. (auth)

Shaikh, M. U., D. G. Jacobs, and F. L. Parker. 1967. Study of the Movement of Radionuclides Through Saturated Porous Media. ORNL-TM-1681.

A theoretical solution of water flow has been obtained for an inverted five-spot system with the injection well located at the center of a square sandstone slab (6 feet by 6 feet by 6 inches) and four relief wells at the corners of a centered 3-foot square, oriented in the same direction as the edges of the slab. Equations for stream function, potential function, and the velocities in the block have been developed. From the distribution of velocities, in the radial flow and distorted flow, it has been shown that the flow pattern is unaffected by wells up to a distance of 8 inches from the injection well. Equipotential contours, streamlines, and the flow history of the system have been plotted by the computer. From the sorption data obtained from linear flow cores, the time required for the breakthrough of ^{89}Sr and ^{45}Ca has been found to be 8.5 and 6.2 times that of water, respectively. Using different linear flow rates, coefficients of dispersion have been obtained using cores of sandstone. By combining the solution of the velocity distribution attributed to geometry with solution dispersion at various rates of linear flow, net solution breakthrough curves have been constructed. (NSA)

Shalmina, G. G., F. P. Krendelev, G. F. Zaripora and V. A. Bobrov. 1972. Radioactive Elements in the Weathering Crusts of Central Urals Granites. Tr. Inst. Geol. Geofiz., Akad. Nauk SSSR, Sib. Otd. No. 149:139-51 (in Russian).

The contents of SiO_2, Al_2O_3, TiO_2, Fe_2O_3, FeO, CaO, MgO, K_2O, Na_2O, U, Ra, Th, and radioactive K in Paleozoic granites of the central Urals and their eluvial Lower Jurassic and Upper Cretaceous weathering products were determined. Samples were taken from bore holes at the Magnitnaya Mountains and from the Krasnaya Gorka deposit. The distribution curves of U, Ra, and Th coincided with those of relative amounts of feldspars and quartz, muscovite and hydromicas, and zircon, respectively, in the silt fractions of the crusts indicating that U, Ra, and K are present in feldspars, muscovite, and hydromicas; Ra mainly in hydromicas and muscovite; and Th in zircon. (CA)

Shaw, D. M., G. A. Reilly, J. R. Muysson, G. E. Pattenden, and F. E. Campbell. 1967. An Estimate of the Chemical Composition of the Canadian Precambrian Shield. Canadian J. Earth Sci. 4:829-53.

A new estimate of the surface composition of exposed parts of the Canadian Precambrian Shield has been obtained, using samples of 122 rocks from northern Quebec--Ungava, 116 from Baffin Island, 116 from southwestern Quebec, 64 from northeastern Alberta, 18 from northern Saskatchewan, and 8076 from northern Ontario. Where feasible an interpenetrating replicate sampling design was used, with probability weighting by rock-type, analyzing both individuals and composites for trace elements, but only composites for major elements. A total of 385 triplicate spectrographic analyses and 48 major-element analyses were made.

Regional differences between the six samples were detected; whether these also include secular variations could not be studied. The overall estimate follows:

	wt.%		wt.%		p.p.m.
SiO_2	64.93	P_2O_5	0.15	Be	1.3
TiO_2	0.52	H_2O+	0.79	Ga	14
Al_2O_3	14.63	H_2O-	0.13	Cr	99
Fe_2O_3	1.36	CO_2	1.28	V	53
FeO	2.75	S	0.06	Li	22
MnO	0.068	Cl	0.01	Ni	23
MgO	2.24	F	0.05	Co	21
CaO	4.12	C	0.02	Cu	14
Na_2O	3.46	Less	0.04	Zr	400
K_2O	3.10	Sum	99.628	Sr	340
				Ba	1070
				Rb	118

The major elements are similar to those found in granodiorite, mica paragneiss, or graywacke, but the trace elements agree better with the last two only. Data for Th and U will follow later.

The Precambrian Shield of Canada (and Fennoscandia also) contains more Si and K, and less Ti, Fe, Mn, Mg, and Ca than recent estimates of the whole crust of the earth. (auth)

Shcnerbina, V. V. 1962. Methods of Elucidating the Transportation Form of Chemical Elements in Geochemical Processes. Geokhimiya. No. 11:945-52 (in Russian).

The paragenetic interrelations of minerals were investigated as criteria for the elucidation of possible transportation forms of chemical elements in geochemical processes. The compounds must possess such physicochemical properties which make their transportation possible in a real geochemical environment (composition of the medium, alkalinity or acidity, oxidation -- reduction level, temperature, and pressure). All natural reactions tend to proceed by the most simple way. The transformation forms of chemical elements define their ability for migration, the types of chemical reaction and the environmental conditions of mineral formation. (auth)

Shcherbina, V. V. Geochemistry of Uranium in Oxidation Zone of Ore Deposits According to Experimental Data. A/CONF 15/P2066 (in Russian).

Investigations of geochemical processes in the oxidation zone of ore deposits and reproduction of these processes by experiment made it possible to reveal the nature of chemical reactions which account for the formation of uranium minerals in the oxidation zone of ore deposits. Superposition of later geochemical processes on the products of earlier processes, their stage of development, and the resulting mineralogical zonality are observed. The reactions proceeding in the oxidation zone of uranium ore deposits are as follows: hydrolysis; ionic exchange resulting in hardly soluble compounds; oxidation-reduction reactions; formation and destruction of complex compounds; and sorption processes. The nature of these reactions depends on humid or arid types of weathering. Examples of reactions that account for paragenesis of exogenous uranium minerals and their connection with endogenous mineralization are given. (auth)

Shearer, S. D. and G. F. Lee. 1964. Leachability of Radium-226 from Uranium Mill Solids and River Sediments. Health Physics. 10:217-227.

Laboratory leaching tests conducted on uranium mill waste solids and river sediments collected from several locations in the Colorado Plateau area of the United States have shown that the amount of ^{226}Ra that can be leached is primarily controlled by the liquid-to-solid ratio (volume of leaching liquid per unit weight of solids).

The diffusion of ^{226}Ra from the interior to the surface of the particles was found to be insignificant since the amount leached was essentially independent of time of contact after 15 minutes. Natural and synthetic river waters showed no greater tendency to leach ^{226}Ra than did distilled water.

Leaching tests conducted with 0.01 molar solutions of the common inorganic cations found in river waters showed that only barium significantly promoted the leaching of ^{226}Ra from the solids studied. (auth)

Sheppard, J. C., J. A. Kittrick, and T. Hardt. 1976. Determination of Distribution Ratios and Diffusion Coefficients of Np, Am, Cm in Soil-Aquatic Environments. RLO-2221-T-12-2.

Research for the period August 1, 1975 to July 31, 1976, is reported. Distribution ratios for $^{241}Am(III)$, $^{244}Cm(III)$ and $^{237}Np(V)$ were measured as a function of time in 12 soils of varying characteristics. Experiments were performed to obtain diffusion coefficients for $^{237}Np(V)$ and $^{241}Am(III)$ in soils where distribution ratios were reasonably constant. Some physical and chemical characteristics of each soil were determined in an effort to better understand the factors that may influence the distribution ratios and diffusion coefficients. Experiments were also carried out to determine the extent of radiocolloid formation of Am(III) and Np(V) by an alpha track method and by centrifugation and filtration techniques. Coprecipitation of $^{241}Am(III)$, $^{237}Np(V)$ and $^{244}Cm(III)$ by iron and manganese hydroxides in synthetic seawater was also studied. (auth)

Shih, C. S. and E. F. Gloyna. 1967. Radioactivity Transport in Water: Mathematical Model for the Transport of Radionuclides. ORO-490-12.

The purpose of this study was to develop a mathematical model which describes the transport of radionuclides injected instantaneously in a stream. Particular emphasis was directed to the influence of sediments on transport. Instantaneous release of dye and continuous release of ^{85}Sr, respectively, were used to measure the dispersion and mass transfer coefficients. Aquaria and model river experiments were undertaken to determine various parameters which define the mechanism of sorption and desorption of radionuclides by sediments. Instantaneous injection of ^{85}Sr into the model river provided data for establishing the relationship between the analytical solution and a proposed mathematical model. FORTRAN programs were designed for the analyses of gamma spectra, dispersion coefficients and transport equations. Some of the important factors affecting the transport of ^{85}Sr in the model river were studied.

The mass transfer coefficient was found to increase with increased velocity. High uptake of ^{85}Sr by sediments may be provided by increased temperature and the presence of an organic pollutant. An exponential relationship was established between the Sherwood's number and the Reynold's number for the model river. (auth)

Shih, C. S. and E. F. Gloyna. 1968. Influence of Sediments on the Transport of Solutes. ORO-490-12a.

A transport relationship which considers the sorption-desorption characteristics of a nonbiodegradable solute was developed. The radionuclide, ^{85}Sr, was used to test the transport hypothesis under a variety of environmental conditions. Experiments included evaluation of the sorption of ^{85}Sr by sediments in both flowing and nonflowing aquatic systems. (auth)

Shiraishi, Y. 1973. Radioactive Contamination of Fruit Trees by Fission Products. 2. Distribution of the Replaceable ^{90}Sr in the Soil of a Citrus Orchard. J. Radiat. Res. 14:225-230.

Since 1961 through 1971, this study was conducted to determine the distribution of the replaceable ^{90}Sr in loam surface soil originated from volcanic ash under three kinds of soil management, i.e. clean, mulch, and sod systems at a citrus orchard. The level of the replaceable ^{90}Sr in the surface soil measured in 1963 was in the order of clean (41) = sod (40) > mulch (31 nCi/m^2 · (0 to 30 cm)) and decreased exponentially with a half-time of approximately 5.9, 12.3, and 10.2 years for clean, mulch, and sod systems, respectively. It was observed that the distribution coefficient of ^{90}Sr calculated for these soils depended largely on the replaceable ^{90}Sr content in surface soil and that the level of the coefficient in the soil under each soil management system in 1971 was nearly equal to that in 1961. The distribution coefficient of three systems are in order of clean < sod < mulch. (auth)

Shiraishi, Y. 1973. Radioactive Contamination of Fruit Trees by Fission Products. 3. Distribution of the Replaceable ^{137}Cs in the Soil of a Citrus Orchard. J. Radiat. Res. 14:231-235.

Since 1961 through 1971, the replaceable ^{137}Cs content in the same surface soil of the same area under clean, mulch, and sod systems of soil management at a citrus orchard was determined in order to compare its annual change with that of replaceable ^{90}Sr. The relation of humus content in surface soils classified as clean < sod < mulch closely related to half-time for an exponential decrease of replaceable ^{137}Cs from 1963 through 1971 and with distribution coefficient for the downward distribution of replaceable ^{137}Cs in surface soil. Both half-times of approximately 8.5, 45.2, and 30.7 years and distribution coefficient of 0.094 to 0.111, 0.142 to 0.165, and 0.129 to 0.140 for clean, mulch, and sod, respectively, are larger than those of ^{90}Sr. The ratios of replaceable ^{137}Cs to ^{90}Sr of 0.92 to 1.13 in surface soil found for the year from 1961 through 1967 followed by a slight increase afterwards and reached 1.24 to 1.36 in 1971. It was found that ^{137}Cs is fixed much more strongly than ^{90}Sr in the surface soil of a citrus orchard. (auth)

Short, N. M. 1961. Geochemical Variations in Four Residual Soils. J. Geol. 69:534-71.

Variations in concentrations of Si, Al, Fe, Mg, Ca, Na, K, and Ti (as oxides) and Ba, Co, Cr, Cu, Ga, Mn, Ni, Pb, Sc, Sr, V, Zn, and Zr were determined by the mutual-standard method of spectrochemical analysis on the total soil and parent-rock samples, separated sand, silt, and clay fractions, and acetic acid leachates of soils developed from ganodiorite (Wyoming), basalt (Colorado), granite (Missouri), and metamorphosed andesite (North Carolina). Intraplate precision is ±7.5%, interplate precision is ±28%. Particle-size distribution, the mineralogy of each size fraction and measurements of -H_2O, pH, Eh, soluble salts, free iron oxide, organic matter, and exchange capacity are related to composition by graphical and statistical methods. Conclusions are presented for the four soils: enrichment or depletion of most trace elements is directly proportional to the amount of clay and silt produced by weathering; the largest concentration changes occur across the parent rock-soil interface; Al-Ga, Fe-Co, Fe-Mn, Fe-Ti, Fe-V, and Mg-Sc show similar behavior during weathering; less definite associations are noted for Fe-Cu, Fe-Cr, Mg-Cu, Ca-Sr, K-Ba, and K-Pb; the B-horizon usually shows maximum enrichment in Co, Cr, Cu, Mn, Ni, Sc, Ti, and V and contains the largest leachable amounts of most elements; climate appears to be more important than parent-rock composition in affecting trace-element distributions; concentration changes of some elements are related to survival or destruction of certain parent-rock minerals; the only distinct differences in element content between the two salic and two mafic parentage soils are in the concentrations of Si, Fe, Cu, Sc, V, and Zr, and no clear-cut relation between minor element variations and pH, Eh, or free iron oxide values throughout a profile was found in any of the four soils. (auth)

Shrinivasan, B., E. C. Alexander, and O. K. Manuel. 1971. Iodine-129 in Terrestrial Ores. Science. 173:327-328.

Xenon extracted from natural iodyrite (silver iodide) from Broken Hill, New South Wales, Australia, contains excess ^{129}Xe from the in situ decay of naturally occurring ^{129}I and excess ^{128}Xe from neutron capture on ^{127}I. On the basis of the amount of radiogenic ^{129}Xe, it is estimated that, prior to the nuclear age, terrestrial iodine contained an equilibrium ratio of ^{129}I to ^{127}I of between 3.3×10^{-15} and 2.2×10^{-15}. (auth)

Shull, R. D. 1968. Radioactivity Transport in Water: Simulation of Sustained Releases to Selected River Environments. Thesis. Univ. of Texas.

The tranpsort of radionuclides in rivers was simulated with a mathematical model. Large unregulated rivers receiving continuous normal waste discharges were studied with the model. The model included stochastic temporal flow variation, deterministic longitudinal flow variation, three-dimensional channel geometry variation with time and distance, generalized boundary sorption, boundary erosion, and flooding. Rivers of erratic flow, gradually varying flow, and nonvarying flow were studied. Hydrologic statistical variations in the system were examined. Effects of variations in radioactive half-life, surface concentration distribution coefficient, mass transfer coefficient, and sorption reversibility were also investigated. Variations in the mass transfer coefficient were not significant, but variations in surface concentration distribution coefficients were influential. On a long-term basis, flow variability had a significant effect on transport of short-lived radionuclides. Studies on continuous sedimentation zones indicated that significant quantities of long-lived radionuclides may accumulate therein. (NSA)

Shull, R. D. and E. F. Gloyna. 1968. Radioactivity Transport in Water: Simulation of Sustained Release to Selected River Environments. ORO-490-15.

The transport of radionuclides in rivers was simulated with a mathematical model. Large unregulated rivers receiving continuous normal waste discharges were studied with the model. The model included stochastic temporal flow variation, deterministic longitudinal flow variation, three-dimensional channel geometry variation with time and distance, generalized boundary sorption, boundary erosion, and flooding. Rivers of erratic flow, gradually varying flow, and nonvarying flow were studied. Hydrologic statistical variations in the system were examined. Effects of variations in radioactive half-life, surface concentration distribution coefficient, mass transfer coefficient, and sorption reversibility were also investigated. Variations in the mass transfer coefficient were not significant, but variations in surface concentration distribution coefficients were influential. On a long-term basis, flow variability had a significant effect on transport of short-lived radionuclides, but a negligible effect on transport of long-lived nuclides. Studies on continuous sedimentation zones indicated that significant quantities of long-lived radionuclides may accumulate therein. (auth)

Shvedov, V. P. and V. K. Vinogradova. The Content, Distribution, and Migration of Long-Lived Fission Products in Soils. AEC-tr-6049, pp. 225-32.

One of the basic links in the movement of fission products into the food chain is the soil. The sorption of radioactive products in soils depends on the chemical structure of the soil, its ion exchange capacity, the presence in the soil of ions close in chemical properties to the radioisotopes, the pH of the soil, and the movement of ground waters in the soil. Results are summarized from a number of studies on movement of ^{90}Sr through soils. Data are included from measurements of the content of ^{90}Sr in soil samples collected from 1956 to 1961 at various locations throughout the world. (NSA)

Sigler, W. F. 1966. Effects of Uranium Mill Wastes on Stream Biota. Agr. Exp. Sta., Bull. 462:76.

Waste waters from uranium mills contain radioactive substances. In the Animas river the radium activity was found to be 5 to 9 times above background in the water and up to 25 times the background level in the bottom deposits. Tissues of fish collected from the river contained 10 to 15 times the background levels of radium 226. Studies in the summer of 1958 showed complete absence of bottom fauna below the mill, and this pollution effect extended for 50 miles downstream. The amount of radium in the water and in the biota of the San Miquel and Dolores Rivers was even higher than in the Animas River. It is stressed that waste waters from uranium mills should receive adequate treatment before discharge to prevent such pollution. (auth)

Sill, C. W. 1971. The Particle Problem as Related to Sample Inhomogeneity. LA-4756.

The effect of the specific activity of single particles of various sizes on the comparative homogeneity of plutonium distribution in soil samples is discussed. Information is presented on the relative efficiency of leaching procedures versus total sample decompositon as a function of particle size and origin. (auth)

Sill, J. W. and F. W. Hindman. 1974. Preparation and Testing of Standard Soils Containing Known Quantities of Radionuclides. Anal. Chem. 46:113-118.

A general procedure for preparation of standard soils containing a known quantity of any given radionuclide is described. Four separate standards have been prepared from three different soils using ^{239}Pu to demonstrate the reproducibility and reliability of the procedure. Extensive analyses using ^{236}Pu tracer show that the standards contain the exact concentration calculated to have been added that they are not detectably inhomogeneous on samples as small as 1 gram, and that homogeneous standards of lower concentrations can be prepared exactly by weight dilutions with the unspiked soils. Of a total of 56 determinations made on 1- and 10-gram aliquots of the four individually spiked standards and two others made by dilution, only four determinations showed distinct signs of inhomogeneity with the particular method of preparation and sample size employed. Of the remaining 52 measurements, all agree with the calculated value within three standard deviations of the determination, and 42 were within two standard deviations. The dramatic effect of heat treatment on the leachability of the plutonium is demonstrated. Also, an alternative method for preparation of solid standards for members of the natural uranium and throium series is suggested. (auth)

Sillen, L. G. and A. E. Martell. 1964. Stability Constants of Metal Ion Complexes. Second edition, Spec. Pub. No. 17. The Chemical Society, London.

This book gives equilibrium constants for various reactions of some of the actinide ions and compounds (Th, Pa, U, Np, Pu, Am, Cm, Bk) with organic and inorganic liquids. This is a comprehensive source for metal-ion complexes of organic and inorganic ligands.

Silver, G. L. 1970. Disproportionation of Tetravalent and Pentavalent Plutonium Ions in the Presence of Hexavalent Plutonium. MLM-1744.

The concept that the disproportionation reactions of tetravalent and pentavalent plutonium ions are special cases of the general plutonium equilibrium problem is illustrated with the estimation of the distribution of plutonium valence states when tetravalent and pentavalent plutonium ions are allowed to disproportionate in the presence of excess hexavalent plutonium. Sources of errors in disproportionation stoichiometry coefficients are described, and a table of relative errors is presented. A computer program suitable for estimating plutonium valence state distributions for any initial plutonium oxidation number is included. Application of the program to the study of the autoreduction of solutions of hexavalent ^{238}Pu and ^{239}Pu is suggested. (auth)

Silver, G. L. 1971. Disproportionation Coefficients of Plutonium. J. Inorg. Nucl. Chem. 33:577-583.

The usual disproportionation for Pu(IV) is written 3 Pu(IV) + $2H_2O$ = 2 Pu(III) + $Pu(VI)O_2^{2+}$ + $4H^+$, with no Pu(V). Pu(V) has been shown to result from Pu(IV) disproportionation. Silver proposes equations based on electron balances that include pentavalent plutonium fractional distributions of Pu species are presented for a range of H M of perchloric acid neglecting hydrolysis.

Silver, G. L. 1971. Plutonium Disproportionation Reactions: Some Unresolved Problems. MLM-1807.

The preparation of a predominance region diagram for aqueous plutonium solutions is discussed, and conditions for the equality of the concentrations of three plutonium species are suggested. Other methods of determining the

Values of variable stoichiometry coefficients for tetravalent and pentavalent plutonium are proposed, as are methods for ascertaining plutonium valence state distributions in dilute acids without recourse to lengthy analytical procedures. These methods involve measurement of two solution variables such as acidity and redox potential or fraction of one plutonium species, and are illustrated with computer programs by Carl Wendling. A method of ascertaining the acidity of maximum stability of pentavalent plutonium is proposed, and the effect of temperature upon the stability of the pentavalent plutonium ion is suggested. (auth)

Silver, G. L. 1971. Plutonium in Natural Waters. MLM-1870.

A method for estimating the concentrations of soluble Pu(III), Pu(IV), and Pu(VI) is given by means of a small computer program. Pu polymer - presoluble ratio also can be determined. The water potential and pH are required as input.

Silver, G. L. 1971. Potential-pH Diagram for Plutonium. Radiochem. Radioanal. Leters. 7:1-5.

A method for solving the general plutonium equilibrium problem is presented, and a potential-pH diagram for plutonium is constructed with the aid of this method. Foru conditions of acidity and oxidation number calculated to result in equal concentrations of three plutonium species are suggested and the locus of each "triple point" is indicated in the potential-pH diagram. (auth)

Silver, G. L. 1972. Aqueous Plutonium Chemistry: Some Minor Problems. MLM-1871.

A method is presented for estimating the distribution of plutonium valence states in dilute aqueous acids which do not contain sequestersing agents. The effects of plutonium disproportionation reactions upon the acidity of plutonium solutions is discussed and a method for estimating such effects is illustrated with a computer program by Steven Tomes. Effects of uncertainties in the solubility product of tetravalent plutonium hydroxide on the pH region calculated to yield a maximum equilibrium concentration of pentapositive plutonium are described, and an analogy between aqueous tetravalent plutonium and a weak acid is suggested. The free energy of formation of tetravalent plutonium polymer is estimated as about -340 kcal/mole Pu, and this estimate is used to define the region of acidity and plutonium concentration which is conductive to the formation of plutonium polymer. Also mentioned is the reaction of plutonium with hydrogen peroxide, the temperature stability of pentapositive plutonium, and the study of plutonium in natural waters. (auth)

Silver, G. L. 1972. Instability of Heptavalent Plutonium in Water Solutions. (p. 7-10); Determination of Plutonium in Soil. (p. 18-20). IN: MLM-1829. Mound Laboratory Chemistry and Physics Progress Report. April-June 1971.

Instability of Heptavalent Plutonium in Water Solutions

One of the interesting discoveries in recent times is the heptavalent state of plutonium. If this newly discovered oxidation state can be stabilized in water solutions, many new procedures for processing plutonium and making plutonium compounds may become available. Present prospects for easy stabilization of heptavalent plutonium are not sanguine, however.

Determination of Plutonium in Soil

A complete procedure was established for the determination of plutonium in soil by a fusion technique, and results were reported previously for blank determinations and soil samples.

Silver, G. L. 1972. Plutonium in Natural Waters. Haman, et al., 1972. Determination of Plutonium in Soil. IN: Mound Lab Chem and Physics Progress Report: Oct-Dec 1972. MLM-1888. p. 13-14, 15.

First article by Silver gives some computations for Pu(IV) - Pu(V) distributions in soluble species Polymer of Pu(IV) may not form in seawater due to low Pu concentrations.

Second article describes continuing work on determination of Pu by a fusion process.

Silver, G. L. 1972. Suggestion for the Determination of Plutonium Valencies in Aqueous Solutions. Radiochem. and Radioanal. Letters. 9:315-320.

An equation is derived which may be useful in the determination of plutonium oxidation state concentrations in aqueous solutions. (auth)

Silver, G. L. 1972. Suggestion for the Study of Plutonium in Environmental Waters. IN: Mound Lab. Chem. & Physics Progress Report. Jan-Mar 1972. MLM-1903, pp. 20-21.

Some thoughts by Silver on ascertaining the form and valence state of Pu in environmental waters including approximation of alpha coefficients for Pu^{2+}, Pu^{4+}, PuO_2^{+} and PuO_2^{2+}.

Silver, G. L. 1972. Valence State Distributions of Uranium, Neptunium, and Plutonium in Acid Solutions. MLM-1933.

Mathematical approaches developed for the study of plutonium disproportionation reactions appear to be adaptable to the study of the distribution of the valencies of uranium and neptunium in aqueous solutions. Valence state distributions of uranium and neptunium for various conditons of solution acidity and oxidation-reduction potential are presented in tabular form. A small computer program for the estimation of valence state distributions is presented, and a "solubility product" of tetravalent plutonium polymer is suggested. The Nernst Equation is used to suggest a maximum in the concentration of soluble pentavalent plutonium when the hydrous oxides of tetravalent and hexavalent plutonium are in equilibrium. (auth)

Silver, G. L. 1973. Ambiguous Variable Combinations in Plutonium Chemistry. Radiochem. Radioanal. Letters. 13:101-108.

Forbidden, tolerable and ambiguous combinations of plutonium oxidation number with given fractions of hexavalent plutonium are graphically presented. A graph of ambiguous combinations of trivalent and hexavalent plutonium is also given, and the suggestion is made that there are some combinations of fractions of two valence states (e.g., hexavalent and tetravalent plutonium) which characterize plutonium solutions uniquely. (auth)

Silver, G. L. 1973. Minor Problems in Aqueous Plutonium Chemistry. MLM-2075.

A method of ascertaining the acidity of the maximum concentration of trivalent and hexavalent plutonium as a function of plutonium oxidation number, and a method of estimating changes in solution acidity caused by disproportionation reactions may find application in the study of plutonium alpha coefficients. A method of ascertaining the temperature response of mixtures of plutonium ions indicates a decreased extent of disproportionation of pentavalent plutonium with increasing temperature over a narrow temperature range. The concept of representing chemical elements by polynomial equations is applied to chlorine and the reaction of plutonium with hydrogen peroxide. (auth)

Silver, G. L. 1973. Plutonium Triple Points in Nitrate Solutions (p. 40-43); Effects of Ionic Strength on Plutonium Reactions (p. 44-46); Program for the Rapid Computation of Tables of Valence State Distributions of Uranium, Neptunium and Plutonium (p. 46-48); Valence State Distributions of Americium in Aqueous Solutions (p. 46-51); Approximations in the Calculation of Disproportionation Stoichiometries of Pentavalent Plutonium at Different Temperatures (p. 49-55). Mound Lab. Isotopic Power Fuels Programs. April-June 1973. MLM-2080.

A recent contention that a plutonium triple point should have been observed near pH 1 in nitrate solutions is disputed. Other considerations affecting plutonium equilibria in dilute nitric acid solutions are also mentioned.

The effects of ionic strength upon plutonium reaction is discussed, and a comparison of theoretical predictions and experimental results is mentioned.

A program is presented for the rapid generation of valence state distributions for uranium, neptunium, and plutonium as a function of solution acidity, actinide average oxidation number, and sequestering ability of the solution.

Approximate valence state distributions of americium as a function of average oxidation number are presented for one molar and tenth molar perchloric acid.

Some approximations used in the calculation of disproportionation stoichiometries of pentavalent plutonium at different temperatures are discussed. While approximations used in these calculations will affect the absolute values of stoichiometry coefficients significantly, the effect of some approximations upon the calculated disproportionation free energy change per mole of pentavalent plutonium may not be large.

Silver, G. L. 1973. Stability of Pentavalent Plutonium. J. Inorg. and Nucl. Chem. 35: 369-72.

A method is suggested for maximizing Pu(V) concentration in solutions not containing hydrous plutonium oxides. An example is given of a solution containing H = 0.3. M then = 19.11 when M is the ratio of ionic hexavalent Pu to ionic pentavalent Pu.

A method also is given for maximizing the concentration of Pu(V) in solutions containing hydrous plutonium oxides.

Silver, G. L. 1973. The Three Actinides Equilibrium Problem. MLM-2007.

Much of the aqueous chemistry of uranium, neptunium, and plutonium can be represented by the solution of a single cubic equation. This equation may take the form of a statement of charge conservation for these elements in which the unknown variable is the ratio of hexavalent to pentavalent actinide. By assigning the relative proportion of pentavalent actinide the value of unity, the fraction of each of the other three valence states may be calculated. Tables of valence state distributions of uranium, neptunium, and plutonium as a function of average oxidation number and equilibrium acidity are presented, and two numerical methods for solving the cubic equation are illustrated with computer programs. Forbidden combinations of solution acidity and fraction of pentavalent plutonium are suggested, and a method of finding these forbidden combinations is proposed. (auth)

Silver, G. L. 1974. Characteristic Equations of Plutonium. MLM-2148.

The general plutonium equilibrium problem was solved in terms of trivalent and tetravalent plutonium. New approaches to the determination of plutonium equilibrium acidity using the concept of nonequilibrium valence state distributions were developed, and tolerable combinations of trivalent and tetravlaent plutonium with plutonium oxidation number were explored. The use of characteristic equations for representing elements and reactions has been evaluated, and appears to be best suited to simple chemical systems in which extensive polymerization of species does not occur. (auth)

Silver, G. L. 1974. Plutonium Valence State Distributions. J. Radioanal. Chem. 23:195-197.

A method for ascertaining equilibrium valence state of plutonium in acid solutions as a function of the plutonium oxidation number and the solution acidity is illustrated with an example. The method may be more practical for manual use than methods based upon polynomial equations. (auth)

Silver, G. L. 1974. Potential-pH Diagrams and Plutonium. MLM-2176.

The concept of the greatest lower bound may be combined with conditions for the predominance of valence states to prepare potential-pH and other types of predominance region diagrams. The technique is illustrated for the case of plutonium together with the discussion of the representation of chemical elements and reactions by polynomial equations. (auth)

Silver, G. L. 1974. The Representation of Chemical Elements and Chemical Reactions by Polynomial Expressions. J. Inorg. and Nucl. Chem. 36:939-941.

Silver presents a method for the description of plutonium in solution by means of a single programmed equation: $K_3K_4^2\,[H^+]^4(3-N) + K_4[H^+]^4M(4-N) + (5-N)M^2 + (6-N)M^3 = 0$ O·N = average oxidation number, K_3 and K_4 are equilibrium constants and $M = \frac{Pu(VI)}{Pu(V)}$. The above equation also can be used to prepare a OH-potential diagram. The same method is further developed to describe a chemical reaction ($Fe^{+2} + Ce^{+4} = Fe^{+3} + Ce^{+3}$) with polynomial expressions.

Silver, G. L. 1974. Topics in Aqueous Plutonium Chemistry. MLM-2108.

The general plutonium equilibrium problem is solved with logarithms and a logarithmic form of the plutonium characteristic equation is suggested. Other topics include numerical methods for estimating the equilibrium acidity in plutonium solutions, a characteristic equation for the iron-plutonium reaction, a method for finding some forbidden combinations of solution variables, and properties of ^{238}Pu radiation concentration cells. (auth)

Silver, W. J., C. L. Lindeken, J. W. Meadows, W. H. Hutchin and D. R. McIntyre. 1974. Environmental Levels of Radioactivity in the Vicinity of the Lawrence Livermore Laboratory. UCRL-51547.

The Lawrence Livermore Laboratory continuously monitors the levels of radioactivity within the Livermore Valley and Site 300. Results of analyses performed during 1973 for gross radioactivity and for specific radionuclides of interest in a variety of environmental samples are presented. In all cases, the levels of activity observed during 1973 were found to be below the appropriate concentration guide values of AEC Manual Chapter 0524.

Particulate air filters showed gross beta activities lower than those observed during 1972, reflecting a reduction in global fallout in the atmosphere. Gamma spectral measurements on Laboratory perimeter air filters also showed lower activities of global fallout gamma emitters. These perimeter air samples were analyzed for ^{239}Pu, ^{238}Pu, ^{90}Sr, ^{235}U, and ^{239}U. With the exception of one sampling location, the annual average ^{239}Pu concentration was 1.3 X 10^{-17} μCi/ml, typical of global fallout. Air samples taken within Site 300 were analyzed for uranium. These analyses showed a lower than normal ratio of ^{235}U/^{238}U. This is due to "depleted" uranium (uranium which is specially processed to lower than ^{235}U content) used at the Site. Airborne uranium concentrations were well below the standards set by the AEC. Soil samples collected in the off-site vicinity of LLL perimeter boundaries and at Site 300 were analyzed for plutonium, uranium, and gamma emitting radionuclides. Traces of plutonium above global background levels were detected in two off-site samples near the east perimeter of the laboratory. Sediment samples collect in surface drainage pathways from LLL showed that the plutonium in these sediments was in the same range observed in soil samples indicate depleted levels of ^{235}U near firing bunkers, but ^{235}U/^{238}U ratios approach that of natural uranium at site perimeters. These data indicate no apparent change from that observed in 1972. Water samples collected within the Livermore Valley exhibited normal background gross beta and tritium activities. Gamma spectral analyses of vegetation samples revealed no gamma-emitting radionuclides other than those present naturally or in global fallout. The vegetation samples collected in areas generally downwind from the Livermore Laboratory revealed tritium activities 10 to 100 times higher than those collected in areas where the laboratory's contribution should be minimal. However, if the vegetation were a regular part of one's diet, the annual whole body radiation dose from tritium would be less than 1 mrem. The off-site radiation exposure rates measured by thermoluminescent dosimeters were in the range to be expected from the naturally occurring radionuclides in the soil and from local cosmic radiation. Assessment of the radiation doses to an individual from the observed environmental activities listed indicates the contribution from artificially produced radionuclides is small in comparison with the approximately 100 mrem/yr dose received from natural sources. (auth)

Simpson, O. D. 1975. Radioactive Effluent Monitoring at the Idaho National Engineering Laboratory. IN: Proc. Third Environmental Protection Conference. ERDA-92. 2:584-606.

The Effluent and Radiation Measurements Laboratory at the Idaho National Engineering Laboratory (INEL) has recently upgraded capabilities in the field of monitoring and analysis of radioactive airborne and liquid effluents using the techniques of gamma-ray spectrometry. The techniques and equipment used include remotely-operated, computer-based Ge(Li) spectrometers which obtain data on a real-time basis. Permanent record files are maintained of both the effluent release values and the gamma-ray data from which the release values are calculated. Should values for release levels ever be challenged, the gamma-ray spectral information for any measurement can be recalled and analyzed as needed. Daily effluent release reports are provided to operating personnel which contributes to prompt correction of any operational problems. Monthly, quarterly, and annual reports are compiled which provide inventories of the radionuclides released. A description of the effluent monitoring, reporting, and records system developed at INEL for this application will be presented. (auth)

Simpson, E. S. 1959. Summary of Current Geological Research in the United States of America Pertinent to Radioactive Waste Disposal on Land. IN: Disposal of Radioactive Wastes. 2:517-31.

Research in geology may be divided into three categories according to the degree of containment required for the waste in order to assure conformance with generally accepted standards of health and safety. (I) Maximum containment environments are intended to retain for centuries or for millenia essentially all waste materials stored in them. Two general types are under investigation, salt deposits and deep permeable formations. In both cases various laboratory experiments are being performed to study the interaction between waste solutions and appropriate earth materials, and, in the case of salt, a field experiment is in progress utilizing simulated (nonradioactive) high-activity waste. (II) Intermediate containment environments are intended to slow down significantly the mobility of radioactive wastes to provide sufficient time for radioactive decay before the wastes come into contact with man or his food chain. Examples of intermediate containment are shallow burial of packaged waste and discharge of bulk liquid waste into seepage pits. Research is in progress to study the combined effect of transport of radio-

nuclides by ground water and retention of radionuclides by sorption on earth materials. (III) Environments of no containment are those in which radionuclides are immediately brought into contact with man or with any of the biota of his food chain. Research is under way both to determine the capacity of individual environments to receive such waste within health and safety limits and to improve techniques for doing so. Current research includes (a) classification of terrains as related to waste disposal problems, (b) study of diffusion characteristics of streams, (c) the effect of organic and inorganic stream solids on radioactivity concentration, and (d) the effect of suspended sediment and river-bed material on the transportation of radionuclides. (auth)

Simpson, E. S. (Pt. 1), J. Souffriau, E. Simpson, L. Baetle and P. Dejonghe (Pt. 2) and L. Baetsle and P. Dejonghe (Pt. 3). 1961. Investigations on the Movement of Radioactive Substances in the Ground. Pt. I. Geohydrology and General Considerations. Pt. II. The Copper-Rod Method for Measuring Ground-Water Flow. Pt. III. Practical Aspects of the Program and Physico-Chemical Considerations. EURAEC-184.

A research program concerned with the treatment and disposal of radioactive wastes is discussed. The program is devoted to development of methods for quantitative evaluation of terrestrial sites for ultimate disposal. Sites chosen for use as outdoor laboratories in which methods may be field tested include a dominantly sandy terrain and a dominantly clayey area. Other information concerning the movement of radioactive substances in the ground is presented in discussions of the Cu-rod ground-water flow measuring method and physiochemical aspects of the disposal sites. (NSA)

Simpson, H. J. and S. C. Williams. 1975. Plutonium and Cesium Radionuclides in the Hudson River Estuary. Annual Technical Progress Report, December 1, 1974-November 30, 1975. COO-2529-1.

We have obtained a large set of gravity cores from the Hudson Estuary through much of the ambient salinity range. A number of core sections have been analyzed for ^{137}Cs, ^{134}Cs, ^{60}Co, and ^{40}K by direct gamma counting, and for ^{239,240}Pu by alpha-spectrometry. The distribution of both ^{137}Cs and ^{239,240}Pu indicates rapid accumulation in marginal cove areas and in the harbor region adjacent to New York City. The distribution of both ^{137}Cs and ^{239,240}Pu in the sediments is quite similar in surface sediments, and the trends with depth in cores are also similar. The ratio of sediment $^{239,240}Pu$ to ^{137}Cs throughout the sampled salinity range (0-20 $^{o}/oo$) approximates that in fallout, except near the nuclear reactor at Indian Point where releases of ^{137}Cs result in a ratio lower (0.004 to 0.008) than typical of fallout (0.015). Measurement amounts of reactor-derived ^{134}Cs, ^{60}Co, and ^{54}Mn are found in nearly all of the samples containing appreciable ^{137}Cs. These samples were between 15 km upstream of Indian Point reactor site and the downstream extent of our sampling, 70 km south of the reactor. (auth)

Singh, B. R. 1974. Migration of Ions in Soils. I. Movement of ^{65}Zn from Surface Application of Zinc Sulphate in Soil Columns. Plant Soil. 41:619-628.

Plastic columns were uniformly packed with two different soils and subjected to percolation with different amounts of simulated precipitation after the addition of $ZnSO_4$ labelled with ^{65}Zn to the surface of each soil column. When drainage stopped, soil columns were frozen and cut into 3-cm segments, and radioactivity was determined with a well-type scintillator. Total Zn was calculated from activity counts. Soil samples were also analyzed for exchangeable Zn, Ca, and Mg. It is concluded that movement of Zn through soils depends not only on cation exchange capacity, but also on additional factors such as water flow-rate, pH, initial Zn content and the migration of other fractions of soils. (NSA)

Singh, B. R. 1974 Migration of Ions in Soils. II. Movement of ^{54}Mn from Surface Application of Manganese Sulphate in Soil Columns. Plant Soil. 41:629-636.

Movement of ^{54}Mn from surface application of manganese sulphate in soil columns was investigated after leaching with different amounts of rain water. Alternate leaching and drying affected the depth of penetration of Mn. The presence of Zn cation had no appreciable effect on the distribution of Mn in the soil columns. Exchangeable Mn displayed distribution patterns similar to total Mn. Mn movement in soil not only depends on cation exchange capacity and clay content, but also involves other factors such as water-flow-rate, pH, migration of clay fractions and oxidation reduction conditions. (NSA)

Sirbu, M. 1974. Determination of the Gamma, Superficial Specific Contamination of the Radioactive Zones, with the Help of a Helicopter. Stud. Cercet. Fiz. 26:575-581 (in Rumanian).

The mathematical formula for the determination of the gamma superficial, specific contamination for radioactive zones in the static case is presented. The calculation error is given. The conditions for measuring in the dynamic case are also discussed. Two diagrams are included. (auth)

Skocek, V. 1962. Patches Enriched in Vanadium in Permian Sediments. Vestn. Ustredniho Ustavu Geol. 37:347-52 (in Czechoslovakian).

In lower Permian sediments of the Plzen and Manetin basins (Czechoslovakia), light-green patches, 0.5 up to 1.5 cm, occur. Their amount in sandy rocks is greater than in the clay ones. According to the form of the center, the patches were divided into five groups. The chemical analyses gave V up to 8.20, U 0.062, MnO 0.02, and Cu 0.70% in the centers. Spectrochemically Ni, Zn, and Sr were detected in subordinate amounts and Ag, Co, Cr, and Pb in traces. The origin of the patches was favored by suitable conditions in the course of diagenesis during which V could migrate in the form of V^{5+} anionic complexes. Small fragments of dark minerals (especially mica), crystals of calcite, and accumulations of organic substance served as the centers of precipitation. The centers enriched in V, U, etc., reduced Fe^{+++} to Fe^{++} and conditioned its transport from the immediate vicinity of the center. This was the principal cause of the bleaching of red sediments. The patches described occur in sediments possessing a special association of authigenic minerals (calcite, oxides of Fe) which originated under special climatic conditions. The patches may serve in parallelizing of stratigraphic profiles. (CA)

Sloat, R. J. 1967. Hanford Low Level Waste Management Reevaluation Study. ARH-231.

