See Pocket 3 for encl.

DISTRIBUTION
WM s/f (B0290/B0287)
WMGT r/f
NMSS r.f
REBrowning
MBell
JOBunting
JWBradbury & r/f
DJBrooks & r/f
KCJackson & r/f
PDR
LPDR (B,NS,)

NOV 27 1985

~~426.1/~~B0290/B0287~~/JWB/85/11/14~~

MEMORANDUM: Malcolm R. Knapp, Chief
WMGT

FROM: Kenneth C. Jackson, Section Leader
Geochemistry Section, WMGT

David J. Brooks
Geochemistry Section, WMGT

John W. Bradbury
Geochemistry Section, WMGT

WM-Res
~~WM Record File~~ B0290+B0287
ORNL

WM Project 10, 11, 16
Docket No.
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Distribution:

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SUBJECT: TRIP REPORT TO OAK RIDGE NATIONAL LABORATORY PROGRAM REVIEW FOR B-0290 and B-0287

A meeting to review aspects of the programs of NRC contracts B-0290 and B-0287 was held at Oak Ridge National Laboratory (ORNL) on September 18-19, 1985. The attendees were K.C. Jackson, D. Brooks, and J.W. Bradbury from the NRC, and S.K. Whatley, G.K. Jacobs, A.D. Kelmers, J.G. Blencoe, R.E. Meyer, D. O'Kelly, and W.D. Arnold from ORNL.

Attachment 1 is the agenda for the meeting. After the introductions, S.K. Whatley briefly discussed the purpose, objectives and accomplishments of contracts B-0290 and B-0287. Some of the tasks planned for FY 1986 under B-0287 were also covered (see attachment 2). The reviews on americium and plutonium in B-0287 will be used as guidance in formulating experimental methodologies to be used in B-0290. Two people were recently hired to work on these contracts. D. O'Kelly has experience in autoradiographic techniques and will use this analytical method to study sorption of radionuclides on polished and fractured surfaces. J. Mailin will be involved in the Pu technical review.

Following the presentation by S.K. Whatley on the progress and plans for B-0287, R.E. Meyer discussed accomplishments and plans for B-0290 (see attachment 3). From the FY 85 studies concerning BWIP, it was found that Np sorption was strongly dependent on surface area. Surprisingly, however, Tc did not show the same relationship. No satisfactory explanation for this behavior was proposed.

With the acquisition of site-specific samples from Yucca Mountain (NNWSI), the emphasis of B-0290 will be shifted from BWIP to NTS related studies. Presently, thin sections are being prepared from core samples and surface samples. The thin sections will be compared petrographically to determine if

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B-0290 PDR

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NAME	JWBradbury;mt	DJBrooks	KCJackson				
DATE	85/11/	85/11/	85/11/				

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rock from the surface material can be used in sorption experiments instead of core material. (Surficial material is easier to acquire than core material.)

We discussed the microbial content of NNWSI J-13 water and the possible effects that micro-organisms have on radionuclide sorption. Questions arose about the methodology LANL used to minimize the content of the micro-organisms. It was suggested that LANL filter the J-13 water as it comes from the well head.

A new glove box is being fitted with CO_2 controlling equipment for batch sorption studies applicable to NTS conditions. It has been found that when J-13 water is open to the atmosphere, CO_2 is lost resulting in an increase in solution pH. In FY 86 the contractors on B-0290 plan to study the effect of CO_2 on radionuclide sorption.

In FY 86 some experiments using bulk samples may be performed to compare radionuclide retardation in fracture flow and porous media systems. Autoradiography may be used to identify the sorbing phases on the fracture or polished surface.

The contractors presented a justification for the selection of the radionuclides that they plan to study in the upcoming year. Those selected are Cs-135, Np-237, Am-241, 243, Tc-99, U-234, 236, and Pu 240, 239, 242. It was suggested that the contractors review possible methodologies for developing a list of "key" radionuclides which could be used by the NRC as guidance.

Attachment 4 is a detailed outline of a talk J. G. Blencoe gave on the geochemical conditions at the Hanford, Washington candidate HLW repository site. He is currently preparing a topical report on this subject.

September 19, 1985

K. Jackson and D. Brooks met with N. Cutshall and G. Jacobs to discuss Oak Ridge support capabilities for low-level waste. Meanwhile, J. Bradbury met with D. Coles, E. Drummond, D. Weslowski, and M. Naney to discuss current projects in the Chemical Division of ORNL involving isotope and hydrothermal geochemistry.

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Following the separate discussions, G. Jacobs gave a "hands-on" demonstration of the data base systems used at ORNL (see attachment 5). Over 3,000 documents have been entered
into the system with 1,000 documents covering geochemical topics. The purpose of this system is to provide an evaluation of important geochemical literature being used to support HLW site performance, and a means of tracking the development of geochemical activities as they develop through site characterization and licensing.

A tour of the sorption laboratory was conducted as the last order of business. It was pointed out to the NRC staff that the counting instrumentation was "old fashioned" and slow. To analyze radionuclide concentrations in one sample vial took about 12 hours. This problem hampers the progress of B-0290 and consideration is being given to obtaining the funding necessary to get more up-to-date equipment.

