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ERRATA SHEET

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Proceedings of the U.S. Nuclear Regulatory Commission
NRC Nuclear Waste Geochemistry '83

Delete: Introduction, pages 1-8.

Replace with: Corrected Introduction, pages 1-3.

DIVISION OF TECHNICAL INFORMATION
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1.0 INTRODUCTION: NRC NUCLEAR WASTE GEOCHEMISTRY '83

Office of Nuclear Regulatory Research
United States Nuclear Regulatory Commission
Washington, D.C. 20555

1.1 INTRODUCTION

The objectives of this document are to: (1) present findings of the U.S. Nuclear Regulatory Commission's (NRC) sponsored research in high-level waste (HLW) geochemistry for 1983; (2) identify regulatory research issues which need to be addressed prior to licensing an HLW repository; (3) present recommendations for licensing; and (4) summarize geochemistry research efforts planned for 1984. The research issues have been contributed by the authors and reflect areas of technical uncertainty addressed by the NRC Research Program in geochemistry and are not intended to represent a comprehensive list of the important geochemistry issues which the Department of Energy (DOE) and NRC will need to consider during the licensing process. The findings of the NRC Research Program in geochemistry will be used to provide a technical basis for waste management rulemaking, to provide the NRC Waste Management Licensing Office with information that can be used to support sound licensing decisions and to identify investigations that need to be conducted by DOE to support a license application.

The Commission recently established regulatory framework for licensing disposal of high-level radioactive wastes in geologic repositories by DOE [46 FR 13971 and 48 FR 28194] which will be used to implement applicable Environmental Protection Agency (EPA) standards [40 CFR 191]. The regulations require numerical prediction of the overall repository system and several of its components in order to assess compliance with these standards. Mathematical models based on a risk assessment approach are being developed which will be used to assess uncertainties and demonstrate compliance with the regulatory criteria. A large contribution to overall uncertainty in performance prediction arises from uncertainties in assessing the long-term changes to baseline hydrological and geochemical conditions. A fundamental reason for the uncertainties is that the earth sciences are descriptive sciences which have not traditionally been applied to making long-term predictions.

Therefore, the NRC has established a research program with the objective of developing the capability to accurately assess compliance of DOE license submittals with regulatory criteria. Moreover, NRC has contracted for technical assistance to determine the reproducibility of site-specific data and the sensitivity of calculated discharges to measurement error. Because

existing models are highly uncertain in predicting performance as a result of difficulty in modeling hydrology and geochemistry, the NRC has committed a substantial portion of its waste management research effort in order to understand the processes that cause uncertainties. The NRC needs this research effort to assess DOE's claims of compliance with regulatory criteria.

The projects provide a basis for NRC review of site characterization reports, data produced by DOE laboratories, and in situ site characterization plans and environmental assessments and have been used extensively in the NRC Site Characterization Analysis (SCA) of the Basalt Waste Isolation Project (BWIP) Site Characterization Report (NUREG-0960).

1.2 ROLE OF GEOCHEMISTRY IN LICENSING RADIOACTIVE WASTE REPOSITORIES

1.2.1 Background and Objectives

Geochemistry is perhaps the single most important area of research for assessing whether proposed high level waste repository sites, low level waste repository sites, in situ uranium mines, and uranium mill tailings disposal sites will meet criteria for radionuclide releases. Geochemical considerations are important in assessment of: (1) site characterization; (2) engineered systems including waste form, waste container, and backfill; and (3) long term performance of the system to meet applicable safety criteria. Geochemical considerations are also important in repository development activities such as site selection, pre-closure and post-closure monitoring, and engineered systems design which are not the subjects of NRC research.

One of the major objectives of the NRC geochemistry research program is to provide a basis for assessing geochemical information collected by the applicant during site characterization. A number of current projects are studying the mobilities of radionuclides in natural systems. Research on the speciation and migration of radionuclides from weapons testing fall-out (Simpson et al., 4.2), power plant effluent (Robertson et al., 4.1), mill tailings ponds (Peterson et al., 5.6), and uranium ore body sources (Airey et al., 4.3) are providing the NRC with information on time dependent processes, natural conditions, and characteristics best suited for retention of radionuclides. Several programs are assessing techniques that may provide direct information on site suitability. For example, ground water age dating techniques (Davis et al., 4.4) are being researched to provide information on groundwater and isotope circulation. Isotope disequilibria techniques (Airey et al., 4.3) are being assessed as a means of directly evaluating the mobility of naturally occurring isotopes in proposed sites.

A second major objective of the NRC geochemistry research program is to provide a basis for assessing the source term and near-field migration of radionuclides released from engineered systems and to provide information on the geochemical environment which will affect the performance of those systems. The long term performance of waste forms is being assessed through laboratory studies of radionuclide doped glasses and naturally occurring basaltic glasses (Seitz et al., 5.5). Radionuclide releases from natural ore bodies (Airey et al., 4.3) may provide information on the performance of spent fuel waste forms. Research sponsored by the Australian Atomic Energy Commission (not supported by NRC) indicates that crystalline waste forms may be far superior

to either glass or spent fuel waste forms but at the moment NRC is not sponsoring research on alternatives to waste forms proposed by the DOE program. Studies on the performance of container materials are being covered by the NRC waste package research program. However, the geochemistry program is assessing the effects of radionuclide interactions with metallic containers (Perry et al., 2.2) and interactions between metallic components and backfill systems (Soudek et al., 3.1). The NRC is also conducting research on backfill which is considered to be an important major barrier because it can be engineered to control release rates (Soudek et al., 3.1) and it is relatively easy to test and to assess. Materials proposed for backfill such as smectite occur in natural hydrothermal systems which approximate very near-field repository conditions (Apps, 2.1). Significant attributes of backfill materials (Soudek et al., 3.1) and potential failure mechanisms (Couture and Seitz, 3.2; Peacor et al., 3.3) are being evaluated.

The third major objective of the geochemistry research program is to provide a basis for performance assessment. Codes are being applied to simulate laboratory systems (Carnahan et al., 5.1 in collaboration with Seitz et al., 5.5) and field systems (Peterson et al., 5.6). We are encouraging collaboration between lab and field research and modelers. Initial results (e.g., Carnahan et al., 5.1, Peterson et al., 5.6) indicate that both laboratory and field data collection and modeling techniques benefit. The NRC is also conducting research on mechanisms and processes such as speciation (Perry, 2.2) and precipitation/ dissolution (Silva, 2.3) to which performance assessment model results are most sensitive (Carnahan et al., 5.1).

Groundwater travel time and engineered systems are considered to be barriers to waste migration in HLW regulations. Serious limitations to the performance of these barriers which have often been overlooked are discussed in the following sections. These limitations are discussed to show that knowledge of the geochemistry of a site is necessary to surmount these limitations.

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