This report details disposal and treatment of aqueous, organic, gaseous, and solid wastes, and the potential effects of increased ground water level.

Rough estimate of capital and operation costs are used to compare alternative and select programs warranting more detailed study. (auth)

Smierzchalkska, K. 1972. Influence of Potassium, Ammonium and Calcium Ions on the Sorption-Desorption Patterns of ^{137}Cs in Various Soils. Pol. J. Soil Sci. 5:117-125.

The NH_4^+ and K^+ ions affected most the adsorption of ^{137}Cs by soils, and their reducing effect took place markedly at increasing concentrations. The NH_4^+ were more effective than the K^+ ions. The Ca^{2+} ions were almost ineffective in the adsorption processes of ^{137}Cs in heavier types of soils; they were of some small effect in sandy soils at very high concentrations. (auth)

Smierzchalska, K. 1973. Sorption and Desorption of ^{137}Cs in Soils and the Effect of Various Cations on Their Patterns. Rocz. Nauk Roln. Ser. A. 99:39-61 (in Polish).

In laboratory experiments, the sorption and desorption patterns of ^{137}Cs (total, exchangeable and nonexchangeable sorption) were determined in 18 soils. The influence of competing cations NH_4, K or Ca applied at various concentrations (0.01-0.5 N), together with ^{137}Cs, on the sorption of radionuclide in soils were studied. The results of potassium sorbed in soils (determined radiometrically using K-42) constituted the basis for the consideration of selective ^{137}Cs sorption when applied as the cation-pair $^{137}Cs/K$. The relative replacing power of cations for ^{137}Cs removal from the soil complexes was investigated using several mono- and bivalent cations (NH_4, K, Rb, Cs-stable, Na, Ca, Mg, H), at various concentrations, ^{137}Cs applied in trace concentrations was almost totally sorbed in mineral soil indicating no differences between values for total sorption, which amounted to 99.5 to 99.9% of the rate added. The differences occurred in the soil capacities for stronger fixation of ^{137}Cs. The soils of greater sorption power released 5 to 27% of adsorbed cesium (exchangeable forms). Nonexchangeable forms of radionuclide in these soil types amounted to 88% as the mean value for 10 soils. In the soils of lower sorption capacities, sandy soils, the fixation of ^{137}Cs was much less; the exchangeable forms amounted to 60% of the total radionuclide adsorbed. Peat soils sorbed even lower quantities of ^{137}Cs. Some of them sorbed 78 and 89% of the rate added; the exchangeable forms of adsorbed cesium varied from 69 to 83%. The ammonium ions present in the solution together with ^{137}Cs added to soils decreased the sorption of radionuclide more significantly than potassium ions. The influence of both cations depended on their concentration in the solution, as well as on soil types. When the concentration of NH_4 or K ions increased, the sorption of ^{137}Cs decreased much more on sandy soils than on heavier ones. The Ca ions introduced together with ^{137}Cs had no effect on cesium sorption in heavier soils. Their greater influence, reducing ^{137}Cs sorption by 20%, occurred on sandy soils, at the highest Ca concentration in the solution (0.5 N). The Ca ions were the most effective on peat soils, where the reduction of ^{137}Cs sorption was remarkable even at their lower concentrations. The investigation of sorption of the ion par ^{137}Cs/K in the soils proved selective sorption of the radionuclide, which was affected greatly by soil types and potassium concentration. Stronger selective sorption of cesium appeared at low K concentration in solution and on heavier mineral soils. The amounts of ^{137}Cs desorbed from soils depended on the kind and concentration of replacing cation, as well as on soil types. (auth)

Smith, A. E., (comp.) 1973. Nuclear Reactivity Evaluations of 216-Z-9
Enclosed Trench. ARH-2915.

Plutonium accumulation and the nuclear criticality implications were evaluated for a subsurface liquid waste disposal site at Hanford, Washington. Remote plutonium detection by infrared, gamma, and neutron surveys are described. Geological drilling and soil sampling techniques were developed and described. Nuclear criticality safety was evaluated by computer model calculations and by neutron pulsing techniques. This study discusses technologies used to evaluate a waste disposal site for a plutonium recovery operations. (auth)

Smith, A. E., D. J. Brown and R. E. Isaacson. 1974. Chemical Behavior and Ground Movement of Selected Radionuclides. Nuclear Tech. 24:444-446.

Waste management practices at Hanford are based on 30 years of experience and special studies. Aqueous high-level wastes are being converted to salt cakes in underground tanks to reduce the potential for loss of liquid high-level radioactive waste due to tank failure. If wastes enter the ground they are sorbed in the Hanford sediments and become fixed in place by natural processes. Water from the equivalent of a thousand years of rainfall in one deluge is not likely to move the radioactive materials such as plutonium, strontium, and cesium to the water table. (auth)

Smith, A. R. and H. A. Wollenberg. 1972. Geology and Natural Terrestrial Dose Rates. HASL-269, pp.88-11.

The natural component of environmental γ-ray radioactivity determined on land depends mainly on the U, Th, and K contents of the rock and soil. Detailed studies of the distribution and abundance of U, Th, and K and associated γ-dose rates in rocks encompassed are summarized. (CA)

Smith, D. B., [illegible]. L. Wearn, H. J. Richards, and P. C. Rowe. 1970. Water Movement in [illegible] nsaturated Zone of High and Low Permeability Strata by Measuring Nat[illegible] Tritium. <u>IN</u>: Isotope Hydrology 1970. IAEA-SM-129/6, pp. 73-87.

Measurement of the natural tritium concentration in groundwater samples from a vertical profile in the unsaturated zone of a formation has been used to provide information on the downward movement of water in the strata since the production of thermonuclear tritium in 1954. The tritium profiles are evaluated in terms of hydrological models to examine the mechanism of water recharge.

Tritium measurements in the Chalk have shown that downward movement is principally by intergranular seepage with a smaller component of movement through crack systems. Two hydrological models offer alternative interpretation of the water recharge. Tritium measurements in a low-permeability clay show the downward movement of water by intergranular seepage and indicate that recharge occurs by replenishment of the summer soil moisture deficit by autumn rainfall. (auth)

Smith, D. D., J. Barth, R. G. Patzer. 1975. Grazing Studies on a Plutonium Contaminated Range of the Nevada Test Site. IAEA-SM-199/73.

A grazing study on a plutonium-contaminated range on the Nevada Test Site was initiated in May of 1973 and is continuing. For this study, cattle are confined to an area of known plutonium contamination. Their entire diet consists of native plants growing in the contaminated soil. The primary objective of this study is to determine the uptake and tissue distribution of the plutonium by ruminants. Other objectives are to evaluate maternal-fetal transfer, to determine uptake and distribution differences in young versus mature animals, and to compare these data with those collected from other contaminated areas. Steers with surgically prepared rumen fistulas served as biological samplers to determine grazing habits (quantity and type of forage ingested) as a function of seasonal plant availability and preference, to estimate intake of actinides over specified periods of time, and to determine the actinide ratios within the ingesta.

Since the study began, tissue samples have been collected from three cows, two calves, and one fetus in October 1973; three cows and two feti in July 1974; and one cow and two yearling calves in June 1975. Other animals sampled from the study area included three goats, three foxes, one jackrabbit, and one coyote.

All animals sacrificed were necropsied and selected tissue and organ samples collected for histopathological examination and actinide analyses. No significant lesions have been found and actinide accumulations in the tissues have been relatively minimal. Using activity levels found in the rumen contents of fistulated steers, it was estimated that a study cow ingested 100 μCi prior to sacrifice. Of this, 16.4 μCi was in fluids from which a combined retention factor of 0.0034% was calculated for the bone, muscle, and liver. Comparisons of ^{239,238}Pu ratios in ingesta and tissues indicate that the ^{238}Pu is more readily absorbed and retained.

Analysis of ingesta from the fistulated steers indicates that the favored plant species were two grasses, *Hilaria jamesii* and *Orhyzopsis hymenoides*; two shrubs, *Eurotia lanata* and *Atriplex canescens*; and one forb, *Salsola paulsenii*. Grasses are preferred in the late spring and early summer months, with shrubs making up the bulk of the diet the rest of the year. Plutonium activity in rumen contents was higher when Eurotia lanata was the preferred shrub species.

Studies on labeled particles indicate that ingested particles from 75 to 500 μm in size have a half-time of 3.5 to 5 days in the intestinal tract, while particles of 15 to 25 μm in size have a half-time of about 1.4 days. (auth)

Smith, R. F. and J. M. Jackson. 1969. Variations in ^{234}U Concentrations of Natural Uranium. KY-581.

Uranium ore concentrates from sixteen world sources were analyzed to determine variations in the ^{234}U content of natural uranium. A spread of approximately 7.5 percent of the ^{234}U content was apparent among the various sources. The lowest concentration, 0.00500 ± 0.00002 wt percent ^{234}U, was obtained on ore concentrate from Mines Development in Edgemont, South Dakota. The highest concentration, 0.00539 ± 0.00002 wt percent ^{234}U, was obtained on Belgian Congo pitchblende. (auth)

Smith, W. L. and F. J. Flanagan. 1956. Use of Statistical Methods to Detect Radioactivity Change Due to Weathering of a Granite. Am. J. Sci. 254:316-24.

Forty-four samples of the Conway granite were collected from the red and green phases of the rock at the Redstone, New Hampshire quarries. A large variation in radioactivity as measured by β-counting is shown between individual samples. Inspection of the data shows that the red phase is higher in radioactivity than the green. An analysis of variance with a single variable of classification shows that the means of the fresh and weathered red phases are not significantly different, whereas a "t" test using differences between pairs of the fresh and weathered green samples shows that the means of these two sets differ significantly. From these tests and a comparison of the variances of the respective sets, it is inferred that weathering has had a significant effect on the green phase only. It has been shown, by comparing the variances of the subsets of data with the known variance of the method of measurement that some external factor such as variations in mineralogic composition or differential leaching or adsorption may be responsible for the variations in radioactivity. (auth)

Smith, V. H. and R. W. Wagner. 1957. Preparation of Aqueous Suspensions of $Ru^{106}O_2$ and $Pu^{239}O_2$. HW-47500.

The preparation of aqueous suspension of radioactive ruthenium oxide and plutonium oxide particles is described. (auth)

Snelling, R. N. 1971. Environmental Survey of Uranium Mill Tailings Pile, Mexican Hat, Utah. Radiological Health Data and Reports. pp. 17-28.

At the request of the Navajo Tribal Council through the PHS Division of Indian Health at Window Rock, Arizona, an environmental radiological survey was conducted on the A-Z Minerals Corporation uranium tailings pile, Mexican Hat, Utah, in May 1968. The purpose of the survey was to identify any radiation hazards which might exist and recommend methods for their control. The survey included evaluation of external gamma radiation and airborne and water borne radioactivity.

The results of the survey indicate that the external radiation levels on the tailings area exceed recommended exposure limits for individuals in the general population. Therefore, the area should not be released for public use in its present state. Action which would permit the release of the area would involve covering the tailings with uncontaminated soil to ar [illegible] that would diminish the external radiation to an acceptable level [illegible] stablilize the covering against wind erosion.

Radiation levels in air and water do not exceed recommended exposure limits. However, to minimize the possibility of increased activity from weather conditions different from those existing during the survey, it is recommended that the tailings be stabilized against wind erosion or periodic monitoring will be necessary. (auth)

Snelling, R. N. 1970. Environmental Survey of Uranium Mill Tailings Pile, Monument Valley, Ariz. Radiological Helath Data and Reports. pp. 511-517.

At the request of the Navajo Tribal Council through the Public Health Service Division of Indian Health at Window Rock, Ariz., an environmental radiological survey was conducted on the Foote Mineral Company's uranium tailings pile, Monument Valley, Arizona, in May 1968. The purpose of the survey was to identify any radiation hazards which might exist and recommend methods for their control. The survey included evaluation of external gamma radiation, airborne radioactivity, and waterborne radioactivity.

The results of the survey indicate that existing radiation levels do not exceed recommended exposure limits. However, to minimize the possibility of increased activity from weather conditions different from those existing during the survey, it was recommended that the mill tailings be stabilized against wind erosion. Otherwise, periodic monitoring will be necessary in the future. (auth)

Snelling, R. N. 1969. Environmental Survey of Uranium Mill Tailings Pile, Tuba City, Arizona. Radiological Health Data and Reports. pp. 475-487.

At the request of the Navajo Tribal Council, an environmental radiological survey was conducted on the El Paso Natural Gas Company uranium tailings pile, Tuba City, Arizona, in May 1967. The purpose of the survey was to evaluate potential radiation hazards and to recommend methods of control. The survey included evaluation of external gamma radiation, airborne radioactivity, and waterborne radioactivity.

The results indicate that the external radiation levels on the tailings area exceed recommended exposure limits for individuals in the general population. Wind carriage of the tailings in an easterly direction from the pile has resulted in elevated radiation levels outside the controlled area.

On the basis of these data it was recommended that the mill tailings be properly stabilized against wind erosion or periodic monitoring would be necessary. In May 1968 the pile was regraded and stabilized against wind erosion using a chemical binder. Because of the external radiation levels on the tailings area, this area was not released for public use. It was fenced and posted as a radiation area. The housing area was released to the Navajo Tribe and is presently occupied. (auth)

Sokol, D. 1970. Ground Water Safety Evaluation-Project Gasbuggy. Teledyne Isotopes. PNE-1009.

The most likely path for hydrologic transport of radionuclides from the Gasbuggy Site to possible water-use points is through the Ojo Alamo Sandstone.

Groundwater in the Ojo Alamo Sandstone flows westward. The point at which groundwater in the Ojo Alamo Sandstone could mix with other water is along the San Juan River near the mouth of Los Pinos River, 38 km northwest of the Gasbuggy Site. Based on available data, groundwater flowing from the Gasbuggy Site will take 5900 years to reach the confluence of the San Juan and Los Pinos Rivers. At the Gasbuggy Site, the total dissolved solids, sodium, and sulfate content of the groundwater occur in concentrations higher than acceptable for irrigation or domestic use.

Tritium, ^{90}Sr, and ^{137}Cs will decay to concentrations below the appropriate concentration guides (CG) for the general public before reaching the San Juan River. Tritium will travel a maximum of 2100 meters in no more than 309 years before decaying to a concentration of 1×10^{-3} μCi/ml (the CG for tritium). Because of their high K_d values, ^{90}Sr and ^{137}Cs will migrate no farther from the cavity than 320 meters and 3.5 meters, respectively, in 1,000 years. By this time, both nuclides will have decayed to well below the CG. (auth)

Somayajulu, B. L. K. and T. M. Church. 1973. Radium, Thorium, and Uranium Isotopes in the Interstitial Water from the Pacific Ocean Sediment. J. Geophy. Res. 78:4529-31.

The Ra, Th, and U isotopic concentrations were determined in the interstitial water expressed from a deep sea core of the eastern equatorial Pacific The isotopes ^{226}Ra, ^{228}Ra, ^{230}Th, and ^{228}Th are higher by 1 to 3 orders of magnitude than their concentrations in seawater. Ra release from sedimentary phases with migration into the water column is indicated. The results are also compatible with the excess ^{228}Th (relative to ^{232}Th) found in authigenic deep sea minerals. (CA)

Somayajulu, B. L. K. and E. D. Goldberg. 1966. Thorium and Uranium Isotopes in Seawater and Sediments. Earth Planet. Sci. Lett. 1:102-6.

Thorium concentrations in three open Pacific Ocean water samples had values of $n \times 10^{-10}$ grams/liter, concentrations similar to those previously measured in the Atlantic. Radioactive disequilibrium exists between the dissolved forms of ^{231}Th and ^{232}Th and the dissolved, excess unsupported ^{228}Th apparently is introduced by the input of ^{228}Ra from the particulate phases containing ^{232}Th. The ^{230}Th/^{232}Th ratios in seawater are similar to those taken from the surface sediments in the same area. Differences in the ^{230}Th/^{232}Th ratios in barite and foraminifera extracted from the same levels in sediments are suggestive of differences in the ratio between surface and deep ocean waters. (auth)

Sorathesn, A., G. Bruscia, T. Tamura, and E. G. Struxness. 1960. Mineral and Sediment Affinity for Radionuclides. CF-60-6-

In determining radionuclide sorption by clay minerals, shortcomings in the filtration technique for solid separation and in the contact times selected for testing were noted. Filters were found to have a high affinity for cesium and strontium when these elements were present in tracer-level concentrations. Sorption equilibrium was not established in 24 hr, and the contact time was extended to 7 days. The affinity of the clay minerals illite, kaolinite, montmorillonite, and vermiculite for selected radionuclides was established after these shortcomings in the testing procedure were corrected. Illite exhibited a very high affinity for ^{137}Cs (K_d = 200,000 after 7-day contact); none of the clay minerals demonstrated exceptionally high affinity for strontium (K_d 4000 for kaolinite, which was the highest measured value). The behavior of cobalt and zirconium-niobium was complicated by the colloidal nature of the elements. The uptake of the above radionuclides by a composited sample of Clinch River sediment showed that cesium and strontium behaved in accordance with the mineralogic character of the sediment. The sediment sorbed more cobalt than was accountable by the mineral composition; organic matter interactions with the cobalt are thereby suspected. (auth)

Sotobayashi, T., T. Suzuki, and S. Koyama. 1967. Geochemical Fractionation of ^{239}Np in Fresh Nuclear Debris Through the Atmosphere. Bull. Chem. Soc. Jap. 40:1555.

Highly fractionated fission products, detected within 36 hours after the third Chinese nuclear test, were enriched with refractory fission products ^{97}Zr, ^{99}Mo, and ^{143}Ce and depleted in ^{132}Te and ^{133}I. Most of the particles were depleted in ^{239}Np, but some were markedly rich in ^{239}Np with no detectable amount of ^{132}Te and ^{133}I. The ^{239}Np seemed to behave refractorily in surface bursts. Data suggest that gravitational and meteorological forces and differences in size and density cause particle separation in an atomic cloud. Observations show fractionation behavior of ^{239}Np to be modified and that particle separation takes place in 1.5 days travel in the cloud. (NSA)

Souffriau, J., E. Simpson, L. Baetsle, and P. Dejonhge. 1962. Investigations on the Movement of Radioactive Substances in the Ground. Part II. The Copper-Rod Method for Measuring Ground-Water Flow. TID-7628, p. 155-65.

Preliminary tests showed the possibility of measuring the ground-water flow using a chemisorption reaction of silver-plated copper rods after injecting ^{131}I as a ground-water tracer. Laboratory tests with the ^{131}I-copper-rod system indicated that a reproducible relation exists between the activity in solution and that fixed on the metallic surfaces (copper, silver-plated copper or mercury coated copper). Two preliminary field tests are described in which silver-plated copper rings were fixed on a steel bar and inserted in the ground after injection of respectively 1 mc ^{131}I in test n°1 and 5 mc ^{131}I in test n°2. In both tests, the ^{131}I solutions were introduced after freezing. Results indicate the copper-rod method is convenient for detailed measurement of the ground-water flow paths and dispersion in shallow aquifers. However, some technical aspects of this method have to be elaborated further with regard to mechanical strength of the rods and possible vertical movement of the injected source. Furthermore it is envisaged to extend the use of the method by studying other tracing systems which could react with a metallic surface. Presently the possibility of using a tracer such as $Co(CN)_6^{4-}$ is under consideration. (auth)

Spalding, R. F. and W. M. Sackett. 1972. Uranium in Runoff from the Gulf of Mexico Distributive Province: Anomalous Concentrations. Science. 175:629-31.

Uranium concentrations in North American rivers are higher than those reported 20 years ago. The increase is attributed to applications to agricultural land of larger amounts of phosphate fertilizer containing appreciable concentrations of uranium. Experiments showing a constant phosphorus-uranium ratio for various types of fertilizers and for the easily solubilized fraction of 0-46-0 fertilizers support this view. (auth)

Spicyn, W. J. 1957. Problems of Radioactive Waste in Modern Technique. Nucleonika. 2:451-4 (in Polish).

Methods for separation and recovery of ^{137}Cs and ^{90}Sr from mixtures of fission products and the absorptive properties of soil as a medium for waste disposal are discussed. (auth)

Spitsyn, V. I. (ed.). 1961. Investigations in the Field of Uranium Chemistry. ANL-Trans-33.

This is a compilation of papers on various aspects of uranium chemistry.

Spitsyn, V. I. and V. D. Balukova. 1967. Investigation of Sorption and Migration of Radioisotopes in Soil and Rocks of Different Compositions. IN: Proc. Symp. Disposal of Radioactive Wastes into the Ground. IAEA-SM-93/13.

As a rule, the sorption properties of soil and rock are assessed by investigating a number of competing physicochemical factors which determine the state of the sorbent itself, of the radioisotope and of the medium in which it is present, and by observing the changes which may occur when liquids interact with the solid phase.

The paper examines the results of investigations of the sorption and migration of individual radioisotopes in soils, rocks and minerals of various geological formations. The authors give data on the effect of the initial concentration of isotope and the accompanying macrocomponents of the liquid phase, together with the results of study of sorption kinetics, static and dynamic capacity and other factors. They describe the basic mechanisms which appear to govern the sorption of the individual microcomponents contained in low-level waste. Finally, they discuss methods of conducting laboratory and field studies for assessing radioisotope migration. (auth)

Spitsyn, V. I. and V. D. Balukova. 1972. Study of the Interaction of Wastes With the Geological Material Subsurface Depositories and Development of Methods of Preparation of Wastes for Disposal. ORNL-tr-2789.

The process of liquid radioactive waste disposal into porous water-bearing layers of deep formations is accompanied by a series of physicochemical processes in the geological environment of the storage site. An evaluation of such processes and their consequences should be performed parallel to the hydrogeological studies of the geological depositories. An entire series of studies necessary for a direct characterization of the material of the layer are described. Factors determining the basic conditions of compatibility of the liquid wastes with the geological material are also considered. A series of methodical measures of experimental practice for the determination of the limits of compatibility of the stratal water and the wastes is described. Data on such determinations for a wide range of concentrations of various components of the waste materials are given for various levels of mineralization of the stratal water. On the basis of an analysis of the liquid radioactive wastes, as well as an examination of the properties, and behavior of individual components, the development of technological measures for the preparation of the wastes and their disposal into the formation by means of boreholes is presented. For individual conditions, the most advisable and suitable measures of chemical treatment of the operating zones of the boreholes are described from the standpoint of maximum increase of their acceptability. (auth)

Spitsyn, V. I., V. D. Balukova, and V. F. Bagretsov. 1968. Physiochemical Conditions of Underground Disposal of Radioactive Wastes. Atomnaya Energiya. 24:133-136.

1. A basic study of physicochemical conditions necessary to evaluate underground disposal of liquid radioactive wastes was undertaken.
2. Conditions governing burial of decontamination waste streams at the NIIAR site are described.
3. Efficient technological schemes providing for a stable liquid phase with wastes compatible with the geological host medium were arrived at.
4. General conditions for sorption of radioactive isotopes in burial of waste waters in a stratum containing highly mineralized stratal water are discussed. (auth)

Spitsyn, V. I., V. C. Balukova, and T. A. Ermanova. 1963. Studies of Sorption and Migration of Radioactive Elements in Soil. IN: Treatment and Storage of High-Level Radioactive Wastes. IAEA, Vienna, pp. 569-77 (in Russian).

The results are presented of investigations into the sorption and migration of radioelements during radioactive filtering flow through the soil. The types of sand, of average coarseness and effective porosity, which are to be found widely disseminated throughout the central belt of the Soviet Union were used. It is shown that the sorption of strontium and cesium take place separately and that the capture of cesium by soils is an irreversible process. It is also shown that sorption processes inhibit the filter-diffusion process at low diffusion rates and that the strontium movement is 40 to 60 times slower than the filtering and the cesium movement 100 times slower. Trials were made with a method of calculating the basic kinetic parameters of sorption, thus making it possible to characterize the movement of radioactive strontium and describe the migration of radioactive cesium. (auth)

Spitsyn, V. I., V. D. Balukova, V. V. Gromov, S. I. Zakharov, B. P. Zhagin, and F. M. Spiridonov. 1959. Sorption Regularities in Behavior of Fission-Product Elements Dueing Filtration of Their Solutions Through Ground. IN: Disposal of Radioactive Wastes. Conf. Proc. 2:429-435.

Research on the sorption of radioisotopes under natural conditions employing the controlled filtration process was performed. Radioisotopes were introduced into the solution as soon as filtration had become steady and the process continued for 4 months. Soil samples were taken by drilling at different depths and analyzed to determine their radioisotope content. Diffusion of radioisotopes was observed at depths of 10 m, two distinct boundaries of soil-activity decrease where ascertained: at the surface of the site and at the depth of the solution filtration front. The radiostrontium absorption by natural sorbents, principally pure minerals widely distributed in soils and subsoils, was investigated separately. The presence of calcium ions, even in small quantities, sharply reduces the degree of radiostrontium sorption. Other conditions being equal, strontium may be absorbed to a greater extent than calcium, according to the composition of the sorbent. The field investigations of radiostrontium sorption and migration showed that when filtering radioactive solutions two possible variants have to be considered. In the first case the solutions are discharged into soil unaffected by any flow of ground water. In this situation the radiostrontium is retained by the soil. In the second case, the radioisotopes proceed directly into the water-bearing horizon. The radiostrontium will then migrate with the ground water flow and through the soil and this migration will be further affected by the sorption and desorption processes occurring. The experiments performed demonstrate the ease with which long-lived radioisotopes migrate under natural conditions and call attention to the need for thorough study of ground water problems in connection with various methods of disposing of radioactive waste into ground. (auth)

Spitsyn, V. I., V. D. Balukova, A. F. Naumova, V. V. Gromov, F. M. Spiridonov, E. M. Vetrov, and G. I. Grafov. 1957. A Study of the Migration of Radioelements in Soils. IN: Hearings on Industrial Radioactive Waste Disposal. 3:1913-37.

A study is presented of the laws governing the sorption of uranium fission products by some natural sorbents, such as soils and soil forming minerals, from solutions with a varying salt content. Particular attention is paid to strontium-90 as the most dangerous isotope from the physiological standpoint. Laboratory tests proved that the sorption of all the known radioelements, with the exception of radiozirconium, radioniobium and radiocesium, is much more complete from alkaline solutions that from acidic. The pH of the medium had a particularly strong effect on the sorption of cerium. Up to 98 to 100% of cerium was absorbed from an alkaline solution containing sodium nitrate, regardless of the initial concentration or the quantity or nature of the soil. As for acidic media, from solutions containing aluminum, cerium was practically not absorbed at all. The degree of sorption of radioruthenium was extremely low, but in an alkaline solution it may reach several tenths of millicurie per 100 gms of soil when cationic ruthenium is used. Practically no ruthenium was absorbed from an acidic medium. Anionic ruthenium was absoutely not absorbed by soils. The sorption of strontium in an acidic medium was several times lower than in an alkaline medium. When an alkaline solution with a strontium concentration of $5.32.10^{-3}$ mg-eq/l was used, the soils, regardless of their nature, absorbed roughly 60% of the strontium. Under similar conditions only 5 to 6% of the input quantity was absorbed from an acidic aluminum solution. Apart from this, a great number of natural sorbents, mainly pure minerals of inorganic origin, making up the earths and soils was tested to determine to what degree they absorb microquantities of strontium. (auth)

Spitsyn, V. I., V. D. Balukova, A. F. Naumova, V. V. Gromov, F. M. Spiridonov, E. M. Vetrov and G. I. Grafov. 1958. A Study of the Migration of Radioelements in Soils. IN: Proc. 2nd U.N. Inter. Conf. Peaceful Uses of Atomic Energy. 18:439-448.

The report emphasizes the migration of strontium radioisotopes in well monitored field trials. Zirconium, niobium and the rare earths did not migrate when injected into sandy soil. Cesium also was well retained. Strontium moved the farthest from the injection point and ruthenium about half as far. The authors suggest the use of the low-lying subsoil waters with slow water movement and low calcium and total salts for disposal of liquid wastes.

Spitsyn, V. I., V. D. Balukova, F. P. Yudin, and M. K. Pimenov. 1973. Physical and Chemical Factors Governing the Disposal of High-Activity Liquid Waste into Deep Geological Formations. IN: Proc. Symp. Management of Radioactive Wastes from Fuel Reprocessing.

A study of the thermal field of a formation after the injection of radioactive wastes shows that there is a limiting activity, above which the injection of waste into the ground is not permissible; this limit is determined by specific geological and hydrogeological conditions such as the thickness of the formation, the mineralogical and lithological composition of the rock in the absorbing layers, and various other factors.

The main limiting factor is the temperature to which the stratum is heated up in the injection region; this temperature should not exceed the boiling point of the water in the formation at the prevailing pressure.

Since the heating up of the formation is a direct function of the concentration of radioisotopes in the injection region (both in the liquid waste and in the solid material of the formation), one of the essentials in evaluating the possibility of burying high-level wastes is to study the distribution of radiositopes in the material of the formation; this factor also affects the secondary processes, such as heat release and radiolysis accompanying the liberation of gas.

The authors consider the conditions under which the main long-lived isotopes accumulate in the different types of rock constituting the reservoir formations. Data are given on the rates and levels of isotope accumulation for wastes of different chemical composition and for different seepage rates. The authors conside· the possibility of prior chemical treatment of the injection zone for the purpose of controlling the accumulation of radioisotopes in the formation material. They also discuss the ways in which transition zones ("fringe zones") are formed as a result of using different buffer solutions. Solid phase in the case of aluminosilicates when the strata have an effective porosity of 8-12%. If the degree of acid attack is only moderate, the rock skeleton is not broken down; however, the ion-exchange capacity of the rock with respect to radioisotopes declines considerably.

In the case of carbonate rocks, breakdown continues virtually to the end of the interaction, sometimes with gas generation.

The interaction of the liquid phases is also associated primarily with changes in acidity and, depending on the composition of the formation waters, is accompanied by: the dissociation of carbonate and bicarbonate wastes; a marked increase in the chemical activity of chloride waters.

A reduction in acidity of the waste causes hydrolysis of the corrosion products in the waste and also secondary sediment formation through dissolved rock components; in other words, the liquid phase becomes unstable and the pores of the formation clogged. At the same time, the distribution of radioisotopes between the phases changes markedly and the generation of heat and gas becomes uncontrollable; this state of affairs cannot be tolerated when one is disposing of high-activity waste.

The first requirements, therefore, are that the high-activity liquid should be compatible with the material constituting the formation and that the liquid phase should be kept homogeneous. These requirements can be met in two ways - by special treatment of the waste before injection or by advance preparation of the receiving formation.

As regards the latter approach, Roedder [4] pumped acid solutions through a formation in the course of creating an underground cavity. This technique, which presupposes a clear delimitation of the disposal zone, is appropriate when the geological structure of the area is homogeneous - which is the exception in practice. (auth)

Spitsyn, V. I., R. N. Bernovskaya, V. V. Gormov, and Yu. A. Bogdanov. 1973. Trapping of Cerium-144 and Yttrium-91 by Ocean Sediments. Oceanology. 12:586-589.

Absorption of ^{144}Ce and ^{91}Y by typical forms of bottom sediments of the Indian Ocean was investigated; ^{144}Ce and ^{91}Y are present in a complex physicochemical state in the ocean, and the best absorbents are fine-aleurite radiolarian muds. The mechanism of extraction of ^{144}Ce and ^{91}Y from seawater is a combination of trapping of collodial particles of these elements by the sediment, and absorption on the latter portion of the radioelement that is present in seawater in a truly dissolved state. (NSA)

Spitsyn, V. I. and V. V. Gromov. 1958. A Study of the Systematic Adsorption of Radioactive Strontium by Montmorillonite and Its Fixation by Roasting. Sov. At. Energy. 5:1341-1347.

The conditions of adsorbing $Sr^{89,90}$ by montmorillonite have been studied in detail. Various cations may be arranged in the following order according to their capacity to lower the adsorption of radioactive strontium:

$Al^{+3} > Fe^{+3}$

$Ba^{+2} \geq Ca^{+2} \geq Mg^{+2} > H^{+} > NH_4^{+} > K^{+} > Na^{+}$.

It has been shown that the adsorption of radioactive strontium by montmorillonite is an ionic exchange process and obeys the law of mass action. The presence of the anions CO_3^{-2}, SO_4^{-2}, and $C_2O_4^{-2}$ in a solution, which form relatively insoluble salts with strontium, does not change the mechanism of the adsorption, but decreases the quantity of radioactive strontium adsorbed, apparently by forming radioactive colloids.

The process of fixing radioactive strontium on montmorillonitic clays during roasting has been studied. Roasting at temperatures above 850-900° and extending the roasting time over 1-2 hours do not affect the degree of fixation of radioactive strontium. In these experiments, the activity lost by washing in stream and sea water amounted to about 2%.

It is suggested that, up to the beginning of alteration in the crystal lattice (T = 800°C), the fixation is controlled by the formation of slightly soluble chemical combinations of strontium and the adsorbent. Above 800°C the process is determined by changes in the crystal lattice and by a gradual vitrification of the mineral. (auth)

Spitsyn, V. I. and V. V. Gromov. 1959. Adsorption of Radiostrontium by Some Soils and Soil Materials. Soviet Soil Sci. No. 12:1410-14.

Adsorption of the radioactive fission product strontium was studied with 50 natural materials frequently found in soils, from solutions containing no extraneous cations and in the presence of stable strontium or calcium ions. The greatest adsorption of radiostrontium was shown by the clay minerals (montmorillonite, kaolinite, halloysite) micas, hydrous micas, peat, pyrolusite, phosphorite, and nepheline syenite. Therefore, when radiostrontium falls on soils, one expects highest contents where these minerals are present, other things being equal. It was established that the ability of natural materials to adsorb radiostrontium strongly depends on a large exchange capacity. The presence of calcium, even as little as 100 mg/l, considerably reduces the adsorption of microquantities of strontium from solution. (NSA)

Sreekumaran, C., K. C. Pillai and T. R. Fo[illegible] 1968. The Concentrations of Lithium, Potassium, Rubidium and Cesium in [illegible] Western American Rivers and Marine Sediments. Geochim. et Cosmochim. Acta. 32:1229-1234.

Lithium, potassium, rubidium and cesium in river water, suspended matter, and bottom sediments have been measured by a flame photometric method in samples from three western America river systems; concentrations in four marine sediments are given for comparison. (auth)

Stakebake, J. L. and L. M. Steward. 1973. Water Vapor Adsorption on Plutonium Dioxide. J. Colloid and Interface Sci. 42:328-333.

Adsorption isotherms of water vapor on plutonium dioxide were measured gravimetrically at 30, 50, and 85°C. The data show water to be irreversibly chemisorbed until the oxide is saturated. Any subsequent adsorption is physical and completely reversible. The chemisorbed limit varied from 1 monolayer at 85°C to 3 monolayers at 30°C. Gravimetric desorption showed water to be chemisorbed as two different species. A three-step model for the total adsorption process is proposed consisting of: surface hydroxylation (chemisorption); hydrogen bonding of water molecules to surface hydroxyls (quasi-chemisorption); and physisorption of water molecules. (auth)

Stapleton, G. B. and R. H. Thomas. 1973. Effect of Sorption on the Migration of ^{7}Be from a High Energy Accelerator Constructed on a Chalk Site. Water Res. 7:1259-1268.

The radioactive nuclides produced in rock surrounding a high energy accelerator installation may migrate from the accelerator environs if subjected to the hydraulic gradients of ground water. Under such conditions it might be possible for neighbouring ground water systems to become contaminated by long-lived radionuclides. This study concerns itself with the influence of chemical sorption on rock surfaces and its influence in minimizing leach rates. A specific study of the migration of ^{7}Be, an important radionuclide produced in accelerator shields, through ground predominantly composed of chalk is reported. Sorption is shown to play a dominant role in minimizing leach rates. (auth)

Starik, I. E., A. N. Elizareva, Y. V. Kuznetsov. 1963. Determination of the Age of Ocean Sediments by the Ionium-Protactinium Method. Radiokhimiya. 5:154-7.

Sediment samples taken from the bottom of the Indian Ocean (depth 4461 m) were decomposed by sintering with NH_4F and the excess fluoride removed by treating the residue with $(COOH)_2$. Pa and Th were then precipitated with Ca oxalate; Pa was separated from Th by extraction with iso-Bu_2CO. The Pa and Th^{230} concentrations were then measured by counting their α-activity and the concentration of Th^{232} was measured by a colorimetric method (with Arsenazo III). The age of the sediments was then calculated by means of the Rosholt equation (R., et al., C.4, 55, 13215b) giving values of 19,900 for the top of the sedimentation bed and 500.000 years for samples taken ~ 100 cm below the top. The experiments revealed an analogy in the vertical distribution of Pa and Th^{230} which indicates an analogous mechanism of sedimentation. No such relation was found in the case of Th^{230} and Th^{232}. The average rate of sedimentation was 2.5 mm/1000 years; the rate of sedimentation at present (3-3.5 mm) is higher than in the geologic past (1.6 mm/1000 years 500,000 years ago). These results agree with data obtained by the radiocarbon dating method. (CA)

Starik, I. E., Y. V. Kuznetsev, S. M. Grashchenko and M. S. Frenklikh. 1958. The Ionium Method of Determination of the Age of Marine Sediments. Geokhimiya. p. 3-13.

A study of the distribution of Ra, Io and U in deep-water marine sediments and sediments of the coastal zone of the Pacific and Indian Oceans. Before making determinations of Io in the sediments, blank experiments were made in order to check reagents and vessels for contamination with Th isotopes. For the determinations themselves, 5 g of mud, calcined at 800°, was placed in a Pt dish, the UX_1 indicator added, and the mixture treated with a mixture of HF and H_2SO_4. The sulfates which formed were washed with five percent HNO_3, dissolved by heating, and a CO_3-free solution of NH_3 was added to the solution. The sesquioxides which formed were filtered off and washed with hot water. The precipitate was dissolved in a give percent solution of HNO_3, the solution was evaporated to a small volume, and the acidity of the solution was brought to 0.1N by dilution with water. Fifty mg of $CaCl_2$ and an equal volume of oxalic acid were added to the hot solution. The Ca oxalate precipitate was filtered off, washed with a one percent solution of oxalic acid, calcined to $CaCO_3$ in a muffle furnace, and dissolved in a solution of five percent HNO_3. An equal volume of a solution of NH_3 and several drops of H_2O_2 (three percent) were added, and the resulting small precipitate of hydroxides was filtered off through two Schott filters connected in series. The precipitate was washed with a solution of NH_3 and dissolved in five percent HNO_3 solution. In the resulting solution coprecipitation of Th isotopes was carried out twice with 10 mg of Ca oxalate. After complete separation of Io from Ca, by passage of the solution through a Schott filter, the active precipitate on the filter was dissolved in 1N HNO_3, and in order to separate Po the solution was subjected to electrolysis in a Pt dish which served as anode. A Pt plate with an area of 7.5 sq. cm served as cathode. The current strength was 100 ma, and the voltage was 2.1 v. The time required for electrolysis was 10 hours. After separation of Po, the solution was evaporated to dryness and the NH_4 salts were removed by heating. The active precipitate was dissolved in HNO_3 solution and the solution evaporated to a volume of 0.5 ml. Then after evaporation of this solution by heating under a lamp α-measurements of Th isotopes were made. Then the precipitate was dissolved in 1:1 HNO_3 and measurements of the yield were made by β-counting. The yield according to the UX_1 indicator varied within limits of 80 to 95%. Accuracy of the measurements was determined by the Io content in the sample, and in the present experiments it varied within limits of 8-15%. The vertical distribution of Ra, U, Th isotopes, Fe, Mn, and Ca was determined in 7 core samples of the marine sediments. The Io content in coastal sediments changed greatly along the length of the core sample. Io and Ra were not found to be in radioactive equilibrium. In all the core samples and in all the experimental points of deep-water sediments, Io and Ra were in radioactive equilibrium. Thus, it was concluded that there is no migration of Ra in the sediments. The forms of occurrence of Io and Th in deep-water marine sediments were apparently different. Rate of sedimentation in areas of the ocean bottom changed little with time. In all the core samples studied the concentrations of U and Th remained constant along the length of the core. In a number of core samples a distinct relationship between the vertical distribution of Ra and Io and that of Ca was observed. (CA)

Starik, I. E., Y. V. Kuznetsov and V. K. Legin. 1959. On the Origin of Uranium and Thorium in Ground Deposits of Antarctic. Radiokhimiya. 1:321-4 (in Russian).

Studies of uranium and thorium distribution in various fractions of the Antarctic shelf show the main depositions are found in the brecciated continental rock. (NSA)

Starik, I. E., Y. V. Kuznetsov, V. K. Legin and Z. N. Simonyak. 1961. On Some Properties of the Ionium Method of Age Determination. Radiokhimiya. 3:490-7 (in Russian).