Kenneth C. Jackson, Section Leader
Geochemistry Section

John W. Bradbury
Geochemistry Section

David J. Brooks
Geochemistry Section

Enclosure:
As Stated

OFC	:WMGT JWB	:WMGT	:WMGT	:	:	:	:
NAME	:JWBradbury;mt	DJBrooks	:KCJackson	:	:	:	:
DATE	:85/11/20	:85/11/21	:85/11/21	:	:	:	:

TECHNICAL ASSISTANCE IN GEOCHEMISTRY

(FIN. NO. B0287)

ORNL WASTE MANAGEMENT
DOCUMENT DATA BASE
(WMDDB)

PROGRAM REVIEW

OCTOBER 1985

WMDDB

WHO: VARIOUS PROJECTS AT ORNL

WHAT: COMPUTERIZED DATA BASE OF REPORTS RELATED TO HAZARDOUS AND RADIOACTIVE WASTE MANAGEMENT

TOTAL DOCUMENTS = 3871

WHERE: INQUIRE SYSTEM ON IBM 3033S

WHY: TO SUPPORT WASTE MANAGEMENT PROGRAMS AT ORNL AND ELSEWHERE

HOW: ORNL SUPPORT AND SPECIFIC ACTIVE PROJECTS

B0287 PROJECT

GEOCHTA:

KEY WORD IDENTIFYING ALL DOCUMENTS CONCERNING GEOCHEMICAL ASPECTS OF HLW ISOLATION

TOTAL GEOCHTA DOCUMENTS = >1000

GEOCHTA

PURPOSE:

TO PROVIDE LONG-TERM COHESIVE TRACKING OF KEY GEOCHEMICAL REPORTS AND ARTICLES

- IDENTIFY AND EVALUATE KEY DOE AND OTHER SUPPORTING REPORTS
- PROVIDE CONTINUITY THROUGHOUT LICENSING PERIOD (E.G., STAFF CHANGES)
- ALLOW DIRECT ACCESS DURING LICENSING ACTIVITIES
- REPORT EVALUATED ONLY ONCE

GEOCHTA

DOCUMENT COVERAGE:

- DISTRIBUTION OF SITE REPORTS (BWIP, NNWSI, AND SRP)
- DISTRIBUTION OF OTHER REPORTS
- ABSTRACT SERVICES
- WEEKLY SCAN OF ORNL LIBRARY ACCESSIONS
- BIMONTHLY COMPUTER SEARCH (E.G., GEOREF)

GEOCHTA

EVALUATIONS:

- EACH REPORT IDENTIFIED FOR LEVEL OF REVIEW NEEDED

- EVALUATIONS BECOME PART OF INPUT

GEOCHTA

INPUT AND SEARCH FIELDS:

- TITLE
- DATE
- PUBLICATION NUMBER
- AUTHOR
- CORPORATE AUTHOR
- ENTRY DATE
- CORRECTION DATE
- ABSTRACT

GEOCHTA

INPUT AND SEARCH FIELDS (CONTINUED)

- CATEGORY (SEE TABLE 1)
- SITE (SEE TABLE 2)
- PROJECT (SEE TABLE 3)
- DOCUMENT TYPE (SEE TABLE 4)
- KEYWORDS (SEE TABLE 5)

GEOCHTA

TO ACCESS:

- CHARGE NUMBER

- TSO ACCOUNT
  - LOGON
  - EXECUTE MENU-DRIVEN MACRO
  - HAVE FUN!

Table 1. Category field parameters

AIRBORNE	-	Airborne (volatile) nuclear wastes
CLAD	-	Fuel assembly structural material wastes
COMML	-	Commercial waste
COST	-	Contains cost information
DEFENSE	-	Wastes for which DOE is responsible for storing and treating
DNA	-	Defense Nuclear Agency, Nevada Test Site
D&D	-	Decontamination and Decommissioning
ENRICH	-	Involves uranium enrichment
FAB	-	Involves fabrication of UO2 fuels
FAILEDEQ	-	Failed/removed equipment wastes
FOREIGN	-	Foreign wastes
FUELCY	-	Involves many aspects of a fuel cycle
FUSRAP	-	Formerly Utilized Sites Remedial Action Program
HAZARD	-	Hazardous waste
HLW	-	High-level waste
I/I	-	Institutional and Industrial wastes
ISOLATE	-	Concerns permanent waste isolation

Table 1. (continued)

LLW	-	Low-level waste
MILL	-	Involves uranium milling
MILLTAIL	-	Uranium mill tailings
MINE	-	Involves uranium mining
ORIGEN	-	Concern ORIGEN and its modifications
PACKAGE	-	Involves packing of fuel and wastes
REACTOR	-	Involves nuclear reactors
REFAB	-	Involves mixed-oxide fuel fabrication
REG	-	Involves licensing or regulations
REPRO	-	Concerns spent fuel reprocessing
RISK	-	Includes information on risk/safety/dose
SF	-	Spent fuel
SOURCE	-	Includes information on source terms or separation factors
STORAGE	-	Concerns waste or fuel in interim storage
SUBSEA	-	Subseabed
TMI	-	Wastes/fuel from TMI Unit 2
TRANS	-	Involves nuclear material transportation
TREAT	-	Involves waste recovery and treatment (waste forms)
TRU	-	Transuranic waste
UMTRAP	-	Uranium Mill Tailings Remedial Action Program

