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MEETING REPORT

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PURPOSE: Attend the annual meeting of the Geological Society of America

PROJECT TITLE: Technical Assistance in Geochemistry

PROJECT MANAGER: G. K. Jacobs

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SUMMARY

The 1985 Annual Meeting of the Geological Society of America was held in Orlando, Florida from October 27-31, 1985. The meeting appeared to be somewhat less well attended than the meeting last year. Perhaps as a result of the reduced attendance, there were fewer presentations that directly addressed the issue of HLW isolation. However, there were numerous presentations which discussed subjects that are pertinent to HLW repositories. For example, the sessions on rock/water interactions and hydrochemistry included several papers that presented information, theories, or experimental techniques that might be used during site characterization activities at the candidate sites. We have listed below authors and titles of particularly good papers that addressed HLW isolation directly or indirectly, and we discuss some of these in more detail in the next section.

Particularly Interesting and Relevant Papers:

Bair, E. S. and O'Donnell, T. P., Flow Directions and Hydraulic Gradients in the Variable Density Flow System at the Proposed High-Level Nuclear Waste Repository Site in the Texas Panhandle.

Barnes, H. L., Hydrothermal Calculations and Miscalculations, Geochemical Society Presidential Address.

Burnell, J. R., Myers, J., and Coles, D. G., Experimental Study of the Interactions of Nuclear Waste with Potential Waste Package Components from Hanford Site, WA.

Dove, P. M. and Rimstidt, J. D., Wollastonite Hydrolysis in a Mixed Flow Reactor.

Drummond, S. E. and Palmer, D. A., Formation Constants for Aqueous Ferrous Acetate Complexes from Magnetite Solubility Measurements from 100°C to 250°C and 250 to 1250 bars.

Dutton, A. R. and Kreitler, C. W., Recharged or Modified-Connate Water in a Carbonate Bed within an Evaporite Aquitard?

Early, T. O. and Solomon, G. C., Geochemical Constraints on Groundwater Flow Models for the Hanford Site, Southeastern Washington.

Fisher, R. S. and Posey, H. H., Extent of Water-Rock Interactions in Lower Permian Wolfcamp Carbonates, Palo Duro Basin, Texas.

Hackbarth, C. J., Hydrothermal Ore Deposit and Geothermal Analogs of Nuclear Waste Repositories.

Horvorka, S. D., Model for Deposition of Bedded Halite in a Shallow Shelf Setting, San Andres Formation, Palo Duro Basin, Texas Panhandle.

Howard, K. W. F., Jones, P. H., and Thompson, M.J., Contaminant Transport Studies of a ^{14}C-Labelled Polymer Using an Aquifer Simulation Tank.

Knauss, K. G., Beiriger, W. J., Peifer, D. W., and Piwinskii, A. J., Hydrothermal Interaction of Solid Wafers of Topopah Spring Tuff with Ground Water and Distilled Water at 90°C, 150°C, and 250°C Using Dickson-Type, Gold-Bag Rocking Autoclaves.

Mazer, J. J. and Walther, J. V., Steady-State Rate Constants for Dissolution of Basalt and Silica Glass as a Function of pH at 65°C.

Murphy, W. M. and Helgeson, H. C., Mineral Dissolution Rate Control by Surface Reconstitution.

Ortoleva, P., Moore, C. H., Chadam, J., Merino, E., and Hettmer, J., A New Algorithm for Simulating Fluid/Rock Interactions.

Rimstidt, J. D., Groundwater in Granitic Rocks.

Wilson, W. E., Hydrologic Investigations to Evaluate a Potential Site for a Nuclear-Waste Repository, Yucca Mountain, Nevada Test Site.

DETAILS

- Bair, E. S., and O'Donnell, T .P., Flow Directions and Hydraulic Gradients in the Variable Density Flow System at the Proposed High-Level Nuclear Waste Repository Site in the Texas Panhandle.

This presentation addressed the characteristics of regional groundwater flow beneath the candidate bedded-salt HLW repository sites at Swisher and Deaf Smith Counties in the Texas Panhandle. Two major technical points were emphasized.

1. The candidate repository sites are underlain by three regional hydrostratigraphic units: (1) a shallow aquifer system in the Ogallala Formation and Dockum Group that is characterized by groundwaters containing less than 1500 mg/l TDS; (2) a shale and evaporite aquitard (including the target salt horizon) wherein groundwaters frequently contain up to 300,000 mg/l TDS; and (3) a deep aquifer system in the Wolfcamp Series and Pennsylvanian System, which includes groundwaters that typically contain between 50,000 and 200,000 mg/l TDS. Consequently, hydrologic models for these sites must properly account for the fact that groundwaters at shallow depths contain much smaller amounts of dissolved solids and (therefore) are much less dense than the highly saline and dense groundwaters that flow at greater depths.

2. A detailed analysis of hydrologic data for the proposed Deaf Smith County Site indicates a downward-oriented hydraulic gradient across the target salt horizon.

- Barnes, H. L., Hydrothermal Calculations and Miscalculations, Geochemical Society Presidential Address.