A radiochemical analysis was made of marine sedimentation containing radium, uranium, ionium, and thorium. The absence of radioactive eqilibrium was established in the lower parts of columns where equilibrium is ordinarily accepted on the basis of ionium vertical distribution. The saturation of radium (in relation to ionium) found in upper levels of deep-water red clays indicate the feasibility of direct radium precipitation. Some data were obtained on sedimentation in the central region of the Indian Ocean that are in good agreement with published data. (NSA).

Starik, I. E., Y. V. Kuznetsov, E. P. Petryaev, and V. K. Legin. 1963. Geochemistry of Radioactive Elements. Khim. Zemnoi Kory, Akad. Nauk SSSR Tr. Geokhim. Konf. 1:374-89.

A study of the geochemistry of radioactive elements in ocean water and sediments revealed several facts which cannot be explained only by the leaching of radioactive elements from minerals. This difference is most distinctly observed in a comparison of the Ra:U ratio, obtained during experiments in mineral leaching, with data on the U and Ra contents in natural waters (formation waters of oil deposits and mineral springs) and with their contents in ocean water. The leaching of Ra and U from minerals suggests that the content of Ra in ocean water should be higher than that of U. Experimental data show the opposite. However, when the form of occurrence of these isotopes is considered, this disagreement disappears. In fact, more Ra than U is delivered into water during rock leaching. But U forms in seawater stable, easily soluble, complexes which migrate in aquatic medium. The Ra under conditions of natural waters (pH >6) was sorbed by suspended and colloidal particles and, together with them, precipitated into sediments. This results in relative enrichment (in comparison with Ra) of ocean waters with U. (CA)

Starik, I. E. and M. S. Lambet. 1958. State of Microquantities of Promethium in Aqueous Solutions. ZhNkh. III:136-138.

The adsorption of Pm on quartz glass at 10^{-10} molar was investigated as a function of pH. The presence of colloidal Pm was shown by ultrafiltration. There was a clear maximum of adsorption on glass at pH 6.2.

Starik, I. E. and K. F. Lazarev. 1960. Effect of Crushing of Minerals on the Extraction of Radioactive Elements. Radiokhimiya. II:749-752.

A study of the dependence of the extractability of atoms of ThX, U, RdTh, and Th on the degree of crushing of samples of monazite has shown that the differences in extractability depend not only on the change in the surface of the mineral on crushing, but also on changes in the adsorption properties of this surface.

Starik, I. E., D. S. Nikolaev, S. M. Grashchenko, Y. V. Kuznetsov, K. F. Lazarev and V. R. Legin. Natural Radioactivity of the Waters and Sediments in the Black Sea and the Sea of Azov. AEC-tr-6641, pp. 10-13.

Radioactivity was measured in water and bottom sediments from the Black Sea and the Sea of Azov during 1958 and 1959. Uranium concentrations varied from 1.5 to 2.8 x 10^{-6} g/l with no apparent regularity of variation in either horizontal or vertical traverses. The constancy of the U concentration in both seas was shown to be related to the presence of the carbonate complex of uranium. Although the uranium contents in the waters of both seas were similar, the concentrations in the upper portion of the bottom sediments were different, a difference explained by variation of hydrochemical conditions. Thorium-232, ^{226}Th, and Ra were also determined. (NSA)

Starik, I. E., D. S. Nikolaev, Y. V. Kuznetsov and V. K. Legin. 1961. Radioactivity of Black Sea Deposits. Doklady Akad. Nauk. SSSR. 139:1456-9 (in Russian).

The content of radium in ocean deposits varies from 4 to 50 x 10^{-12} g/g, while the radium content in Black Sea deposits is relatively constant at 5 to 9 x 10^{-13} g/g (substantially lower than in ocean deposits). The radium content does not vary with the height of the core sample. The absolute content of ionium varies from 0.8 to 5.8 x 10^{-10} g/g (approximately that found in ocean deposits) with the higher ionium values being found in the surface layers. Since the Black Sea deposits are relatively young in age, the amount of ionium is almost always greater than the amount of radium, and the ionium and radium are not in equilibrium with each other. The uranium content in Black Sea deposits is 10 to 12 x 10^{-6} g/g (5 to 7 times greater than the uranium content in typical ocean deposits). The surface layers of the core sample have a higher uranium content than the lower layers. The precipitation of uranium is favored by the reducing conditions prevalent in the Black Sea. The ratio of thorium to uranium is low in the upper layers of the core sample, but rises to a value that is more typical of ocean deposits in the lower layers of the core sample (Th/U >3). For the last 1500 years the rate of deposition in the Black Sea is estimated at 36 to 60 cm per 1000 years. This high rate of deposition accounts for the deficiency of radium in the Black Sea deposits.

Starik, J. E., D. S. Nikolaev, Y. V. Kuznetsov and V. K. Legin. 1961. The Ratio of Radioactivities in Deposits of the Azov Sea and of the Black Sea. Doklady Akad. Nauk SSSR. 139:456-9 (in Russian).

The distributions of Th, Io and Ra contents as a function of depth in 5.0-meter core samples from three stations in the Azov Sea were investigated in the summer of 1959. The absolute contents of U, Th, Io and Ra in sediments of the Azov Sea are approximately the same as those in littoral ocean deposits. The average uranium concentration in sediments of the Azov Sea was 1.3 x 10^{-6} grams per gram of sludge, while the uranium in the upper layers of the Black Sea sediments was 5.7 x 10^{-6} g/g. The average concentration of thorium is greater in deposits of the Azov Sea than it is in deposits of the Black Sea, but the concentration of ionium is somewhat greater in deposits of the Black Sea than it is in deposits of the Azov Sea. Apparently, the main part of the ionium precipitates from solution after being formed from the uranium in solution. The concentration of Ra was found to be 7.2 x 10^{-13} g/g of sludge in the Azov Sea. The Ra is continuously carried down by sediments which act as carriers. Hence, the amount of Ra is almost twice the equilibrium amount based on the amount of U present in solution. The ratio of Th to U is variable, but is always greater than three. (NSA)

Starkey, H. C. 1964. Determination of the Ion-Exchange Capacity of a Zeolitic Tuff. IN: Short Papers in Geology and Hydrology. Articles 122-172, p. D93-5.

Determination of the exchange capacity of some zeolitic tuffs may require an extremely long time for the reaction rate to attain a constant value. A heating method is suggested whereby the rate of the reaction is increased, so that the exchange-capacity determinations can be made within a period of time as short as 24 hours. (auth)

Stead, F. W. 1963. Tritium Distribution in Ground Water Around Large Underground Fusion Explosions. Science. 142:1163-1165.

Tritium will be released in significant amounts from large underground nuclear fusion explosions in the Plowshare Program. The tritium could become highly concentrated in nearby ground waters, and could be of equal or more importance as a possible contaminant than other long-lived fission-product and induced radionuclides. Behavior of tritiated water in particular hydrologic and geologic environments, as illustrated by hypothetical explosions in dolomite and tuff, must be carefully evaluated to predict under what conditions high groundwater concentrations of tritium might occur. (auth)

Stead, F. W. 1964. Distribution in Groundwater of Radionuclides from Underground Nuclear Explosions. IN: Proc. Third Plowshare Symp. Engineering with Nuclear Explosives. April 21-23, 1964. TID-7695, p. 127-138.

Radionuclides released from underground nuclear explosions in the Plowshare Program will be initially distributed in the medium by direct explosive action; long-lived and biologically significant radionuclides may later enter into and move with groundwater flow. Where adequate precautions have been taken, as at the Nevada Test Site and at other sites such as Plowshare Project Gnome, no significant post-explosion movement of radionuclides can as yet be demonstrated; however, radioactive waste disposal operations clearly indicate that; radionuclides can be transported considerable distances by groundwater flow. A single, universally applicable prediction of the character and extent of possible radionuclide contamination of groundwater is precluded by the complex interrelationship and variability of the environmental factors; thus, each proposed site of a Plowshare nuclear explosive application must be carefully evaluated, to determine if unique geologic and hydrologic conditions are present which might permit relatively rapid and prolonged migration of radionuclides. (auth)

Stevenson, P. C. and W. E. Nervik. 1961. The Radiochemistry of the Rare Earths, Scandium, Yttrium, and Actinium. NSA-NS-3020.

This book gives a general review of chemistry of scandium, yttrium, and actinium. Details of chemistry (metals, amalgams, and various oxidation states; soluble salts; insoluble salts; spectrometry, titration, and colorimetry; complex ions and chelate compounds; extraction; ion exchange; electric and magnetic field separations), dissolution and exchange, counting techniques; and radionchemical procedures for scandium, yttrium, and actinium are given.

Stewart, G. D. 1953. Samples of Soil from Arco, Idaho, AECD-3487.

Soil samples from a single drilling made at Arco, Idaho, were tested for the adsorptive capacity of the soil for radioactive elements. Weighed and powdered soil samples were shaken for 1 hr with measured amounts of reactor waste solution containing radioactive Cs, Ru, Te, and Sb. The mixture was then centrifuged, and the radioactivities of aliquot samples were counted with a G-M tube. Data are tabulated for the type of soil, the percent of activity removed for each stratum, and the depth of each stratum. (NSA)

Stewart, G. L. 1967. Fractionation of Tritium and Deuterium in Soil Water. IN: Isotope Techniques in the Hydrologic Cycle. Geophys. Monograph. Ser. No. 11.

Laboratory investigations are being conducted to determine the potential capabilities of hydrogen isotopes in age-dating techniques and as tracers for ground and surface waters. Preliminary results show that tritium and deuterium interact with clay minerals as water diffuses through Davidson clay. The data suggest that two stages characterize this interaction with clay minerals: a rapid exchange with more labile hydroxyl groups, followed by exchange with other structural hydroxyls. The initial and rapid exchange was characteristic, but to varying degrees, of all clay minerals used in this investigation. Except for tritium in Davidson clay, the data were not sufficient to show that additional exchange occurs beyond the first stage. The data suggest that isotopic exchange and fractionation of hydrogen isotopes in the clay-water system may be significant for some age-dating and water-tracing investigations where water flow is slow through some kinds of clays. For many investigations, however, this isotope effect is not important, because it is small compared with accuracies required of the data. As the tracer art progresses, it will become possible to apply isotope effect corrections to the data.

Stewart, G. L. 1973. Behavior of Tritium in the Soil. IN: Tritium. Moghissi, A. A. (ed.). Messenger Graphics, Las Vegas. pp. 463-470.

Because of the characteristics of the clay — water system, tritium fractionation occurs as tritium in bulk pore water exchanges with water in different physical states and with hydroxyl groups. Both thermodynamic theory and experimental data suggest that tritium fractionation is small as isotopic exchange occurs between the bulk pore water phase and the tenaciously adsorbed water phase. Isotopic exchange occurs between hydrogen in adsorbed water and crystal lattice hydroxyls for all clay minerals and soils studied. A few samples of illite and Davidson clay showed high exchange rates and suggested that considerable tritium fractionation may occur. The conditions and/or factors responsible for this high exchange are not known. Many practical hydrologic investigations will not require that corrections be applied to experimental data for the isotope effect of tritium because other factors associated with water flow are more significant. (auth)

Stockdale, P. B. 1951. Geologic Conditions at the Oak Ridge National Laboratory (X-10) Area Relevant to the Disposal of Radioactive Waste. ORO-58.

This is a review of Oak Ridge physiography, areal geology, stratigraphy and hydrology pertinent to waste disposal. Water analyses and underground contamination are given. A new burial ground site is suggested that will be underlain by shale rather than the more soluble limestone of the then-current burial ground.

Straub, C. P. 1975. Radioactive Wastes. J. Water Pollut. Control Fed. 47:1498-1513.

A review is presented on the environmental behavior of radioactive wastes. The management of high-level wastes and waste disposal methods were discussed. Some topics included were ore processing, coagulation, absorption and ion exchange, fixation, ground disposal, flotation, evaporation, transmutation and extraterrestrial disposal. Reports were given of the ^{226}Ra, ^{224}Ra and tritium activity in hot springs, ^{90}Sr concentrations in the groundwater and in White Oak Creek, radionuclide content of algae, grasses and plankton, radionuclides in the Danube River, Hudson River, Pacific Ocean, Atlantic Ocean, Lake Michigan, Columbia River and other surface waters. Analysis showed that ^{239}Pu was scavenged from Lake Michigan water by phytoplankton and algae by a concentration factor of up to 10,000. Benthic invertebrates and fish showed higher ^{239}Pu concentrations than did their pelagic counterparts. Concentration factors are also given for ^{234}Th, ^{60}Co, Fe and Mr in marine organisms. Two models for predicting the impact of radioactivity in the food chain on man were mentioned. In an accidental release from a light-water power reactor to the ocean, the most important radionuclides discharged were found to be ^{90}Sr, ^{137}Cs, ^{239}Pu and activation products ^{65}Zr, ^{59}Fe, and ^{95}Zr. (A)

Strom, P. O. and E. C. Watson. 1975. Calculated Doses from Inhaled Transuranium Radionuclides and Potential Risk Equivalence to Whole Body Radiation. IAEA-SM-199/114.

Through the use of the information provided in the summary report by the Task Group on Lung Dynamics, as well as other pertinent data, the dose resulting from internal deposition following inhalation, lung deposition and subsequent translocation of radioactive material may be calculated for a number of human organs. This report examines the distribution of radiation dose commitments within the body that can result from the lung deposition of a number of transuranic radionuclides. The variables that influence these organ dose commitments include the mobility of the particle or its dissolution products within the body, the radiation characteristics of the inhaled radionuclides and their progeny, and the size of the particles inhaled.

The calculated dose commitments form a part of the bases of a more speculative section of the report. The BEIR Committee estimates of the risk of excess deaths from cancer due to whole body radiation doses are included in the calculations to provide an estimate of cancer death risks associated with the inhalation of transuranic compounds. These results are then equated to those from whole body radiation doses. The uncertainties associated with such calculations are recognized, and, in particular, the implicit assumptions of internally and externally generated dose equivalence and dose-effect linearity are discussed.

People are exposed continually to radiation from many sources, such as extraterrestrial sources (i.e., cosmic radiation), radionuclides in the environment, X-ray machines, and television sets. Some of this exposure results in external doses; i.e., doses from radiation originating from sources external to the body. Internal exposure, resulting in doses to individual organs within the body, occurs when the human body assimilates radionuclides through the respiration of air and ingestion of food and water. These nuclides reside within the body until and unless removed by natural processes including radioactive decay. The specific radionuclide, the mode of entry and the tendency to remain within the body are factors which often determine the organ or organs receiving the greatest exposure.

Both genetic and somatic risks are associated with dose from ionizing radiation absorbed by the human body and its organs. The BEIR Committee has documented a re-evaluation of existing scientific knowledge concerning radiation exposure of human populations. The Committee also reported its best estimates of the risk of death from cancer to the population of the United States from exposure to the ionizing radiation. (auth)

Stuber, C. E. 1975. Transplutonium Elements -- A Bibliography. TID-3317-56.

This bibliography, prepared especially for distribution at the IAEA/ERDA International Symposium on the Transuranium Nuclides in the Environment, San Francisco, November 17-21, 1975, comprises 589 references on the transplutonium elements compiled through the period January 1 to October 15, 1975. The references were retrieved from the Nuclear Science Abstracts (NSA) data base using a computerized information retrieval system and were formatted for publication with indexes by computer. In each group, references are arranged in order by the original NSA abstract number, which places them in approximate chronological order. Sequence numbers appear beside each reference, and the indexes refer to these sequence numbers.

Part I includes 565 references dealing with the production and chemical, nuclear, physical, and biological properties and health, safety, and environmental aspects of elements with $Z \geq 95$. References treating more than one element are grouped with the element having the lowest atomic number; therefore, the subject index must be consulted for a complete set of references on an element. The Actinides group includes references dealing with the actinide elements in general or treating the actinides collectively. References dealing with $Z \geq 104$ elements are included in the Transactinide group.

Study Panel on Assessing Potential Ocean Pollutants. 1975. Assessing Potential Ocean Pollutants. Chapter 3. Transuranic Elements, pp. 27-63.

The chapter is a review of the chemistry of transuranic elements and how the variables in a marine environment, including ionic composition, redox potential, pH, temperature, pressure and the presence of complexing agents effect transuranic migrations to man.

Struxness, E. G., W. J. Boegly, Jr. et al. 1960. Evaluation of Consequences of Disposal to ORNL Environs. ORNL-2994, p. 36-45.

The more hazardous fission products are adsorbed by the dominantly clay soils of the ORNL area; this provides a safety factor in the case of accidental release of radioactive cations. There are three shortcomings in the natural environment at ORNL: the high rainfall results in leaching of adsorbed activity; owing to low soil permeability, surface runoff leads to erosion and sediment transport; and the heterogeneity of ground-water movement patterns makes monitoring difficult. (auth)

Struxness, E. G., K. E. Cowser, W. deLaguna, D. G. Jacobs, R. J. Morton and T. Tamura. 1959. Waste Disposal Research and Development in the United States of America. IN: Disposal of Radioactive Wastes. Conf. Proc. Monaco. 16-21, November 1959. 2:481-98.

A review of the waste disposal research and development carried out in the United States is given. The major research effort concerns the conversion of high-level liquid wastes into solids. At Hanford and Oak Ridge low-level wastes are disposed to the ground in pits, cribs, and lagoons. Geochemical studies related to waste disposal are conducted at Hanford, Oak Ridge, and the University of North Carolina. Experiments with soil columns are described; these are more effective for the decontamination of waste streams than either cribs or pits. The most suitable exchange materials for the soil columns are found to be vermiculite supported by rock phosphate and the latter supported by graded gravel. The progress of research work on the possibility of injecting radioactive liquid wastes into porous formations through deep wells and disposing of radioactive wastes in impermeable formations by hydraulic fracturing is outlined. (auth)

Sugimura, T. and T. Sugimura. 1962. Uranium in Recent Japanese Sediments. Nature. 194:568-9.

Samples of sediments, of which two were marine, three from inlets, four sections of a core from a brackish lake, one from an oilfield, and one from a gasfield, were analyzed for their U content. The U contents ranged from 1.3 to 18.1 µg U/g, and the high U contents of Lake Hamana and Kagoshima Bay are probably due to reducing conditions. The average U content, excluding the unusually high contents, is 2.5 ppm. (NSA)

Sugimura, Y. 1964. Natural Radioactive Elements in the Ocean. Kagaku No Ryoiki. 18:89-101 (in Japanese).

A review is given of the distribution of natural radioactive elements and isotopes in seawaters and sediments. The U contents in seawaters are tabulated; the average is 3.3×10^{-6} g U/l. The $^{234}U/^{238}U$ ratio is discussed. The U contents in sea sediments are from 0.1 to 80 ppm. Attempts were made to determine ^{231}Pa in seawaters and sediments. Seawaters contain $2 \times 10^{-9} - 1 \times 10^{-7}$ g Th/l and $n \times 10^{-11} - n \times 10^{-14}$ g ^{230}Th/l. Sea sediments contain 6-13 ppm Th; 60-70 percent of the Th is leached with cold HCl. Studies were made to determine the sedimentation rate of sediment from the contents of ^{232}Th and ^{230}Th(Io). Many data are available on the ^{226}Ra contents in seawaters, and the table is given. These contents are less than those in equilibrium with U. Pelagic sediments contain an average of 10×10^{-12} g ^{226}Ra/g. Distributions of ^{210}Pb, ^{210}Po, ^{227}Ac, etc., are discussed. The surface seawaters off California contain 0.2×10^{-6} Pb/l. The sea sediments contain an average of 30 ppm Pb. (NSA)

Sugimura, Y. 1969. Study of the Chronology of Deep Sea Sediment with Radioisotopes. Nippon Kaiyo Gakkaishi. 25:261-8 (in Japanese).

The sedimentation rate and other characteristics of the ocean floors in the western North Pacific, Indian Ocean, and Japan Sea were studied by the ^{230}Th/Th method first proposed by Picciotto,et al. The samples of 1 to 2 gram from each horizon of deep sea cores were processed with an anion exchange resin to separate the Th isotopes. These isotopes were fixed to an electroplating unit made of platinum, and the α intensity was measured by α-spectrometry. The distribution of surface $^{230}Th/Th$ ratio in the Pacific Ocean showed a remarkable regional difference, and the sedimentation rate in the world oceans was below 10 mm per thousand years. The surface sedimentation rate in the western North Pacific ranges from 0.5 to 7.3 mm/10^3 year, but the ratio changes sharply at 10^5 year B.P., suggesting that the rate was greater before turning point of 10^5 year. The average rate of 15 mm/10^3 year was obtained in the equatorial region of the Indian Ocean. The sedimentation rate in the Japan Sea was found to be about ten times as large as the Pacific Ocean, and the distribution of uranium shows a remarkable increase from 10^4 year B.P. on. The cause of this change was probably due to the glacial custacy which might control and water exchange in the Japan Sea, and it shows that at the time some oxygen-free conditions were brought about at the bottom of the sea. (NSA)

Surganova, N. A., L. V. Gorbushina, A. I. Spiridonov, and V. G. Tyminskii. 1971. Extraction and Radiochemical Methods in the Determination of Uranium Isotopes in Ground Waters. Geol. Rozved. 14:100-105.

Determination of isotopic ratios of uranium in natural waters is generally accomplished in three steps: concentration of the U with an adsorbent, removal of the U from the adsorbent, and alpha spectrometric measurement. A number of published methods were tested for efficiency and accuracy, including U adsorption on activated carbon or on iron hydroxide. Since accurate alpha spectrometry depends on a high degree of purification of the U sample, exchange chromatography and extractive methods based on the use of TBP, Conpleron III, and ammonium oxalate are discussed as purification techniques. (0-77).

Sutton, J. 1949. The Hydrolysis of the Uranyl Ion. Part I. J. Chem. Soc. Part V:275-86

Cryoscopic measurements prove conclusively that the hydrolysis of uranyl salts leads to the formation of the ions $U_2O_5^{++}$ and $U_3O_8^{++}$, and not $UO_2(OH)^+$ and $UO_2(OH)_2$.

Measurements of pH of solution of UO_3 in solutions of uranyl salts, pH titrations of uranyl perchlorate with sodium hydroxide, and the conductivity and absorption spectra of these solutions, point to the formation of further ions $U_3O_8(OH)^+$, $U_3O_8(OH)_2$, and $U_3O_8(OH)_3^-$. More highly charged anions may be formed but the evidence is still inconclusive. The equilibrium constants for the formation of some of these ions have been determined. (auth)

Sutton, W. R. and N. M. Soonawala. 1975. Soil Radium Method for Uranium Prospecting. Can. Mining Met. Bull. 68:51-56.

The soil radium technique of uranium exploration is described. Radium in soil samples is measured by immersing them in water for a fixed period, and then analyzing for the radon emanated into the water. The method achieves an increase of at least several feet in depth penetration over that possible by radiometric equipment. Field examples are provided, which compare soil radium, scintillometer, and emanometer results over specific uranium occurrences near Uranium City, Saskatchewan. Some of the other advantages of the soil radium method are that results can be obtained at the site of the survey, equipment is simple and results are reproducible. (auth)

Swanson, J. L. 1973. Nature of Actinide Species Retained by Sediments at Hanford: Interim Progress Report. BNWL-B-296.

A program to develop leach procedures appropriate to characterizing the behavior of different actinide species retained by soils is in progress. Characterization of the Pu species present in samples taken from the 216-Z-8 trench has been made difficult by the presence in these samples of materials which form only sparingly soluble Pu compounds. Because of the presence of these materials, in some cases the leaching of the Pu is more a function of the solubility of Pu in the leach solution than it is a function of the Pu species present in the soil. Pretreatments of the soil samples with alcohol, with hydroxide solutions, and with TBP solutions have been found to give at least partial removal of these Pu solubility-limiting materials.

The percentage of the Pu that dissolved readily in 5M HNO_3 at room temperature (using repeated solution changes to minimize the effect of the Pu solubility-limiting materials) was found to range from 3 to 90 percent depending on sample location and depth. The higher removal percentages were achieved with the deeper portions of the samples.

Data on the amounts of actinides, water, and organophosphates present in the 216-Z-9 trench samples used in this work are included in the Appendix. The Pu content was found to range from 0.06 mg Pu/g soil near the 24-inch level to 10 mg Pu/g soil in the surface portion of one of the samples; the water content was found to range from 4 to 33 percent and the organophosphate content ranged up to 1.4 percent. (auth)

Swanson, J. L., T. R. Garland, and R. E. Wildung. 1974. Preparation and Chemical Characterization of Plutonium-DTPA Complexes. BNWL-1950 (Pt 2), pp. 21-36.

The preparation of DTPA complexed Pu solutions are described and their spectral changes with time. The effects of Pu and Pu complexes on soil microorganisms (fungi and Actinomycetes) are given. A split-root technique was used to determine the uptake of plutonium by barley and soybean plants. The distribution of plutonium in the plant tissues also was reported.

Swift, W. H. 1973. Program for the Management of Hazardous Wastes. PB-233-629.

This document discusses 1) the definition and identification of hazardous wastes, 2) management and inherent costs, 3) radioactive wastes, 4) the siting of processing and disposal facilities, and 5) implementation of the findings of the study. Estimates of volume and composition of waste streams are included in appendices. (auth)

Szabo, A. and A. Soo. 1957. Radioactivity of Waters and Muds from Salt Lakes and Mineral Springs in Sovata and Praid Baths. Acad. Rep. Populare Romine Inst. Fiz. Atom. IFA/R/12.

In the salt lakes and mineral springs in this area, the radon content ranged from 0 to 1.17 millimicrocuries and the Ra from 0 to 31.5 x 10^{-2} g/g. The saltwater contains either traces or detectable amounts of Rn or Ra. Thermal water contained the highest amounts. (CA)

Szabo, B. J. 1972. Uranium-Series Systematics in Natural Materials from the Newport Area, Oregon. U.S.G.S. Professional Paper No. 880-C, pp. 199-201.

Analyses of U, Th, and Pa isotopes in recent and fossil wood and kelp samples from this region indicate that migration of these radioelements was extensive. Thus, this type of material at this location is unsuitable for U-series dating. The analytical data from a shell sample from the same area showed evidence of recent U assimilation, which contributed to a minimum age estimate only. (CA)

Szabova, T. 1976. Effect of pH Value of Applied Solution on Radioiodine Sorption by Soils. Pol'nohospodarstvo. 22:196-201.

Sorption of radioiodine by soils was followed under static conditions at different pH values of the initial solution in five soil types. Sorption of radioiodine by soils is affected by the amount of the organic mass and by the pH solution. With the same pH, soils containing a higher amount of the organic mass absorb more radioiodine. The highest sorption percentage of $^{131}I^-$ for all pH values was found in meadow chernozem soil and the lowest in the rendzina and in carboniferous meadow soils. The highest sorption of $^{131}I^-$ for degraded chernozem, meadow chernozem soils and brown soil was recorded at pH 5 and for carboniferous meadow soil and rendzina at pH 7. (auth)

Szalay, A. 1954. The Enrichment of Uranium in Some Brown Coals in Hungary. Acta. Geol. Acad. Sci. Hung. 2:299-311.

Geochemical enrichment of uranium is ascertained in some brown coal strata in Hungary. These strata are situated near to the detritus zone of the two existing granitic mountains of Hungary. The uranium content of these coal strata is about the same (about 0.01 percent) as the U content of bioliths (oil shales, carbonate rocks, etc.) used to be. It seems highly probable that the same unknown general geochemical law is responsible for all such enrichments in bioliths. The granitic rocks are the primary sources of uranium, the U migrated into the sea or moor water during the age of chemical decomposition of the rocks. Uranium became adsorbed by the decomposing organic substance of the sediments. Laboratory experiments revealed that decomposing plant debris, peat, lignite, and brown coal have a very high adsorption power and capacity for uranium, which is in fact sufficiently high to explain geochemical enrichment. Subsequent experiments revealed and control experiments verified that the humic acid colloid particles are responsible for the adsorption, which is a cation exchange process. The adsorption equilibrium constant of humic acid substance is much higher for uranium than for cations of lower valence and lower atomic weight. It seems that the hitherto unknown law of geochemical enrichment of uranium in bioliths is herewith explained. This law may be formulated in the following manner: the geochemical enrichment of uranium in carbonate rocks (bioliths) is caused by the adsorption of dissolved uranium by the humic acid content of the sediments. The adsorption is a cation exchange process. (auth)

Szalay, A. 1957. The Role of Humus in the Geochemical Enrichment of U in Coal and Other Bioliths. Acta. Phys. Acad. Sci. Hung. 8:25-35.

Investigations established that the enrichment of U in peats, coals, and other bioliths is caused by adsorption on the humic acid. Adsorption isotherms have been measured and numerically evaluated. The adsorption itself is actually a cation exchange process. The enrichment factor of 1:10,000 agrees well with the quotient of the concentration of U in bioliths and natural waters. (auth)

Szalay, A. 1964. Cation Exchange Properties of Humic Acids and Their Importance in the Geochemical Enrichment of UO_2^{++} and other Cations. Geochem. et Cosmochim. Acta 28:1605-14.

It was demonstrated that the cation-exchange capacity for UO_2^{2+} has a maximum value in the peat state of 2-3 meq. The cation-exchange capacity of lignites never exceeds about 0.7 meq. The role of humic acids in the geochemical enrichment of other cations is more than a possibility, although it has not yet been sufficiently explored. A number of cations were studied and found to be sorbed and exchanged by humic acids. Similar observations were made by others. Inasmuch as the overwhelming majority of nuclear fission products can be sorbed, humic acid presents a very useful substance for waste disposal problems of the atomic energy industry. The enrichment constant is high for many other cations, and at least for some of them it is higher than for uranium; examples are Th^{4+}, rare earths, Zr^{4+}, etc. The enrichment constant, however, is not the sole factor for geochemical enrichment. The cation must be mobile in natural waters and soluble in the pH range of 4-7, which is favorable for sorption. This presents a bottleneck for study of geochemical enrichment, for to investigate the general role of humic acids in geochemistry the mobility of cations must first be studied.

Szalay, A. and M. Szilagyi. 1964. Retention of Fission Products by Peat Humic Acids, a New Possibility in Waste Water Treatment. A/CONF.28/P/784.

The authors investigated the retention of fission products on peat preparations in laboratory tracer experiments. The experiments demonstrated that the majority of the fission products, the cations, are strongly fixed on peat humic acids of approximately favorable conditions are secured. The fission products can be classified according to their fixation on humic acids into anionic and cationic groups. For an efficient binding, the pH of the aqueous phase must be kept between limits of about 4 to 6, optimally at about 5. The elution sequence of the long-living cationic fission products was investigated, and the "breakthrough volume" was determined under optimal laboratory conditions from chemically pure tracer solutions. The sorption capacity of one ton of peat is roughly about one thousand chemical equivalents. This is sufficient for the fixation of megacuries of Sr and Cs. The breakthrough volume — the tolerable amounts of waste water — filtrable by a given quantity of peat is about 1000 to 10,000 times its quantity, if optimum conditions are secured. Further investigations concerned the possible interference of various nonradioactive chemical contaminants which might be present in industrial waste waters. The presence of salts, complexing agents and detergents can cause displacement or even remobilization of the sorbed fission products. The breakthrough volume is decreased if their concentration is excessive. The volume and weight of the contaminated peat humic acids can be reduced to a very small fraction by incineration before ultimate disposal. (auth)

Szepke, R. and D. Grzybowska. 1962. Strontium-90 in Soil, Poland, 1960. CLOR-12.

Measurements of Sr-90 content in 37 soil samples collected in Poland during 1960 are presented. Data concerning the Sr deposition in soil are tabulated. Correlation between the amount of Sr-90 deposited in soil and calcium content, soil acidity, and soil type are discussed. (auth)

Syromyatnikov, N. G. 1961. Migration of Uranium, Radium, and Thorium Isotopes and Interpretation of Radioactive Anomalies. Alma-Ata, USSR, Publishing House of the Kazakh SSR Academy of Sciences.

Isotopic migration of U, Th, and Ra was studied and a method was developed for interpreting radiohydrochemical anomalies by their isotopic content. The suggested methods estimates aqueous anomalies by the ratios of U^{234}/U^{238}, Ra/MsTh, and Io/Th. (NSA)

Tagamets, T. and Y. M. Sternberg. 1974. A Predictor-Corrector Method for Solving the Convection-Dispersion Equation for Adsorption in Porous Media. Water Resources Research. 10:1003-1011.

The one-dimensional convection-dispersion equation subject to a nonlinear adsorption isotherm is formulated and solved by using a predictor-corrector finite difference scheme. The effects of convection, dispersion, and adsorption are illustrated for some typical values of variables encountered in real systems. A comparison between the numerical results and some experimental data is also presented. (auth)

Takahashi, H. and M. Nishidoi. 1963. Exchange-Adsorption of Radioactive Cations by Zeolitic Tuff. J. Clay Res. Group Japan. 3:239-45 (in Japanese).

The exchange-adsorption of radioactive ^{90}Sr and ^{137}Cs in batch system by zeolitic tuff from Kawarago, Shiroishi, Miyagi Prefecture was studied. The relation between the affinity of both radioactive cations and the form of exchangeable cation of adsorbent was investigated in NaCl chloride solution. In general, the mono-valent forms show the selectivity for ^{90}Sr except H-form, while the divalent forms do not show so remarkable selectivity. H-form only shows the highest selectivity for ^{37}Cs. Moreover, zeolitic tuff show the higher capacity for these both cations than other clay minerals, for example, kaolinite or montmorillonite. Since the zeolitic tuff is relatively soft mineral and swells very little in water, it is very effective and economical to apply it for the treatment of radioactive aqueous waste. (auth)

Talibudeen, O. 1964. Natural Radioactivity in Soils. Soils Fert. 27:347-59.

This review presents extensive data and numerous tables showing levels of natural fallout levels of radioelements in soils under various conditions. About 90 references are cited. Also considered are applications of studies of natural radioactivity to soil science. The properties of radioelements found in nature, given in a table, are discussed to assess their contribution to the natural radioactivity of soils. Another table summarizes the calculated contribution of long-lived natural radioelements to the total radioactivity of soils from the Great Russian Plains. Two-thirds of the total is from potassium and thorium, over one-fifth from uranium, and about 7% from rubidium. Less than 0.5% is from ^{14}C, while the rare earth and other elements together contribute negligible amounts. The ratios of pairs of naturally radioactive elements sometimes provide information about the intensity of weathering of a soil profile, the composition of its parent material, and the pedological composition of the soil horizons. The most important of these pairs of elements are uranium and thorium, and uranium and radium. Some effects of pedological processes on these ratios are described. Radiocarbon dating of soil organic matter is also discussed. It is shown that fallout contamination, particularly from the long-lived fission products, can confuse the determination of the potassium, thorium, and uranium contents of soils by β and γ measurements unless suitable precautions are taken. Special methods of α, β, and γ assay of soil radioactivity are considered. (NSA)

Talibudeen, O. and Y. Yamada. 1966. Total Potassium in Soils by Radioactivity Measurements. J. Soil Sci. 17:107-20.

The natural radioactivity in 19 British soils was studied, particularly that from ^{40}K. It was shown that the principal β emitters in soil are ^{14}C, ^{40}K, ^{87}Rb, ^{232}Th and its daughter elements, and ^{238}U and its daughter elements. The half-thicknesses of self-adsorption for all β radiations from these elements are calculated from the relation $d_{1/2} = 32E_{max}^{1.33}$ and $g_{1/2} = 2.3d_{1/2}$, where $d_{1/2}$ and $g_{1/2}$ are the half-thicknesses in mg cm^{-2} for external and self-adsorption and E_{max} in Mev is the max β energy. These range from 0.2 to 3.54 mg cm^{-2} for natural radionuclides in the soil and necessitate corrections for the apparent density of the experimental material during β-radioactivity assay. Also calculated was the contribution of α, β and γ emissions from K and from uranium and thorium families to the natural radioactivity of soils, based on their chemical composition. In general the β assay method for K content is cumbersome and inaccurate; however, it is relatively inexpensive and simple. With similar soils containing the same proportions of radionuclides from the U and Th families, it gives K contents agreeing with those determined by chemical methods. The β and γ analysis methods were compared on 19 British soils; marker γ photopeaks of daughter elements were used for estimating Th and U, and the 1.46-Mev ^{40}K photopeak for K. (NSA)

Talvite, N. A. 1971. Radiochemical Determination of Plutonium in Environmental and Biological Samples by Ion Exchange. Anal. Chem. 43:1827-1830.

The oxidizing and reducing properties of H_2O_2 in HCl are utilized for adsorption and desorption of Pu. Sample preparation procedures are given for several materials, including siliceous and limestone soils. The mean recovery of separated and electrodeposited Pu was 94%. (0-77)

Tamers, M. A. and H. C. Thomas. 1960. Ion-Exchange Properties of Kaolinite Slurries.

The ion-exchange properties of kaolinite have been studied by use of isotopic exchange reactions on continuously stirred slurries of the material in a fluidized bed type of arrangement. The results show that the cation and anion exchange capacities of the clay vary with the concentration and type of electrolyte used. An isotherm is presented which illustrates the specificity of kaolinite for cesium over sodium exchange. The slow attainment of ion-exchange capacity equilibrium and other unusual properties are explained by the changing state of aggregation of the clay particles. Flocculation removes both anion and cation exchange sites from availability and thus reduces the observed ion-exchange capacity in the more dilute solutions. (auth)

Tamura, T. 1962. Strontium Reactions with Minerals. TID-7628, pp. 187-97.

Results are reported from slurry tests of the reactions of Sr^{85} in simulated waste solutions with various absorbent minerals. Mechanisms investigated included ion as an absorption process exemplified by the resins, clinoptilolite, and the clay minerals; ion exchange as an adsorption process characterized by the reaction of alumina; metasomatic replacement as characterized by the $CaCO_3$-phosphate reaction; and precipitation reactions as evidenced by natural vermiculites and clinoptilolite in contact with phosphated waste. Data are tabulated. (NSA)

Tamura, T. 1963. Cesium Sorption Reactions as Indicator of Clay Mineral Structures. Clays Clay Minerals, Proc. Natl. Conf. Clays Clay Minerals. 10:389-98.

At low cesium ion concentrations extremely high selectivities for cesium are exhibited by layer lattice silicates with unexpanded 10 Å c-spacing. The total amount of cesium which can be sorbed by these minerals depends on the edge area and the exchange capacity. At a concentration of 10^{-5} meq of cesium and 5 meq of sodium, a sample of biotite representing less than 0.025 meq of exchange capacity sorbed over 90% of the cesium and a hydrobiotite with 50% vermiculite and representing 1.0 meq of exchange capacity sorbed 80% of the cesium. After heating bentonites to 500 to 700°C more cesium was sorbed from solutions containing high sodium concentrations by the heated bentonite than the original material. The change in the amount of cesium sorbed as a result of heating may be a useful property for detecting the presence of montmorillonite in mixed or interlayered mineral systems. Lattice expansion of biotite resulted in improved cesium sorption; this behavior was due to generation of sufficient favorable exchange sites to offset the loss of edges with favorable 10 Å spacing. (auth)

Tamura, T. 1963. Mineral Exchange Work at Oak Ridge National Laboratory. TID-7644, pp. 29-45.

Experimental findings on vermiculite and biotite ion exchange reactions are discussed. Also the effects of commercial grundite for Cs removal from waste are reported. Data and other information are also included on Sr removal from wastes by various clays and other ion exchange materials such as hydrous Al and Fe minerals and Conasauga shale. (NSA)

Tamura, T. 1963. Selective Ion Exchange Reactions for Cesium and Strontium by Soil Minerals. Colloq. Intern. Retention Migration Ions Radioactifs Sols, Saclay. pp. 95-104.

The basis for discharge of low and intermediate activity wastes into the ground is the retention of the nuclides, particularly cesium and strontium, by ion exchange on the soil particles. Studies at Oak Ridge have shown that minerals with the mica structure are efficient in selectively sorbing cesium. For the low concentration of cesium generally found in wastes, ion-exchange capacity is seldom the controlling parameter for its removal. Biotite, a primary mica mineral, will sorb cesium even more effciently than vermiculite even though biotite has about 1% the exchange capacity of vermiculite. In a demineralized water system, montmorillonite with 90-meq-per-100 g exchange capacity gave a distribution coefficient (Kd) of 1700 ml per g, whereas illite with 20-meq-per-100 g gave a Kd of 49,000. In the acidic pH range, ion exchange originating from isomorphous substitutions is the dominant mechanism for strontium removal by soils. In neutral and alkaline systems, additional reactions may occur. Hydrous oxides of iron and aluminum show high selectivities for strontium in this pH region. A Conasauga shale soil did not sorb as much strontium after being subjected to free iron oxide removal in spite of an increase in capacity resulting from the removal of the iron coating. An aluminum saturated montmorillonite showed the lowest removal of strontium at pH 6.0: when the pH was raised to 10, this sample removed more strontium than potassium, sodium, or calcium saturated samples. Knowledge of the mechanisms responsible for selective ion exchange reactions made possible the preparations of materials that show even greater selectivities than their natural counterparts. Thus, in solutions high in sodium nitrate concentrations, montmorillonite heated to 600°C and vermiculites saturated with potassium ions remove more cesium than the natural minerals. Gibbsite, an aluminum hydroxide mineral commonly found in soils, was made 50 times more selective for strontium by heating to temperatures that decomposed the mineral to the oxide. (auth)

Tamura, T. 1964. Reactions of ^{137}Cs and ^{90}Sr with Soil Minerals and Sesquioxides. ORNL-P-438.