Table 2. Site field parameters

ANL	-	Argonne National Laboratory; Argonne, IL
BARN	-	Barnwell, SC (commercial site)
BETY	-	Beatty, NV (commercial site)
BNL	-	Brookhaven National Laboratory, Brookhaven, NY
CYPRESS CREEK	-	Cypress Creek Dome Site, Perry County, MS (salt site)
DAVIS	-	Davis Canyon, Paradox Basin, UT (salt site)
DEAF SMITH	-	Deaf Smith County, Palo Duro, TX (salt site)
FSVR	-	Fort St. Vrain Reactor, Platteville, CO
HAN	-	Hanford complex, HANF, H100, and others; Hanford, WA
ID	-	Idaho site
LANL	-	Los Alamos National Laboratory, Los Alamos, NM
LAVENDER	-	Lavender Canyon, Paradox Basin, TX (salt site)
LL	-	LLNL, LBL; Livermore, CA
MFKY	-	Maxey Flats, KY (commercial site)
MFRP	-	Midwest Fuel Recovery Plant; Morris, IL (commercial site)
ML	-	Mound Laboratory; Miamisburg, OH
NLO	-	National Lead of Ohio; Cincinnati, OH
NIGF	-	Niagara Falls, NY
NTS	-	Nevada Test Site; Mercury, NV
OR	-	Oak Ridge Complex; ORNL, ORGDP, Y12; Oak Ridge, TN
PAD	-	Paducah Gaseous Diffusion Plant; Paducah, KY
PANT	-	Pantex Plant; Amarillo, TX
PORT	-	Portsmouth Gaseous Diffusion Plant, Portsmouth, OH

Table 2. (continued)

RFP	-	Rocky Flats Plant; Golden, CO
RICHTON	-	Richton Dome, MS (salt site)
SALTVALT	-	Project Salt Vault; Lyons, KS
SAND	-	Sandia National Laboratory; Albuquerque, NM
SHEF	-	Sheffield, IL (commercial site)
SRP	-	Savannah River Plant; Aiken, SC
SWISHER	-	Swisher County, Palo Duro, TX (salt site)
TMI	-	Three Mile Island; Harrisburg, PA
VACHERIE	-	Vacherie Dome, LA (salt site)
WIPP	-	Waste Isolation Pilot Plant; Carlsbad, NM
WVNY	-	West Valley, NY

Table 3. Project field parameters

AGNS	-	Allied-General Nuclear Services reprocessing plant at the BARN site; Barnwell, SC
BARN	-	Waste burial ground at the BARN site; Barnwell, SC
BETY	-	Waste burial ground at the BETY site; Beatty; NV
BNL	-	Brookhaven National Laboratory at the BNL site; Brookhaven, NY
BWIP	-	Basalt Waste Isolation Project at the HAN site; Hanford, WA
DNA	-	Defense Nuclear Agency at the NTS site; Mercury, NV
DWPF	-	Defense Waste Processing Facility at the SRP site; Aiken, SC
FSVR	-	Fort St. Vrain Reactor at the FSVR site; Platteville, CO
GRANITE	-	
HEDL	-	Hanford Engineering Development Laboratory at the HAN site; Richland, WA
ICPP	-	Idaho Chemical Processing Plant at the ID site; Idaho Falls, ID
INEL	-	Idaho National Engineering Laboratory at the ID site; Idaho Falls, ID
LANL	-	Los Alamos National Laboratory at the LANL site; Los Alamos, NM
LBL	-	Lawrence Berkeley Laboratory at the LL site; Livermore, CA
LLNL	-	Lawrence Livermore Laboratory at the LL site; Livermore, CA
MFKY	-	Waste burial ground at the MFKY site; Maxey Flats, KY

Table 3. (continued)

MFRP	-	Midwest Fuel Recovery Plant at the MFRP site; Morris, IL
ML	-	Mound Laboratory at the ML site; Miamisburg, OH
MLO	-	Remedial actions at the MLO site; Cincinnati, OH
NFS	-	Waste burial ground at the WVNY site; West Valley, NY
NFSREP	-	D&D of the NFS reprocessing plant at the WVNY site; West Valley, NY
NIGF	-	Remedial actions at the NIGF site; Niagara Falls, NY
NNWSI	-	Nevada Nuclear Storage Investigation at the NTS site; Mercury, NV
ORGDP	-	Oak Ridge Gaseous Diffusion Plant at the OR site; Oak Ridge, TN
ORNL	-	Oak Ridge National Laboratory at the OR site; Oak Ridge, TN
PAD	-	Paducah Gaseous Diffusion Plant at the PAD site; Paducah, KY
PANT	-	Pantex Plant at the PANT site; Amarillo, TX
PORT	-	Portsmouth Gaseous Diffusion Plant at the PORT site; Portsmouth, OH
REECO	-	Reynolds Electrical and Engineering Co., Inc. at the NTS site; Mercury, NV
RFP	-	Rocky Flats Plant at the RFP site; Golden, CO
RHO	-	Rockwell Hanford Operations at the HAN site; Hanford, WA
SALT	-	Potential bedded salt repository (temporary)
SALTVALT	-	Project Salt Vault at the SALTVALT site; Lyons, KS

Table 3. (continued)

SAND	-	Sandia National Laboratory at the SAND site; Albuquerque, NM
SHALE	-	
SHEF	-	Waste burial at the Sheffield site; Sheffield, IL
SLAPSS	-	Remedial actions at the SLAPSS site, St. Louis, MO
SRL	-	Savannah River Laboratory at the SRP site; Aiken, SC
STRIPA	-	Stripa granite repository in Sweden
SYS INT	-	System Integration
TMI	-	Cleanup of TMI Unit 2 at the TMI site; Harrisburg, PA
TWSO	-	Transuranic Waste Systems Office at the RFP site; Golden, CO
UCN/NI	-	UNC Nuclear Industry at the HAN site; Hanford, WA
WIPP	-	Waste Isolation Pilot Plant at the WIPP site; Carlsbad, NM
Y12	-	Y-12 Plant at the OR site; Oak Ridge, TN