Mechanisms of ^{137}Cs and ^{90}Sr on various mineral structures are discussed. Selective sorption of Cs was strongly favored in the tracer range by a ten angstrom 001 spacing of layer silicates. Chemical and heat treatments that alter the 001 spacing can drastically change the distribution coefficient for Cs. The influence of soil sesquioxides in sorbing Sr from waste solutions is suggested from removal data on soil materials.

Tamura, T. 1964. Selective Sorption Reactions of Cesium with Soil Minerals. Nuclear Safety. 5:262-5.

A review of work done on retention of Cs from radioactive waste solutions by soils, Cs sorption by clay minerals and Cs-K relations with soils. (NSA)

Tamura, T. 1972. Sorption Phenomena Significant in Radioactive - Waste Disposal. IN: Underground Waste Management and Environmental Implications. Cook, T. D. (ed.). Amer. Assoc. Pet. Geol. Tulsa, OK. pp. 318-330.

Disposal of radioactive liquid wastes poses a particularly vexing problem, because these wastes contain various radionuclides and chemicals used in processing operations which are potentially dangerous, even in low radionuclide concentrations. Sorptive properties of minerals, particularly ion-exchange reactions, have been studied for potential direct application in waste treatment and for the purpose of defining the fate of radionuclides when released to soils and geologic formations. Because most waste streams normally contain stable-ion concentrations far in excess of radioactive ions, sorption reactions of interest are those which exhibit high selectivity for the radionuclides. Structural and/or steric factors are generally of highest significance in selective reactions. Micaceous minerals selectively sorb radiocesium from high-sodium, aluminum, or calcium solutions, primarily because of favorable structure. Zeolitic minerals show selectivity for certain ions by excluding other ions whose sizes exceed lattice parameters. Some sorbents show selective sorption reactions under particular pH conditions; thus, alumina and related hydrous oxides selectively sorb radioactive cobalt and radiostrontium in alkaline sodium systems. In addition to the exchange reactions, sorbent properties, such as flocculation, swelling, and adsorption of liquids, and chemical properties of radionuclides are important considerations in waste-disposal operations and management. In practical applications of the sorptive phenomena in waste disposal, it is necessary to know the solution characteristics, sorbent properties, and formation characteristics, as well as the interactions of these factors. In the hydraulic-fracturing technique employed at Oak Ridge, the waste-solution characteristics influence the choice of sorbents used to prepare waste-cement slurries. The high-sodium salt concentration requires attapulgite instead of bentonite, and illite is added to fix radioactive cesium. To immobilize the mix after injection underground, cement is added, but the cement further complicates the reactions and behavior of the clay slurries. The behavior during injection and ultimate setting of the grout is further influenced by the characteristics of the formation. Each underground-disposal operation will require understanding of the environment into which the waste is to be placed. The final facility and technique should be tailored to meet the requirements of maintaining safe operation and insuring long-term safety for future generations. (auth)

Tamura, T. 1974. Distribution and Characterization of Plutonium in Soils from Nevada Test Site. IN: Dunaway, P. B. and M. G. White (eds.). The Dynamics of Plutonium in Desert Environments. NVO-142, pp. 29-42.

This study was undertaken to determine the distribution and characterization of plutonium in soil fractions of the Nevada Applied Ecology Group (NAEG) intensive site study area samples. This report discusses analytical results obtained on three selected surface soil samples from two areas at Nevada Test Site.

Analytical methods are described for determination of total plutonium content, plutonium distribution in different particle size fractions, and short-time digestion leachability by HNO_3 revealed that 65 to 91 percent of the plutonium could be leached. The leaching results suggest the possibility of using the acid extraction as a means of predicting the "availability" of plutonium in soils. Preliminary data suggest that plutonium in the coarser size fractions is PuO_2, whereas plutonium associated with finer size particles possibly is a hydrous PuO_2. (auth)

Tamura, T. 1975. Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site. IN: White, M. G. and P. B. Dunaway (eds.). The Radioecology of Plutonium and Other Transuranics in Desert Environments. NVO-153, pp. 27-41.

Total plutonium was determined in nine surface soil samples (0-5 cm) from Area 13 in the Nevada Test Site (NTS). Particle size segregation was performed, and each particle size fraction of seven samples was analyzed for plutonium. The coarse silt fraction [53-20 micrometers (μm)] contained the highest percentage of plutonium in the soil (about 65%). Evidence of erosional translocation of plutonium was observed in one sample and corroborative evidence was noted in describing the soil type. Tests with 8 molar (M) nitric acid showed that about 13% of the plutonium was leached from the NTS sample, about 70% from sediments at Oak Ridge, and about 83% from sediments at Mound Laboratory. In 0.1 M citric acid, about 1% of the plutonium was extracted from an NTS sample, 25% from Oak Ridge samples, and 44% from Mound. Implications of these results on transport of plutonium within the NTS are discussed. (auth)

Tamura, T. 1975. Physical and Chemical Characteristics of Plutonium in Existing Contaminated Soils and Sediments. IAEA-SM-199/52.

Plutonium from three sites has been studied to provide information necessary in understanding its behavior and fate under prevailing conditions. Plutonium in soils from the Nevada Test Site (NTS) was predominantly associated (50-75%) with the coarse silt (53-20 μm) fraction. The coarse silt fraction was further segregated by density gradient zonal centrifugation; the plutonium in the sample from a bare soil ranged from 60-85% in the "heavy" mineral plutonium in a sandy mound taken beneath shrubbery occurred predominantly (80-95%) in a lighter fraction (2.5-2.7 g/cm^3) associated with feldspar. Soil extraction of NTS plutonium with 0.1M citric acid solution showed very low solubility (~1 percent).

The plutonium in samples from Oak Ridge National Laboratory (ORNL) and Mound Laboratory (ML) was predominantly in the clay size (<2 μm). The solubility in citric acid was about 20-25% in the ORNL sample and 40-50% in the ML sample. Density gradient segregation of the clay size fraction of the ML sample showed the activity distribution to be drectly related to the weight of the recovered fraction with enhanced contribution by the very light organic fraction. Approximately 71% was found in the 2.3-2.4 g/cm^3 fraction which controlled 65% weight percent of the clay and 16% in the <1.8 g/cm^3 fraction (organic fraction) which contained 6% of the weight fraction. (auth)

Tamura, T., W. P. Bonner, and C. W. Francis (et al.). 1970. Fate of Trace Elements and Radionuclides in Terrestrial Environment. ORNL-4584, pp. 1-10.

Banding of several reference clay minerals was evaluated in a continuous density-gradient solution using zonal centrifugation. Variables examined were particle sizes, cationic saturations, and centrifugal forces. Zonal centrifugation was also used to segregate mineral fractions of several environmental samples, and then these were investigated for phosphate or radionuclide distribution. For phosphate distribution, samples were obtained from the bottom and suspended sediments of the ORIC pond and a soil whose runoff drains into the pond. The principal finding is that most of the phosphate is present in the iron and aluminum phosphate forms. For radionuclide distribution samples, bottom sediments from White Oak Lake Bed and Creek were examined. Cesium-137 was found primarily in the clay mineral band; ^{90}Sr was found in most bands, including the bands containing calcium carbonate, which tentatively confirms earlier conclusion. Distribution of ^{137}Cs in a soil from previously tagged trees (Liriodendron forest, suggests that the mineral illite plays a dominant role in fixing this radionuclide. Water quality studies of Walker Branch Watershed were contined. Water temperatures were measured continuously at several locations in the two streams which drain the watershed. Differences in water temperatures were observed with time and location, and the differences were not predictably uniform. The differences are discussed, with reference to the source of groundwater and to air temperatures. (auth)

Tamura, T., W. P. Bonner, C. W. Francis, F. S. Brinkley, and E. R. Eastwood. 1969. Fate of Trace Elements and Radionuclides in Terrestrial Environment. ORNL-4446, pp. 1-8.

Zonal centrifugation techniques are described for analysis of clay and bottom sediments. The studies are primarily concerned with an improved mineral identification technique and increased understanding of environmental systems, with particular reference to phosphate distribution in the pond. The property of different densities of clay minerals was used for identification of clay minerals. A figure is presented to show smoothed x-ray diffraction tracings of magnesium-saturated glycerol-solvated clays from recovered bands. Phosphorus-32 distribution in soils and sediments was studied and effects of calcium carbonate on forms of phosphate in soil and sediment are shown by a table. Studies on the ORIC pond revealed that there was a significant decrease in phosphate since 1966 and organic nitrogen appeared to increase. Data showed that nutrients in the pond were being depleted and it is suggested that the minimal algal growths observed during 1968 could have resulted from the decrease in the concentration of phosphate. (NSA)

Tamura, T., F. S. Brinkley, et al. 1961. Fundamental Studies of Sorption by Minerals. ORNL-3189, pp. 27-42.

Removal of fixed cesium was significant only when cations capable of expanding the collapsed lattice were used. Intensive cropping by oats grown on vermiculite with fixed cesium released only about 1% of the sorbed cesium. In reactions involving strontium removal, the ion-exchange capacity, saturating cation, and surface characteristics of sorbent influenced the degree of sorption. Precipitation reactions involving calcium and phosphate ions were also important in removing strontium. Ruthenium removals were increased when reducing conditions were imposed on the system; chalcopyrite ($CuFeS_2$) was found to be one of the more effective minerals for sorbing ruthenium. (auth)

Tamura, T., F. S. Brinkley, B. L. Houser, D. G. Jacobs, and O. M. Sealand. 1961. Sorption and Retention by Clay Minerals: Oak Ridge Studies. TID-7621, pp. 54-68.

Methods of using clays for containment of fission products are examined. By heating mixtures of waste and clay that contain appropriate fluxes, fission products can be fixed in the resultant durable and insoluble matrix. Another method is by contacting the waste solution with the clay material, after which the fission products can be sorbed from solution, immobilizing the cationic fission products and lessening the probability of environmental contamination. Data and discussion related to these processes are included. (NSA)

Tamura, T., E. R. Eastwood and O. M. Sealand. 1972. Applied Soils and Waste Management Studies. IN: Environmental Sciences Division Annual Progress Report Ending September 30, 1972. ORNL-4848, pp. 49-51.

A recovery technique for Pu is outlined. Total extraction was accomplished from Pu contaminated soil by use of HNO_3-HF-HCl, ferric hydroxide and anion exchange purification and electrodeposition. Only about 12% of the Pu was extracted by a 2-hour digestion with 8M HNO_3. Eventual goal is to characterize the Pu-soil relationship and migration. (auth)

Tamura, T. and D. G. Jacobs. 1960. Structural Implications in Cesium Sorption. Health Physics. 2:391-398.

The results of this study help to explain the effectiveness of the local Conasauga shale for removing cesium from radioactive waste solutions. Illite, which is present in the [illegible]e has a particularly high affinity for cesium. The importance of the c-a[illegible] dimension of the 2:1 layer lattice clays was demonstrated by using synthetic micas and selected cation treatment. The beneficial role of potassium in the mica and illite is primarily because this element can induce and maintain collapse of the c-axis. Ion exchange capacities and surface area are secondary to the c-axis dimension in predicting the cesium sorption behavior of clays.

The potassium treatment and oven-drying of clays followed by cesium sorption may be used to differentiate montmorillonite from vermiculite; the importance of the findings in terms of weathering and diagenetic processes involving clays is discussed. (auth)

Tamura, T., D. G. Jacobs, et al. 1960. Sorption and Retention by Minerals and Compounds. ORNL-2994, pp. 58-78.

Cesium-sorptive capacity of several minerals was measured in simulated waste solutions and was found to vary with mineral structure, ion-exchange capacity, and saturating cation. For strontium removal from waste solution, apatite (rock phosphate) and variscite minerals were found to be potentially useful materials. (auth)

Tamura, T. and D. E. Jacobs. 1961. Improving Cs Selectivity of Bentonites by Heat Treatment. Health Physics. 5:149-154.

Selectivity for cesium was improved by heating montmorillonites to temperatures in the range of from 600 to 700°C. The optimum temperature depends on the saturating cation and bentonite type. For montmorillonites heated in this temperature range and at higher temperatures, clay-solution contact time was an important consideration. Sorption characteristics over a wide range of cesium concentration were investigated; the results suggested a multifunctional exchange reaction for the 600°C calcium-montmorillonite and a simple mass action reaction for the oven-dried calcium-montmorillonite. The study of the influence of heating periods at 600°C for calcium-montmorillonte showed that longer heating periods resulted in a decreasing degree of initial sorption; however, cesium sorption gradually increased with solution-clay contact time and eventually exceeded the cesium sorption of oven-dried samples.

These findings are significant for the understanding of clay mineral genesis and for applications in ground disposal of radioactive waste. (auth)

Tamura, T. and E. G. Struxness. 1960. Removal of Strontium from Wastes. ORNL-60-10-43.

Several mechanisms for removal of low concentrations of strontium from solution are described including adsorption on variscite or phosphate rock, scavenging of strontium by phosphate precipitation with Ca or Al, adsorption on alumina columns, and ion exchange on vermiculite columns.

Tamura, T. and E. G. Struxness. 1963. Reactions Affecting Strontium Removal from Radioactive Wastes. Health Physics. 9:697-704.

Alumina powder with an exchange capacity of about 1 meq/100 g removed as much strontium as a montmorillonite sample with 91 meq/100 g capacity when tested in a simulated waste solution of 0.1$\underline{M}$ $NaNO_3$ containing $1.1 \times 10^{-5}\underline{M}$ $Sr(NO_3)_2$ and in a basic pH. Additions of orthophosphate to the simulated waste solution resulted in improved strontium removal by $CaCO_3$ powder. With 5000 ppm of orthophosphate, 0.5 g of $CaCO_3$ removed over 99% of the strontium from 50 cm^3 of simulated waste adjusted to pH 9. Under the same test conditions, natural vermiculite showed improvement, but sodium-saturated vermiculite showed a reduction in strontium removal. By pretreating vermiculite with solutions of NaCl and NaCl-NaOH, the mineral's affinity for strontium was improved, and an increase from 35 to 85% removal was obtained using a 0.5 g sorbent/50 ml solution ratio. From the slurry tests four possible mechanisms for removing strontium from radioactive wastes are suggested. These are: ion exchange as an absorption process exemplified by vermiculite, clinoptilolite, and the clay minerals; ion exchange as an adsorption process characterized by alumina and possibly variscite; metasomatic replacement as characterized by the $CaCO_3$-phosphate waste reaction; and precipitation reactions as evidenced by natural vermiculite in contact with phosphated waste. (auth)

Tanaka, K. H. 1971. B Plant Ion Exchange Feed Line Leak. ARH-1945.

One of the objectives of the Waste Management Program is to separate the long-lived heat emitter ^{137}Cs from the bulk of the high-level liquid wastes. This separation is accomplished by the ion exchange process in the 221-B Building. Interim storage of the cesium is in solution as a nitrate. The feed for the B Plant cesium ion exchange process is pumped from the lag storage tank, 105-C, through a pipeline and several diversion boxes to the 221-B Building. On December 19, 1969, a leak was discovered near the 241-C-152 diversion box in the section of this line, V-122, from the 105-C tank. Although the leak represented a loss of feed for the processing of ^{137}C, more important was the consequence of environmental contamination to the soil from the line leak. For this reason, an investigation was made to establish the extent of the radioactivity spread. The results of a well drilling operation undertaken to define the boundary and to estimate the extent of the leak are summarized. (NSA)

Tanner, A. B. 1964. Radon Migration in the Ground: A Review. IN: Natural Radiation Environment. J. A. S. Adams and W. M. Lowder (eds.). Univ. of Chicago Press.

A review is presented in which factors that determine the distance that radon isotopes may migrate in the ground are discussed. The geophysical and geochemical implications of radon migration are also discussed. A bibliography of 162 references is included. (NSA)

Tarutani, T. and S. Misumi. 1962. Adsorption of Cerium Ion by Various Solid Substances in Aqueous Solution. Mem. Fac. Sci. Kyushu Univ., Ser. C. 5:21-6.

Experiments were conducted with ^{144}Ce to evaluate the extent of adsorption of this element on suspended matter in river water. It was necessary to assume the amount of suspended matter. The amount of suspended matter in water tested, near the mouth of Chikugogawa River, Kyushu, was a few hundred milligrams per liter. This river was adopted as a model for experiment with solids of less than 1 g/l. A 10-mg deposit of Chikugogawa water adsorted about 90% of cerium in solutions of pH 6 and 8 and of sea water. With bentonite, the percentage of cerium adsorbed in a solution of pH 8 was larger than that in sea water, but the difference between them was small. Bentonite and quartz showed maximum adsorptions at about pH 8. The percentage of cerium adsorbed by kaolinite and calcite increased with increasing pH. It was found that the adsorption of cerium by solid substances agreed well with the Freundlich adsorption isotherm. As the deposit of Chikugogawa is a good adsorbent of cerium, it is evident that a considerable amount of cerium is adsorbed by muddy suspensions in river water. It is presumed that cerium is accumulated in mud of marine sediment. (NSA)

Tate, K. R. 1972. Radiocarbon Dating in Studies of Soil Organic Matter--Vegetation Relationships. <u>IN</u>: Proc. of the Eighth International Radiocarbon Dating Conference Vol. 2. Raffer, T. A. (comp.). Wellington, New Zealand. pp. E27-E38.

Radiocarbon dates of topsoil and subsoil humic acids from a New Zealand yellow-brown earth at a pasture and a forest site have been used to evaluate humic acid hydrolysis techniques in studies of soil organic matter-vegetation relationships. Identification of charcoal from the topsoil under an introduced pasture has shown that the pasture site was originally covered with a forest composed largely of hard beech (Nothofagus truncata). Measurements have been made of the enrichment by atmospheric radiocarbon of the whole soils and of the humic acids extracted from these soils. These experiments have indicated that ^{14}C enrichment was principally restricted to the topsoil under the pasture of ryegrass (Lolium perenne) and white clover (Trifolium repens), but occurred throughout the profile under hard beech. The humic acids from the topsoils and subsoils were hydrolysed with hydrochloric acid. The ratio of the vanillic acid to p-hydroxybenzoic acid in the acid hydrolysates decreased down the soil profile under hard beech, but markedly increased down the profile under pasture. The hydrolysis data suggest that the organic matter in the pasture subsoil still retained the imprint of the former forest vegetation. These results are consistent with the radiocarbon measurements, and confirm the value of the acid hydrolysis technique in soil organic matter-vegetation studies. (auth)

Tatsumoto, M. and E. D. Goldberg. 1959. Some Aspects of the Marine Geochemistry of Uranium. Geochim. et Cosmochim. Act. 17:201-8.

The U concentrations in marine calcareous material of a biological origin varied between 0·0X and 0·X ppm, with the exception of corals which had concentrations of several ppm. The aragonitic oolites and aragonite precipitated from seawater had values similar to those of the corals. A geochronology based on the growth of ionium (Th^{230}) from U is applicable not only to corals, as previous investigators have pointed out, but also to oolites. Several examples of "oolite ages" are given. The U content of ferromanganese minerals from pelagic deposits is of the order of from 4 to 5 ppm. (auth)

Taylor, A. W. 1968. Strontium Retention in Acid Soils of the North Carolina Coastal Plain. Soil Science. 106:440-7.

The mechanism by which some acid soils of the Southeastern U.S. retain Sr was investigated. The Sr present in the soil samples was labeled with a solution of ^{85}Sr and extracted by centrifuge. The results showed that, when trace quantities of radiostrontium are equilibrated with some acid soils from the Coastal Plain of North Carolina for periods of 40 days, significant amounts--sometimes 40% cannot be recovered in rapid extraction with normal solutions of strontium nitrate. Isotopic equilibrium is approached only when the extraction is extended over a time equal to that taken for the original labeling. The mechanism of occlusion of this strontium is not a permanent fixation, but is due to a slow exchange reaction in which the rate-limiting step is a diffusion process acting with the exchanger matrix of the soil. The reaction does not appear to be characteristic of strontium alone, and is probably also shown by calcium ions. The rate of release of strontium is sensitive to the concentration and composition of the extracting solution, and all the occluded strontium is immediately released on destruction of the soil organic matter. The amounts of strontium occluded cannot be correlated with acidity, exchange capacity or clay mineral content, and are believed to reflect variations in the physical or chemical character of the organic matter in the soils examined. Since isotopic equilibrium is approached only over a period of 6 to 8 weeks, it is clear that rapid extraction methods are not likely to give satisfactory estimates of the amounts of radiostrontium that will be taken up by a crop that is grown to maturity on such soils. (auth)

Taylor, A. W. 1969. The Selectivity Coefficient of Slowly Exchangeable Calcium and Strontium. Soil Science. 107:58-62.

The slow approach to isotopic equilibrium shown by the exchangeable strontium in some acid soils of the North Carolina Coastal Plain and also exhibited by the exchangeable calcium is discussed. In these soils the exchange equilibrium between these ions may not be reached in less than one month. At equivalent fractions of calcium from 1.0 to 0.9 the slow exchange reaction does not show any significant selectivity for either ion, although the calcium may approach isotopic equilibrium a little more rapidly than the strontium. The slow exchange has no practical significance for the separation of calcium and strontium in field conditions, but has important implications for the interpretation of data from laboratory or pot experiments with soils in which it occurs. (auth)

Taylor, C. I. (ed.). 1975. Environmental Sciences Division, Annual Progress Report for Period Ending September 30, 1974. ORNL-5016, pp. 1-8.

Initial adsorption measured after three weeks of addition of 163 μg Pu/l solid, showed that Ca-saturated humic acid was a very effective sorber and did not release Pu readily upon equilibration with citrate. Ca-montmorillonite and Ca-kaolinite did not sorb 2-3% of the 163 μg/g Pu addid. When Pu was added at the rate of 0.6 μg/g solid, the removal of natural organic matter and/or iron oxide coatings from clay reduced the efficiency of Pu sorption by clay by only 1-5%. The higher Pu solubility of soils in which Pu was associated with clay fraction compared to soils in which Pu was mainly associated with coarser silt sand fractions indicate that the solubility differences may be due to particle size of plutonium particles. (auth)

Taylor, S. R. and A. J. R. White. 1965. Trace Element Abundances in Andesites. Presented at IAV International Symposium on Volcanology Scientific Session of Nov. 25, 1965.

Data for 8 major and 45 trace elements in 6 central North Island andesites and 8 Japanese andesites of Kuno's Hypersthenic series are presented. The andesite compositions are compared with that of average continental crustal material, and differences and similarities are noted. The rare earth abundance patterns are similar to those of well mixed crustal material. Present data for the absolute abundances of Rb, K, Ba, U and Th in particular appear to be too low for derivation of andesitic magma by mixing of average basaltic and granitic material.

Implications of the data for the origin of andesite magma and for continental growth are discussed. (auth)

Telfair, D., R. Garrison and C. Smith. 1960. Natural Radioactivity of Miami Soils. Science. 131:727-8.

The relation between gross γ activity and soil depth for a particular soil (Miami silt loam) is presented, together with a discussion of the contribution of K^{40} and the U and Th series and of the effects of fallout from bomb tests in increasing the radioactivity of a thin layer of surface soil. The increased count rate in the B horizon is caused partly by K^{40} in the lower soil horizons and partly by a similar trend for Ra. The greater accumulation of Rn in the B horizon must be accompanied by a higher Ra concentration. This was not expected, since Ra is known to behave chemically somewhat as Ca does, and Ca (in these soils) has been leached from the B horizon but occurs at higher concentrations in the underlying glacial till (C horizon). It is possible that the leaching of U from the A horizon and its adsorption on clay surfaces in the B horizon are important here. (CA)

Templeton, W. L. and A. Preston. 1966. Disposal of Radioactive Waters into Seas, Oceans and Surface Waters. IN: IAEA Publication. pp. 267-289.

Authors reported that various radioactive materials penetrate or redistribute with depth in seabed materials in different proportions. The penetration was in the following order: ^{239}Pu, ^{137}Cs, ^{90}Sr, ^{106}Ru. The penetration ratio (amount in 15-23 cm depth divided by amount in 0-5 cm depth) for plutonium and cesium were 0.17 and 0.08, respectively. (auth)

Templeton, W. L. and A. Preston. 1966. Transport and Distribution of Radioactive Effluents in Coastal and Estuarine Waters of the United Kingdom. STI-PUB-126, pp. 267-89.

The available data on the transport and distribution of radioactive effluents in coastal and estuarine waters of the United Kingdom are discussed. The major part is derived from surveys following the disposal of fission products from the fuel element reprocessing plant of the UKAEA at Windscale. Some data are presented on the disposal of corrosion products from a C.E.G.B. nuclear power station into the Blackwater Estuary. In the Irish Sea, data collected between 1959 and 1965 on the concentration of radionuclides in sea water, seabed material, shore silt, algae, invertebrates and fish are presented to describe the pattern of distribution up to 50 miles from the discharge point. Hydrographic data are discussed to support this. Seaweed surveys around the coastline of the United Kingdom compare the levels at Windscale with background fallout levels and indicate the limit of Windscale contamination to be at 75 to 100 miles. A comparison of ^{137}Cs concentration in fish, sampled from fresh waters in high and low rainfall areas, from the Irish Sea, and from other sea areas is presented. In the Blackwater Estuary, data on the concentration of ^{65}Zn in oysters are presented and the distribution in the estuary discussed. (auth)

Tensho, K., K. Yeh, and S. Mitsui. 1961. Absorption of Radioactive Strontium by Soil, Especially in Relation to Native Calcium. Soil Sci. Plant Nutr. 7:152-6.

After shaking soil suspensions with carrier-free ^{89}Sr, its absorption by soil was examined in relation to soil Ca content and soil pH. The soil pH was changed by adding HCl, NaOH, or Ca $(OH)_2$. The distribution ratios of ^{89}Sr for 7 soils ranged from 0.7 to 3.9%, 72 to 94%, and 5.4 to 25% for the nonabsorbable, exchangeable, and nonexchangeable fractions respectively. With regard to the ratio ^{89}Sr to Ca, a significant difference was found between nonabsorbable and exchangeable fractions, and the degree of this unequal distribution between the 2 fractions was not identical among the soils tested. Maximum ^{89}Sr absorption by 3 soils was obtained by the addition of a small amount of NaOH to give a pH value of about 6.5 to 7, but its absorption was scarecely influenced by $Ca(OH)_2$. The ratio of ^{89}Sr to Ca of the nonabsorbable fraction was increased by lowering soil pH, and the reverse was found for the addition of $Ca(OH)_2$ and a small amount of NaOH. Autoradiographic experiments showed that the ^{89}Sr in distilled water was accumulated on the surface of soil column, and the deposited ^{89}Sr barely migrated after washing with distilled water. Appreciable downward movement, however, was caused by washing with water containing Ca. (NSA)

Tewari, S. G., P. C. Ghosh, and A. S. Bhatnagar. 1968. Closed Circuit Technique for the Measurement of Radon/Thoron Ratio in Soil-Gas. Indian J. Pure Appl. Phys. 6:33-36.

A closed circuit technique for measuring the ^{226}Rn/^{222}Rn ratio in soil gas as an aid to the geophysical method of prospecting by radon survey is discussed. This method is suitable for field applications and gives good statistical results in spite of limited available volume of soil gas and short half-life of Th. Significance of some experimental results are discussed. (auth)

Tewhey, J. D. 1976. Preliminary Results of Experimental Work in the Radionuclide Migration Program -- The Sorptive Character of Tuffaceous Rocks in a "Static" Versus "Dynamic" Mode of Testing. UCID-17064.

A preliminary set of experiments has been conducted in order to determine the sorptive characteristics of rock with respect to ionic species under conditions of dynamic flow of an aqueous solution through a rock core. The results of the dynamic experiments have been compared to the results of static or batch experiments which were conducted under corresponding physical and chemical conditions. It was found that, gram for gram, sorption of the ion of interest was always greater in the dynamic experiments. These results are contrary to early predictions and indicate that the effect of rock surface area on adsorption was overshadowed by another parameter.

It has been suggested as a working hypothesis that the competitive effect of ions that were dissolved and/or leached from the rock in batch experiments has resulted in reduced sorption of the ion of interest. Several experimental observations support this hypothesis. The hypothesis could be further tested by means of the following: (1) analyzing the solution in batch experiments for other components (Si, Al, Mg, Fe) in order to further define the dissolution/leaching process by which Na, K and Ca are introduced into the solution, (2) conduct more sets of corresponding static and dynamic runs in order to obtain a larger sampling of results and (3) conduct static and dynamic runs on rock types with a variety of mineralogical make-up.

If the hypothesis is confirmed by further experimental work, a ramification of the study is that calculations concerning transport of radioactivity in groundwater which utilize input parameters derived from static tests will tend to be conservative with respect to what occurs in nature. (auth)

Texas Agricultural and Mechanical College. 1958. A Study of Some Factors
Involved in the Disposal of Radioactive Wastes at Sea. Pt. I. General
Project Info. Pt. II. Physical Oceanography and Sedimentology. Pt. III.
Marine Biol. Pt. IV. Clay Mineralogy. Pt. V. Physico-Chemical Considerations. Ann. Rpt. ORNL-186. Pt. I-V.

The Mississippi River in the vicinity of the South and Southwest Pass and the adjacent water of the Gulf of Mexico were investigated. The gross categories into which the investigation was divided include physical, physico-chemical, and biological aspects. Field operations, including sampling cruises, are briefly described in the first part as well as personnel qualifications and disposal conferences attended. As a starting point in the evaluation of physical factors involved, data were obtained from U.S. Corps of Engineers. The physical and sedimentary environment of the west Mississippi Delta area may be divided into three sub-environments such as the fresh water regime within the river channel influenced principally by river discharge and tides, the fresh-saline water regime in the vicinity of the mouth of the Pass affected by river discharge and other factors, and the saline water regime of the open Gulf influenced by the prevailing winds and currents. In view of the importance of clay minerals in the process of chemosorption with respect to radioactive materials, their distribution in the bottom deposits of the western Mississippi Delta area was investigated. The most abundant clay mineral in the area is montmorillonite which makes up about 50% of the clay mineral suite. Illite and kaolinite compose about 25% each. The abundance of montmorillonite is significant since it has the greatest number of exchangeable positions and the greatest capacity for adsorbing organic complexes. The physico-chemical characteristics of the clays and other suspended materials in the water include exchange capacity and adsorption and the differential flocculation potential of the various clay minerals. The suspended sediment load in the lower Mississippi River, which consists of an appreciable amount of clay minerals is of such a magnitude that the accumulation of radioactive ions may be appreciable. The salinity of the water and the extent of the salt water wedge in the river as well as the extent of the turbid mass in the Gulf of Mexico must be considered in the problem of localization of any radioactive contamination. The exchange capacity of the clays are effected by the organic material present. In the marine environment there appears to be a blocking effect which is not readily observed in the river environment. The organic material which is in turn adsorbed on clays is capable of complexing ions and thus accomplish chemical scavenging. An evaluation of the biological accumulation, a study of the copepod fauna, was undertaken in the Mississippi Delta region in 1956. Samples were collected in the spring, summer, fall, and early winter. The work was conducted mainly from off the South Pass to about 30 miles offshore. The pattern of distribution of the number of species seems to be associated with the salinity conditions of the area, for in the fall and winter when the salinities increased near the delta many offshore and oceanic species advanced into the region. The seasonal abundance of the copepods varied from rich in the summer to poor in the winter; in the fall they appeared to be more abundant and more varied than in the spring. (NSA)

Texas University. 1968. Radioactivity Transport in Water. Interaction Between Flowing Water and Bed Sediments. ORO-49-17.

The delay in transport of radionuclides caused by the interaction between flowing water and bed sediments was determined. This interaction phenomenon for ^{137}Cs was observed by using a set of flumes, each 50 ft in length and a model river which was 200 feet long. The greatest uptake rate, K_{st}, by bed sediment was 88.7 x 10^{-4} [(cpm/cm^2)/(cpm/cm^3)1/(sec) with a velocity of 1.65 fps and a flow rate of 0.345 cfs/ft. In this case the sediment transport rate was 0.0795 lbs/sec-ft. A mathematical model was developed describing the migration of radionuclides into the sediments. The relative concentration of radionuclides on the surface of the bottom sediments to that in the bed sediment was found to be a function of $z/(2\sqrt{Dt})$, where z, D, and t, respectively, are the depth of bed sediment from the surface, diffusion coefficient of ^{137}Cs in water, and time after migration started. (auth)

Texas University. 1969. Analysis of Radionuclide Transport Project. Progress Report. TID-25134.

Prediction models for the transport of radionuclides into surface water investigated through the use of a model river system which simulated river processes in a flowing ecosystem. This study was undertaken to evaluate the environmental factors affecting radionuclide transport through laboratory ecosystems and a model river. Measurements of the amounts of radioactive tracers retained in water, plants, and sediments in the research flume were recorded. The results indicate that radioisotope transport in streams is influenced by the stream dispersion characteristics; the organic, inorganic, and thermal stream pollution; the amount of radioactivity already in the bed sediments; the amount of sediment agitation; and environmental factors such as plant growth, pH, light intensity, and oxygen content. Further experimental work for refining the mathematical models is recommended. (NSA)

Thomas, C. W. and R. W. Perkins. 1975. Transuranium Elements in the Atmosphere. HASL-291, pp. I.80-I.103.

The main release of transuranium elements to the atmosphere has been a result of nuclear weapons testing, particularly the high yield fusion bomb tests beginning with the Ivy Mike test in 1952. It has been estimated that approximately 300 kCi of $^{239-240}Pu$ were deposited on the earth's surface through 1972. Approximately 17 kCi of ^{238}Pu was injected into the atmosphere of the southern hemisphere in April 1964 when a satellite containing a power source failed to achieve a stable orbit. Analysis of the debris of Ivy Mike and subsequent high yield nuclear weapons debris has shown transuranium elements up to mass 257. The amounts of these heavy radionuclides compared with $^{239-240}Pu$ drop off rapidly with mass. However, there are very considerable amounts of ^{241}Pu and ^{241}Am, and the ^{241}Am after total decay of ^{241}Pu will actually exceed the $^{239-240}Pu$. On comparing the airborne $^{239-240}Pu$ to ^{137}Cs, it is found that their ratio has been relatively constant for the last several years, thus one can use the atmospheric models which describe the behavior of the fission products in describing the movement of the transuranium elements. Thus, it is possible to predict what the deposition pattern of the transuranium elements has been from past nuclear tests on the surface of the earth. It has been estimated that the nuclear power industry will generate approximately 10^9 curies of transuranium elements during the remainder of this century. While it is highly unlikely that a significant amount of this material can enter the atmosphere, this source needs consideration, particularly in view of the much higher levels of some of the transuranium elements than that of ^{239}Pu. (auth)

Thomas, H. C. 1963. Mineral Exchange at the Univ. of North Carolina.
TID-7644, pp. 13-28.

The thermodynamics of ion-clay interactions in small chromatographic columns are reviewed. Tracer techniques were used in montmorillonite uptake experiments on ion pairs such as Na--Cs, Cs--Ba, and Na--Ba. Other work is reported on clinoptilolite ion exchange under equilibrium conditions with special attention directed toward hydrogen ion behavior. Simpler cases involving interaction of complex solutions and the mineral sorbents in the soil were studied. (NSA)

Thomas, H. C. 1967. The Thermodynamics of Ion Exchange on Colloidal Materials
with Applications to Silicate Minerals. Final Technical Report to USAEC.
University of North Carolina. Contract No. AT-(40-1)-2130.

THERMODYNAMICS OF INTERFACIAL REGIONS

A review of some necessary parts of classical thermodynamics followed by a detailed development of the application to surface regions.

ION EXCHANGE ON CLAY MINERALS

Illustrations of the use of the results of the first chapter to various cases of ion exchange on montmorillonite clays.

APPROXIMATE APPLICATIONS TO FLOWING SYSTEMS

Examples of the great simplifications which must be made in the application of equilibrium data to flow through beds of ion exchangers. (auth)

Thomas, H. C. 1968. Problems in Sorption on Clay Minerals Illustrated with
Data on the System Ca-Ba-Montmorillonite. TID-7628, pp. 179-86.

Problems encountered in studies on the sorption of radionuclides on soil minerals are discussed. Tentative results are included from investigations on the characteristics of the exchange sorption of Ca-Ba on heated montmorillonite clay. Data are tabulated. (NSA)

Thomas, H. C. and N. T. Coleman. 1957. The Interaction of Radioactive Nuclides and Soils. An Account of Our Present Position with Respect to the Basic Problems Involved. IN: Hearings on Industrial Radioactive Waste Disposal. 3:1861-1912.

By assuming that fixation will never be quite complete and disposal never quite final, the problem of the fate of radioactive poisons which have escaped to the environment is discussed. A classification is given of the distribution and different kinds of surface activity exihibited by the soil minerals with emphasis on complex mixtures of hydrous oxides and clay minerals. A thermodynamic description of exchange sorption and Donnan invasion is given and thermodyanmic functions for various clay systems are graphically shown. (NSA)

Thomas, K. T., D. G. Jacobs, T. Tamura, and E. G. Struxness. 1960. Strontium Sorption Studies Using Naturally Occurring Ion Exchange Materials. CF-60-10-35.

Four naturally occurring materials, namely, vermiculite, variscite, Tennessee rock phosphate, and Florida pebble phosphate, were studies to determine the feasibility of their use in columns for the sorption of strontium from high pH, intermediate-level wastes produced at ORNL. With the exception of vermiculite, all materials were found to be effective in strontium removal. The addition of soluble phosphate to the waste solution remakably improved the strontium-sorption characteristics of vermiculite, 100 ppm of PO_4^{3-} being a satisfactory concentration. A reduction in pH of the solution adversely affected strontium-removal properties of all the materials. All the materials showed beneficial effects with in increase of Ca^{2+} concentration in the solution, but the results were not very marked. An increase in the mass equivalent of strontium or sodium concentration did not show any beneficial effects for strontium sorption. (auth)

Thomas, W. A. and D. G. Jacobs. 1969. Curium Behavior in Plants and Soil. Soil Science. 108:305-307.

Curium-242 was used to measure curium sorption by several clays in equilibrium experiments and in loading and leakage of hydrobiotite columns. Results indicated that above a pH of about 3, an increasing amount of radiocolloid existed as the pH was increased. Plants grown on a curium-contaminated soil relocated very little of the curium to foliage. (auth)

Thompson, M. A., (ed.). 1972. Research and Ecology Semi-Annual Progress Report, January-June, 1972. F. J. Miner and H. W. Miller. Plutonium Behavior in the Soil/Water Environment. RFP-1921-A, pp 1-3.

A program has been undertaken to obtain information about the behavior of plutonium in a soil/water environment. The work to date has been concerned with the investigation of the parameters effecting the movement of plutonium in the soil. (auth)

Thompson, R. C. 1976. Biology of the Transuranium Elements. An Indexed Bibliography. BNWL-2056.

The coverage and format of this bibliography remain as described in the first edition. "I have attended to cover completely, the biological behavior and biological effect of the transuranium elements - "biological" being broadly interpreted to include behavior and effect within natural ecosystems and work locations as well as within discrete organisms. Borderline areas not covered, or represented only be selected articles of special interest, include: applications of transuranium elements where biological effects are not directly involved; monitoring, counting or analytical techniques where biological data are not presented; descriptions of chemical or physical properties where these are not reflected in biological behavior.

In areas where complete coverage is attempted, this coverage extends only to publications in scientific and technical journals, books, and the published proceedings of scientific meetings. The document literature has been cited selectively, where there seemed reason to believe that the information would not later appear in a more accessible form. Thus, publications in recent periodic reports of major laboratories are not included, but reports from older documents are sometimes included when the information contained is not available elsewhere." (auth)

Thomson, J., K. K. Turekian, and R. J. McCaffrey. 1974. Accumulation of Metals in and Release from Sediments of Long Island Sound. COO-3573-8. p. vp.

The detailed analysis of a short diver-obtained core and a long gravity core along a line south of New Haven harbor is used to determine the modes and rates of accumulation of metals over time in sediments of central Long Island Sound and the patterns of their release. The ^{210}Pb dating of the long core shows an increase in Zn, Cu, Pb, Hg and Mn (the metals determined) over the last 70 years. This is presumed to be the consequence of human activity around the Sound. The short diver-obtained core was analyzed for ^{210}Pb, ^{226}Ra, ^{234}U, ^{238}U, ^{230}Th and ^{232}Th as well as Cu, Pb, Zn, Cd and Mn. The interpretation of the sedimentary and chemical data yields a picture of an episodic deposition of approximately 18 cm of sediment about 16 years ago with subsequent bioturbation of the upper 10 cm with the lower portion retaining its stratification. Loss of U and ^{228}Ra (and probably ^{226}Ra by analogy) and gain of ^{210}Pb, ^{228}Th and possibly some Mn has occurred since the sediment load was deposited. The metals Cu, Pb and Zn showed no loss from the sediment. (auth)

Thomson, J. and A. Walton. 1971. Natural Radioactive Decay Series Elements in the Oceans and Sediments. Proc. Roy. Soc. Edinburgh, Sect. B. 72:167-82.

A literature review is presented of studies on radioisotopes in oceans and sediments. Studies of radium in oceans and sediments are reviewed with regard to the origin of high radium concentrations in sediments and the migration of radium in sediments. Studies on thorium and protactinium in oceans and sediments are discussed under the following headings: analytical advances; direct measurements of uranium, thorium, and protactinium isotopes; thorium isotope ratio ($^{230}Th/^{232}Th$) approach; throium/protactinium ($^{230}Th/^{231}Pa$) approach; uranium isotope ratio ($^{234}U/^{238}U$) deviation; leaching versus solution of sediments; and comparisons of age determination methods. (NSA)

Thorburn, R. C. 1950. Absorption on Hanford Soil and Related Soil Properties. HW-15655.

The effects of a solution of $MgCO_3$ and $CaCO_3$ on the retention of Pu by Hanford soil columns was ascertained. There was no effect on measured effluents as compared to noncarbonate-containing influents. From 55 to 94% of the water eluted Pu was resorbed by another soil column. Only 24% of the Pu was retained on a soil at pH 10 compared to 77% to 87% at pH 3.8 to 7.2. (auth)

Thorn, R. J., R. J. Ackerman, J. R. McCreary, E. G. Rauh, and G. H. Winslow. 1974. High-Temperature Chemistry. IN: Chemistry Division Annual Report, July 1972 through June 1973. ANC-8096, pp. 94-105.

The thermodynamic properties or quantities were given for several compounds including PuF_3, Cs_2MoO_4, α-Na_2UO_4, U_3O_8-Z and gaseous thorium monoxide and dioxide.

Thornthwaite, C. W., J. R. Mather, and J. K. Nakamura. 1960. Movement of Radiostrontium in Soils. Science. 131:1015-1019.

From the results of laboratory experiments it was possible to develop a mathematical model of movement in the soil which showed that a certain percentage of the strontium moved downward to the next lower layer of the soil for each unit volume of surplus water which is added to the layer. The model was verified by laboratory experiments and by actual field observations of strontium content in the soil.

During the development of the mathematical model it became clear that a number of factors would be important in any attempt to apply the model to variable field conditions. Among these factors are (i) the cation-exchange capacity of the soil both areally and with depth; (ii) the quantity of surplus water available for leaching; (iii) the initial concentration of strontium in the soil and the increments to the soil due to fallout; (iv) the chemical composition of the rain water and the soil solution; and (v) the leaching efficiency of various solutions containing cations and anions.

Before the mathematical model can actually be applied to the problem of determining the distribution of strontium with depth at a given place, precise information on these factors is needed. While information on the water surplus at any time or place is relatively easy to obtain from the climatic water balance, and information on fallout is available from those stations at which pot collectors are being operated, and in highly generalized form elsewhere, information on some of the other quantities is not as readily available. For instance, even though soil samples are taken by the Health and Safety Laboratory of the New York Operations Office of the AEC at 17 different places in the United States, these are limited to one sample a year at a site and generally to only two layers (0 to 2 inches and 2 to 9 inches) in the soil. We do not know much about the seasonal or monthly variation in soil concentration of strontium or in its real variation with depth.

Information on the cation-exchange capacity of many different soils is available in the literature, but these data have never been assembled in a map, while information on the variation of cation-exchange capacity with depth is not at all readily available. Detailed information on the chemical composition of rain water and of soil solutions is practically nonexistent.

The future course of this study and its possible practical application will depend on the course of world events in the next several years. If weapon testing should be discontinued, either through international agreement or through unilateral decision, and if no further ^{90}Sr burden is added to the present stratospheric reservoir, fallout will soon reach very small levels and contamination of the soil will end. The ^{90}Sr in the soil will then serve as a tracer which will be of unparalleled value in studies of leaching, soil development, and ground-water hydrology.

If weapon testing should be resumed, or if a nuclear war should break out and soils all over the earth should be seriously contaminated, the natural processes of soil purification through leaching would proceed at different rates in different areas. After only a few years some soils would be decontaminated to a point where they would produce food suitable for human consumption. Soils in other areas would remain contaminated for many years and presumably would have to remain under quarantine. New sets of land values would develop, and a wholesale redistribution of any remaining population would occur. As the work begun under this research study continues, it will yeild a body principles which will apply regardless of the direction of future events. (auth)

Thurber, D. L. 1962. Natural Variations in the Ratio of ^{234}U to ^{238}U. Radioactive Dating. Proc. Symp., Athens. pp. 113-20.

Anomalous ^{234}U/^{238}U activity ratios in integrating basins, such as the ocean and playa lakes, provide a promising new geological dating method for the period 10^5-10^6 years in both continental and marine systems. The ^{234}U/^{238}U activity ratios of CO_3 -- deposits from 2 glacial lake basins and a few selected marine samples, were measured by α-spectrometry after a chemical separation of U from Th. Core samples from an Eniwetok drill-hole gave ages based on ^{234}U/^{238}U ratios in agreement with other methods. Six samples from the Lake Lahontan Basin gave a ratio ~1.5, and 6 from Lake Bonneville were ~2.0, indicating that these samples are $<1.5 \times 10^6$ years old. (CA)

Tiller, K. G., J. F. Hodgson, and M. Peech. 1963. Specific Sorption of Cobalt by Soil Clays. Soil Science. 95:392-399.

Sorption of Co^{+2} from very dilute solution by soil clays in the presence of 0.1 N $CaCl_2$ was studied and compared with the sorption by pure minerals (mica, montmorillointe, vermiculite, kaolinite, quartz, hematite, goethite) under similar conditions. The cobalt sorption results were not very different. Organic matter in soils containing small to moderate amounts did not seem to effect cobalt adsorption.

Tiratsoo, E. N. 1949. The Radioactivity of Sediments (3) Determination of Rock Absorption Coefficients. Petroleum. 12:166-9.

The author discusses the general nature and properties of γ rays, derives the exponential absorption law and gives absorption coefficients for several elements and several γ-ray energies. Results of several previous measurements of the absorption coefficients of geological specimens are cited. Only γ rays are considered because alphas and betas are very quickly absorbed. The experimental technique used by the author is outlined, and absorption coefficients, calculated from data obtained by the author, are listed for several types of sandstone, shale, marl, and limestone. A pitchblende source was used in these measurements, and the calibration of the source is described. (auth)

Tiratsoo. E. N. 1949. The Radioactivity of Sediments. IV. Radioactivity and Petroleum. Petroleum. 12:313-15.

Previous workers have reported unusually high radon activities in crude oils and in oilfield waters (Bohn, J. Franklin Institute 210, 461 (1930); Bern, Kali 30, 41 (1936)). Activity measurements were made on crude oil samples from Germany, Holland, Iraq, and Trinidad. Alpha-ray activities were found which indicated high radon concentrations, but no γ radiation was detected. These results tend to confirm previous reports and to indicate that radon is absorbed by crude oil from the surrounding rocks. No radioactivity was detected in the oilfield waters. However, high activities were noted in several samples of oil shales. The activities of the oil shale and crude oil samples are tabulated. The author considers the possible influence of this radioactivity on the formation of oil deposits. (NSA)

Titaeva, N. A. 1967. On the Character of Radium and Urar'um Bond in Peat. Geokhimiya. No. 12:1493-99.

In little-mineralized hydrocarbonate-calcic surface waters uranium is considerably more mobile than radium. Radium is well sorbed not only by clay sediments but also by peat. In peat uranium is bound to the fraction of humic acids and fluvoacids being soluble in alkalis, and radium to the insoluble residue. The bond of elements under oxidizing conditions has an exchange character. In the presence of great calcium amounts in water the radium bound in peat and in the insoluble residue becomes poorly exchangeable. In humic acid the exchange character of the radium bond is preserved. (auth)

Titaeva, N. A. 1969. Behavior of Natural Radioactive Elements During Mechanical and Chemical Transportation Under Yakutia Conditions. Vestn. Mosk. Urui., Geol. 24:88-91 (in Russian).

Modes of chemical and mechanical migration of radioactive elements under the extremely cold continental climate of Uakutia are studied. Average concentration (c) and standard deviation (e) of U and Th in the alluvial transported sands of Aldan-Timptonsk and Lena are 1.3 (U,c) and 1.7 (Th, c), respectively. The Th/U ratio changes 4.1-11.7. Chemical migration of radioactive elements is more prominent in slightly mineralized ($Na-HCO_3$) waters of Yakutia. The coefficient of migration of $^{234}U > ^{238}U > ^{226}Ra > ^{230}Th > ^{232}Th$.

Titaeva, N. A. and T. I. Veksler. 1969. Uranium and Thorium During Weathering of Yakutia Rocks. Geokhimiya. No. 6:740-4 (in Russian).

The behavior of U and Th was studied during weathering of bedrock under specific conditions of the sharply continental climate of Yakutia and widely distributed permafrost, i.e., under conditions inducive to intense physical weathering. Cold waters over the permafrost layer are rich in organic substances and have elevated O_2 and CO_2 concentrations favorable for chemical weathering of upper thawing layers of rocks. The study was made in two areas in the upper reaches of the Vilyui River and in the Aldan-Timpton interfluve. The first region was within the large differentiated trap intrusion and the second consisted of an Archean metamorphic gneiss and crystalline schist complex. Noticeably high removal of Th, accumulating in alluvium, was observed in both areas. The U was also removed from all rocks. The removal of U somewhat lagged behind that of other metal components in rocks which were relatively easily chemical weathered (carbonate rocks, tuffs, and dolerites), the U concentration increasing somewhat in the eluvium from these rocks. This was not observed in crystalline metamorphosed and acidic igneous rocks where the eluvium had a somewhat low concentration of U. The mobile U was removed first. The Th/U ratio increased in the weathering products of all rocks. The Th/U ratio can be used as an indicator of chemical weathering of rocks. (CA)

Todorovic, Z. and A. Filip. 1967. Movement of Complex Compounds Through Different Soil Types. IN: Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. IAEA, Vienna. pp. 241-9.

Results of the behavior of complex compounds of zinc (bivalent), iron (trivalent), cobalt (trivalent) and chromium (trivalent) on passing through four sorts of soils are given. The soils had a dominant content of sand, clay, humus and carbonate. The investigations were carried out by the radioactive tracer technique. The complexing was carried out with Na-citrate, EDTA, Na-thiocyanate, potassium cyanide, ammonium-hydroxide, Na-oxalate, Na-tartrate and Na-citrate. The effect of the excess complexing agent on the percentage of the complex compound in the eluate, retention and spread of the elution curve, is shown. The investigations were carried out on a column always filled with the same quantity of soil of given granulation. The movement of the complex compound was observed by taking samples of the eluate and measuring their activity. For each elution curve parameters $\overline{X} \pm \sigma$ were determined as a measure for the retardation and spread of the complex compound waves. The smaller the difference between retardation ($\overline{X}$) and free volume (X_0) and the smaller the standard deviation, the smaller was the retardation of the complex compound. From these characteristics and from those of the elution curves for ^{131}I and ^{35}S, which are considered to be passing through the soil without considerable difficulty, those complex compounds which showed the least retardation and wave spread on passage through the soil type investigated were determined. (auth)

Toeroek, I. 1972. ^{90}Sr Contamination of Some Soils in Hungary. Agrokem. Talajtan. 21:315-320 (in Hungarian).

Soil samples taken from 34 different places of Hungary have been examined. After the extraction by hydrochloride acid, the Sr was separated by the oxalate precipitation method and the activity was determined by GM scattering. The efficiency of the Sr extraction was 86%. The relative measuring error was 18%. The amount of the ^{90}Sr was 260-360 pCi/kg on pastures, and 140-240 pCi/kg on cultivated areas. According to the Sr-unit related to the Ca, the studied soils could be ranged into 4 different groups. Out of the 34 soil samples 4 had a Sr-unit below 100, that of 14 samples 100-150, that of 11 samples 150-200, and for 5 samples values higher than 200 were obtained. Extremely high values did not occur. The values measured are in accordance with data measured on other territories in Europe. (auth)

Toeroek, I. and J. Kovacs. 1973. Distribution of Radioactive Soil Contamination in Hungary. Izotoptechnika. 16:21-31 (in Hungarian).

The geographical, meteorological, soil chemical and physical, and agrotechnological factors involved in soil contamination are discussed. Methods of fallout measurement are also discussed and results of measurements are given. (auth)

Tolstoi, M. I. 1961. Relation of the Radioactivity of Clays to Their Mineralogical Composition. Izv. Vysshikh Uchebn. Zavedermi, Geol. i Razveaka. 4:66-71.

A study was made of 55 clay samples taken from wells in Carpathia. Studied were: 1) the total radioactivity of the samples; 2) the U and Th contents; and 3) the content of organic material. A total of 500 samples of clays and clay fractions was studied. The total radioactivity increases with increasing contents of K salts and organic residues in the clay material. (CA)

Towell, D. G., J. W. Winchester, and R. V. Spirn. 1965. Rare-Earth Distributions in Some Rocks and Associated Minerals of the Batholith of Southern California. J. Geophys. Res. 70:3485-3496.

The rare-earth and yttrium abundances in four whole-rock samples and eight associated mineral fractions from the batholith of southern California have been determined by means of neutron activation and partition chromatography. It is shown that, on a whole-rock basis, an increase in total rare earth content in the sequence gabbro-tonalite-grandiorite-quartz monzonite is paralleled by an increase in relative fractionation favoring the lighter more rare earths. In the same sequence, there is an apparently systematic, increased relative removal of Eu which is attributed to the existence of Eu(II). Analyses of feldspar, pyroxene, amphibole, mica, and apatite mineral fractions also indicate that divalent Eu was an important constituent during the evolution of the rocks studied. The feldspar mineral fractions were invariably enriched in Eu relative to the adjacent rare earths, whereas the ferromagnesian minerals were relatively depleted. (auth)

Travis, J. R. 1974. Model for Predicting the Redistribution of Particulate Contaminants from Soil Surfaces. LA-UR-74-1340.

A computerized model was developed to describe the redistribution of wind eroding soil-contaminant mixtures. Potentially mobil particulate contaminants can, in the first approximation, be assumed to be indistinguishable from the wind eroding soil in which they are distributed. A grid network characterizes important soil and surface conditions, and mass conserving control volumes are constructed on each cell. Material is transported through the vertical and top surfaces of a control volume by a modified Bagnold-Chepil Horizontal flux formulation, and modified Gillette vertical flux formulation, respectively. The vertical emissions, considered as puffs from area sources, create at regular time intervals a contaminant cloud which is proportional to the suspendable ground concentration. These puffs diffuse downwind under time dependent wind velocity and atmospheric stability conditions, maintaining during the time interval a three-dimensional Gaussian distribution of concentration with cloud volume. Material from each puff is deposited in downwind cells, leading to the possibility of many different flights from these new sources. The usefulness of this predictive tool is demonstrated by calculations involving mixtures of particulate $^{238}PuO_2$ in highly erodable soils under dust storm conditions. Time dependent surface concentration and breathing zone exposure isopleths, evolving from a small contaiminated area, show the potential hazard from wind eroding toxic materials. (auth)

Trent, D. S. 1975. Mathematical Modeling of Transport Processes in Aquatic Systems. CONF-750413-P2, pp. IV.119-IV.121.

The various levels of approximation and application of mathematical modeling techniques which are applied to transport processes of chemical, biological, and thermal wastes, and radioactive effluents in rivers, lakes, estuaries, coastal seas, and the open ocean are reviewed. In addition, the various numerical techniques in general use are discussed as applied to the velocity-pressure and vorticity-stream function equation sets. (auth)

Tritremmel, C. H., G. Knollmayer, E. Wanderer, H. G. Heintschel, and P. Stipanits. 1966. Behavior of Radioisotopes Released to a Stream. STI-PUB-126. pp. 89-105.

The behavior of various radionuclides in surface water was studied by field experiments in the Leitha-Mühl Canal and by complementary experiments in the laboratory. The boundary and profile characteristics of the stream were ascertained and flow rate calculated. Suspensions were examined for size and mineral or organic content in relation to current velocities, and core samples were collected from the bed at selected regions of deposition. Experiments were carried out on dispersion and transport of wastes under varying outlet conditions and the diffusion constant was measured. In the laboratory, sedimentation and uptake experiments were conducted on mineral and organic suspensions in conjunction with nuclides such as ^{90}Sr, ^{131}I, ^{140}La, ^{24}Na and mixed fission products. Uptake was found to be dependent on mineral species and varied inversely with particle size. Elution experiments were also carried out on accumulated sediments. From these results it is possible to assess the radioactive content and frequency of batch discharges of effluents that may be released to a river without causing unacceptably high concentrations. (auth)

Triulzi, C., M. G. Mezzardi, and G. Giacoletto. 1969. Radioactivity of the Sediments in the Taranto Gulf. G. Fis. Sanit. Prot. Radiaz. 16:101-108 (in Italian).

Sediment samples collected (in November 1969) in the Taranto Gulf (Ionian Sea) in front of the Sinni river mouth, were analyzed for ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{155}Eu, ^{60}Co, and ^{125}Sb contents. These samples appear to be slightly contaminated and the data obtained are compared with those concerning zones of other Seas (Ligurian and High Adriatic) along Italian coasts. (auth)

Troitskaya, M. N., M. S. Ibatullin, B. Ya. Litver, A. N. Nizhnikov, P. V. Ramzaev, and L. A. Teplykh. 1969. Cesium-137, Strontium-90, and Lead-210 in Soil of the Far North Regions. TT-74-50011. pp. 67-71.

The part played by soil in the pollution of subsequent links of the chain of natural and artificial radionuclides in regions of the Far North is considered. It is shown that while a geographic variation exists of the levels of artificial contamination of the soils, the ratio of ^{137}Cs to ^{90}Sr in all regions remains between 1.3 and 1.6. Experimental data are given on the mechanism governing the contamination of lichen (the main fodder of reindeer) by natural and artificial nuclides. An analysis is given of museum samples (1900-1945), indicating the absence of any connection between high levels of ^{210}Pb in the North and nuclear tests. The levels of ^{239}Pu content in the vegetation of some regions of the Far North are determined. (auth)

Troitskaya, M. N., M. S. Ibatullin, B. Ya. Litver, A. N. Nizhnikov, P. V. Ramzaev, and L. A. Teplykh. 1971. ^{137}Cs, ^{90}Sr, and ^{210}Pb in Soils of the Arctic Regions. Tr., Inst. Eksp. Meteorol. 21:72-76 (in Russian).

The role of soil in contamination of subsequent links of the chain by natural and artificial radionuclides in the Far North regions is considered. It is shown that there are geographic variations in the level of artificially contaminated soil, but that the ^{137}Cr/^{90}Sr ratio in the soil in all regions is from 1.3 to 1.6. Experimental data on the mechanism of contamination of lichens, a basic food of northern deer, by natural and artificial nuclides are presented. Analytical data for museum samples (1900-1945) indicate the absence of any connection between high ^{210}Pb levels in the north and nuclear explosions. The ^{239}Pu level in plants of some regions of the Far North was determined. (auth)

Trojan, O. A. D. and K. G. McNeill. 1962. Radioactive Contamination of Soil. Can. J. Phys. 40:370-2.

All soil samples came from the same location in King township, Ontario. For each test, a set of samples from a 500-cm^2 plot was taken. Each sample was dried, weighed, and its gamma activity measured using a 5-in. NaI(Tl) scintillation crystal. Activities detected, other than the naturally occurring ones, were Ru^{103}, Rn^{106}, Zr^{95}, Nb^{95}, and Cs^{137}. After spring, 1960, Cs^{137} was the only remaining fission product. In July 1961, the Cs^{137} dose rate was measured. (NSA)

Tso, T. C. 1970. Limited Removal of $^{210}\mathrm{Po}$ and $^{210}\mathrm{Pb}$ from Soil and Fertilizer by Leaching. Agron. J. 62:663-4.

The radioelements $^{210}\mathrm{Po}$ and $^{210}\mathrm{Pb}$ are known to be present in plants. They enter the plants primarily by root absorption. Heavy and continued fertilization increases the level of radioelements in soil and thus in crops so produced. Results obtained from laboratory experiments show that there is limited removal of $^{210}\mathrm{Po}$ and $^{210}\mathrm{Pb}$ by leaching from soil or from fertilizer. Mechanical agitation appeared to increase the leaching rate of these elements. Generally, $^{210}\mathrm{Po}$ was leached from soil or from soil-fertilizer mixture much easier than $^{210}\mathrm{Pb}$, with or without agitation. (auth)

Tsujino, T. and T. Ishihara. 1966. Radiation Damage to TBP/Kerosene Solvent. (II) Effect on Extraction Behavior of Uranium and Thorium and Their Loading Effect. J. Nucl. Sci. and Tech. 3:144-49.

Radiation damage to 30 v/o TBP/kerosene was investigated to determine changes in the extraction behavior of uranium and thorium with the solvent irradiated up to 10^8 R in nitrate system and similarly in the stripping behavior with 0.01 N nitric acid.

The effect on uranium and thorium was discernible only with irradiations reaching 10^8 R.

Changes in the behavior of fission products present in company with uranium or thorium were found to be the similar to the case where they existed free of uranium or thorium. At irradiations below 10^7 R, uranium and thorium manifested loading effect, but it disappeared when irradition reached 10^8 R.

Calculation of one stage decontamination factors of fission products from uranium and thorium confirmed deterioration of the power of separation with irradiation, and the degree of deterioration was determined quantitatively. The decontamination factor for $^{95}\mathrm{Zr}$-$^{95}\mathrm{Nb}$ was decreased to 1/2,000 by irradiation to 10^8 R, while the same dosage of irradiation had little effect for $^{106}\mathrm{Ru}$-$^{106}\mathrm{Rh}$.

Physical properties such as density, viscosity, emulsification tendency and phase separation time were also observed to be effected by irradiation to 10^8 R. (auth)

Tsutsui, T., K. Katsurayama, and K. Nishimaki. 1973. Storage of Radioactive Waste in the Ground KURRI-TR-121 (in Japanese).

The behavior of radionuclides in the ground was investigated in order to determine the safety of underground storage of radioactive wastes. For the purpose of this investigation, many experiments (field and laboratory) were made. The results of laboratory experiments are detailed, using ^{131}I, ^{51}Cr ^{54}Mn, ^{60}Co, ^{137}Cs and ^{59}Fe. The migration of each of these radionuclides was investigated, as each was transported by ground water through columns packed with soil. The migration of each radionuclide was very slow compared to that of ground water and is predicted by theory governing the movement of these radionuclides. (auth)

Tsutsui, T. and K. Nishimaki. 1972. Movement of Radionuclides Through Saturated Sand Zone. Doboku Gakkai Ronbun Hokokushu. No. 200:25-29.

The modes of movement of radioactive nuclides through water-bearing formations, when they escape from the radioactive wastes stored underground and mix into groundwater were studied. The nuclides used in this study are ^{90}Sr, ^{60}Co, and ^{137}Cs, and the aquifer used is sand. The study was done for the following three cases, in which they move (1) through the ordinary aquifer, (2) through the aquifer affected by some nitric acid wastes, and (3) mixing with nitric acid wastes, such as reprocessing waste-solution. It was known from this study that the movement of these nuclides is relatively slow, and that their speed is some 30% higher in the aquifer previously affected by the nitric acid waste-solution than in the ordinary aquifer. (NSA)

Tugarinov, A. I. and I. B. D'yachkova. 1967. Some Common Geochemical Characteristics of Selenium and Uranium. Vop. Prikl. Radiogel. No. 2:380-6 (in Russian).

The Se geochemistry in earth crust is controlled above all analogy of its properties with those of S. The highest Se/S ratio, typical of sedimentary rocks in which the Se is present mostly in the form of native Se or selenides is accompanied, as a rule, by U mineralization. The mobility of Se and U under oxidizing conditions and their almost complete inert behavior in reducing medium are the main geochemistry properties controlling Se and U in exogenic processes. Extraction of Se and U from rocks is possible by solutions, having sufficiently high E_H, through oxidation. The alkaline medium is the most favorable for simultaneous transfer of Se and U into the mobile state. The Se and U, migrating in surface waters, are concentrated in rocks having high reducing capacity. If, under favorable conditions (short distance from the denudation area, oxidation character of the solution, etc.), the Se reaches the sea, then, similarly to U, it is precipitated immediately and is accumulated in the continental shelf region. Absorption phenomena promote the separation of Se and S in addition to oxidation-reduction factors. Organic substances played a large part in the concentration of Se and U. Under hypogene conditions, the oxidation-reduction factor controlled to a large degree the formation of sediments of elements having changed valency in a definite sequence. (CA)

Tunell, G. 1964. Chemical Processes in the Formation of Mercury Ores and Ores of Mercury and Antimony. Geochim. et Cosmochim. Acta. 28:1019-1037.

Several instances of hot spring waters depositing mercury and antimony were investigated to ascertain how these elements are carried in the spring waters. Temperatures range from 90° to 250°C and pressures below 30 atmospheres. Sb and Hg are not very soluble in the above temperature and pressure ranges unless the solution is alkaline and contains sulfide ions.

Turekian, K. K. and K. K. Bertine. 1971. Deposition of Molybdenum and Uranium Along the Major Ocean Ridge Systems. Nature. 229:250-1.

In order to investigate the time varying pattern of the deposition of U and Mo along a ridge site the distribution of these elements with depth in a core raised from the Mid-Atlantic ridge Lamont-Doherty core A 180-74 was studied. The two elements are shown to vary sympathetically with a pronounced enrichment at the depth interval between 40 and 70 cm. It is proposed that most of the sediments with high concentrations of molybdenum and uranium found on seismically active and relatively inactive ocean rises reflect the formation of anaerobic sediments, in part the result of the high rate of supply of orgainic material to the relatively shallow ocean bottoms along the ridge area. (NSA)

Turekian, K. K., J. P. Riley and G. Skirrow (eds.). 1964. Geochemistry of Marine Sediments. TID-21074.

A discussion of the major features of deep-sea sediment geochemistry is presented. The information is presented in sections on components of deep-sea sediments, radioactive dating and rates of accumulation, trace-element geochemistry in the oceans, and geographical variations. (NSA)

Tyuryukanova, E. B. 1969. Accumulation of Strontium-90 in Soils. TT-74-50011, pp. 61-66.

A very uneven distribution of ^{90}Sr is observed in the soils of the Russian Plain. The content of this radioactive nuclide in sandy soils is lower than in loamy soils, and depends on the amount of soil humus and its qualitative composition. The accumulation of ^{90}Sr in soils is determined both by its physicochemical composition, and by the landscape and geochemical conditions. Of great importance is the character of the runoff. In most soils ^{90}Sr is concentrated in the upper layer (0-5 to 0-20 cm). (auth)

Tyuryukanova, E. B. 1969. Methods of Studying the Behavior of Radio Strontium in Soils of Different Geochemical Regions. AEC-tr-7030, pp. 134-44.

The behavior of ^{90}Sr in soils of different regions is determined by many factors including: the place where it is produced; the manner and rate of entry; and the nature of the topographic-geochemical situation into which the isotope enters. Methods for evaluating the effects of these variables are presented. It is concluded that topographic-geochemical studies must precede any forecasting of the radiation situation for a particular locality, especially the distribution, migration, and formation of secondary foci of ^{90}Sr accumulation. (NSA)

Tyuryukanova, E. B. 1971. Buildup of ^{90}Sr in Soils. Tr., Inst. Eksp. Meteorol. 21:66-71 (in Russian).

The ^{90}Sr distribution in the soils of the Russian plains was found to be very unequal. In sandy soils the ^{90}Sr content was lower than in loam and depended on the humus concentration of the soil and its qualitative make up. Accumulation of ^{90}Sr in soils was determined both by its physico-chemical composition and regional-geochemical conditions. The nature of the run-off had considerable effect. In most soils the ^{90}Sr was concentrated in the upper layer (0 to 5, 0 to 20 cm). (auth)

Tyuryukanova, E. B. 1972. Migration of Strontium-90 and Cesium-137 in Soils. INIS-mf-1036.

Geochemical migration and the redistribution of ^{90}Sr and ^{137}Cs is a slow process taking place over an extended period of time. At present an undeviating decrease in ^{90}Sr content is observed in soils of watersheds, and an increase of ^{90}Sr is observed in bottomland soils. Strontium-90 migrates faster than ^{137}Cs. In forest soils of watersheds the migratory ability of the radioisotopes depends on features of the forest litter. A local soil-geochemical barrier, in which ^{90}Sr and ^{137}Cs accumulate, is the coarse humus litter (A_0''). In bottomlands the secondary accumulation of ^{90}Sr is connected with processes of the hydrogenic accumulation of ^{137}Cs--with mechanical infiltration (in the form of sediments deposited by water). (NSA)

Tyuryukanova, E. B., L. I. Belyaeva, N. I. Levkina, and V. V. Emel'yanov. 1973. Landscape-Geochemical Aspects of ^{90}Sr Behavior in the Forest and Flood Plain Ecosystems of Wooded Boggy Areas. INIS-mf-1136 (in Russian).

In woods podzols and fallow forest sands from 1962 to 1964 the ^{90}Sr content increased and then began to drop. The ^{90}Sr distribution in forest soils was spotty and depended on the litter. It accumulated in coniferous litter with a high content of crude humus. Mosses had a higher ^{90}Sr content in the surface parts than did grasses. In herbaceous plants a significant amount of ^{90}Sr was contained in the root systems. Strontium-90 was unequally distributed in the designated soils. It was lost from slightly developed soils and accumulated in woods and meadow soils. (auth)

Tyuryukanova, E. B. and V. A. Kalugina. 1971. The Behavior of Thorium in Soils. Soviet Journal of Ecology. 2:467-469.

An investigation of thorium distribution in soil profiles showed that it accumulated in the ferruginous humus horizon or in the humus horizon of meadow soils. The latter accumulation may be indicative of biological cycling. Thorium contents were lowest in peaty horizons indicating limited uptake of thorium by bog plants.

Tyuryukanova, E. B., N. I. Konova, and V. V. Emel'yanov. 1973. Aqueous Migration of Strontium-90. INIS-mf-1037.

A study was carried out on the ^{90}Sr content of soil water, ground water and river water. It is shown that the elution of ^{90}Sr from soil with runoff water depends to a significant degree on features of soil processes, plant cover, relief, type of high water flooding, and weather characteristics. Variation in soil cover causes a variation in the behavior of ^{90}Sr. A change in content of oxygen, carbon dioxide, carbonate, bicarbonate, et al., causes a change in the behavior of ^{90}Sr. Some years active elution of ^{90}Sr is observed, and in other years there is accumulation of ^{90}Sr. This evidence indicates that ^{90}Sr is not held firmly by ground water, and its behavior in soil has not yet been established. In connection with the fact that ^{90}Sr eluted from the soil does not all appear in river water but is partially retained in local geochemical barriers, the average annual elution of ^{90}Sr by river water is significantly less than its elution from soils. (NSA)

Tyuryukanova, E. B., F. I. Pavlotskaya, and V. I. Baranov. 1967. Distribution of Radioactive Strontium in the Soils of Different Natural Zones. AEC-tr-7214, pp. 143-60.

The distribution of ^{90}Sr in various soils in the USSR was studied to ascertain the zones of concentration and scattering and the possibility of using this radioisotope in the analysis of recent soil forming processes. Depths to 150 cm were investigated, although most of the data is for measurements to less than 70 cm. The soil types were classified as sod, sandy loam, clay, humus, peat, cropland, forest, and flood plain. It was concluded that the ^{90}Sr distribution in the soil mantle is largely determined by geomorphological and hydrometeorological conditions; ^{90}Sr is held most firmly in soils with high humus content; the lack of correspondence in the behavior of stable and radioactive strontium in years with considerable fallout levels can be explained by the different sources the forms of their entry into the soil, and their reaction times with it; and the vertical migration of ^{90}Sr depends on the genetic structure of the soils, i.e., ^{90}Sr is delayed in humus horizons, washed away in podzonic horizons, and retained in illuvial horizons. (NSA)

Tyuryukanova, E. B., F. I. Pavlotskaya, A. N. Tyuryukanov, and V. I. Baranov. 1964. Studying Radioisotope Migration in Soils. Distribution of Strontium-90. Pochvovedenie. 8:88-95 (in Russian).

Strontium-90 from the atmosphere was found to accumulate on poorly drained unmown bottomlands and in water-logged depressions adjacent to sandy watersheds. The vertical distribution of ^{90}Sr in a given geochemical landscape was found to depend on the genetic soil type and the character and thickness of its humose horizon. (auth)

Tyuryukanova, E. B., F. I. Pavlotskaya, A. M. Tyuryukanov, L. N. Zatsepina, E. V. Babichev, and L. M. Rodionova. 1964. Migration and Distribution of Strontium-90 and Cerium-144 in Soils of Moscow Region. Pochvovedenie. 10:66-73. (in Russian).

Distribution of radioisotopes in genetic horizons of the soils of Moscow region was studied. It was found that ^{90}Sr and ^{144}Ce are distributed in soil profiles according to not only the soil type but also vegetation, geomorphology, and other conditions. (auth)

Tyuryukanova, E. B., T. A. Vostokova, L. T. Belyaeva, N. I. Konova, and V. V. Emelyaov. INIS-mf-887-3. pp. 63-76 (in Russian).

The distribution and the migration was studied in various areas of the USSR of ^{90}Sr and ^{137}Cs for the period of 1960 to 1970. Methods are listed of the sampling of ^{90}Sr and of its activity determination by means of its daughter ^{90}Y. Flood lands were found to play a special role in radionuclide migration. Observations in soil-geochemistry areas, i.e., in the areas of secondary accumulation, showed that the accumulation of ^{90}Sr proceeded more slowly and to a lesser extent than that of Sr, Ca, and other elements. A study of the characteristics of ^{90}Sr and of ^{137}Cs migration in soils shows that the migration is largely affected by the characteristics of a given area and its geochemical conditions. Strontium-90 and ^{137}Cs redistribution during the migration of the radionuclides with solid and liquid erosion products results in the formation of secondary accumulation sites. (NSA)

Umemoto, S. and M. Sakanoue. 1958. Geochemical Studies on the Radioactive Sediments. I. Uranium and Radium in the Sedimentary Beds at the Ningyo Pass, Tottori Prefecture. Nippon Kagaku Zasshi. 79:27-32.

The sedimentary beds consist (in downward order) of ash-colored shale, silts, ash-colored shale (I), brown shale (II), black shale (III), silt and clay, limonite (IV), and conglomerate (V). The bed rock is granite. The U content of I, II, III, and IV are 0.11, 0.08, 0.13, and 0.03 percent, respectively. A strong radioactivity of III containing large amounts of MnO_2 (7-8%) is mainly due to the activity of Ra (5.4×10^{-9} g Ra/g). Differential thermal analysis curves for I, II, and III show the presence of halloysite. There is a relation between the U content and the estimated content of halloysite. Analysis of autunite found in the layer of V gave 49.0% U and 3.53×10^{-8} g Ra/g. By assuming that the mineral originally contained no Ra, and that the present Ra has been derived from U, its age is calculated to be about 30,000 years. (CA)

United States Atomic Energy Commission. 1969. Technical Discussions of Offsite Safety Programs for Undergound Nuclear Detonations. NVO-40 (Rev. 2).

Hydrologic safety involving the detonation of nuclear devices requires predicting the location of radioactively contaminated water and describing it. As time passes the volume of contaminated water will increase and then decrease. The concentration of the radioactivity will also decrease. Shrinkage of the volume of contaminated water and reduction of its concentration are caused by radioactive decay, sorption, and dispersion. Variations in porosity and permeability between the explosion zone and aquifer and within the aquifer distort the contaminated volume. The area of the ground surface underlain by above MPC water is the vertical projection of the above MPC water volume. At present all concentrations are referred to MPC as a standard. Radioactive decay, sorption, and dispersion ultimately reduce all radioactivity concentrations to below MPC. If only radioactive decay and ground water velocity are considered, a crude migration prediction is possible. A circular above MPC area twice the diameter of the explosion zone is moved downgradient at the ground water seepage velocity for 10 or 11 half-lives. At the end of this time the contaminant concentration will probably be close to or below MPC. This prediction has a high probability of representing the worse conceivable case. (auth)

United States Atomic Energy Commission. 1972. Contaminated Soil Removal Facility, Richland, Washington. Environmental Statement. WASH-1520 (Dr.).

The environmental impact of removing approximately 1800 ft^3 of plutonium-contaminated soil from the floor of the Z-9 enclosed trench which was used from July 1955 to June 1962 as a subsurface disposal facility for liquid wastes from the Plutonium Finishing Plant near Richland, Wash. is discussed. It is estimated that 100 kg of Pu are contained in the soil to be removed and that three-quarters of this Pu can be extracted economically. Residues from the extraction and the Pu-depleted soil would be packaged in plastic bags, placed in steel drums, and stored underground. Information is included on the probable, unavoidable, and extraordinary adverse environmental effects; alternatives; commitments of resources; and cost analysis. It is concluded that the benefits to be obtained from removing the Z-9 enclosed trench soil exceed the environmental and economic costs, and that the proposed excavation should be undertaken. (Three appendixes on the Hanford Plant Environment, seismic activity at the Hanford area, and the Radiochemical Reprocessing Facilities are included.) (NSA)

United States Atomic Energy Commission. 1972. Contaminated Soil Removal Facility, Richland, Washington. Environmental Statement. WASH-1520.

Liquid wastes from the Plutonium Finishing Plant (PFP) at Richland, Wash. have been discharged to subsurface disposal facilities (enclosed trenches) since the startup of the facility approximately 22 years ago. It is proposed to construct and operate a Contaminated Soil Removal Facility near the Z-9 trench to permit excavation and packaging of contaminated soil, to add equipment to the existing PFP to permit recovery of Pu from the contaminated soil, and to construct an underground storage vault 14 ft wide by 8 ft high by 400 ft long for interim storage of contaminated soil. The environmental impact of constructing and operating the proposed Contaminated Soil Removal Facility was studied. Data are presented on the probable, extraordinary adverse, and unavoidable adverse environmental effects of this facility, the irreversible and irretrievable commitments of resources, and a cost-benefit analysis. Two alternatives to the proposed facility are considered. After assessing and balancing the benefits to be obtained from removing Pu-contaminated soil from the Z-9 enclosed trench against the environmental and economic costs, and after considering the range of alternatives and their environmental impact, the AEC concluded that the proposed action should be undertaken. (NSA)

United States Atomic Energy Commission. 1973. Enewetak Radiological Survey. NVO-140, Vol. 1.

The AEC has conducted a survey in 1973 of the total radiological environment of Enewetak Atoll in order to provide data for judgments as to whether or not all or any part of the Atoll can be safety reinhabited. More than 4500 samples from all parts of the marine, terrestrial, and atmospheric components of the Atoll environment were analyzed by instrumental and radiochemical methods. In addition, an aerial survey for γ radiation levels was conducted over all land areas. Strontium-90, ^{137}Cs, ^{60}Co, and ^{239}Pu are the predominant radioactive isotopes now present, but their distribution is far from uniform. Islands on the southern half of the Atoll from ALVIN to KEITH have levels of contamination comparable to or less than those due to world-wide fallout in the United States. On the northern half, islands ALICE to IRENE are most heavily contaminated, KATE to WILMA are least contaminated, and JANET is at an intermediate level. These radiological data were combined with the best information currently available on the expected diet of the Enewetak people to estimate potential whole-body and bone doses to the population for six living patterns at 5-, 10-, 30-, and 70-year intervals after return. The main contribution to the population dose comes through the terrestrial food pathway, followed in decreasing order of significance by the external gamma dose, marine, food pathway, and inhalation pathways. In the terrestrial food pathway, the main contribution to both whole-body and bone dose is due to the consumption of pandanus and bread-fruit. Percentage contributions to the 30-year integral dose for each of the terrestrial food items for a population engaged in agriculture on JANET were calculated. It was concluded that corrective actions to reduce population doses will be most beneficial if they are directed at the primary contributors, i.e., pandanus and breadfruit in the diet and external γ dose in the residence areas. (NSA)

United States Atomic Energy Commission. 1973. Plan for the Management of AEC - Generated Radioactive Wastes. WASH-1202 (73).

This document presents the AEC's plans for controlling the releases of radioactivity and ensuring the safe storage of radioactive wastes generated by past, present and future operations of the AEC. The basic and fundamental objective of this Plan is to handle these wastes at all times in a manner: (1) that will not endanger the health and safety of its employees or the public; (2) that will not have an adverse impact on man's environment or on the ecology; and (3) that will be accepted by the public. (auth)

United States Atomic Energy Commission. 1973. Radioactive Waste Management. A Bibliography of Publicly Available Literature Pertaining to the USAEC's Hanford, Washington Production Site. TID-3340.

This bibliography contains abstracts of 1098 technical reports and journal articles which have appeared in Nuclear Science Abstracts from January 1951 through July 1973 pertaining to radioactive waste management at the Hanford site.

The abstracts are grouped into ten categories as indicated by the table of contents. Within the categories, they are arranged by the Nuclear Science Abstracts volume and abstract number.

United States Atomic Energy Commission. 1973. Radioactive Waste Management. A Bibliography of Publicly Available Literature Pertaining to the USAEC's Savannah River, SC, Production Site. TID-3341.

This report is an annotated bibliography of publicly available literature pertaining to the Savannah River, South Carolina, ERDA production site to August 1973.

United States Atomic Energy Commission. 1974. Final Environmental Statement. Radioactive Waste Facilities, Oak Ridge National Laboratory, Oak Ridge, Tennessee. WASH-1532.