Table 4. Document Type Parameters

ARTICLE	-	Article from a journal, magazine, or other publication
BOOK	-	Books, pamphlets, etc.
LETTER	-	A letter or letter report containing a substantive amount of technical information
PRESENT	-	Exhibits used in a presentation when the presentation was not published in a proceeding
PROCEED	-	Entire proceedings of meetings (selected excerpts are categorized as ARTICLE)
PROGRESS	-	Progress report
REF	-	A document that can be considered to be a reference or source document; should be used sparingly and in conjunction with other DOCTYPEs; examples are waste management dictionary, waste management ETS, GESMO, TAD document, etc.
SUMMARY	-	Summary of long abstract of one of the other document types; should be used in conjunction with one of the other DOCTYPEs
TOPICAL	-	Topical report

Table 5. Keywords for Categorization of Reports Related to the NRC Geochemistry TA Project

Keyword	Subject/Description
#ANALOG	Includes documents with information on natural analogs as they apply to waste repositories.
#BACK/SEAL	Backfill (defined as material used to fill drifts) and shaft seals. Does not include material around waste package. Does include mineralogy and geochemistry of backfill material.
#CALC	Calculational aspects of repository analysis, including geochemistry codes (e.g., EQ6), data bases. Does not include aspects involving waste packages or performance assessment.
#COND/REAC	Conditions and reactions relevant to waste repository analysis. Includes Eh, pH, temperature, kinetics, etc. Does not include groundwater chemistry, which is included under hydrology, Includes radiolysis and rock-water reactions.
#EXP	Indicates that the document involves experimental or measured parameters.
#GEOCHEM	Includes general background work on geochemistry, i.e., works not specific to one of the repository sites, such as text and reference books.
#GEOLOGY	Includes general background work on geology, i.e., works not specific to one of the repository sites. Also includes aspects of site geology such as structural geology, regional geology, and stratigraphy.
#HYDROLOGY	Includes documents relevant to the hydrology of repository sites. This keyword includes groundwater chemistry.
#MIN/PET	Includes documents relevant to the mineralogy and petrology of the repository sites. Does not include mineralogy of the backfill, seals, or parts of the waste package.

Table 5. (continued)

#MITIGATE	Includes documents concerning effects/processes that may mitigate/circumvent radionuclide solubility and/or sorption. Examples are colloids, particulates, organic complexing agents, filtration, coprecipitation.
#PACKAGE	Documents concerning the waste package, which includes the waste form, canister, overpacks, and any other material inserted between the waste canister and the host rock. Includes failure mechanisms, source terms from the package, and corrosion chemistry specific to waste packages.
#PERFORM	Includes documents related to repository performance assessment (e.g., migration studies, calculation of release rates or dose).
#REG	Documents concerning the regulatory aspects of waste repositories (regulations, criteria, standards)
#SOLUBILITY	Documents concerning the solubilities of radionuclides, either calculated or measured.
#SORPTION	Documents concerning the sorption behavior of radionuclides. Includes matrix diffusion.
#SPECIATION	Documents providing information on the identify and amounts of different species (e.g., free ions having different valence states; complex of ions) of a given element that are in solution.
#SUMMARY	Document that is a summary or compilation of information on a site. Includes documents such as SCRs and progress reports.

AGENDA FOR ORNL PROGRAM REVIEW

September 18-19, 1985

Oak Ridge, TN

September 18:

1:30 pm	Overview of B0287 and B0290	S.K. Whatley
1:45 pm	Progress and plans for B0287	S.K. Whatley
2:00 pm	Progress and plans for B0290	R.E. Meyer
2:15 pm	Discussion of the basis for selecting key radionuclides (B0290)	
3:15 pm	BREAK	
3:30 pm	Status of Concerns on NNWSI Sorption and Discussion of Sorption in fractured rocks (B0287/B0290)	R.D. Kelmers
4:30 pm	Review of Topical Report on Geochemical Conditions at BWIP (B0287)	J. Blencoe

September 19:

8:30 am	Demonstration of data base storage and retrieval system (B0287)	G.K. Jacobs R.M. Gove
9:00 am	Discussion of ORNL support capabilities for low-level waste	N. Cutshall
10:00 am	BREAK	
10:15 am	Tour of laboratory facilities (B0290)	
12:00	Discussion and wrap-up	

EVALUATION OF RADIONUCLIDE GEOCHEMICAL INFORMATION DEVELOPED BY DOE HLW REPOSITORY SITE PROJECTS. B0290

PROGRESS AND PLANS

A. D. KELMERS, F. G. SEELEY
CHEMICAL TECHNOLOGY DIVISION

W. D. ARNOLD, J. G. BLENCOE, R. E. MEYER
CHEMISTRY DIVISION

G. K. JACOBS
ENVIRONMENTAL SCIENCES DIVISION

S. K. WHATLEY, PROGRAM MANAGER
CHEMICAL TECHNOLOGY DIVISION

LICENSING ISSUES:

* DOE sorption data used to calculate retardation of nuclides.

* DOE solubility/concentration limit data used to calculate conservative estimates of migration of nuclides.

* Objectives of B0290

  - Collect limited amount of sorption/solubilty data for comparison with DOE data.
  - In so doing, assess DOE methodologies for determination of data.
  - Results used by NRC for evaluation of DOE documents relative to licensing of nuclear waste repositories.