In the existing intermediate level liquid waste system at ORNL, waste solution from various sources is neutralized and collected in one or more of the 170,000 gallon concrete (Gunite) tanks that were built in 1943. This waste is concentrated by evaporation and stored temporarily in one of the Gunite tanks. Periodically this concentrated solution is pumped to a shale fracturing facility for disposal. The new facilities would permit operation of the ORNL waste handling system without use of the Gunite waste tanks--the first step toward eventual retirement of these tanks. The proposed facilities will be designed to handle alkaline wastes with a specific activity of up to 20 curies per gallon, although very little waste with this high a specific activity is anticipated. It will be noted that small quantities (about 4000 gallons/year) of waste will be generated by the TRU facility with a specific activity of up to 30 curies/gallon. These wastes will be diluted to facilitate safe handling and storage. The most significant waste on both a volume and a curie basis is expected to be concentrated ILW solution with a specific activity of up to 2 curies per gallon--predominantly ^{137}Cs. The quantities of transuranium wastes that are handled will be quite small. It is not anticipated that the waste solutions handled in this system will generate enough decay heat to require cooling of the tank contents and cooling coils will not be installed in any of the waste storage tanks. Removable water-cooled coils can be inserted through the roof plugs provided in the top of the tanks if cooling is required. All tanks and waste lines will be doubly contained with provisions for monitoring the secondary containment space for leakage. (auth)

United States Energy Research and Development Administration. 1975. Final Environmental Statement. Waste Management Operations. Hanford Reservation, Richland, Washington. ERDA-1538 (Vols. 1 and 2).

This Final Environmental Statement has been prepared toward compliance with the National Environmental Policy Act to assess the environmental impact of continuing the ERDA's waste management operations at the Hanford Reservation in Benton County, Washington.

Current waste management operations consist of the treatment and storage or disposal of radioactive and nonradioactive solid, liquid, and gaseous effluents from production and research and development programs at Hanford. The current program for the management of high level radioactive waste is to convert stored and currently generated waste from a liquid to a salt cake form. Additional facilities, such as waste tanks and evaporators, will be added as required in the process of this program. The current program also includes research and development to determine the best ultimate long-term storage method for the salt cake.

The environmental effects of handling the wastes generated by activities at Hanford are discussed. The radiation total-body dose to man from Hanford operations is small when compared to the natural radiation background. Only minor effects to terrestrial or aquatic life have been observed in the 30 years of operation. Approximately 6,000 acres of desert land (about 3% of the total Hanford Reservation area) are committed to waste storage activities.

Alternatives to current waste management operations are presented for radioactive and nonradioactive liquid, solid, and gaseous waste. Alternatives to the current waste management operations discussed include both the additional treatment of waste streams, discontinuance of solidification to salt cake and the reduction of waste generation by curtailment of operations at the site. Ceasing waste management operation is not considered due to the continuing need to manage existing radioactive waste at Hanford. (auth)

Urry, W. D. 1948. Radioactivity of Ocean Sediments. VII. Rate of Deposition of Deep-Sea Sediments. J. of Marine Research. 7:618-34.

The rate of sedimentation can be determined from Ra content of the sediments, since variations in Ra content occurred during the establishment of radioactive equilibrium in deep-sea deposits. Rates of deposition as a function of time (for the past half million years) are reported for red clay, globigerina ooze, foraminiferal marl, glacial marine deposits, and calcareous blue mud. The results agree well with those of other methods. (NSA)

Urry, W. D. 1948. The Radium Content of Varved Clay and a Possible Age of the Hartford, Connecticut, Deposits. American Journal of Science. 246:689-700.

The radium content of the summer and winter portions of the varves in the clay deposits at Hartford, Connecticut, vary rhythmically. When the radium contents of the summer and of the winter portions are plotted against time as measured by the varve count, the curves exhibit slopes of opposite sign. The total radium content of any varve, however, is practically constant. These phenomena may be due to a disturbance of the radioactive equilibrium but this hypothesis, while plausible, is far from proved. A greater concentration of the uranium relative to ionium in the winter clay than in the summer clay would explain these phenomena. Such a disturbance of the equilibrium provides a means of determining the age of the deposits. On this basis, one derives a tentative figure for the age of the Hartford clay (varve 3700) of 18,000 years. The hypothesis of a disturbance of radioactive equilibrium is supported by the fact that the analyses of the summer and winter curves which are completely independent give very nearly the same age. (NSA)

Urry, W. D. 1949. Radioactivity of Ocean Sediments. VI. Concentration of the Radioelements in Marine Sediments of the Southern Hemisphere. American Journal of Science. 247:257-275.

In the previous publications of this series [American Journal of Science 55 229(1933); J. Wash Acad Sci 29 405(1939); Amer J. Sci 239 81(1941); 240 1(1942); 240 23(1942)] the use of measurements of the radium concentration in the sediments beneath the ocean as a means of determining the age of the sediments has been described. Since the previous data were taken in the northern hemisphere, further determinations have been made using cores obtained from the southern hemisphere. Seventy such deteminations of the uranium content of ocean sediments have been made for a number of depths in each of six cores obtained from various areas. The curves thus obtained of the radium content as a function of depth below the ocean bottom are similar in all qualitative respects to the curves previously obtained for cores from the North Atlantic and Caribbean Sea. (NSA)

Urry, W. D. and C. S. Piggot. 1942. Radioactivity of Ocean Sediments. V. Concentrations of the Radioelements and Their Significance in Red Clay. American Journal of Science. 240:93-103.

The relationship among U, ionium and Ra in deep-sea red clays is similar to that in calcareous ocean sediments. The red clay, represented by a core 246 cm long, is distinguished from the calcareous sediments by a very rapid decrease in Ra just below the surface of the ocean bottom and the attainment of equilibrium between U, ionium and Ra in the bottom 1/4 of the core, which signifies a very slow deposition compared with that of calcareous deposits. The Ra content at equilibrium with the U is only 7 percent of that near the surface of this deposit. The high surface concentrations of Ra and ionium, particularly in red clay, are transient phenomena, produced by some unknown mechanism, which concentrates these elements, relatively to the U content, during the deposition of the sediment. (CA)

Vachnadze, Y. A. 1961. The Radioactive Analysis of Ore Samples. Soobshcheniya Akad. Nauk Gruzin. SSR. 26:405-7.

The attempt to assay ores containing Th, U, and K by measuring β-rays with and without shielding, and by measuring γ-radiation, led to erroneous results in some cases, including calculated zero or negative values for the individual elements. The calculations were carried out by a system of equations suggested by Nazarov (CA 54, 1090a) and Serdyukova and Kapitanov (CA 52, 9864b). The error could be proven by chemical separation of the compounds of the individual metals, and separately radioassaying them. Therefore, the radiometric analysis of a large number of samples could provide only a qualitative characteristic or determine the order of magnitude of the content of radioactive elements and not their absolute value. (auth)

Van Dalen, A., F. de Witte and J. Wiskstra. 1975. Distribution Coefficients for Some Radionuclides Between Saline Water and Clays, Sandstones and Other Samples from the Dutch Subsoil. RCN-75-109.

Distribution coefficients for Pu and Am were determined on Dutch subsoils of marine origin from 90% NaCl saturated solutions at pH 7 to 8. For samples composed of mainly illite and kaolinite Kd Pu is $\sim 10^4$ and Kd Am is $\sim 5 \times 10^4$. The Kd Pu and Kd Am for river sand are respectively 200 and 400. Gypsum-bearing and clay-bearing sandstones were intermediate. The pH dependence on sorption processes for the elements Pu and Am between pH 5-8 was minor. (auth)

Vanderploeg, H. A., R. S. Booth, and F. H. Clark. 1975. Specific Activity and Concentration Model Applied to Cesium-137 Movement in a Eutrophic Lake. Conf-750503-7.

A linear systems-analysis model which simulates time-dependent dynamics of specific activity and concentration of radio-cesium in lake ecosystems was applied to a shallow, eutrophic lake that had received a pulse input of ^{137}Cs. Best estimates of transfer coefficients fo[illegible]tic compartments (sediment, interstial water, and water) and macrophyte compartment which control mass balance of cesium in water were determined by tuning our initial estimates of the transfer coefficients to observed data on ^{137}Cs concentrations and contents of these compartments. In most cases, the optimized transfer coefficients of of the abiotic compartments were not greatly different from our independently-derived initial estimates, and the simulations for optimized coefficients were close to those based on initial estimates. The simulations of ^{137}Cs concentration in water predicted by the optimized transfer coefficients were used to derive ^{137}Cs kinetics in biota other than macrophytes. In general, model simulations were close to concentrations observed in the biota. The agreement between ^{137}Cs concentrations and simulations in bottom invertebrates supported our assumption that bottom sediments are not a major source of Cs to the biota. (auth)

Van der Westhuizen, H. J. and H. A. J. Van Rensburg. 1973. Movement of Some Nuclear Fission and Activation Products in Duinefontein Soil. PEL-226.

As part of the site investigation in connection with the erection of the first South African nuclear power station, Koeberg-A (Escom Reactor), the movement in the ground of important products of nuclear fission and activation was investigated. The sorbtion capacity of different layers of the ground for the elements was determined by laboratory tests. The tests were conducted using a solution that corresponds to the groundwater of the reactor site. Results of these tests were used to calculate the relative speed of the ion front of each element in relation to the liquid front. The values obtained indicate that the speeds at which the various elements move through the ground under the influence of the moving groundwater are spread out over a wide range. The movement of Ru, Ce, Co, Mn, and Zn was retarded by sorption on sand and in view of the relatively short half-lives of their radionuclides, it was concluded that they would not constitute a serious hazard. Both ^{137}Cs and ^{90}Sr moved too rapidly through the sand to allow sufficient time for their decay and it was concluded they would be a hazard to the biosphere. (NSA)

Van Haaren, F. W. J. 1964. The Limiting of Radioactive Isotopes in Soil (Underground Water). Foederation Europaeischer Gewaesser-Schutz, Informationsbl. No. 10:56-61 (in German).

The problem of finding out how ground water is influenced by radioactivity in the soil under normal conditions, by radioactivity in precipitation, and by discharges of concentrated radioactive wastes was considered. Potassium as a factor in the radioactivity of ground water is discussed. Because the radioactive materials in precipitation are cheifly adsorbed and fixed by a top layer of soil, contamination of ground water by these radioactive materials is not very considerable. Several tests were made of water infiltration through different kinds of soils. It was found that the velocity of flow and the presence of adsorbing material alien to the soil are of great importance. Soil contamination by discharge of radioactive wastes is described. (NSA)

Varga, J. A. and D. G. Jacobs. 1970. Dissolution of Calcium-Strontium Carbonate and Its Subsequent Movement in the Ground. ORNL-TM-3130.

A series of laboratory experiments was performed to determine the relative behavior of strontium and calcium in the dissolution of strontium-contaminated calcium carbonate and subsequent movement through a mineral exchange system. The behavior of the two elements was found to be similar, and their release from the system was directly related to the amount of hydrochloric acid used in the leaching process. (auth)

Varshal, G. M., I. Ya. Koshcheeva, and R. P. Morozova. 1972. Possible Forms of Ruthenium Migration in Surface Waters and Soils. Geokhimiya. No. 8:971-6 (in Russian).

The interaction of ruthenium (IV) with organic matter isolated from the effluents of the Moscow River, including their main component--fulvic acids, was studied. The formation of stable anionic forms of complex compounds of ruthenium (IV) with fulvic acid was studied by means of solubility and electrophoresis. Ruthenium solubility increases in the presence of fulvic acids by 2 to 4 orders in comparison with ruthenium solubility in water in the absence or organic matter. The conventional equilibrium constant of the reaction of ruthenium interaction with fulvic acids was calculated. The relatively high capacity of ruthenium for migration in waters and soils was considered from the standpoint of its complexing with the organic matters of water. (auth)

Vaughn, B. E. 1974. Pacific Northwest Laboratory Annual Report for 1973 to the U.S. Atomic Energy Commission, Division of Biomedical and Environmental Research, Part 2, Ecological Sciences. BNWL-1850. Pt. 2, pp. 19-24.

Previous studies have indicated that plutonium is largely insoluble in soil over the short-term and is not accumulated by plants. However, it is possible that naturally occurring ligands in soil arising from organic matter decomposition process may form complexes with plutonium increasing plutonium solubility in soil and uptake by plants. Furthermore, the possibility exists that the chemical form of plutonium may be directly altered by the soil microflora as has been demonstrated for other metals.

The present studies were undertaken to determine (1) the effects of plutonium on the soil microbial population and on soil microbial processes, (2) the potential for formation of plutonium complexes in soil and the role of the soil microflora in this process, (3) the extent of plant uptake and translocation of plutonium or its complexes, and (4) the bond types and chemical forms of plutonium or its metabolites in microbial and plant tissues and soils. The progress of these investigations is summarized. (auth)

Vaughan, B. E. 1974. Pacific Northwest Laboratory Annual Report for 1974 to the U.S. Atomic Energy Commission Division of Biomedical and Environmental Research, Part 2, Ecological Sciences. BNWL-1950. Pt. 2, pp. 21-62.

Previous studies have indicated that plutonium is largely insoluble in soil over the short-term and is not accumulated by plants. However, it is possible that naturally-occurring ligands in soil arising from organic matter decomposition processes may form complexes with plutonium increasing plutonium solubility in soil and uptake by plants. Furthermore, the possibility exists that the chemical form of plutonium may be directly altered by the soil microflora as has been demonstrated for other metals.

The present program was undertaken to determine (1) the effects of plutonium on the soil microbial population and on soil microbial processes, (2) the potential for formation of plutonium complexes in soil and the role of the soil microflora in these processes, (3) the extent of plant uptake and translocation of plutonium or its complexes, and (4) the bond types and chemical forms of plutonium or its metabolites in microbial and plant tissues and soils. Previous studies in this program involved measurement of (1) the influence of plutonium on the soil microflora and soil microfloral processes and demonstration of the role of the soil microbiota in influencing plutonium solubility in soil, (2) the subsequent availability of solubilized plutonium to plants and (3) the distribution of plutonium in plant shoots and roots. The progress of subsequent investigations to develop an understanding of the mechanisms of the microbial effects and to further elucidate the fate of different plutonium isotopes and chemical forms in soils and mature plants is summarized. (auth)

Vdovenko, V. M. 1960. Chemistry of Uranium and Transuranium Elements. AEC-tr-6421.

The book deals with solid and solution phase chemistry of uranium, neptunium, plutonium, americium, cesium, and transcurium elements. The scientific principles of the chemistry of fuel processing are also disucssed.

Vdovenko, V. M. and Yu. V. Dubasov. 1973. Analytical Chemistry of Radium. Israel Program for Scientific Translations, Jerusalem.

In addition to radium analytical chemistry, the aqueous chemistry, occurrence and natural abundance of radium were given.

Vdovenko, V. M., A. G. Kolesnikov, V. I. Spitsyn, and R. N. Bernovskaya, (et al.). 1971. Radioactivity of Ocean Waters and Behavior of Some Fission Products. A/CONF. 49/P-457.

The contamination of oceans by radioactivity due to fallout and waste disposal was investigated. The ^{137}Cs and ^{90}Sr contents of surface waters of the Atlantic and Pacific Oceans were measured during 1965 to 1970. It was found that the concentration of these isotopes decreased with time in the Pacific Ocean, but remained fairly stable in north Atlantic Ocean waters at latitutdes of 20° and 40°. The ^{137}Cs and ^{90}Sr contents of deep ocean waters were measured and found to be markedly influenced by fallout. Some deep currents labeled with ^{90}Sr from waste disposal were found. The behavior of ^{144}Ce, ^{95}Nb, and ^{91}Y in the ocean was studied. The specific influence of seawater over the state of radionuclides was studied. In particular ^{91}Y has a considerable influence on the natural ligands and in the layers of large density gradients in a genuine-soluted state; as for the other samples of water about 60% of the element changes into the state of suspension. The biogenic and abiogenic processes of extraction of radionuclides from seawater were investigated. The abiogenic capture and the fixing of the radionuclides by suspension depends on the ocean suspension properties. Iron, as a biogenic element is shown to promote the involving of ^{144}Ce, ^{95}Nb, and ^{91}Y in plankton organisms, i.e., in the active biological cycle. The absorption of these nuclides by bottom sediments of the Indian and Pacific Oceans from seawater was studied. (NSA)

Vecherkin, S. G., V. G. Barkhurov, and I. K. Lutsenko. 1968. Underground Leaching of Poor Uranium Ores. At. Energ. (USSR). 24:128-133.

A new method for the extraction of uranium from poor ores is described. The basic reason for which a sufficiently high quantity of uranium in poor ores is not used and is left, is the absence of profitable technology for their processing. An economic analysis showed that the special extraction and processing of these ores in hydrometallurgical plants or by means of leaching collectively and in pits is not profitable. The cost of leaching uranium can only be reduced by its leaching on the site of occurrence. Test operations were made in mines in which there were worked out ores and which were closed down although there remained large quantities of uranium in the ores. The studies made were used to determine their kinetic regularities and to work out a method and regime for industrial underground leaching. In this method an ore mass was decomposed by drilling. The ores are stored in blocks and sprinkled with solvent. The uranium-containing solutions, passing through all stratum of ores, are accumulated at the bottom of the block and are led to the lower level, from where it is distributed by pumps to the surface for extended processing. The method of underground leaching makes it possible to conduct profitable processing of homogeneous and nonhomogeneous ores. (auth)

Veeh, H. H. 1967. Deposition of Uranium from the Ocean. Earth Planet. Sci. Lett. 3:145-50.

Anaerobic sediments from the upper continental slope in the eastern Pacific, the Gulf of California, and a Norwegian Fjord have been analyzed for their total uranium content and ^{234}U/^{238}U ratios by alpha-spectrometry. The uranium concentrations range from 4.8 to 39 ppm and are thus significantly higher than the average uranium content of three ppm in deep sea clays, stream sediments and soils. The ^{234}U/^{238}U ratios approach the seawater value of 1.15 in samples with high uranium content. These results indicate that uranium is being removed from seawater in near shore areas under certain conditions. If such conditions prevail in only 0.4 percent of the total area covered by the ocean, an amount of uranium equal to that supplied by streams (assuming 0.04 μg/l) can be removed from the ocean, on the basis of measured accumulation rates in the Gulf of California, off southern California, and in other areas. The effect of Pleistocene sea level fluctuations as a controlling factor in determining the concentration of uranium in seawater is diminished by the occurrence of extensive areas of uranium deposition below 200 m and by the very long residence time of uranium in the ocean. (auth)

Venkataramian, K. 1966. Uranium in Carbonaceous Clays in Neyveli, South Arcot, Madras State. Journal of Geological Society India. 7:129-33.

Lignite seams are low in U (0.004% U_3O_8 in the ash), but a thin seam of carbonaceous clay overlying the lignite showed in 19 analyses 0.005-0.086% U_3O_8. The clay is also high in V (90-1300), Mo (5-23), Se (3-180), and As (3-40 ppm). The material shows radioactive disequilibrium. (CA)

Verdnikov, A. I. and V. F. Oreshko. 1964. Feasibility of Using Soils for Low-Radioactivity Waste-Water Purification. I. ^{60}Co Adsorption by Peats. Izv. Vyssh. Ucheb. Zaved., Khim. Tekhnol. 7:594-7.

The adsorption of ^{60}Co by peat from aqueous solutions as a function of the type and degree of decomposition of the peat and of the ^{60}Co concentration and pH of the solution was studied. The significance of studies of radioactive contamination of environment and the danger inherent in peats owing to their high sorption capacity were noted. The ^{60}Co sorption was carried out batchwise at 30°C from $CoCl_2$ solutions (radioactivity, 2.6×10^4 to 2.6×10^5 cpm) with 5 types of peat. All the peats exhibited good sorption of ^{60}Co from solution. The maximum sorption rate was shown by samples of two types of peat having low (10%) and average (50%) degrees of decomposition. The radioactivity level had practically no effect on the sorption process. The maximum sorption dependence on the pH was in the pH range from 5.0 to 8.0. It was concluded that peats are cheap natural sorbents suitable for the purification of low-radioactivity waters. (NSA)

Veselý, V. 1963. A Method of Deactivation of Radioactive Waste Waters by Countercurrent Adsorption of Coagulated Suspensions of Natural Adsorbents. UJV-973/63.

Research work is described on the development of an original method of deactivating radioactive waste waters contaminated with artificial radioisotopes, principally ^{90}Sr and ^{137}Cs. For the deactivation, countercurrent contact of the contaminated waste water with a coagulated slurry of natural adsorbents is used. The most convenient natural material from a series of materials investigated proved to be rhyodacitic tufa from Lower Hrabovce in Slovakia. This material also has the optimum sedimentation characteristic in the form of a suspended powder with particle size up to 0.1 mm. Investigation of the countercurrent adsorption showed that it is possible to apply the well-known laws of extraction to the system. The distribution coefficients for tracer cesium are quite high. For tracer strontium with a small calcium content a lower value is attained; however, the overall efficiency of separation in a three stage system will be at least one order higher than with the use of the classical single stage system. The efficiency of separation of tracer strontium is caused to increase by means of a preformed phosphate precipitate. A proposed technological scheme and some data for construction of a device with a capacity of 3.6 m^3 of waste water per hour are presented. (NSA)

Vesely, V., I. Napravnik, S. Gaderka, M. Paar, and L. Mazel. 1964. Equipment for a Counterflow Sorption Using Natural Sorbent Suspensions. UJV-1108/64.

A method for countercurrent sorption of radionuclides from aqueous waste, using bentonite and tuff was developed on a laboratory scale. The tuff showed relatively high extraction coefficients, especially for Cs. Values for Sr were lower and depended on a Ca ion concentration. An industrial process carried out in conical-bottomed mixers is outlined. (NSA)

Vilenskii, V. D. 1969. Distribution of ^{210}Pb and ^{226}Ra in Soils. ORNL-tr-2989.

Studies of ^{210}Pb and ^{226}Ra distribtuion in soil specimens taken from four vertical sections in two districts of European USSR territory, showed that (calculated as air-dry specimens) the ^{210}Pb content was within the range of ~0.1 to 7.7 nCi/g and ^{226}Ra was 0.1 to 2.2 nCi/g. In the lower levels the ^{210}Pb content in soil was identical to the ^{226}Ra content while in the upper levels it exceeded the ^{226}Ra content. The higher ^{210}Pb content indicated that the actual fallout was within 6.5.to 4.2.3 nCi/m^2 per day with the mean of 22 nCi/m^2 per day. (Previously announced in NSA from the original language as abstract 24:9496.) (auth)

Vinogradov, A. P. 1959. The Geochemistry of Rare and Dispersed Chemical Elements in Soils. Consultants Bureau, Inc., New York.

This volume consists of nineteen chapters which cover the following subjects: methods of determining rare and dispersed elements in soils; some general geochemical regularities in the distribution of rare elements; soil-forming rocks and soils of the eastern European plain; boron in soils, fluorine, bromine, and iodine in soils; arsenic and selenium (tellurium) in soils; lithium, rubidium, and cesium in soils; strontium and barium in soils; rare earth metals and yttrium, titanium and zirconium (hafnium) in soils; vanadium, chromium, manganese, cobalt, and nickel in soils; copper, zinc, and cadmium in soils; lead and tin in soils; molybdenum and tungsten, radioactive elements in soils; other dispersed elements in soils; and geochemical regularities in the distribution of rare elements in soils. (NSA)

Vinogradov, A. P. (ed.) 1963. Principal Characteristics of Uranium Geochemistry. Publishing House of the Academy of Sciences.

The geochemical properties of uranium are discussed. Topics include the crystal chemistry of uranium minerals; the geochemistry of uranium in magmatic, pegmatic, and metasomatic processes; the behavior of uranium in processes of deposit formation; uranium in sedimentary rocks; and uranium in natural waters. (NSA)

Vodovozova, I. G. 1971. Horizontal Water Migration of ^{90}Sr. Tr., Inst. Eksp. Meteorol. 21:87-90 (in Russian).

In spring thaws, strontium fallout on the earth's surface migrates with the water formed. Data are given on the physico-chemical state of the migrating strontium, showing that 73% is in the cationic form. Atmospheric precipitations falling on the soil and entering into the migration process leach out the soluble strontium from the soil, and essentially 100% of that in run-off and rivers is cationic. The cationic ^{90}Sr in flood waters is discharged to rivers. (auth)

Vodovozova, I. G., S. Ya Zaidman, and Z. G. Antropova. 1973. Interaction of Radioactive Isotopes with Organic Soil Material. INIS-mg-1032 (in Russian).

By extracting the organic soil matter by means of KU-2 it is possible to isolate the organic fraction in a less changed form than with pyrophosphate isolation, and this method can be applied in studying the interaction of organic soil matter with radioisotopes. As a result of studying the interaction of organic matter with radioisotopes, quantitative data has been obtained on the binding characteristics of ^{90}Sr, ^{45}Ca, ^{137}Cs and ^{91}Y with organic matter isolated from three soils: turf-podzolic, gray forest and chernozem (black earth). The interaction of ^{90}Sr, ^{45}Ca, ^{137}Cs and ^{91}Y is different in the presence and absence of stable analogous elements. (auth)

Voitekhovskaya, Y. V., G. V. Gurskii and S. A. Tikhonov. 1965. Content of Uranium in Soddy Podsolic Soils of the Belorussian SSR. Mater. Nouc. Konf. Molodykh Geol. Beloruss., Fist Mish. pp. 98-9 (in Russian).

Uranium in the Belorussian soddy podsolic soils, developed on various soil-forming rocks, varies 0.2-5.0 with an average content of 1.8 ppm. The soils, developed on the glacial loams, and soils in depressed parts of the topography had the highest content of U ($\leq$ 3.5-5 ppm). The smallest content of U was observed in soils developed on colian sands and loess loams. (CA)

Volchok, H. L. 1971. Resuspension of Plutonium 239 in the Vicinity of Rocky Flats. IN: Fowler, E. B., R. W. Henderson, M. F. Milligan (cochairmen). Proceedings of Environmental Plutonium Symposium, held at LASL, August 4-5. LA-4756, pp. 99-103.

Continuous, high-volume airborne particulate sampling has been maintained for over a year, close to, and downwind from the Rocky Flats plant. The sampler is in the vicinity of the highest ground concentrations have averaged about 2 fCi/m^3 of air sampled, 10 to 100 times higher than the expected levels from fallout. In addition a qualitative correlation is demonstrated between wind velocity and ^{239}Pu concentration in the air. The results to date suggest resuspension factors of between 10^{-7} and 10^{-9} depending upon the assumption taken, for the depth of soil reentrainment. (auth)

Volchok, H. L. 1974. Transuranic Elements in the Marine Environment. WASH-1359, pp. 155-168.

Transuranic elements have been introduced in dispersed form into the marine environment in: close-in fallout from nuclear explosives testing; world-wide fallout from nuclear explosives testing; atmospheric burn-up of ^{238}Pu power sources; and liquid wastes from chemical reprocessing plants and reactor operations. The environmental redistributions of Pu have been followed after its introduction by each of these avenues, and a small amount of information exists about Am. Unfortunately the data now at hand do not premit us to distinguish among the distributions of Pu following its introduction in different ways. Data are summarized on the content of ^{241}Am, ^{239}Pu, and ^{238}Pu in samples of seawater and sediments collected at various ocean depths and in samples of plankton, seaweeds, invertebrates, fishes, and mammals collected at various locations. (NSA)

Volesky, A. F. 1976. Niagara Limestone Absorption of Plutonium from Salt Solutions. ANL.

Studies were conducted to determine what effects a changing concentration of salt solution would have on the absorptivity of ^{237}Pu on Niagara limestone. The experimental methods involved placing a rock sample in an aliquot of water spiked with ^{237}Pu tracer. When equilibrium is attained, a measurement of the activity absorbed on the rock and of the activity left in solution is made using a sodium iodide detector. The ratio of these is expressed in a percentage absorption value or as a surface absorption coefficient $k = (\text{activity/ml of solution})/(\text{activity/cm}^2 \text{ of stone})$. A measured amount of salt is added and after equilibrium is again attained the measurements are repeated. The results show that the value of k is essentially constant until the point of 1M concentration after whence it increases rapidly to the point of 3M and becomes constant again. This demonstrates that the absorptivity of the limestone decreases in solutions whose concentration is greater than 1M. In the method used it also shows that the ^{237}Pu is actually leached from the rock. (auth)

Von Backstroem, J. W. 1973. Uranium Amongst the Fossils. Nucl. Active. pp. 31-4.

Au and U occurrences are related in the sediments of the Witwatersrand Supergroup. The two were deposited together as an integral part of sediments transported by water. U is found with reptile fish and flora fossils embedded in line clastic sediments in the Karoo basin. This geological formation is similar to that of the Colorado Plateau where U deposits are being exploited. An aerial radiometric survey of the Karoo deposits will be undertaken. (CA)

Von Gunten, H. R., W. Buser and F. G. Houtermans. Determination of Extreme Th/U-Ratios in Minerals. A Radiochemical Method for Determination of Thorium A/CONF 15/P/250.

For age determination of U and Th minerals an accurate measurement of the Th/U ratio is needed, especially when accessory lead is present. The correction of accessory lead may be made on the basis of the isotope ^{208}Pb. It is therefore necessary to determine very low contents of Th in U minerals very exactly to have a measure for radiogenic ^{208}Pb. The quantitative determination of thorium in minerals by chemical methods is rather laborious. The proposed radiochemical method reduced the chemical separations to a minimum. The principle of the method consists of an analysis of the decay curve of the lead fraction. After dissolution of the mineral all lead is extracted by the dithizone method. The extracted lead is measured in liquid counter tubes. After decay of short-lived RaB, AcB, and daughter products the radioactivity increases, until equilibrium of ThC and ThB is attained. Then the radioactivity is determined during 3 to 48 hours by ThB + C + C". In case of very low Th/U ratios ($<10^{-3}$) the solution was extracted twice with inactive lead as carrier. The second extraction of the same solution, after growth of ThB, allows an accurate measurement of ThB, and therefore of the Th content in the solution. The disturbing effect of RaE is in this way reduced by the ratio of 0.5 days to 30 years. Th can be determined down to a ratio Th/U $\sim 10^{-4}$. The method is also practicable for high Th/U ratios. It is evident that the method is restricted to Th and U minerals in complete radioactive equilibrium. (auth)

Vought, R. L., F. A. Brown, and W. T. London. 1970. Iodine in the Environment. Arch. Environ. Health. 20:516-522.

This report evaluates the possibility that atmospheric iodine (I) can make a significant contribution to I nutrition and concludes that the combustion of gas and oil can increase atmospheric I. Sedimentation treatment of water supplies extracts some I from raw water, and sewage plants concentrate I and return it to the environment via sewage effluent. The I cycle in nature is discussed, and it is concluded that minute amounts of I usually are present in the atmosphere but are not usually in significant enough amounts to contribute substantially to bodily I requirements. (auth)

Wahlberg, J. S., J. H. Baker, R. W. Vernon, and R. S. Dewar. 1965. Exchange Adsorption of Strontium on Clay Minerals. U.S.G.S. Bulletin 1140-C.

A study was made of the ion exchange adsorption of strontium from calcium magnesium, sodium, or potassium solutions by the clay minerals kaolinite, montmorillonite, and illite. The calcium, magnesium, sodium, and potassium concentrations were varied from 10^{-1} N to 10^{-5} N while the strontium concentrations were varied from 10^{-1} N to approximately 10^{-10} N. The exchange of strontium by the clay minerals tested was adequately defined by the mass-action equilibrium equation. The adsorption of strontium was greatest from sodium solutions and least from calcium solutions. (auth)

Wahlberg, J. S. and R. S. Dewar. 1965. Comparison of Distribution Coefficients for Sr Exchange from Solutions Containing One and Two Competing Cations. U.S.G.S. Bulletin 1140-D.

The ion exchange adsorption of tracer-level strontium by the clay minerals kaolinite and montmorillonite from solutions containing two competing cations was investigated. The exchange of strontium in these systems was successfully predicted from the results of the exchange adsorption of strontium from one competing cation solutions. (auth)

Wahlberg, J. S. and M. J. Fishman. 1962. Adsorption of Cs on Clay Minerals. U.S.G.S. Bulletin 1140-A.

Kaolinite, montmorillonite, halloysite and illite were used to determine Cs K_d over a Cs concentration range of from 0.1 to 10 [illegible] normality. Na, K, Ca and Mg were used as competing cations. At low Cs concentrations, montmorillonite gave the largest Cs K_d. The effects of competing ions on Cs removal was found to be $K > Ca \geq Mg > Na$. The concentration of Cs and the amount and type of competing cations had important effects on the Cs K_d. The highest K_d values occurred with dilute Cs in the presence of Na.

Wahlgren, M. A. and J. S. Marshall. 1974. Distribution Studies of Plutonium in the Great Lakes. IN: Proc. Second International Conference on Nuclear Methods in Environmental Research. CONF-740701, pp. 267-275.

The distribution of residual fallout plutonium in Lake Michigan between water and various trophic levels of the food chain has been studied. Concurrent measurements of the conservative fallout radioisotope ^{90}Sr in the water column are used to estimate the cumulative fallout deposition on Lake Michigan; these data indicate that ca 97% of the fallout ^{239}Pu (and ca 94% of the fallout ^{137}Cs) presently constitute a sediment reservoir pool. The results of analyses of comparison samples of water, plankton, and fish indicate that the residual fallout ^{239}Pu remaining in the water column has attained a consistent physiochemical form in all 5 Great Lakes. (A)

Wahlgren, M. A. and D. M. Nelson. 1972. Plutonium in Lake Michigan Water. IN: Radiological and Environmental Research Division Annual Report. Ecology, Jan.-Dec. 1972. ANL-7960, Part III, pp. 7-14.

Plutonium-239 fallout is rapidly sedimented in Lake Michigan with half life of removal 1.0 ± .3 years. There is no vertical or horizontal plutonium gradients in early June in Lake Michigan waters.

Three percent of the plutonium fallout deposition is in water column at any given time.

Wahlgren, M. A. and D. M. Nelson. 1973. Evidence of an Annual Plutonium Cycle in the Near-Surface Waters of Lake Michigan. ANL-8060, Pt. 3, pp. 90-92.

The rapid depletion of ^{239}Pu from the surface waters of Lake Michigan during July and August, the concurrent changes in the season, and the demonstrated preferential sorption of fallout ^{239}Pu over ^{137}Cs by net plankton all suggest that a biological mechanism is the major removal step in a cycling process involving Pu and may contribute to the eventual removal of this element to the sediments. (NSA)

Wahlgren, M. A. and D. W. Nelson. 1973. Plutonium in the Five Great Lakes: Comparison of Surface Waters. ANL-8060, Pt. 3, pp. 93-98.

Studies of the fallout radionuclides ^{239}Pu, ^{137}Cs, and ^{90}Sr in Lake Michigan demonstrated that a homogeneous distribution can be found throughout the water column following the winter mixing period, provided that the input of new fallout radioactivity is low as was the case in 1972 and 1973. Assuming that generally similar mixing behavior prevails in all the Great Lakes, surface water and plankton samples were obtained during May and June, 1973, and analyzed for ^{239}Pu, ^{137}Cs, ^{90}Sr and ^{125}Sb as an indicator of recent fallout. The results of the interlake comparison study are consistent with the results of more detailed studies on ^{239}Pu and ^{137}Cs in Lake Michigan, indicating that the major fraction of both of these fallout isotopes has been removed relatively rapidly to the sediment, and suggesting that the average cumulative deposition rate in sediments will approximate that on land for all five Great Lakes. (NSA)

Wahlgren, M. A. and D. M. Nelson. 1973. Residence Times for ^{239}Pu and ^{137}Cs in Lake Michigan Water. ANL-8060, Pt. 3, pp. 85-89.

Study of the long-term behavior of ^{239}Pu and ^{137}Cs in natural waters is simplified by working on a lake that is essentially a closed system, located where adjacent land fallout measurements are available. Lake Michigan meets both criteria, with an outflow only about 1% of lake volume each year, and with fallout monitoring stations nearby at Argonne, Illinois, and Green Bay, Wisconsin. The determination of the removal rate of the fallout input from the water column, and of the fraction remaining in the water column, requires knowledge of both the cumulative fallout and the relative annual inputs. The latter is readily obtained from ^{90}Sr measurements in rainfall pots on land, but the uncertainty in the cumulative total for ^{90}Sr on land has been estimated as several tens of percents. The relative amounts of rainfall on Lake Michigan and on nearby land differ by less than 10%. Extensive lake-wide sampling carried out in June 1972, established the inventory of ^{239}Pu, ^{137}Cs, ^{90}Sr and ^{3}H in the water column of Lake Michigan at a season when it should be well mixed. The results of the analyses confirmed that this was indeed the case. For ^{90}Sr, the mean lake value from our experimental measurements was 0.81 pCi/l. Based on the average of Green Bay and Argonne ^{90}Sr fallout estimates from precipitation monitoring, the predicted 1973 concentration in Lake Michigan is 0.71 pCi/l, assuming the contribution to the lake from land runoff to be 2%/year, and loss of outflow and by incorporation to the sediments to equal 2%. The difference between the measured and calculated values may be due to dry deposition; the degree of agreement is encouraging in that an input inventory by direct measurement cannot readily be made for the three lower Great Lakes where residence times are much shorter. The cumulative fallout input of ^{137}Cs to Lake Michigan can now be deduced fairly rigorously, since the ratio of ^{137}Cs to ^{90}Sr is fixed in the fission process. (NSA)

Wahlgren, M. A. and D. M. Nelson. 1974. Studies of Plutonium Cycling and Sedimentation in Lake Michigan. Proc. 17th Conf. Great Lakes Res. pp. 212-218.

Estimates of cumulative deposition, together with the results of extensive lakewide sampling in 1972, yielded estimates of mean halftimes for removal from the water column of Lake Michigan of 1.0 ± 0.3 years for ^{239}Pu, ^{240}Pu and 1.4 ± 0.3 years for ^{137}Cs. However, data from 1971, 1972, and 1973 water samples indicate that the recent halftime is much greater than the 1963-1972 average, presently being on the order of 3 to 4 years for both ^{239}Pu and ^{137}Cs. The longer turnover time is consistent with the ^{137}Cs turnover time in the water column deduced from analysis of preserved Lake Michigan alewives. Water filtration experiments have demonstrated that >75% of the plutonium is nonfilterable and is present as colloid or subcolloidal sized fractions. At an offshore station near Grand Haven, Michigan, the concentration of ^{137}Cs in the epilimnion underwent a slight but significant decline from June to November, whereas ^{239}Pu was reduced to a small fraction of its spring value. In new plankton samples dominated by phytoplankton as much lower mean ^{137}Cs: ^{239}Pu ratio is observed than in water samples, indicating a preferential sorption of ^{239}Pu over ^{137}Cs by phytoplankton. The results of these experiments suggest that sorption by phytoplankton (and the subsequent rapid settling from the epilimnion of phytodetritus and/or zooplankton fecal pellets) is responsible for the rapid removal of ^{239}Pu from the epilimnion. (auth)

Wahlgren, M. A., E. M. Yaguchi, D. M. Nelson and J. S. Marshall. 1974. Spatial Distribution of Radionuclides in Lake Michigan Biota Near the Big Rock Point Nuclear Plant. CONF-750593-17.

A survey was made of four groups of biota in the vicinity of the Big Rock Point Nuclear Plant near Charlevoix, Michigan, to determine their usefulness in locating possible sources of plutonium and other radionuclides to Lake Michigan. This 70 MW boiling-water reactor, located on the Lake Michigan shoreline, was chosen because its fuel contains recycled plutonium, and because it routinely discharges very low-level radioactive wastes into the lake. Samples of crayfish (<u>Orconectes</u> <u>sp</u>.), green algae (<u>Chara</u> <u>sp</u>. and <u>Cladophora</u> <u>sp</u>.), and an aquatic macrophyte (<u>Potamogeton</u> <u>sp</u>.) were collected in August 1973, at varying distances from the discharge and analyzed for $^{239\text{-}240}$Pu, ^{90}Sr, and five gamma-emitting radionuclides. Comparison samples of reactor waste solution have also been analyzed for these radionuclides. Comparisons of the spatial distributions of the extremely low radionuclide concentrations in biota clearly indicate that ^{137}Cs, ^{134}Cs, ^{65}Zn, and ^{60}Co were released from the reactor; their concentrations decreased exponentially with increasing distance from the discharge. Conversely, concentrations of $^{239\text{-}240}Pu$, ^{95}Zr, and ^{90}Sr showed no correlation with distance, suggesting any input from Big Rock was insignificant with respect to the atmospheric origin of these isotopes. The significance of these results is discussed, particularly with respect to current public debate over the possibility of local environmental hazards associated with the use of plutonium as a nuclear fuel. (auth)

Wakeel, S. K. and J. P. Riley. 1961. Chemical and Mineralogical Studies of Deep Sea Sediments. Geochim. et Cosmochim. Acta. 25:110-146.

Chemical and spectrographic analyses are presented for the major and several minor elements in ten calcareous, twelve argillaceous and three siliceous deep-sea sediments from the Atlantic, Pacific and Indian Oceans and Mediterranean Sea; a 5 m core from the Atlantic; three deep-sea volcanic sediments; an unusual calcareous manganiferous ooze, and the <2μ fractions from two near-shore muds. The distribution of the minor elements was very similar to that described by Goldberg and Arrhenius for Pacific sediments. Except for their higher content of ferrous iron and organic carbon the chemical composition of the <2μ fraction of the near shore clays closely resembled that of the deep-sea argillaceous sediments. This resemblance and the similarity of the abundances of certain of the minor elements, such as Ti, Zr, Cr and V, in the pelagic to their abundances in igneous rocks, suggests a mainly terrigenous origin for red clay. The argillaceous material of two globigerina oozes from the Mediterranean was very similar in composition to that of the deep ocean sediments. The proportions of all the major elements down the length of the 5.05 m core of red clay from off the Bermuda rise in the Atlantic were very constant. Niggli values have been used to compare the sediments, on a carbonate-free basis, the sediments from the Atlantic are characterized by their higher Al and lower Fe values compared with those from the Pacific and Indian Oceans. Illite and chlorite, with lesser amounts of montmorillonite, are the principal clay minerals in the deep-sea sediments. The near shore clays are richest in kaolinite, but illite and montmorillonite are also present.

Waldichuk, M. 1961. Sedimentation of Radioactive Wastes in the Sea. NP-9905.

Sedimentation, if it occurs at large distances from shore outside of bottom fishing areas, can be considered a favorable process in effective radioactive waste disposal. Being a concentrating process, however, it can enter into one of the routes of radioactivity from the sea to man through contamination of fish products, edible sea weed, fishing gear, and beaches. Flocculation, sorption, precipitation, and ion exchange reactions would probably occur freely in Pacific coastal waters, because of the presence of silt-laden water from the Columbia River, Fraser River, and other western streams. While turbid waters from runoff and coastal pollution can be expected to contribute to substantial sedimentation, no quantitative values can be assigned for this effect. Provided that it removes the radioactive wastes from man's environment and deposits them in areas where they can do no harm, sedimentation can be considered as a safety factor in estimates of maximum permissible relase of radioactive wastes. If contamination of marine products by ingestion and sorption of the precipitated waste occurs, the effect that this would have on man's uptake of radioactivity through utilization of the products must be taken into account in evaluations. A review is given of the investigational results on radioactive waste discharge into the Irish Sea from the Windscale Works, England. A large proportion of the released radioactivity has been found in the sea bed near the outfall. Sea waters in this area are almost completely mixed vertically and contain a high concentration of suspended material. There is no reason to believe that liquid radioactive wastes discharged off the Pacific Coast of North America would behave in the same way as those released into the Irish Sea, in view of the different oceanographic conditions. A series of studies in the field and laboratory needed to elucidate some of the problems related to sedimentation of fission-product elements is suggested. (auth)

Waldichuk, M. 1971. Radioactivity in the Marine Environment. A Summary Report. WASH-1185.

The state of knowledge on injection, dispersal, uptake by the biota, transfer through the food web, effects on the ecosystem, and ultimate disposition of artificial radionuclides in the marine environment are summarized. Topics covered include: sources of radioactivity and their characteristics;

oceanic distributions of radionuclides from nuclear explosions; physical processes of water movement and mixing; marine chemistry; marine sediments and radioactivity; accumulation and redistribution of radionuclides by marine organisms; ecological interactions of marine radioactivity; radiation effects; and evaluation of human radiation exposure. (NSA)

Wallace, A., et al. 1971. Effects of Micronutrient and DTPA Applications on Americium-241 and Micronutrient Contents of PI54619-5-1 Soybeans Grown in Calcareous Hacienda Loam Soil. UCLA-34-p-51-33, pp. 8-9.

PI54619-5-1 soybeans which are susceptible to lime-induced chlorosis were grown in calcareous Hacienda loam soil with micronutrient and chelate additions. Americium-241 which had been mixed with the soil was greatly increased in plants to which iron DTPA had been added to the soil. Application of high levels of zinc or manganese decreased Americium-241 content of plants only slightly. The FeDTPA was of slight value only in correcting the lime-induced chlorosis. The 4 pounds per acre of iron as DTPA increased zinc contents of leaves as much as did 100 pounds per acre of added zinc. Manganese increased manganese contents of leaves; 200 pounds manganese per acre doubled the manganese content. (auth)

Wallace, A., et al. 1971. Retranslocation of Americium 241 in Bush Beans. UCLA-34-p-51-33, pp. 96-7.

Americium-241 initially after absorption was largely located in leaves of plants. During a subsequent growth period some of the americium-241 was transported from the old leaves to the new leaves and to new roots. The chelating agent DTPA had no effect on the retranslocation. Since the chelating agent has been shown to increase americium-241 uptake by plants this study was made to determine if DTPA had any effect on retranslocation of americium-241 once it was accumulated in plants. Plants were allowed to accumulate americium-241 and then the americium-241 was removed and plants allowed to grow to maturity with and without DTPA. The results have implications on the absorption of and behavior of chelating agents in plants. (auth)

Wallace, A. 1972. Effect of Soil pH and Chelating Agent (DTPA) on Uptake by and Distribution of Americium 241 in Plants Parts of Bush Beans. Radiation Botany. 12:433-35.

Bush Bean (<u>Phaseolus</u> <u>vulgaris</u> <u>L</u>. var. Improved Tendergreen) plants were grown with and without chelating agent diethylenetriaminepentaacetate (DTPA) in Yolo loam soil, which was amended to give a range of soil pH values. A level of 1.68 uCi ^{241}Am was uniformly mixed with each 500 g quantity of soil. Highest amounts of ^{241}Am were found in plant parts at soil pH around 7.7 with the DTPA. The results are interpreted as chelated ^{241}Am not only being available to the plants especially at pH 7.7 but also the ^{241}Am being transported through the plants as the metal chelate. (auth)

Wallace, A. 1972. Increased Uptake of ^{241}Am by Plants Caused by the Chelating Agent DTPA. Health Physics. 22:559-562.

The chelating agent diethylenetriaminepentaacetic acid (DTPA) which has the ability to increase uptake by plants of several metals and is widely used as a practical means of correcting iron deficiency in plants has been shown to greatly increase the uptake of soils of ^{241}Am by plants. Application of high levels of zinc or manganese salts decreased ^{241}Am content of plants only slightly, indicating little, if any, competing effect. Most accumulated ^{241}Am was transported to leaves of all species studied. The ability of plants to accumulate ^{241}Am was not related to root temperature. During a subsequent growth period after applications of ^{241}Am to bush beans, some of the ^{241}Am was transported from the old leaves to the new leaves and also to new roots. The chelating agent DTPA had no effect on the retranslocation, however. Extraction studies with soil indicated that DTPA, but not EDDHA, could quantitatively extract ^{241}Am from soil. (auth)

Wallace, A. and E. M. Romney. 1974. Feasibility and Alternate Procedures for Decontamination and Post Treatment Management of Pu-Contaminated Areas in Nevada. UCLA-12-973.

This report was prepared in response to needs for determining the feasibility and environmental impact of cleaning up Pu-contaminated areas in Nevada. Instead of considering all aspects of radioactive decontamination, it deals primarily with findings from pertinent land area decontamination and post-management experiences that can be applied to solving Pu problems at the Nevada Test Site and the Tonopah Test Range. Previous experiences from accidental and planned releases of Pu in the environment are discussed along with those gained from nuclear fallout decontamination studies. Considerable attention is given to problems concerning revegetation of arid lands. The fragile nature of the desert is such that any drastic alteration will result in a seriously damaged ecosystem. Revegetation by natural means is difficult, if not impossible, from a practical point of view. Post treatment management of disturbed areas is almost always necessary to insure recovery. Correction of the damage may require greater efforts than the decontamination, and may have more far-reaching consequences than those concerned with the present status of the land. Alternate procedures are discussed which may be useful in Nevada, providing the necessary experimental work is done to test the validity of the assumptions made. Many answers to pertinent questions can be obtained from investigations conducted outside of the Pu areas. Recommendations are made for experimental work that should be done to determine the best course of action before cleanup begins. (auth)

Walton, R. D. and G. A. Cowan. 1975. Relevance of Nuclide Migration at Oklo to the Problem of Geologic Storage of Radioactive Waste. LA-UR-75-876.

Analyses of Oklo samples published by French scientists and the data presented by U.S. scientists at this symposium indicate that escape of radioactive products from the Oklo reactor zones was quite limited. Apparently, the major radioactive products that might have been measured in the surrounding environment at the time of the reaction would have been due to ^{85}Kr and, possibly, ^{137}Cs and ^{90}Sr. Other fission product elements which have been significantly displaced over the intervening epochs include Xe, Rb, Ba, Mo, and I. The heavy elements have remained relatively fixed. These conclusions must remain tentative until additional analyses are completed on samples taken near the interfaces between reactor and nonreactor zones. Relevance of these tentative conclusions to other geologic formations must await further study of comparative geochemistry and geology. (auth)

Wanderer, E. 1969. Accumulation of ^{235}U Fission Products on Polymicron River Sediments. Naturwissen-Shaften. 56:281 (in German).

Adsorption experiments with ^{235}U fission products and river sediments were carried out. The relation of particle size to adsorption was determined for

^{140}La, ^{103}Ru, and ^{132}Te as well as total beta activity. The adsorption maximum was in the particle size region of 75 to 100 μ. (NSA)

Ward, F. N. and H. W. Lakin. 1954. Determination of Traces of Antimony in Soils and Rocks. Analytical Chemistry. 26:1168-1173.

A relatively simple, rapid, and moderately accurate method for the determination of traces of antimony in soils and rocks is based on the reaction of pentavalent antimony with rhodamine B in isopropyl ether after extraction of the antimony from 1 to 2M hydrochloric acid. The suggested procedure is applicable to samples containing from 0.5 to 50 ppm of antimony, and with modifications it can be used on samples containing larger amounts. Four determinations on two rocks containing less than 2 ppm of antimony agree within 0.4 ppm, and four determinations on seven soils containing 2 to 10 ppm of antimony agree within 1 ppm of the mean. The conditions for oxidation of the antimony and the subsequent extraction of the pentavalent form with isopropyl ether have been established. Experiments show that the antimony-rhodamine B compound is stable in isopropyl ether for more than 3 hours. The suggested procedure permits the determination of 2 γ of antimony in the presence of 30,000 γ of iron, 250 γ of arsenic, and 300 γ of gold and/or thallium. Data are given to show the applicability of the method to routine laboratory and field use. Under field conditions the method has been used to determine traces of antimony in as many as 20 soil samples in an 8-hour day. (auth)

Washington, University of. 1952. Work in Progress at the Applied Fisheries Laboratory. AECD-3445.

A comparison was made between the radiosensitivity of dry, encysted eggs of Artema and similar eggs after resumption of development stimulated by soaking in water. Dry eggs were found to be twice as resistant as soaked eggs. Studies were initiated in the effects of various stages of development on radiosensitivity of snail eggs. Preliminary analysis of data from studies of the effects of graded doses of x radiation on salmon eggs indicate that radiosensitivity decreases rapidly with age up to formation of the optic capsules. The relation of radioactivity to particle size was determined for sand from Eniwetok Atoll. Preliminary studies indicate that the activity from a solution of the mixed fission products from Eniwetok test-site sand is concentrated in goldfish primarily in the scales. Tissue distribution studies of Ce^{144} in goldfish are reported. Preliminary data are reported from studies of the effects of water of various temperatures on physiological processes in salmon. Studies that have been conducted with trace amounts of Co added to the diet of anemic salmon have indicated an improvement of the red blood cell count. (NSA)

Watkins, J. W., F. E. Armstrong, and R. J. Heemstra. 1960. Feasibility of Radioactive Waste Disposal in Shallow Sedimentary Formations. Nuclear Sci. and Eng. 7:133-43.

General considerations pertinent to the disposal of radioactive wastes are reviewed. Suggested methods of disposal, geographical influences, and the factors pertaining to shipping liquid and solid radioactive wastes are discussed. The methods of disposing of oil-field brines are reviewed. The economics of brine injection is compared to costs of storing and estimated costs of disposing of high-level radioactive wastes. A comparison is made of the costs of drilling wells to different depths. The relative economics of drilling exploratory, injection, and monitoring wells to different depths in a disposal or test project is discussed. The geology of comparatively shallow and stratigraphically isolated sandstone lenses and shoestrings common to midcontinental United States is considered. Particular emphasis is given to the geological, engineering, and chemical information available about such formations that have proved to be productive of petroleum and have been repressured with fluids to stimulate oil production. Laboratory and field research problems pertinent to the disposal of radioactive wastes by injection are outlined. A hypothetical sample is given of a pilot plant for secondary treatment and injection of dilute fission products into a shallow, lenticular sandstone formation with well-defined boundary conditions. Monitoring facilities and techniques designed to determine horizontal and vertical migration and differentiation of the migrating radioisotopes are described. A partial cost analysis is made of the pilot system. The advantages and disadvantages of a full-scale system of this type, as compared with other methods of disposal are discussed. (auth)

Watson, L. C. 1963. Mineral Exchange in Canada's Waste Treatment Program. TID-7644, pp. 75-82.

A brief review of waste disposal to ground at Chalk River is presented. Results of work using clinoptilolite and plans for use of this material on low-level waste streams are also included. Work in mineral preparation, waste liquor clarification, and process chemistry is emphasized. (NSA)

Weed, H. C., D. D. Jackson, and G. Koskinas. 1976. The Distribution of Radioactivity Between Rock Materials and Water at Nevada Test Site. EOS. Trans. Am. Geophys. Union. 57:1016.

Static leaching experiments were performed on radioactive debris from Nevada Test Site. Two levels of tracer were used in the leach solution, which was well water from NTS. Debris consisted of puddle glass (samples 1 and 3) and chimney materials (samples 2 and 4). The maximum leaching time was 384 days. High values of K_{DA}, the ratio of the activity per unit area of solid to the activity concentration in the leach solution, are associated with high values of pH for samples 1, 2, 3, but not 4. A correlation between high K_{DA} and high pH suggests that as the solid particles dissolve during the leaching experiments, the acid used in making up the tracer solutions is neutralized. However, the behavior of sample 4 indicates that other factors besides pH can influence the K_{DA}. Insofar as K_{DA} increases with time or with pH, this has favorable practical consequences for NTS hydrology since a species with a high K_{DA} tends to remain associated with the debris near its point of origin. Such association would be expected to inhibit transport of the species by ground water. The effect of debris type is smallest for ^{85}Sr and ^{60}Co: K_{DA} for these species is approximately the same for both puddle glass and chimney material. The effect of tracer level is not noticeable for ^{85}Sr and ^{60}Co, but in the case of ^{134}Cs and ^{152}Eu, high tracer level is associated with high K_{DA}. (auth)

Weed, S. A. and R. A. Leonard. 1964. A Comparison of Mg^{2+}, Ca^{2+}, and Sr^{+2} as Exchange Ions for Mineralogical Studies of Clays. Soil Sci. Soc. Am. Proc. 28:58-62.

Strontium-, Ca^{2+}-, and Mg^{2+}-saturated clay minerals were studied with respect to x-ray diffraction, differential thermal analysis, cation exchange capacity, and glycerol adsorption. In general, 3-layer clay minerals saturated with Sr^{2+} lost interlayer water at lower temperatures and at higher vapor pressures than did Mg^{2+}-clays; Ca^{2+}-clays were intermediate. A clay mineral-ion-saturation interaction was apparent. Calcium- and Sr^{2+}-saturation of clays yielded similar values for cation exchange capacity. Strontium-saturated 3-layer clays retained more glycerol than did clays saturated with Ca^{2+}. Expansion of vermiculite with glycerol and ethylene glycol was dependent on cation saturation with lattice charge. Strontium-saturated vermiculites expanded to near 16 Å more readily than did Mg^{2+}-clays, and Ca^{2+}-clays were intermediate. Vermiculites with high lattice charge expanded less readily than did vermiculites with relatively low lattice charge. Strontium can satisfactorily substitute for Ca^{2+} and Mg^{2+} in routine mineralogical studies of clays though special care may be needed to control relative humidity. Additional information regarding lattice charge of 3-layer clays may be obtained by using several divalent ion saturations. (auth)

Weeks, A. D. 1956. Mineralogy and Oxidation of the Colorado Plateau Uranium Ores. U.S.G.S. Professional Paper 300, pp. 187-93.

The V-rich ores contain mainly rescocnte and montroseite. Primary ores with V/U 15:1 to 1:1 contain the U as uraninite and coffinite, the V as montroseite. Ores lacking V contain chiefly uraninite with pyrite, Cu sulfides, and galena. On oxidation, trivalent V yields quadrivalent and quinquevalent V minerals such as rauvite, melanovanadite, and corvusite. Further oxidation yields minerals containing U(VI) and V(V), such as carnotite, tyuyamunite, hewettite, pascoite, and others. Oxidation on nonvanadiferous U ores yields a wide variety of U(VI) oxides, carbonates, sulfates, phosphates, arsenates, and silicates. Oxidation of the ores is much slower in ore below the water table. (CA)

Weissbuch, H., L. Clain, E. Botezatu, S. Freund and I. Avaravarei. 1973. Behavior of ^{134}Cs, ^{85}Sr, and ^{65}Zn Radionuclides Released to Water Basins. A Study of an Experimental Laboratory Model. IN: Health Physics Problems of International Contamination. E. Bujdoso (ed.). Budapest. pp. 421-430.

A laboratory experiment in a nonflowing regime was carried out to investigate the accumulation of ^{134}Cs, ^{35}Sr, and ^{65}Zn radionuclides in Danube and Siret basin sediments, as well as in Bicaz accumulation lake sediment. The influence of specific activity, water pH, and contact time upon the accumulation process was studied. (auth)

Welty, C. G. and M. B. Biles. 1973. The U.S. Atomic Energy Commission Program for Monitoring the Behavior of Radionuclide Released to the Environment. IN: Environmental Behavior of Radionuclides Released in the Nuclear Industry. IAEA-SM-172/36, pp. 139-156.

The U.S. Atomic Energy Commission (AEC) conducts major nuclear energy programs at about 30 sites. The environmental monitoring programs at these sites are conducted by AEC or its operation contractors and are governed by general requirements set forth in AEC management directives. The objective of these directives is to ensure that environmental monitoring is adequate to determine the extent to which levels of radioactivity released from AEC facilities comply with applicable environmental quality standards and to evaluate the effects, if any, of planned and unplanned releases on the environment. Emphasis has been placed on the monitoring of pathways of human exposure, although environmental media such as soil and sediment have been monitored to detect significant trends in radioactivity levels. In some instances direct gamma body counts on members of the public and hypothetical dose estimates for selected individuals and population groups have been made to define more accurately the risks of public exposure in the vicinity of AEC facilities. Environmental monitoring programs have generally demonstrated public exposures in the vicinity of AEC facilities to be less than 1% of the ICRP recommended standards. Some operations, however, have resulted in potential public exposures representing somewhat larger fractions of the ICRP recommended standards. The levels of exposure that resulted from these and other AEC operations will be discussed. With few exceptions, exposures to individuals and groups in the population have not ranged above a few percent of the ICRP standards. Comprehensive soil and sediment monitoring is being accomplished in the vicinity of a number of AEC facilities and sites to determine the degree of build-up of plutonium in the environment due to routine and accidental releases. There is no evidence that build-up of plutonium in soil and other media present a public health hazard. The quantities of plutonium released and the levels of plutonium detected in the environment will be discussed. (auth)

Westerdahl, H. E. 1973 Particulate Organic ^{32}P in a Simulated Sediment - Water System. Thesis. University of Oklahoma.

The role of the sediment heterotrophic community in the biodegradation of algal particulate organic ^{32}P and the subsequent release of ^{32}P to the overlying water was studied. To accomplish this, a simple laboratory continuous flow sediment and water system was designed to simulate a portion of the sediment-water interface. The data revealed that the rate of mineralization of particulate organic ^{32}P was much slower than previously suggested in the literature. It was also shown that the capacity of the sediment to sorb phosphorus, as well as the redox condition in the overlying water, affected to a lesser extent the interchange of ^{32}P to the overlying water. The rate of degradation of the algal particulate organic ^{32}P was apparently the major rate controlling step in governing the release of ^{32}P to the overlying water. (NSA)

Wheeler, M. L. and J. L. Warren. 1975. Tritium Containment After Burial of Contaminated Solid Waste. Trans. Amer. Nucl. Soc. 22:741.

Los Alamos has a semiarid climate, with potential evapotranspiration equaling or exceeding precipitation. As a result of the dry climate and the relative impermeability of the tuff, little moisture penetrates below a depth of a few meters. Numerous studies have indicated that, with the exception of tritium, no migration of radionuclides is occurring away from the disposal sites. Tritium has a relatively short half-life of 12.3 yr, and acceptable concentrations of tritium in air and water are considerably higher than for other radionuclides of environmental concern. However, tritium is very mobile in biological systems, and there is a legitimate need to minimize the quantities of tritium entering the environment.

Tritium concentrations in the samples varies from 160 to 180,000 pCi/cm^3, with the highest values occurring closest to the disposal shafts. The distribution of tritium indicated that tritium was migrating into the tuff surrounding both asphalted shafts. The migration was occurring more rapidly in directions coincident with major joint orientations in the tuff at the disposal site. Tritium concentrations in the tuff surrounding the asphalted shafts were compared with those surrounding shafts where no asphalt was employed. The comparison indicated that the asphalt containment techniques, as they were employed in the past, did not significantly reduce the migration of tritium out of the disposal shafts. (auth)

Whicker, F. W., C. A. Little and T. F. Winsor. 1974. Plutonium Behavior in the Terrestrial Environs of the Rocky Flats Installation. Environmental Surveillance Around Nuclear Installations. IAEA, Vienna. Vol. II. pp. 89-103.

Dow chemical Corporation's Rocky Flats installation, located between Denver and Boulder, Colorado, processes large quantities of plutonium for the USAEC. Storage barrel leakage was a major incident, which resulted in detectable plutonium contamination of air, soil, and biota within and around the plant boundaries. Commerical and residential land development is rapidly approaching the plant from several directions, and this, coupled with increased public concern over environmental contamination, led to considerable controversy concerning radiation protection guidelines, such as permissible levels of ^{239}Pu in soil for various clases of land use. Radioecological studies designed to elucidate existing patterns of plutonium concentration in terrestrial ecosystems surrounding the plant and to define transport pathways, mechanisms, and appropriate intercompartmental rate constants are being initiated by the Department of Radiology and Radiation Biology at Colorado State University under support from the Division of Biomedical and Environmental Research, USAEC. Intensive sampling of soil, litter, vegetation, arthropods, small and large wild mammals, reptiles, and amphibians is being conducted for ^{239,240}Pu assay within an area known to be contaminated, and also within a relatively uncontaminated control area nearby. Ancillary field and laboratory experiments are being planned and conducted to isolate the relative importance of transport pathways and to provide quantitative evaluations of plutonium intake and loss rates by specific biotic and abiotic compartments. From such information, an ecosystem model of plutonium surveillance programs to achieve maximum information per unit effort. The research approach, findings to date, and methods of plutonium surveillance in terrestrial ecosystems are discussed. (auth)

Whicker, F. W., C. A. Little and T. F. Winsor. 1973. Plutonium Behavior in the Terrestrial Environs of the Rocky Flats Installation. COO-1156-68.

Pu behavior in the terrestrial environs of the Rocky Flats Plant located between Denver and Boulder, Colorado was investigated by: defining the major components of the terrestrial ecosystem adjacent to Rocky Flats; measuring plutonium in such components in order to quantify plutonium "compartments;" determining intercompartmental transport pathways, mechanisms, and rates; and developing a quantitative model which can be used for conceptual and possible predictive purposes. The Rocky Flats environs are described, plutonium data gathered to date are summarized, and methods of plutonium surveillance in terrestrial ecosystems are discussed. From the results obtained, it is concluded that soil constitutes the principal Pu reservoir in the terrestrial environs of Rocky Flats, and that although Pu is detectable in all environmental sample material assayed, there is, at present, no evidence of significant biological concentration mechanisms. Further experimental studies are recommended. (NSA)

White, A. and E. F. Gloyna. 1969. Radioactivity Transport in Water: Mathematical Simulation. ORO-490-19.

A mathematical model has been developed for routing a radionuclide through a model river system. The capabilities of this simulation model include the following characteristics: it distributes radionuclide activity by advective and dispersional mechanisms along the longitudinal axis of the system; it may be discretized into any number of segments (vertical planes normal to the longitudinal axis) as may be appropriate to describe spatial variations in radionuclide activity; it is capable of treating instantaneous, continuous, or time-varying releases of radionuclide activity; it provides for a temporal description of radionuclide activity throughout the system; and it provides for sorption and desorption by both plants and bottom sediments. (auth)

White, M. G. and P. B. Dunaway. 1974. Nevada Applied Ecology Group Environmental Studies of Plutonium. WASH-1332. 2:931-947.

The plutonium program of the Nevada Applied Ecology Group is conducted on the Nevada Test Site (NTS), Tonopah Test Range (TTR), and surrounding areas. Objectives of this relatively comprehensive ecological program are to (1) delineate locations of plutonium contamination, (2) determine concentrations in ecosystem components, (3) quantify rates of movement among those components, (4) evaluate radiological hazards of plutonium in organisms, (5) identify areas that need to be cleaned up or treated, and (6) develop techniques for cleanup or treatment. Results indicate that measurable concentrations of plutonium are not being moved now by resuspension of NTS or TTR, but that resuspended plutonium is present in areas close in to "ground zeros." Plutonium concentrations in undisturbed soil decrease with depth, but plutonium is not uniformly distributed in the particle-size fractions within soil samples. At present, and for several hundred years, ^{241}Am may be of more concern than ^{239}Pu. Relatively uniform concentrations of ^{239}Pu and ^{241}Am were found for each plant species, but considerable variation in concentrations was found among species. Field populations of microorganisms varied considerably from site to site. Plutonium in Aspergillus spores was about one-fourth that in a growth medium. Addition of bile and changes in pH in an artificial digestive tract caused sharp rises in solubility of plutonium nitrate, citrate, and dioxide. Plutonium levels in tissues of small mammals residing on contaminated areas were only two orders of magnitude less than concentrations in their gastrointestinal tracts and pelts. Transfers of plutonium to cattle tissues varied according to form of plutonium and mode of administration. Preliminary results from a comprehensive model indicate that some areas on NTS would have to be cleaned up or treated before constant habitation by people could be permitted. (auth)

White, M. G. and P. B. Dunaway, (eds.). 1975. The Radioecology of Plutonium and Other Transuranics in Desert Environments. Nevada Applied Ecology Group Progress Report as of January 1975. NVO-153.

A progress review of the applied ecology group that includes reports of results since 1974 (NVO-142) under the headings of soils, vegetation, large vertebrates, small vertebrates, microorganisms, resuspension, distribution and inventory, decontamination procedures, statistics and support activities. Nevada Applied Ecology Group is currently preparing a handbook of methods.

Whitehead, N. L., R. R. Brooks and G. E. Coote. 1971. Gamma Radiation of Some Plants and Soils from a Uraniferous Area in New Zealand, N. Z. J. Sci. 14:66-76.

The amounts of several γ-emitters in plants (Weinmannia racemosa, kamahi; Nothofagus fusca, red beech; Coprosma australis; Quintinia aculifolia; Blechnum procerum, fern; Marchania berteroana, liverwort; Unicinia leptostachya, sedge; Fissidens rigidulus and Bryum blandum, aquatic bryophytes; and Stereocaulon ramulosum, a lichen) growing on a uraninite vein and associated soils from a uraniferous area were determined by γ-spectrometry with the use of a Ge detector operating in the low energy region. The following isotopes were absorbed by plants: ^{210}Pb, ^{227}Ac, ^{238}U, ^{235}U, and ^{226}Ra. The average plant/soil ratios (dry weight) were 0.092, 0.170, 0.197, and 0.815, respectively. The contribution of each radionuclide and its daughters to the activity of the plant samples were 2.2, 3.3, 81.5, 1.9, and 10.4 percent, respectively. The remainder, 0.7 percent, was due to ^{228}Th and its daughters. Th isotopes were absorbed by a fern and a liverwort. Cesium-141 and ^{144}Ce from fallout were found in leaf tissue. (CA)

Whitehead, N. E., R. R. Brooks and P. J. Peterson. 1971. Nature of Uranium Occurrence in the Leaves of Coprosma Australis (A Rich.) Robinson. Aust. J. Biol. Science. 24:67-73.

The distribution and chemical form of uranium was investigated in leaves collected from plants of C. australis (Rutiacace) growing in a mineralized soil in the fuller Gorge, New Zealand. Only small amounts of uranium (<10% were found in a low molecular weight form. The predominant occurrence of uranium (65%) was as a uranium - RNA complex, which was isolated by high-voltage electrophoresis from an aqueous extract of the freeze-dried leaves. Uranium (25%) was released from the solvent extracted leaf residue by pepsin, thus revealing the presence of a uranium-protein complex. However, in view of the known dissociation constants for these two complexes, and other tests, it is clear that the majority of the uranium in vivo is in the form of a uranium-protein complex. This finding is confirmed by a differential centrifugation experiment, in which it was shown that at least 50% of the total uranium was bound to cell proteins. (auth)

Whitman, A. and R. G. Beverly. 1958. Radium Balance in the Monticello Acid R.I.P. Uranium Mill. WIN-113.

A study of radium distribution through the Monticello Acid Resin-in-Pulp plant is presented. Emphasis is placed on the flow of radium through the process in an effort to determine the effect of the uranium treatment process on the dissolution and the ultimate disposition of radium. (auth)

Whitman, A. and E. S. Porter. 1958. Chemical Stream Pollution from Uranium Mills. WIN-99.

The utilization of chemical processes for extraction of uranium from its ores has introduced the problem of pollution of receiving waters by uranium mill tailings. Those states concerned with production of uranium concentrates provide for control of stream pollution by rather flexible statutes which generally do not indicate permissible chemical concentrations for disposal. The state of Utah, however, limits stream pollution by provisions derived from Federal water quality regulations, which are specific with regard to the concentrations of many metal ions and salts allowable in a stream receiving chemical wastes. Limiting concentrations have thus been specified by Utah on the basis of health, taste, appearance, and danger to livestock, plants, and aquatic life.

Material balances were calculated for hypothetical mills for each of the major chemical processes used in uranium ore processing. These balances were made to indicate the nature and extent of possible contamination of rivers and streams by the domestic uranium mills. Where available, actual mill effluent and stream samples were analyzed both as a confirmation of the calculated values, and as an indication of those elements for which no estimate could be made.

These calculated and actual analyses indicated probable contamination by manganese, nitrate, sulfate, dissolved solids, and magnesium. However, manganese would be a problem only if it were introduced as an oxidant for leaching and, furthermore, is primarily restricted for taste and esthetic reasons rather than for health. The manganese specification is included in a combined limit on total iron plus manganese, but practically no iron was found in solution at a pH of 7.0. Nitrate is a serious problem for health reasons in those cases in which nitrate is used as a reagent, especially as an ion exchange resin eluant.

The results of laboratory tests on a mixed acid-alkaline tails solution indicated that manganese and magnesium concentrations may be reduced to specification levels by raising the pH of the solution to 10 with hydrated lime. No practical procedure, other than process change, has been found for nitrate removal.

A calculation of stream flows required to provide sufficient dilution for specification tailings disposal indicated that some mills might be able to discharge directly into large rivers. Mills located on lesser rivers can meet specifications in some cases by addition of calcium hydroxide to the tailings before they overflow from the pond. (auth)

Wilding. M. W. and D. W. Rhodes. 1963. Removal of Radioisotopes from Solution by Earth Materials from Eastern Idaho. IDO-14624.

Naturally occurring earth materials from Idaho, many of which were from localities near the National Reactor Testing Station (NRTS), were used in laboratory tests to determine the most likely candidates for decontaminating low-level radioactive wastes at the NRTS. It was concluded that the material containing a high content of clinoptilolite was the most promising candidate for the following reasons: (1) excellent physical and chemical stability, (2) a cation exchange capacity of about 0.3 milliequivalent per gram, (3) ability to remove radioisotopes from solution over a wide pH range, and (4) the ready availability of thousands of tons of the raw material at a location near the NRTS. This conclusion was based on the results of column breakthrough experiments and batch equilibrium-type tests. The distribution coefficients of this material for cesium and strontium were determined to be greater than 1000 at favorable pH values.

A brief study of the effect of complexing agents on the reaction of radioisotopes with the earth materials indicated that citrate depressed the adsorption of ruthenium markedly and that EDTA depressed the adsorption of strontium, cobalt, and ruthenium more than the adsorption of cerium and chromium. (auth)

Wilding, M. W. and D. W. Rhodes. 1976. Removal of Cesium and Strontium from Fuel Storage Basin Water. IN: M. H. Campbell (ed.). High-Level Radioactive Waste Management. Advances in Chemistry Series--153. pp. 134-151.

Spent fuel from nuclear reactors is stored underwater at the Idaho Chemical Processing Plant for cooling and shielding before processing. The fuel storage basin water becomes contaminated with fission products, primarily ^{137}Cs and ^{90}Sr, from fuel elements that "leak" and from cut pieces of fuel and miscellaneous scrap contained in cans, which are vented to release gases. This report describes laboratory research and plant-scale tests of candidate ion-exchange materials for removing ^{137}Cs and ^{90}Sr from the contaminated storage basin water, which contains moderate quantities of nonradioactive dissolved solids. Cesium-137 is removed by a zeolitic ion-exchange material; ^{90}Sr is removed by an organic ion-exchange resin. Operational experience with plant-size ion-exchange columns indicate that both ^{137}Cs and ^{90}Sr are removed effectively by ion exchange. (auth)

Wildung, R. E., D. A. Cataldo and T. R. Garland. 1975. Accumulation of Technetium from Soil by Plants. I. Uptake of Technetium from Soil by Plants. BNWL-2000, pt. 2, pp. 37-42.

Soybean and wheat plants were grown in pots containing a Ritzville silt loam amended with ^{99}Tc as pertechnetate ranging from 0.01 to 5 μg/g soil. Controls also were grown. Plants were harvested 30 days after emergence. Tc markedly reduced plant yields at concentration levels above 0.1 μg/g soil. Tc was readily taken up and concentrated in the aerial portion of the bean-plant. The wheat did not emerge at Tc soil levels of 1 and 5 μg/g. Up to 640 μg/g of stem was concentrated by the soybean at a soil level of 5 μg/g.

Wildung, R. E., H. Drucker, and F. H. F. Au. 1976. The Relationship of Microbial Processes to the Fate of Transuranic Elements in Soil. IN: M. G. White and P. B. Dunaway (eds.). The Dynamics of Tranuranics in Terrestrial and Aquatic Environments. NVO-178.

This review considers the influence of soil physiochemical and microbial processes on the long-term solubility, form, and plant availability of plutonium and other transuranic elements important in the nuclear fuel cycle. Emphasis is placed on delineation of the relationships between soil chemical and microbial processes and the role of soil microorganisms in effecting solubilization and transformation of elements considered largely insoluble in soils strictly on the basis of their inorganic chemical characteristics.

Soluble, diffusible Pu in soils (usually less than 0.1% of total) appears to be largely present as particulates of hydrated oxide, but several lines of evidence suggest that microorganisms may influence the solubility of Pu and that the nonparticulate plant-available fraction is stabilized in solution by inorganic or organic ligands of limited concentration in soil. The role of soil microorganisms in influencing the solubility, form and plant-availability of the transuranics is discussed on the basis of the (1) known chemistry of organic ligands in soils, (2) effects on the soil microflora, and (3) principal microbial transformation mechanisms, including direct alteration (valence state, alkylation), indirect alteration (metabolite interactions, influence on the physiochemical environment), and cycling processes (biological uptake and release on decomposition of tissue).

The toxicity of Pu to microorganisms depends on Pu solubility in soil. However, soil microorganisms are generally resistant to Pu, with toxicity apparently due to radiation rather than chemical effects. Highly resistant bacteria, fungi, and actinomycetes have been isolated from soil, and these organisms have been shown to be capable of transporting Pu into the cell and altering its form in the cell and in solution. The resulting soluble Pu complexes tend to be of higher molecular weight than simple complexes (Pu-DTPA) and negatively charged. The form of Pu, although not well-defined, is dependent upon organism type, carbon source, and time of Pu exposure during growth. These factors, in turn, are a function of Pu source, soil properties, and soil environmental conditions. Knowledge of the relative influence of these factors serves as a valuable basis for predicting the long-term behavior of Pu and other transuranic elements in the terrestrial environment. (auth)

Wildung, R. E. and T. R. Garland. 1973. Influence of Soil Microbial Activity on the Uptake and Distribution of Plutonium in the Shoots and Roots of Barley. BNWL-1850, Pt. 2, pp. 22-25.

Barley plants, cultured by a split root technique, showed increased Pu in barley shoots with decreased soil Pu concentration (μCi Pu/g of tissue/μCi Pu/g of soil). Past data on Pu uptake by plants at high Pu soil concentrations may not therefore be applicable to low Pu environmental conditions. (auth)

Wildung, R. E. and T. R. Garland. 1974. Relative Solubility of Inorganic and Complexed Forms of ^{238}Pu and ^{239}Pu in Soil. BNWL-1950, Pt. 2, pp. 23-25.

Plutonium was added to the soil as nitrate and DTPA complexes amended with starch, nitrogen and water. Pu nitrates were only 0.05 to 5% soluble. Pu DTA complexes were 100% water soluble for the first 40 days. The ^{238}Pu DTA complex became somewhat less soluble after 40 days. (auth)

Wildung, R. E. and T. R. Garland. 1977. The Relationship of Microbial Processes to the Fate and Behavior of Transuranic Elements in Soils and Plants. IN: The Transuranium Elements in the Environment. W. C. Hanson (ed.).

This review considers the influence of soil physicochemical and microbial processes on the long-term solubility, form, and bioavailability of plutonium and other transuranic elements important in the nuclear fuel cycle. Emphasis is placed on delineation of the relationships between soil chemical and microbial processes and the role of soil microorganisms in effecting solubilization, tranformation and plant/animal uptake of elements considered largely insoluble in soils strictly on the basis of their inorganic chemical characteristics.

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Preliminary studies indicate that Pu present in solution as an organic complex is readily assimilated by the plant. Evidence to data indicates that organometal complexes serve mainly to deliver the metal to the root membrane, and the ligands are not taken up by the plant stoichiometrically with the metal. After passing the root membrane, Pu is transported to the shoots in the xylem through formation of a number of complexes with plant ligands. The form of Pu differs in leaves and stems, but greater than 90% was not present as the ionic Pu(IV) originally added to soil on which the plants were grown. A reevaluation of plant-to-animal transfer coefficients may be required as Pu incorporated in plant tissues is markedly more available to animals than Pu(IV) gavaged. Differences in gastrointestinal transfer of Pu in stems and leaves of alfalfa are related to differences in Pu solubility in these tissues. Thus, the form of Pu in soils and plants may be closely related to Pu availability to animals.

Although information leading to an understanding of the complex interrelationships that exist between soils, plants and animals is rapidly developing, these phenomena are not sufficiently understood, at present, to be described by simple models. (auth)

Wildung, R. E., T. R. Garland, and D. A. Cataldo. 1975. Accumulation of Technetium from Soil by Plants: A Potential Mechanism for Uptake and Toxicity. BNWL-SA-5393.

The isotope ^{99}Tc (T 1/2, 2.15 x 10^5 years) is produced by the spontaneous fission of ^{238}U in nature and by the slow neutron fission of ^{238}U in nuclear reactors. In the latter case, the potential exists for Tc entrance into the environment in emissions from nuclear reactors, nuclear fuel reprocessing plants, and other facilities which use Tc for commercial purposes. Results are reported from studies on Tc uptake by plants. The most stable chemical species of Tc in aqueous solution is the pertechnetate ion (TcO_4^{-1}), and it is this form which is most likely to enter surface soils. Recent studies indicated that at least over the short term, pertechnetate is soluble and highly mobile in most soils and is sorbed in significant quantities only in high organic matter, low pH soils. Plant availability normally increases with increased ion solubility in soil provided the ion is not discriminated against at the plant root level. Furthermore, the aqueous chemistry of pertechnetate is similar in several respects to permanganate and molybdate, compounds of elements essential in plant nutrition. Experiments were undertaken to determine the uptake and distribution of Tc in plants as a function of time using soybeans (Glycine max) and ^{99}Tc as a tracer. (NSA)

Wildung, R. E., T. R. Garland and H. Drucker. 1973. Potential Role of the Soil Microbiota in the Solubilization of Plutonium in Soil. BNWL-1850, Pt. 2, pp. 21-22.

Sterile and nonsterile soils were inoculated with 10 µCi/g Pu(IV) nitrate and incubated for 30 days. A liter of water was used to leach a gram of soil for four hours with filtration through 5, 0.5 and 0.01µm millipore filters. The 0.01 and 0.5 µm material were considered to be solubilized. Results suggested that the solubility of Pu in soil is influenced by soil microflora. (auth)

Wildung, R. E., R. C. Routson, T. R. Garland, and A. V. Robinson. 1974. Sampling and Characterization of Surface Soils for Pu Studies. BNWL-1850, Pt. 2, pp. 23.

Ecosystems has 35 soils on which they will measure particle size; primary and secondary minerals verses size; CEC, $CaCO_3$; Percent OC ash; FeAl amorphous; and water-holding capacity.

Wildung, R. E., R. C. Routson, and R. L. Schmidt. 1977. Seasonal Changes in Particle Size Distribution, Composition and Strontium Exchange Capacity of a Particulate Matter Suspended in the Columbia River. BNWL-1638.