OUTLINE

A. Hanford Site Evaluation

1. Strontium isotherm
2. Tc - Anoxic vs oxic, use of redox reagents
3. Uranium - isotherms - formation of sodium boltwoodite
4. Np - anoxic vs oxic - isotherms counting problems

Geochemical Modeling

B. Yucca Mountain Evaluation

1. Rock samples
2. Groundwater - J-13 - synthetic
3. Carbon dioxide equilibrium
4. Apparatus
5. Initial experiments

Sorption of uranium on basalt

1. McCoy Canyon/GR-2 - oxic
   14 day vs 50, 27C vs 60C
2. McCoy Canyon - anoxic
   vs oxic, 27C and 60C
3. Formation of sodium boltwoodite
4. Cohassett/GR-4 - larger values
   of Rs
5. Need for more work on sodium
   boltwoodite

SORPTION OF NEPTUNIUM ON BASALT

1. Studied extensively under B0462 (Valence Effects of Sorption)
2. B0462 mostly trace studies using Np-235
3. Valence analysis (developed under B0462) used to understand data
4. Counting problems - presence of decay product Pa-233 from decay of Np-237 used at higher concentrations
5. Time study
6. Particle size study
7. Isotherm determinations

SOME CONCLUSIONS FROM BASALT WORK

* Tc - Hydrazine should not be used. Rather, anoxic conditions should be established.
  - Solubility data for Tc oxides needed (now being determined under B0462).
  - Freshly crushed basalt reduces Tc under highly anoxic conditions.
  - Question - Is freshly crushed basalt an analog for field conditions?
* Np - Similar to Tc (still under investigation).
* U - Sodium boltwoodite formed from GR-2 and GR-4.
  - Formation process not clearly understood.
* Sr - Results same as BWIP'S.

GEOCHEMICAL MODELING

(ACCOMPLISHMENTS (FY 1985)

- BROUGHT EQ3/6 SOFTWARE PACKAGE ON-LINE AT ORNL

- PROVIDED SOLUBILITY/SPECIATION CALCULATIONS TO SUPPORT NRC REVIEW OF HANFORD SITE EA

- ATTEMPTED TO VERIFY SOLUBILITY/SPECIATION CALCULATIONS FOR YUCCA MOUNTAIN SITE

- EVALUATED ADEQUACY OF MICHIGAN NATIVE COPPER DEPOSITS AS NATURAL ANALOG FOR COPPER CANISTERS AT THE HANFORD SITE

EQ3/6 SOFTWARE PACKAGE

- EQ3NR, EQ6, EQLIB, EQTL, MCRT PART OF SOFTWARE PACKAGE
- TEST CASES RUN SUCCESSFULLY
- FURTHER TESTING IS REQUIRED

PLANS (FY 1986):

- SENSITIVITY CALCULATIONS
- COUPLED HYDROLOGIC/GEOCHEMICAL CALCULATIONS
- SUPPORT EVALUATION OF NNWSI GEOCHEMICAL CONDITIONS (B0287)
- SUPPORT LABORATORY STUDIES (B0290)

YUCCA MOUNTAIN SOLUBILITY/SPECIATION CALCULATIONS

- USED MINTEQ TO EVALUATE SOLUBILITY/SPECIATION CALCULATIONS (EQ3/6) OF OGARD AND KERRISK (1984)
- RADIONUCLIDES: URANIUM, PLUTONIUM, AMERICIUM, AND STRONTIUM
- THREE GROUNDWATERS USED (J-13, UE-25P#1, AND H-5)

CONCLUSIONS:

- CALCULATIONS AGREE (GENERALLY) FOR THE ASSUMPTIONS AND THERMODYNAMICS USED
- ONLY VERIFIES THAT TWO CODES SOLVE EQUATION CORRECTLY AND THAT THERMODYNAMICS ARE NOT ENTIRELY INCONSISTENT
- SENSITIVITY CALCULATIONS WOULD BE BENEFICIAL

EVALUATION OF NATIVE COPPER DEPOSITS AS NATURAL ANALOG FOR COPPER CANISTERS AT THE HANFORD SITE

- COPPER "PROBABLY" RELATIVELY STABLE IN BASALT
- BASALT/WATER SYSTEMS HAVE SIMILAR BULK COMPOSITION
- SPECIFIC REACTIONS MAY BE QUITE DIFFERENT
- ALTERNATIVE CONCEPTUAL MODELS OF ROCK/WATER REACTIONS IDENTIFIED THAT MAY AFFECT CONCLUSIONS REGARDING APPLICABILITY OF NATURAL ANALOG
- BASALT/WATER SYSTEM IN MICHIGAN MAY BE EXCELLENT CANDIDATE FOR VALIDATION STUDIES OF HYDROLOGIC/GEOCHEMICAL CODES

YUCCA MOUNTAIN TUFF SAMPLES

1. Core and outcrop (Table and photographs)

2. Crushed samples (Table)

3. Thin sections

4. X-ray results

YUCCA MOUNTAIN GROUNDWATER

1. Analysis of J-13 (Table)
2. Bacterial content
3. Synthetic GW (Table)
4. Carbonate equilibrium
5. Special atmosphere box
6. Carbon dioxide pressure vs pH

INITIAL EXPERIMENTS WITH CRUSHED TUFF

1. Evaluate sorption with respect to:
   a. Particle size
   b. CO_2 vs no CO_2
   c. Real vs synthetic GW
   d. Washed vs unwashed outcrop
   e. Other variables
2. Begin with Cs and Sr which are selected to:
   a. Compare our procedures with NTS
   b. Gain experience in handling tuff
   c. Determine capacity, pH sensitivity, etc
   d. Compare behavior of mono- and divalent ions to trivalent Am(III)

EXPERIMENTS WITH BULK SAMPLES

1. Autoradiography

   a. Construct apparatus for use with polished samples
   b. Identification of adsorbing phases

2. Fracture flow apparatus

   a. Construct apparatus
   b. Possibly use autoradiography or collimated gamma detector

Nuclides

	Cs-135	Np-237	Am-241,243	Tc-99	U-234,238,236	Pu-240,239,242
Half-life	2.3×10^6a	2.1×10^6 a	432,7380	2.1×10^5a	2.4×10^5a 4.5×10^9a 2.3×10^7a	6537a 2.4×10^4a 3.8×10^5a
Radiation	beta,gamma	alpha,gamma	alpha,gamma	beta	alpha,gamma	alpha,gamma
% 1000a activ.	0.022	0.058	51.84,1.75	0.79	0.113 0.018 0.015	26.87 17.37 0.10
Important Oxidation States	I	IV,V,VI,III	III	IV,VII	VI,IV	IV,V,VI,III
Colloids	no	sometimes	serious problem	sometimes	sometimes	serious problem
Chemistry	simple	moderately complex	relatively simple	moderately complex	moderately complex	extremely complex

Eu analog

Table 3.1 Source and description of Yucca Mountain tuff samples[a]

Sample	Weight (g)	Rock Unit	Depth (ft)	Well
Core	1,779	Topopah Spring: lithophysal	1189.7-1190.3	USW-G1
Core	927	Topopah Spring: non-lithophysal	1226.8-1226.9	USW-G1
Core	1,767	Calico Hills: lithics in matrix	1474.8-1476.0	USW-G1
Core	1,778	Bullfrog: saturated	2314.4-2315.7	USW-G1
Outcrop	14,500	Topopah Spring	surface	Busted Butte outcrop

[a]Information supplied by the U.S. Geological Survey, Mercury, NV.

Table 3.2. Sieve analysis of crushed sample of Busted Butte outcrop[a]

Sieve No. range	Weight (g)	Particle-size range (μm)	Percent of total
-70/+100	564.7	<210/>149	23.5
-100/+170	689.6	<149/>88	28.7
-170/+200	196.3	<88/>63	8.2
-200/+325	438.6	<63/>44	18.3
-325	512.7	<44	21.3
Total	2401.9		100.0

[a]Analytical samples (which were proportional to the above weight fractions)were obtained from each of the particle-size fractions by using a riffle sample splitter. The remainder of the ground fractions were combined, mixed for several hours in a V-blender, and then riffled to appropriate size storage samples (50 and 100 g).

Table 3.3 Analyses of J-13 well water

Constituent	Reference J-13[a] (mg/L)	Reference J-13[a] (meq/L)	J-13-1 (mg/L)	J-13-1 (meq/L)	J-13-2 (mg/L)	J-13-2 (meq/L)
Mg	2.1	0.17	2.0	0.16	1.9	0.16
Si	31.	4.3	30.	4.3	29.	4.1
Fe	0.04	0.002	<0.03	<0.002	0.21	0.01
Sr	0.05	0.001	0.034	0.0008	0.03	0.0007
Ba	0.003	0.00004	<0.02	<0.0003	0.02	0.0003
Ca	14.	0.7	12.	0.6	12.	0.6
Li	0.05	0.007	–[b]	–[b]	<0.2	<0.03
K	4.9	0.13	4.4	0.11	4.6	0.12
Al	0.03	0.003	<0.2	<0.02	<0.2	<0.02
Na	51.	2.2	56.	2.4	52.	2.3
meq/L		7.51		7.57		7.29
Anions						
F^-	2.2	0.12	2.0	0.11	2.0	0.11
Cl^-	7.5	0.21	7.0	0.20	6.0	0.17
PO_4^{3-}	0.12	0.004	<5.	<0.16	2.0	0.06
NO_3^-	5.6	0.09	11.	0.18	9.0	0.15
SO_4^{2-}	22.	0.46	18.	0.36	16.	0.33
CO_3^{2-}	0.0	b	0.0	–[b]	0.0	–[b]
HCO_3^-	120.	1.97	102.	1.67	104.	1.70
meq/L		2.85		2.52		2.52
Other Analyses						
pH		7.1		7.4		7.2
		b		6.8[c]		6.8[c]

[a]DANIELS 1982. W. R. Daniels, et al., Summary Report on the Geochemistry of Yucca Mountain and Environs, LA-9328-MS, Los Alamos National Laboratory, Los Alamos, NM, 1982.

[b]Not determined.

[c]These pH values were obtained immediately upon opening the jugs of well water; the higher pH values were taken after the samples had been removed and had been exposed to air for approximately one day.

Table 3.4 Concentrates for preparation of synthetic J-13 well water

Concentrate number	Volume for 1 L synthetic J-13 (mL)	Concentrates: Constituents	Concentrates: Volume prepared (L)
1	100	0.04663 g MgO 81 µL 48% HF 0.2561 g $Mg(NO_3)_2 \cdot 6H_2O$	2.0
2	10	0.0100 g $LiNO_3$ 0.00240 g $Sr(NO_3)_2$ 0.00183 g $BaCl_2 \cdot 2H_2O$ 0.00727 g $Fe(NO_3)_3 \cdot 9H_2O$ 0.01412 g $Al(NO_3)_3 \cdot 9H_2O$ 24 µL 1 M H_3PO_4	0.20
3	100	0.789 g $CaSO_4 \cdot 2H_2O$ 0.06917 g $Ca(NO_3)_2 \cdot 4H_2O$ 0.2325 g $CaCl_2$	2.0
4	17.06	29.56 mg/mL SiO_2 4.76 mg/mL NaOH	(previously prepared)
5	10	0.3195 g $NaHCO_3$	0.20

Table 3.5. Carbonate, bicarbonate and hydroxyl ion concentrations before and after pH adjustment of synthetic J-13.