A centrifugation method was employed to fractionate, according to equivalent spherical diameter, particulate matter suspended in the Columbia River during November, February, April, June and August. The isolated size fractions were characterized as to particle size distribution, carbon content, predominant primary and secondary minerals and strontium exchange capacity. The results were related to watershed characteristics and seasonal changes in river conditions. Relative to other seasons, the concentration of suspended matter increased markedly (over 100 fold) during the spring freshet. This increase was accompanied by a change in particle size distribution with the clay size fraction ($<2.0\ \mu$) accounting for approximately 63% of total solids compared to a range from 14 to 30% for other peiods of the year. Of the total suspended sediment load in the spring 24% and 8% occurred in the <0.5 and $<0.2\ \mu$ fractions, respectively. Primary minerals inherited from parent rocks (quartz, feldspar and amphibole) and the layer silicate mineral species (mica-illite, chlorite and montmorillonite) were generally present in particulate matter isolated throughout the year. Whereas seasonal changes in the primary mineral composition were not pronounced, the relative concentrations of the layer silicate minerals commonly present in soils increased during spring and summer corresponding to the periods of spring runoff and the return of irrigation water to the river. Mineral composition also differed between size fractions. Montmorillonite, a layer silicate mineral of comparatively high ion exchange capacity increased in relative abundance with decreased particle size. The Sr exchange capacity of materials isolated in the spring increased with decreased particle size ranging from 11.5 to 93.9 me./100g for the $>2.0\ \mu$ and $<0.2\ \mu$ fractions, respectively. likely reflecting relative differences in mineral type as well as increased reactive surface area. Increases in suspended particulate concentration due to spring runoff and the return of irrigation waters results in a large capacity for cation sorption and transport during the spring and summer months. In fact, the Sr exchange capacity of particulate matter in equivalent volumes of river water amounted to from 6 to 26 times higher in the spring than during other periods of the year. (auth)

Wildung, R. E., R. C. Routson, R. J. Serne, and T. R. Garland. 1975. Pertechnetate, Iodide and Methyl Iodide Retention by Surface Soils. BNWL-1950, Pt. 2, pp. 37-40.

A total of 22 soil types were characterized and used in batch equilibrium studies with ^{99}Tc as pertechnetate, ^{131}I as I^- and methyl iodide. Correlation coefficients significant at the 1% confidence level, and relating soil properties to K_d values, were found between organic carbon and ^{99}Tc and methyliodide K_d values, and cation exchange capacity and methyliodide K_d. At the 5% confidence level were silt percent and iodide K_d, clay percent, pH and methyl iodide K_d and cation exchange capacity, pH and ^{99}Tc K_d.

Williams, C. and G. Brown. 1971. Uranium Content of Peaty Soils Rich in Molybdenum and Selenium from Co. Limerick, Eire. Geoderma. 6:223-5.

Peaty soils from Kilcolman, Co. Limerick previously shown to contain anomalously large amounts of selenium and molybdenum contain up to 550 ppm uranium and 150 ppm bromine. The uranium probably derives from the Clare Shales and is likely to have been concentrated on the peat from drainage waters. (auth)

Willkomm, H. and H. Erlenkeuser. 1972. ^{14}C Measurements on Water, Plants and Sediments of Lakes. IN: Proceedings of the Eighth International Radiocarbon Dating Conference. Vol. 1. Rafter, T. A. (comp.). Wellington, New Zealand. pp. D1-D112.

The hard water effect of 22 lakes lies between 0 and 1600 y. It is shown by measuring recent samples marked by the atomic bomb effect that the ^{14}C activity of aqueous plants is in equilibrium to water activity, and that a delay time of a few years lies between atmosphere and water and between water and surface sediment. In volcanic regions, the hard water effect is enlarged by magmatic CO_2. A correlation to δC^{13} values found in old sediments could not be confirmed by measurement of recent aqueous plants. (auth)

Wilson, D. O. and J. F. Cline. 1966. Removal of Plutonium 239, Tungsten-185 and Lead-210 from Soils. Nature. 209:941-942.

The authors confirmed that only small amounts of ^{239}Pu were translocated from the sediments to plant leaves during plant growth. Leaf to soil ratios of ^{239}Pu were about 0.001 on the average for barley grown on Milville silt loam, Cinebar silt loam and Ephrata fine sandy loam. (auth)

Wilson, D. W., N. C. Yook, and W. L. Robison. 1975. Evaluation of Plutonium at Enewetak Atoll. Health Physics. 29:599-611.

An extensive survey was carried out in 1972-1973 to assess the current radiological status of Enewetak Atoll. The radionuclides detected in the Atoll environment were studied for their potential contributions to the dose commitment of the returning population according to several pathways of exposure. Plutonium was detected in air and in the terrestrial and aquatic environment at concentrations that varied from background levels due to worldwide fallout to levels several orders-of-magnitude above. The dose commitments from plutonium via the terrestrial food chain and inhalation vary according to the postulated living pattern. The dosages via marine foods can be expected to be insensitive to living pattern and to exceed those via terrestrial foods. Plutonium would contribute nearly all of the dosage via inhalation, but this pathway ranks low in overall importance compared with the food-chain and external-dose pathways. Although the potential dose from plutonium via all pathways in low relative to that from ^{60}Co, ^{90}Sr, and ^{137}Cs, plutonium will still remain in the Atoll environment after the other major isotopes have decayed away. (auth)

Windham, S. T. and C. R. Phillips. 1973. Radiological Survey of New London Harbor, Thames River, Conn., and Environs. Radiat. Data Rep. 14:659-666.

In July 1972, the Eastern Environmental Radiation Facility, in cooperation with the U.S. Naval Ship Systems Command, conducted a radiological survey of the New London Harbor, Thames River and environs to determine if nuclear ship activity in that area has contributed radioactivity which could result in detectable radiation exposure to the public. Comparison with a similar survey conducted in 1965 shows that ^{60}Co activity levels in sediment have decreased by an average factor of 33 due to a reduction in the amount of radioactivity discharged, radioactive decay, and natural sedimentation. Analysis of samples indicative of direct pathways for human exposure leads to the conclusion that no significant radiation exposure to the public has resulted from nuclear ship operation in the area. It is concluded that the environmental surveillance routinely conducted by the Navy should be adequate to assure protection of the public from the routine nuclear ship operations. (auth)

Winkler, R. 1962. The Suitability of Peat for the Purification of Radioactive Waste Solutions. II. The Adsorption of Zirconium and Ruthenium Compounds on Peat. Isotopentechnik. 2:50-5 (in German).

The adsorption of hydrolysis products of zirconium oxynitrates and of trinitratenitrosyl ruthenium on peat were investigated as functions of the contact time, pH value, quantity of solution, and sodium nitrate concentration. A significant superiority of the clay with respect to cation exchange resins was found. Ruthenium can be completely adsorbed from 0.005 M solution at pH 3 to 4 and zirconium from 0.04 M solution at pH > 3. It was shown that the hydroxides of the elements studied are present in colloidal distribution at these pH values. The colloids were adsorbed well on the porous extensive surface of the peat, whereas they cannot penetrate into the fine pores of the exchange resin. (auth)

Winkler, R. and J. Gens. 1961. The Suitability of Peat for the Purification of Radioactive Wastes. I. Peat as Cation Exchanger. Isotopentechnik. 1:246-7 (in German).

Studies of the exchange of Cs^+, Sr^{2+}, and Ce^{3+} on peat under static and dynamic conditions were continued. In this section, the consequences of the experimental results are discussed. (NSA)

Winograd, I. J. 1974. Radioactive Waste Storage in the Arid Zone. EOS, Transactions of the American Geophysical Union. 55:884-894.

The assets and liabilities for the use of thick unsaturated zones as repositories for solidified high level wastes are discussed. Comparisons are made to high level waste disposal in bedded salt deposits and deep caverns.

The advantages of unsaturated zone storage include the potential for radionuclide removal represented by arid zone soils and sediments.

Wiseman, J. D. H. 1949. Geology on the Deep-Sea Floor. Nature. 164:682-4.

The six papers given before the geological section on problems concerning the deep-sea floor at a recent meeting of the British Association at Newcastle upon Tyne are discussed and some relevant information and comments added. The papers discussed included "The Chronology of the Ocean Floor" by H. Pettersson (Nature 164, 468(1949)) and one by the author on manganese nodules found on the surface of the deep-sea floor of the Arabian basin. These nodules are associated with red clay and are largely composed of manganese, iron, and water and contain, in addition, unusual amounts of nickel, copper, cobalt, barium, and radium. Definite confirmation about the fragmentation of spherical nodules and the deposition at a later date of a secondary manganese layer is given by the distribution of radium in tetrahedral nodules. The radium content of the secondary peripheral layer is practically constant (11×10^{-12} g/g), while immediately below this layer the content is much lower (0.9×10^{-12} g/g), and toward the center no radium could be detected. It is clear from these determinations that the original nodule was spherical and increasing radium content toward the periphery, and that it afterwards broke into tetrahedral masses, around which a secondary layer of manganese material was deposited. The Pettersson paper dealt with the methods used for correlation in deep-sea cores; first the radioactive method, second the mineralogical method, third the pollen analysis method, and fourth the biological method. The significance of the high content of radium in seawater, which has been noted in his article in Nature, is discussed. (NSA)

Wollenburg, H. 1972. Fission Track Radiography of Uranium and Thorium in Radioactive Minerals. RSO-228.

The fission track method is a quick, relatively simple, and inexpensive technique to determine the location and abundance of U, and in some cases Th, in thin or polished sections of rocks. Thermal n induce fission in ^{235}U, while ^{232}Th and ^{238}U fission with fast-n bombardment. Therefore, sections with appropriate track detectors are exposed first to thermal n to induce only U, then to fast n for U plus Th. The detectors are etched to reveal the tracks caused by passage of massively charged fission fragments. High quality muscovite mica is the preferable track detector for minerals with U concentrations > 10 to 15 ppm, mainly because tracks in mica are easy to recognize. Polycarbonate plastic (Lexan or Makrofol) is preferred as a track detector for low concentrations of U and Th because this material contains essentially no inherent U, therefore, it has no background tracked. Th is determined successfully if the Th/U ratio of the mineral is sufficiently large. Relative errors (from counting statistics) in Th are <25% if Th/U is >3, for ratios <3 the errors increase rapidly and exceed 40-50% of Th/U is <1. (CA)

Wollenberg, H. A. and J. Fitzpatrick. 1975. Status of the Geodose Project. LBL-3646.

The evaluation of the impact of man upon the natural gamma-radiation environment requires a clear understanding of the distribution and abundance of the natural radioelements in rocks and soils. The GEODOSE Project is an attempt to characterize rock and soil types by their natural gamma-ray exposure rates. The world's geochemical literature is being searched for data on K, U, and Th contents of earth materials, and these data are categorized by rock type, based on standard petrologic classifications. A data bank is being assembled, presently incorporating radioelement information on the igneous rocks. The data are treated to produce computer plots of histograms of K, U, Th contents, calculated gamma-ray exposure rates, and radiogenic heat production for given rock types. (auth)

Wong, K. M. 1971. Radiochemical Determination of Plutonium in Seawater, Sediments and Marine Organisms. Anal. Chim. Acta. 56:355-364.

A radiochemical procedure is described for the determination of plutonium in large samples of seawater, sediments and organisms with a sensitivity of 0.004 dpm per 100 liters of seawater (for a 50-liter sample), 0.02 dpm per kg of sediments (100-g sample) and 0.002 dpm per kg of marine organisms (1-kg sample). An iron (II) hydroxide coprecipitation method is used for the concentration of plutonium in seawater. A nitric-hydrochloric acid leaching method is adapted for the treatment of sediments and ashed organisms. Factors influencing the recovery, contamination and blank activity are discussed. (auth)

Wong, K. M., J. C. Burke, and V. T. Bowen. 1971. Plutonium Concentration in Organisms of the Atlantic Ocean. IN: Proceedings, 5th Annual Health Physics Soc. Midyear Topical Symposium: Health Physics Aspects of Nuclear Facility Siting. 2:529-539.

A series of marine organisms, collected about Cape Cod or in the open north Atlantic Ocean, have been analyzed for plutonium 239 and for other fallout radionuclides. These data are compared with those from analyses of marine aerosols, sediments and seawater. The results show that ^{239}Pu has been concentrated in some tissues of each organism so far examined. In fish ^{239}Pu concentrations range from 0.2 to 140 dpm per 100 kg; fresh weight in benthic invertebrates from 23 to 140 dpm per 100 kg; in plankton from 130 to 340 and, in Sargasso week, to 1280 dpm per 100 kg. Plutonium-239 ratios to ^{90}Sr or ^{137}Ce are higher in organisms that are in their environment. (auth)

Wong, K. M., V. F. Hodge, and T. R. Polson. 1972. Plutonium and Polonium Inside Giant Brown Algae. Nature. 237:460-2.

Certain marine algae accumulate Pu so effectively that they might be used to detect small concentration changes of the element in seawater, where direct determination would be difficult. In a survey made in 1971, near a coastal power reactor after reported accidental burnup of fuel rods carrying 17,000 Ci of ^{238}Pu, Pu and other nuclides were compared in various types of algae, and large accumulations were found in several species; concentrations, however, ranged widely within species and suggested a correlation between activity and surface area. Attention was turned to comparing different tissues of one giant brown algae, Pelagophycus porra. Samples dissected for Pu analysis by alpha spectrometry were also analyzed for ^{210}Po; it was hoped that the distribution of ^{210}Po might serve as a model for predicting distributions of the less easily analyzed ^{239}Pu and certain other heavy metals. Concentrations of ^{210}Po varied significantly between different parts of the plant, and even between different sections of the same part, but were always much higher in the outermost layers; this also applied to ^{239}Pu concentrations, but to a lesser degree. Another finding was that for comparison of two different environments it is not sufficient merely to sample a given species, but identical sample tissue must be compared. (NSA)

Wong, K. M., V. E. Noshkin, L. Suprenant, and V. T. Bowen. 1970. Plutonium-239 in Some Marine Organisms and Sediments. HASL-227. pp. I-25-I-33.

Sediments may show concentration factors over contacting seawater for Pu of 10^4 or greater. Fish mussels and clams collected from various parts of the world's oceans showed lesser Pu concentration factors with bottom feeders among the higher values. (auth)

Wrenn, M. E. 1974. Environmental Levels of Plutonium and the Transplutonium Elements. WASH-1359. pp. 89-112.

The major transuranic activity in the environment is composed of ^{239}Pu, ^{240}Pu, and ^{241}Am from weapons testing, and ^{238}Pu from the SNAP-9A burnup in 1964. This material is detectable in surface soils around the world, although their presence raises the α background in surface soils generally less than 1%. The Pu and Am activity per gram near the surface will decrease slowly with time. Local sources of Pu, although much smaller in quantity than that from globally distributed weapons testing fallout, can result in concentrations of Pu in soil exceeding the concentrations of the global level from weapons testing. (auth)

Wrenn, M. E., S. M. Jinks, N. Cohen, and L. M. Hairr. 1974. ^{137}Cs and ^{134}Cs Distribution in Sediment, Water, and Biota of the Lower Hudson River and Their Dosimetric Implications for Man. CONF-730907, pp. 279-284.

Since 1964, the magnitudes and distributions of natural, fallout, and reactor-produced radionuclides present in the lower Hudson River Estuary have been under study. Concentrations of the major radionuclides released to the estuary in liquid waste from a pressurized light water reactor have been measured in samples of water, sediment, and biota. These measurements have been combined with information related to site characteristics and human use of the environment to obtain estimates of the magnitudes and pathways of human radiation exposure from routine power reactor operation. At present ^{137}Cs and ^{134}Cs are the critical radionuclides in the lower estuary, and consumption of fish is the most important route of exposure for man. Based on measurements to date, releases from a PWR of 20 Ci/yr each of ^{137}Cs and ^{134}Cs would result in an annual total-body dose to an avid local fish eater of about 0.2 mrem/year. (auth)

Wrenn, M. E., J. W. Lentsch, M. Eisenbud, G. J. Lauer, and G. P. Howells. 1971. Radiocesium Distribution in Water, Sediment and Biota in Hudson River Estuary from 1964 Through 1970. CONF-710501-P1, pp. 334-343.

The spatial and temporal distribution of ^{137}Cs and ^{134}Cs was measured in fish, plants, water, and sediments of the Hudson River Estuary along an 80-mile stretch of the river, encompassing salinities from one-fifth seawater to fresh water, in order to better understand the cycling of this radionuclide in an estuarine environment. Since the major route of exposure to man in this environment is through consumption of fish, a model was developed to predict the average amount in fish, which depends upon the average concentration of radiocesium in water and in sediments. Although the ^{137}Cs content of Hudson River water has dropped tenfold since 1964, the average content in fish and sediments has remained relatively constant. This implies that the ^{137}Cs content of fish resident in the river has depended primarily on the cumulative deposit in the sediments. The major source of this ^{137}Cs has been fallout, although in a limited section of the river an elevation of ^{137}Cs in sediments from the Indian Point nuclear plant can be seen. In order of decreasing content, ^{137}Cs was found in sediments, aquatic plants, and fish, roughly in the ratios of 30:1:1. The average content of radiocesium in fish has shown strikingly little variation from year to year, from a minimum of 20 pCi/kg in 1967 to a maximum of 56 in 1969. Cesium-137 was measured in 16 species of fish and is generally an order of magnitude lower than ^{137}Cs content of fish from lakes at this latitude. In relative terms, the highest concentrations of ^{137}Cs are found in the bottom feeding species such as catfish and suckers, intermediate levels in plant-eating species such as killifsh, and lowest levels in anadromous fish such as shad. Aside from the anadromous fish, the range of variability is about a factor of 3. (auth)

Wright, T. D. and J. Monahan. 1958. Optimum Conditions for the Use of Vermiculite in the Decontamination of Radio-Active Effluent. AERE-E/R-2707.

It is shown that the ion exchange efficiency of vermiculite (a natural magnesium aluminosilicate) is impaired by the precipitation of magnesium hydroxide in the exchanger matrix when considering the removal of radioactive isotopes from effluent at pH 11.5 to 12.0. Experiments are described which show that this deficiency can be overcome by either of the following operations:

conversion of the vermiculite to the sodium form prior to use; neutralization of the column influent to pH 7.0. It is concluded that the former method is the better, both from an economic and practical point of view. (auth)

Wright, T. L. and M. Fleischer. 1965. Geochemistry of the Platinum Metals. U.S.G.S. Bulletin 1214-A.

This paper summarizes the literature pertaining to the geochemistry of the platinum metals. The platinum metals--platinum, iridium, osmium, palladium, rhodium, and ruthenium--occur as alloys of metals, as intermetallic compounds, and as compounds with oxygen, sulfur, tellurium, arsenic, antimony, tin, and bismuth. The synonomy and known ranges of composition of platinum-metal compounds are summarized in tables. Platinum metals also occur as trace constituents of rock-forming minerals, in amounts as much as 10 ppm, although commonly less than 1 ppm. The form in which platinum metals occur in these minerals is imperfectly known.

Platinum metals are unevenly distributed throughout rock masses, probably in the form of pure metals or alloys. Data for content of platinum metals in rocks are of uncertain reliability owing to inherent sampling difficulties and to errors in the analytical procedures. The following abundances are estimated to within one order of magnitude: Ultramafic rocks (0.05 ppm); mafic igneous rocks (0.02 ppm); silicic and intermediate igneous rocks (0.005 ppm). In general, data are insufficient to give estimates for metamorphic and common sedimentary rocks. Some uncommon sediments--for example, copper-bearing shale, coal ash--have platinum-metal contents as high as 1 ppm.

Recent estimates of crustal abundances of the platinum metals are as follows (all values in ppm): Palladium, 0.01-0.02; platinum, 0.005; iridium, osmium, rhodium, and ruthenium, all less than 0.001. Data for industrial recovery of plantinum metals indicate a much greater recovery of platinum than of palladium, which suggests that the crustal abundance figures for platinum and palladium should be reversed.

Meteorites contain more platinum metals than crustal rocks; siderites contain, on the average, 30 ppm total platinum metals compared with 4 ppm in chondrites. In individual meteorites, platinum and iridium are largely concentrated in the iron phase, whereas osmium, iridium, ruthenium, and rhodium are also present in significant amounts in the troilite (sulfide) phase. The following average contents of the platinum metals in meteorites have been calculated from data in the literature (all values in ppm): Platinum, 2.3; osmium, 1.7; ruthenium, 1.6; palladium, 1.4; iridium, 0.7; rhodium, 0.6.

The cosmic abundances of the platinum metals, as summarized from the recent literature, are as follows (atoms per 10^6 atoms silicon): platinum, 1.3-1.6; ruthenium, 1.5-0.9; osmium, 1.0-0.6; iridium, 0.8-0.5; palladium, 0.7-0.6; rhodium, 0.2. (auth)

Yabuki, H. and M. Shima. 1973. Uranium and Other Heavy Elements in Deep-Sea Sediments Coexisting with Manganese Nodules. Sci. Pap. Inst. Phys. Chem. Res. 67:155-6 (in Japanese).

Mn, Fe, Cu, Ni, and Co were analyzed by atomic absorption spectrometry and U was determined by the induced fission-track method by applying internal standard addition. The samples were deep-sea sediments, a kind of foraminiferous ooze which consists mainly of $CaCO_3$ found [illegible] the area with the Mn nodules. The analyses were compared with similar data obtained previously for the Mn nodules. The nodules were richer by a factor of ∿5 for U and by a factor of >100 for the other elements. This tendency of U is also seen in the relation between seawater and nodules or sediments. This may mean that UO_2^+ ion in seawater rarely coprecipitates with Mn or Fe by scavenging effect, but forms complex ions with carbonate and is adsorbed on the surface of sediments or nodules. Data suggest that Mn, Ni, and Co are accumulated in both nodules and sediments at about the same rate. Results imply that Cu coprecipitates with Fe, rather than Mn. (CA)

Yaguchi, E. M., B. J. Waller and J. S. Marshall. 1974. Plutonium Distribution in Lake Michigan Biota. CONF-740813-1.

Samples of plankton, algae, benthic invertebrates, and eight fish species were collected from Lake Michigan during 1972 and 1973. After ashing, the samples were analyzed by radiochemical methods and gamma ray spectrometry for ^{239}Pu, ^{90}Sr, and ^{137}Cs, all of which are components of fallout from atmospheric tests of nuclear weapons. Analyses indicated that ^{239}Pu was scavenged from Lake Michigan water by phytoplankton and attached algae by a concentration factor of up to 10,000. In each of two food chains considered, a progressive discrimination against ^{239}Pu was observed at successive trophic levels: phytoplankton to zooplankton to planktivorous fish to piscivorous fish, and benthic invertebrates to bottom-feeding fish. The benthic invertebrates and fish had somewhat higher ^{239}Pu concentrations than their pelagic counterparts, presumably because of their ingestion of sediments. Ash content was correlated with ^{239}Pu concentrations in samples of plankton and fish. (auth)

Yakobenchuk, V. F. 1968. Radioactivity and Chemical Properties of Sod-Podzolic Soils in the Ukrainian Western Polesie. Visn. Sil's' Kogosped. Nauki. 11:45-50 (in Ukranian).

The level of α-activity of sod-podzolic soils of the area is dependent on the content of Al sesquioxide Al_2O_3. The level of β-radioactivity is correlated with the amount of sandy and muddy particles of mechanical composition of the soil, and with the amount of K, U, and sesquioxides of Al and Fe. The concentration of U is correlated with the amounts of oxides of Si, Fe, Al, Th, and Ra. The amount of Th is dependent on the reaction of soil solution and on the amount of CaO. The amount of Ra is correlated with the amount of organic substances in the soil. Chemical analyses are tabulated. (CA)

Yakovleva, M. N. and M. A. Shurshalina. 1959. A Field Method for Determining Uranium Migration in Natural Waters. Radiokhimiya. 1:445-9 (in Russian).

A field method based on dialysis is suggested for determining the migration of uranium in natural waters. (NSA)

Yamagata, N., M. Chiba, and H. Kobayashi. 1969. Total Ground Disposition of ^{90}Sr in Japan. J. Radiat. Res. 10:62-72.

In view of the descrepancies between some data on soil analysis and the accumulated deposition of ^{90}Sr technical errors in the analysis and sampling errors due to the horizontal surface distribution were examined. The NaOH-HCl leach method was found to be the best among the conventional substitutes for the standard fusion method and an interlaboratory comparison also probed the applicability of this method as a standard. A study was made of how to obtain a representative sample from an area of 1000 m^2 at a particular location. Statistical analysis of data obtained from undisturbed rice- and wheat fields suggested that to get a confidential limit of 10% at least 10, 4, and 8 cores, respectively, should be taken for making a composite sample. A preliminary study on the verticle distribution was also made in undisturbed soils. The amount in the upper 10 cm layer was 81.3% on the average of the total to the depth of 30 to 50 cm in different soil profiles. (auth)

Yamamoto, T., K. Masuda and N. Onishi. 1968. Studies on Environmental Contamination by Uranium. I. Environmental Survey of Uranium in Kamisaibara Village. Okayama Prefecture. J. Radiat. Res. 9:92-9.

In order to investigate situations of uranium contamination in Kamisaibara villiage where uranium mines are being developed, measurements have been made on the amounts of uranium contents in soil and in farm produce since 1965 by counting system and fluorimetric method. As a result, it has been found that the mean amounts of uranium flow in the streams in each year is higher at the sampling spots where drainages of gallarium and the pilot refinery were disposed, and the amounts were between 5.39 and 204.5 mg per minute. At sampling spots about 2000 m lower than gallery and pilot refinery drainages, the detectable amounts were 0 to about 30 percent more than detected amounts in each preceding year. In general, the spots where the element can be detected gradually move downward year by year. The uranium contents in soil sampled in the village were 1.9 to 4.0 ug per g of air-dried soil. Uranium was detected in all vegetables sampled in the village, and the contents were between 0.1 and 0.67 ug per g of ash, while it could not be detected in all the vegetables sampled in Okayama City. On uranium contents in soils and vegetables, however, no remarkable variation with time could be observed. (auth)

Yamamoto, T., E. Yunoki, M. Yamakawa and M. Shimizu. 1973. Environmental Contamination by Uranium. III. Effects of Carbonate Ion on Uranium Adsorption to and Desorption from Soil. Journal Radiat. Res. 14:219-224.

Adsorption of uranium on soils and its desorption from uranium-adsorbed soils in the presence of carbonate ion were examined by using three kinds of soils: alluvial soil, sandy soil and volcanic ash soil. The adsorption ratio of uranium for each soil was approximately 100 percent for the mixtures of uranyl (1 to 50 μgU/ml) and carbonate solutions (4.3 to 109 μgCO_3^{2-}/ml). In the uranium adsorbed soil (7.1 to 500 μgU/g air-dried soil) with carbonate ion (4.3, 43.4 μg/ml), the desorption ratio of uranium for each soil was low (0.09 to 1.2 percent). The adsorped soils with stream water were probably similar to those with carbonate solution. (auth)

Yastrebov, M. T. 1973. Natural Radioactivity of Some Soils in Landscapes of the Tamov Forest Steppe. Vestn. Mosk. Univ., Biol., Pochuved. 28:9[illegible]-6 (in Russian).

Behavior of ^{238}U, ^{226}Ra, ^{232}Th and ^{40}K in meadow soils in well watered Ca-Na forest-meadow landscape and in typical paleohydromorphic chernozems was described. Data on ion mobilities of these isotopes were tabulated and the level of natural isotopes determined at various depths. The contents of the four isotopes in such soils was determined mainly by their content in the horizons and mineral structures, by land profiles, by the action of surface and soil waters, and by bioaccumulation. In A_1 horizons of the chernozems and meadow soils the ^{226}Ra predominated over ^{238}U owing to greater bioaccumulation of the former. In chernozem-meadow and chernozemoid bottom soils, ^{238}U predominated over ^{226}Ra owing to greater inflow in the water supplies. (CA)

Yastrebov. M. T. 1971. Natural Radioactivity of Some Soils Formed in Various Landscapes of the Sod-Podzol Zone. Izv. Akad. Nauk SSR Ser. Biol. No. 3:408-14 (in Russian).

Gamma-ray spectrometric investigations of soil samples showed that ^{238}U, ^{226}Ra, ^{232}Th, and ^{40}K migrated from the sod-podzol soils in eluvial and trans-eluvial landscapes of the Valdai Hills into the silt-gley soils of the hydromorphous landscape in the Priilmensk lowland. This will increase the exposure of plants and microorganisms of this area to radioecological influences. (CA)

Yastrebov, M. T. 1971. Natural Radioactivity of Some Black-Earths in the European Areas of the USSR. Biol. Pochvoved. 26:93-97 (in Russian).

The radionuclides ^{238}U, ^{226}Ra, ^{242}Th, and ^{40}K in black earth were determined by gamma spectrometry, with a maximum error of 11%. The order of adsorption of these heavy nuclides by plant roots is $^{226}Ra > {}^{238}U > {}^{242}Th$. In the southern chernozems the ^{238}U content in the humus-accumulating layers was a factor of 1.3 to 1.8 lower than in rock because of the loss of this isotope by being taken up in plant roots. The ^{226}Ra, ^{232}Th, and ^{40}K contents of the southern chernozem layer is 1.3 to 1.5 times that in rock, apparently because of less intense removal by plants. In distinction from the leached soils, the ^{238}U accumulation in carbonate illuvial layers of the southern chernozems is small. Analytical data are tabulated. (NSA)

Yoshida, M., K. Takahashi, N. Yonehara, T. Ozawa, and I. Iwasaki. 1971. The Fluorine, Chlorine, Bromine, and Iodine Contents of Volcanic Rocks in Japan. Bull. Chem. Soc. Japan. 44:1844-1850.

The halogen contents of 49 Japanese volcanic rocks are; F:50-1700 (average 410), Cl: 17-1220 (average 270), Br: 0.09-8.10 (average 0.35), I: 0.011-0.32 (av. 0.088) μg/g. The fluorine and chlorine were determined by usual photometric methods, and the bromine and iodine, by photometric methods based on their catalytic action, after decomposition and separation procedures suitable for each case. The bromine and iodine contents are appreciably lower than the values generally accepted for igneous rocks. The bromine content agrees with Sugiura's value. The frequency distribution of each halogen content shows an approximate lognormality. The chlorine and bromine contents are strongly correlated, and the Br/Cl atomic ratio is in a narrow range (0.66-3.7) x 10^{-3} (av. 1.5 x 10^{-3}). No other correlation is observed among the halogen contents at all. Each halogen content has no marked relation to the type of rock. A regional difference is seen in the F/Cl and I/Br ratios. Three ultrabasic rocks have very low fluorine (≤20 μg/g) and chlorine contents (≤50 μg/g). On the other hand, they have a slightly lower bromine content (0.15-0.34 μg/g) than, and almost the same iodine content (0.07-0.13 μg/g) as, the volcanic rocks. (auth)

Yousef, Y. A., A. Kudo, and E. F. Gloyna. 1970. Radioactivity Transport in Water: Summary Report. ORO-490-20

A transport model is presented which describes the behavior of radionuclide movement in an ecological system, and considers hydraulic transport, sediment sorption and desorption, and biomass uptake and release. Solutions of the transport model are programmed and verified using data obtained from the laboratory ecosystem and the research flume. The limitations and relative importance of environmental factors affecting transport were evaluated. Recommendations for the use of this prediction model are discussed. Flume experiments limited to fresh water systems and slow-moving streams were conducted. In general, radionuclide movement followed the same pattern as Rhodamine B dye releases. However, discrepancies were observed due to interactions of radionuclides with sediments, biomass and organic debris. Therefore, before tests were conducted in the fully instrumented flume (model river), laboratory experiments with small ecosystems (aquaria) were conducted to help evaluate the functional form and factors involved in prediction models. The effects of specific environmental factors such as pH, temperature, dissolved oxygen, oxidation-reduction potential of sunlight were studied to estimate the uptake and release rates of radionuclides. The radionuclides investigated included ^{65}Zn, ^{59}Co, ^{103}Ru, ^{137}Cs, ^{85}Sr, and ^{51}Cr. (auth)

Zeschke, G. 1959. Uraninite Occurrence in Heavy Mineral Sands in the Indus Valley. Mineral. Abhandl. 93:240-56 (in German).

In the gold-rich sands of the Indus River, especially in the northern part of West Pakistan, uranite, monazite, scheelite, zircon, ilmenite, and previously unknown minerals were discovered. Uraninite exhibits an abnormally high radioactivity which could be traced back to the decay products of the radium series. The type of radiation was investigated and discussed. Chemical and physical separations were made to detect the radiation source. Uraninite is especially enriched in the smallest grains, generally in idiomorphic form. The occurrence was compared with other known occurrences. It was shown that a weathering of uranite can follow different patterns and that a liquid transport of several km as well as an enrichment in alluvial ores results. The economic possibilities were mentioned. (auth)

Zillich, J. A. 1974. Biological Impacts of AEC Rocky Flats Plant Waste Discharged to Surface Waters. IN: Proceedings of the Second AEC Environmental Protection Conference WASH-1332-74-V.1, pp. 193-260.

Nutrients discharged from the Rocky Flats Plant site caused algae growth increases as much as 35 times above ambient conditions. Such nutrient discharges if continued could eventually cause taste and odor problems in the water supply for the City of Broomfield. Macroinvertebrate populations in plant site drainages indicated the waste waters were not very toxic. In comparison to other macroinvertebrate populations in other Denver area waters, Rocky Flats drainages were of much better quality. Fish not only live in all plant site drainages but also have been observed reproducing as well. No plant materials showed any significant biomagnification in the aquatic food chain. This includes chlorinated hydrocarbons, plutonium and tritium. The highest yearly average concentration of Plutonium in any offsite plant waters was 16.6 pCi/l. The average yearly concentration in the Great Western Reservoir was less than 0.11 pCi/l. Radiation exposure to Broomfield residents from Rocky Flats products in city drinking water during 1973 was less than 4 millirem. Broomfield residents received more than 500 times that amount from natural sources, therefore, the amount attributed to the Rocky Flats Plant was small in comparison and was not felt to be a public health concern. (auth)

Zimmermann, U., D. Ehhalt, and K. C. Münnich. 1967. Soil-Water Movement and Evapotranspiration: Changes in the Isotopic Composition of the Water. IN: Isotopes in Hydrology. IAEA-SM-83/38, pp. 567-585.

An artificial rainfall spiked with tritium, marks the boundary between older rain-water below and younger rain-water above. When the tracer mark has reached a certain depth, the amount of soil water above the tracer mark gives that fraction of the rain fallen since the date of tracer input, which is still present in the soil.

The principles of the method have been dealt with in a preceding paper. The present paper contains new data. This includes field experiments in sands showing larger dispersion effects than found previously. Larger dispersion is usually combined with a scatter in the position of the tracer maximum in parallel cores. A theoretical discussion of dispersion is given. Among recent improvements in sample processing is a newly developed plant to distill six samples simultaneously, which makes it possible to process several hundred samples a month without much handling. The change in stable isotope composition of the soil water during the downward movement has also been studied in detail. Experiments show that plant transpiration results in practically no isotopic enrichment of the soil water. The considerable average velocity with which the water moves upwards from the root to the leaves through the fine leads of the stem makes this possible despite the heavy enrichment of the water in the leaves. Under Central European conditions a bare soil may, however, show a deuterium enrichment up to about 20% in the top layers.

Zlobin, V.S. and O. V. Mokanu. 1970. Mechanisms of the Accumulation of Plutonium-239 and Polonium-210 by the Brown Alga Ascophyllam Nodosum and Marine Phytoplankton. Radiobiology 10:594-589.

The accumulation of plutonium-239 by Ascophyllum nodosum and marine phytoplankton, as well as that of polonium-210 by macrophytes under the influence of inhibitors of cellular respiration, was investigated. It was established that plutonium and polonium exist in sea water in the form of colloidal particles. Sodium cynaide induces uniform suppression of the accumulation of ^{239}Pu and ^{210}Po in plant cells, while ammonium chloride briefly stimulates accumulation. It is demonstrated that the accumulation of plutonium-239 by marine algae is an active process, and it involves an energy expenditure by the cell. (auth)

Zlobin, V. S. and V. Zlobin. 1973. Active Phase of Assimilation of Plutonium-239 by the Marine Algae ASCOPHYLLUM NODOSUM. Dolyar. Nauch.-Issled. Proekt. Inst. Morsk. Ryb. Khoz. Okoanogr. No. 29:169-175.

A study was made of the problem of accumulation of Pu 239 by the brown algae Ascophyllum nodosum during suppression of cell respiration. As the inhibitors the author used sodium cyanide in a concentration of 1 X 10^{-4} M ammonium chloride 10 mM and 100 mM and cadmium chloride 2 mM. It was established that they cause an increase in the Pu-239 accumulation factors in dependance on the substrate on which they act. A study was made of the mechanism of this phenonenon and it was possible to establish the dependence of the intensity of cell respiration and the accumulation factor. The article gives hypotheses on the means and methods by which Pu-239 in a colloidal state penetrates through the cell membrane. (0-77)

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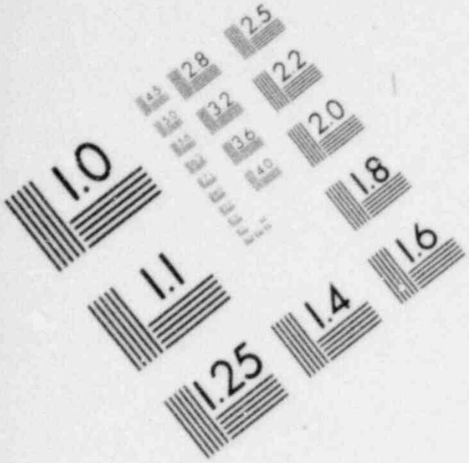

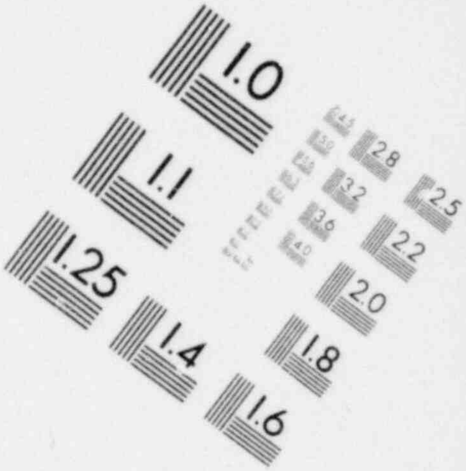

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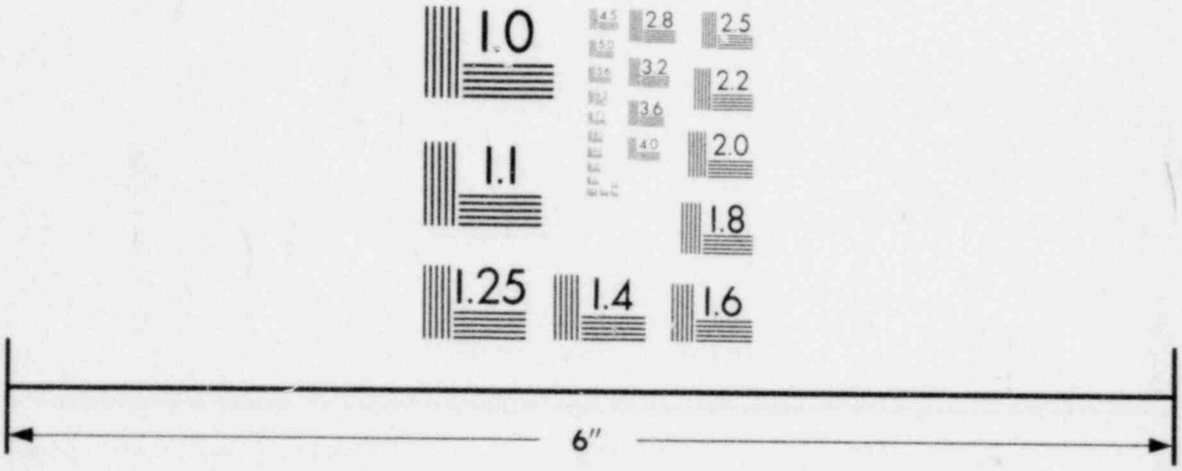
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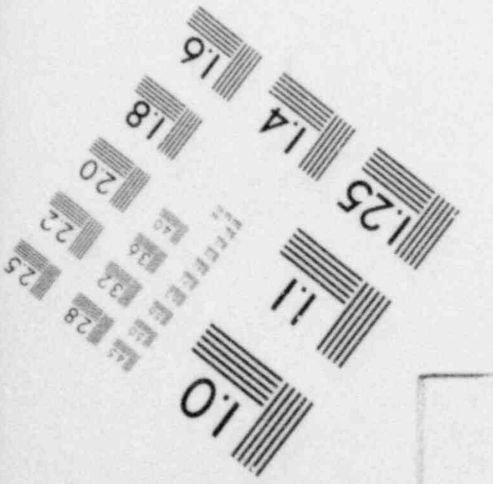

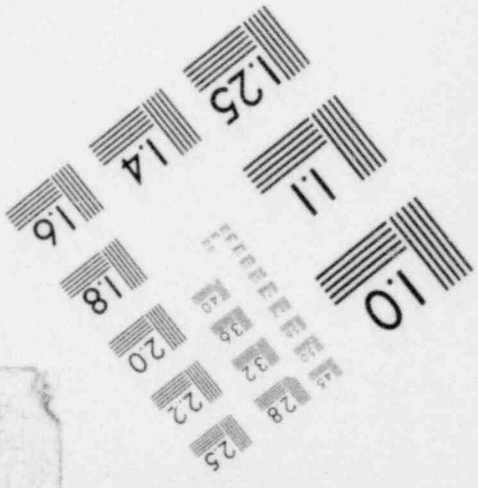

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