Sample	pH	CO_3^{2-}	Concentration (meq/mL): OH^-	HCO_3^-	Total alkalinity
Unadjusted	10.7	0.00056	0.00158	-	0.00214
Adjusted	7.0	-	-	0.00210	0.00210

REVIEW AND ASSESSMENT OF INFORMATION ON GEOCHEMICAL CONDITIONS AT THE HANFORD, WASHINGTON, CANDIDATE HLW REPOSITORY SITE

Part 1: Ambient Geochemical Conditions at the Hanford Site

Information sources: outcrop samples, drill cores, *in situ* and laboratory measurements of the physicochemical properties of groundwaters.

Major findings: a wealth of information on host-rock characteristics, temperature, pressure, and groundwater characteristics.

- Host-Rock Characteristics

  (1) Rocks at the Hanford Site consist of flat-lying, layered basalts that are intercalated with sedimentary interbeds and overlain by Quaternary and Recent alluvium.

  (2) The basalts are fine-grained, occasionally microporphyritic, tholeiite basalts that consist principally of various amounts of the primary phases plagioclase, pyroxene, iron-oxide minerals, and glassy mesostasis.

  (3) Secondary minerals in the basalts--which occur mainly in fractures, flow tops, flow bottoms, and vesicular zones--vary widely in proportion and composition from flow to flow but are typically iron-rich smectite, zeolites (usually predominantly clinoptilolite), silica minerals, calcite, and pyrite.

- Temperature

Rocky Coulee basalt:	47.7 to 49.7°C.
Cohassett basalt:	49.7 to 52.7°C.
McCoy Canyon basalt:	55.2 to 56.8°C.
Umtanum basalt:	56.8 to 59.5°C.

- Pressure

  Pressures at the depths of candidate-repository horizons (~1000 m) are:

  lithostatic -- 20 to 30 MPa,
  horizontal -- 45 to 75 MPa,
  hydrostatic -- ~10 MPa.

REVIEW AND ASSESSMENT OF INFORMATION ON GEOCHEMICAL CONDITIONS AT THE HANFORD, WASHINGTON, CANDIDATE HLW REPOSITORY SITE

Part 1: Ambient Geochemical Conditions at the Hanford Site (cont'd)

- Characteristics of Grande Ronde Groundwaters

  (1) Dominance relationship of principal chemical constituents by weight: sodium > total silica > chloride > sulfate > total carbonate > fluoride > potassium > calcium > magnesium.

  (2) Principal dissolved gas: nitrogen.

  (3) However, immediately beneath the RRL, Grande Ronde groundwaters are unusually saline and contain significant amounts of dissolved methane.

  (4) pH: measured values range from 8.7 to 10.6, the mean value is 9.5 ± 0.5 (1σ).

  (5) Eh: values measured with platinum electrodes range from +0.35 to -0.2 V, while calculated values range from -0.38 to -0.53 V.

REVIEW AND ASSESSMENT OF INFORMATION ON GEOCHEMICAL CONDITIONS AT THE HANFORD, WASHINGTON, CANDIDATE HLW REPOSITORY SITE

Part 2: Expected Geochemical Conditions in the Disturbed Zone of an NWRB at the Hanford Site

(1) Available information is sketchy.

(2) Predictable events: initial increase in repository temperature, groundwater resaturation, hydrothermal activity, gradual return to ambient conditions.

(3) The timing and details of postclosure repository events have yet to be specified by DOE/Hanford. Therefore, at present, conclusions regarding expected geochemical conditions in the near-field after repository closure are highly conjectural.

REVIEW AND ASSESSMENT OF INFORMATION ON GEOCHEMICAL CONDITIONS AT THE HANFORD, WASHINGTON, CANDIDATE HLW REPOSITORY SITE

Part 3: Information Needs

1. The field data available at present are insufficient to unambiguously identify radionuclide-release pathways at the Hanford Site.

   Appropriate field data on potential radionuclide-release pathways are needed to:

   -- identify geochemical conditions along the pathways,
   -- develop defensible models of radionuclide transport,
   -- specify radionuclide source terms at strategic points along the pathways.

2. DOE has yet to develop a detailed conceptual model of postclosure groundwater resaturation of an NWRB at the Hanford Site.

   A detailed conceptual model of postclosure groundwater resaturation may be required to: (1) establish near-field geochemical conditions during the postclosure period, and (2) devise defensible predictions of the containment performances of engineered system materials.

3. The data available at present are insufficient to verify the hypothesis that basalt will act as a reductant in the various geochemical environments of an NWRB at the Hanford Site.

   The principal difficulties are that:

   -- measured values of Eh are unreliable,
   -- calculated values of Eh are suspect,
   -- it is not known whether spatial variations of redox conditions are rapid or gradual,
   -- it is uncertain how redox conditions in basalt/groundwater systems vary with temperature.

4. Colloids and particulates are potential vehicles of radionuclide transport in the basalt/groundwater systems at the Hanford Site, but little is known about how these suspended materials might form and evolve.

5. It is uncertain that the effects of radiation are a major concern in: (1) assessing the performance of waste package materials, and (2) establishing defensible source terms at the boundaries of the engineered facility.

   At present, it is extremely difficult to predict the effects of radiolytic reactions in the near-field of a repository during the postclosure and postcontainment periods.

TECHNICAL ASSISTANCE IN GEOCHEMISTRY

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TECHNICAL ASSISTANCE IN GEOCHEMISTRY

PURPOSE/OBJECTIVES

PROVIDE THE NRC STAFF WITH TECHNICAL ASSISTANCE IN THE EVALUATION OF CANDIDATE REPOSITORY SITES IN BASALT (HANFORD SITE), TUFF (YUCCA MOUNTAIN SITE), AND SALT BY:

- COLLECTION AND REVIEW OF THE DOE GEOCHEMICAL INFORMATION BASE
- REVIEW AND EVALUATION OF THE GEOCHEMICAL PORTIONS OF DOE SITE ENVIRONMENTAL ASSESSMENTS AND SITE CHARACTERIZATION PLANS
- ANALYSIS OF THE DOE PROGRAM FOR CHARACTERIZING THE GEOCHEMICAL ASPECTS OF POTENTIAL REPOSITORY SITES
- PROVIDING SHORT-TERM GEOCHEMICAL TECHNICAL ASSISTANCE

TECHNICAL ASSISTANCE IN GEOCHEMISTRY

ACCOMPLISHMENTS

- TECHNICAL REVIEWS

  BASALT – GEOCHEMICAL CONDITIONS
  SOLUBILITY INFORMATION
  SORPTION INFORMATION

  TUFF – GEOCHEMICAL CONDITIONS
  SOLUBILITY INFORMATION
  SORPTION INFORMATION
  MATRIX DIFFUSION

  SALT – GEOCHEMICAL CONDITIONS

- PROCEEDINGS OF WORKSHOP CONDUCTED ON GEOCHEMICAL MODELING

- REVIEWED GEOCHEMISTRY PORTIONS OF DRAFT ENVIRONMENTAL ASSESSMENTS

- LETTER REPORTS AS INPUT TO NRC TECHNICAL POSITIONS

  USE OF HYDRAZINE IN BASALT EXPERIMENTS
  SOLUBILITY
  GEOCHEMICAL CONDITIONS
  SORPTION

- ATTENDED DOE/NRC GEOCHEMICAL WORKSHOPS AND MEETINGS

- GEOCHEMISTRY DATABASE

TECHNICAL ASSISTANCE IN GEOCHEMISTRY

SUMMARY

- IDENTIFIED TECHNICAL ISSUES IN GEOCHEMISTRY THAT NRC SHOULD ADDRESS
- REVIEWED ADEQUACY OF EXPERIMENTAL METHODOLOGY AND GEOCHEMICAL DATA GENERATED BY CANDIDATE HIGH-LEVEL WASTE REPOSITORY SITES
- RECOMMENDED AREAS OF GEOCHEMISTRY RESEARCH RELEVANT TO LICENSING OF CANDIDATE HIGH-LEVEL WASTE REPOSITORY SITES
- MODELING THE GEOCHEMICAL BEHAVIOR OF A HIGH-LEVEL WASTE REPOSITORY IS AN ESSENTIAL PART OF ESTIMATING THE OVERALL SAFETY AND PERFORMANCE OF THE SYSTEM AS A FUNCTION OF TIME

TECHNICAL ASSISTANCE IN GEOCHEMISTRY

FUTURE

- WORKSHOPS NEEDED ON SORPTION, MINERAL STABILITY, AND WASTE PACKAGE SOURCE TERM
- INCREASED EMPHASIS ON DATABASE EVALUATION INPUT
- REVIEW GEOCHEMICAL PORTIONS OF SITE CHARACTERIZATION PLANS AS AVAILABLE
- CONTINUE TO UPDATE TECHNICAL REVIEWS AS NEW DATA IS PUBLISHED
- CONTINUE INPUT TO NRC ON TECHNICAL POSITIONS

SPECIFIC TASKS FOR FY 1986

- PUBLISH TECHNICAL REVIEW ON BWIP SOLUBILITY INFORMATION
- FINISH FINAL DRAFT ON MATRIX DIFFUSION
- COMPLETE DRAFT TECHNICAL REVIEW ON AMERICIUM
- INITIATE DRAFT TECHNICAL REVIEW ON PLUTONIUM
- REVISE DRAFT TECHNICAL REVIEW ON NNWSI GEOCHEMICAL CONDITIONS
- PLAN SORPTION WORKSHOP

LABORATORY EVALUATION OF DOE RADIONUCLIDE SOLUBILITY AND SELECTED RETARDATION PARAMETERS, EXPERIMENTAL STRATEGIES, LABORATORY TECHNIQUES, AND PROCEDURES

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LABORATORY EVALUATION

PURPOSE/OBJECTIVES

PROVIDE THE NRC STAFF WITH AN INDEPENDENT EVALUATION OF DOE'S EXPERIMENTAL AND CALCULATED GEOCHEMICAL DATA RELEVANT TO THE PERFORMANCE OF HIGH-LEVEL WASTE REPOSITORY PROJECTS

- GEOCHEMICAL PARAMETER VALUES AND DATA ACQUISITION METHODOLOGY FOR REPOSITORY PERFORMANCE
  - RADIONUCLIDE SOLUBILITY
  - RADIONUCLIDE RETARDATION
  - GEOCHEMICAL CONDITIONS AFFECTING THESE
- GEOCHEMICAL PARAMETER VALUES AND DATA ACQUISITION METHODOLOGY FOR WASTE PACKAGE PERFORMANCE
  - GEOCHEMICAL CONDITIONS AFFECTING THE PERFORMANCE OF WASTE PACKAGE MATERIALS
  - GEOCHEMICAL CONDITIONS AFFECTING THE RELEASE OF RADIONUCLIDES AFTER PACKAGE FAILURE
- EVALUATE EFFICACY OF GEOCHEMICAL MODELS AND ADEQUACY OF SUPPORTING DATABASES USED FOR SITE PERFORMANCE ASSESSMENT CALCULATIONS OR GEOCHEMICAL MODELING