This presidential address discussed two aspects of geochemical calculations in detail: (1) standard states and (2) uncertainty analysis. Most relevant to HLW isolation was the discussion of uncertainty calculations. Barnes emphasized that the lack of an adequate uncertainty analysis accompanying geochemical calculations is one of the most significant weaknesses in geochemical calculations at the present time. He urged that anyone performing geochemical calculations begin to include uncertainties with their results. He specifically mentioned analyses of HLW repositories as one area where such accounting of uncertainties is essential. As mentioned in our last monthly progress report (FIN No. B0290), we plan to perform an uncertainty analysis for the uranium system using MINEQL.

- Burnell, J. R., Myers, J., and Coles, D. G., Experimental Study of the Interactions of Nuclear Waste with Potential Waste Package Components from Hanford Site, WA.

This poster session presented the results of an experimental investigation of interactions between spent fuel and GR-4 groundwater--with and without basalt and steel present--under simulated near-field geochemical conditions. Experiments were performed in Dickson-type autoclaves for periods as long as six months, and the compositions of fluids were measured at regular time intervals in order to monitor the progress of rock/water reaction. The most significant results of the experiments are itemized below:

1. Only a few of the major solute components achieved a steady-state concentration during experimentation.

2. The final concentrations of dissolved Cs, Sr, Tc, and various actinide elements were lower in basalt-present experiments.

3. Effects of the presence of steel were most noticeable in basalt-absent experiments. In these experiments the concentrations of aqueous silica dropped steadily as experimentation proceeded, evidently because this silica was reacting with steel to form iron-silicate minerals. By contrast, in basalt-present experiments the concentration of dissolved silica remained high--probably because rates of partial dissolution of basalt glass were sufficiently rapid to keep the concentration of dissolved silica at elevated levels, despite the concurrent formation of iron-silicate minerals.

- Early, T. O. and Solomon, G. C., Geochemical Constraints on Groundwater Flow Models for the Hanford Site, Southeastern Washington.

This paper presented little new information pertaining to the groundwater flow system at the Hanford Site. Most of the discussion was similar to that presented at the last geochemistry workshop (January 1984). However, the presentation does represent the first public dissemination of the conceptual model that vertical flow may be occurring in the area of the RRL within the Cold Creek Syncline.

- Knauss, K. G., Beiriger, W. J., Peifer, D. W., and Piwinskii, A. J., Hydrothermal Interaction of Solid Wafers of Topopah Spring Tuff with Ground Water and Distilled Water at 90°C, 150°C and 250°C Using Dickson-Type, Gold-Bag Rocking Autoclaves.

This poster session described the results of nine short-term (up to 66 day) experiments in which monoliths of Topopah Spring tuff were contacted with J-13 well water at 50-100 bars and 90, 150, and 250°C. The experiments were performed in Dickson-type, gold-bag rocking autoclaves that were sampled periodically in order to monitor the

progress of rock/water reaction. Collectively, the results of the experiments indicate that groundwater composition and the degree of alteration of the tuffaceous monoliths vary systematically with temperature.

The most significant observation regarding groundwater composition was that concentrations of dissolved silica increased significantly with increased experimental temperature--in each case rising to levels indicative of saturation with cristobalite. By contrast, the concentrations of other solute components remained essentially constant or changed only slightly during experimentation.

The tuffaceous monoliths exhibited significantly increased degrees of alteration with increasing experimental temperature. In 90°C experiments the principal result of rock/water interaction was minor dissolution of the primary crystalline phases; evidently, this effect was not accompanied by formation of new secondary minerals. However, in runs performed at 150°C, the principal result of rock/water interaction was the formation of small quantities of poorly crystallized secondary minerals. In 250°C experiments, significant quantities of secondary minerals were obtained--mainly zeolites (dachiardite and mordenite), a pure silica phase (cristobalite?), and minor amounts of a poorly crystallized, K-bearing clay-like phase.

Finally, the authors claimed that all of the experimental results described above correlate reasonably well with predictions made by the computer code EQ3/6.

Despite the obvious merit of the work performed by Knauss et al., there are several apparent deficiencies of the research. First, no information was provided on the mineralogical make-up of the tuffaceous monoliths used in the hydrothermal experiments; on the display materials in the booth it was simply noted that the monoliths were made from Topopah Spring "core material." Therefore, at present it is uncertain how much Knauss et al. know about the mineralogy of the tuffaceous monoliths. Second, Knauss et al. provided no justification for the use of J-13 well water as the starting groundwater composition in their experiments. Therefore, in this study, as in most previous experimental investigations of interactions between groundwater and Topopah Spring tuff, it was simply assumed that J-13 well water is representative of the groundwater that will interact with waste package components during the post-closure period.

However, it is not difficult to envision circumstances which would virtually guarantee that the first groundwaters to contact waste canisters in a Yucca-Mountain-hosted HLW repository would have compositions significantly different from J-13 well water. For example, consider the sequence of hypothetical repository events described below.

During the early post-closure period, there is pervasive and prolonged boiling and evaporation of groundwater in the very near field of the repository. As a result of this hydrothermal activity, the tuffaceous rocks adjacent to waste packages are corroded by steam, and groundwaters that flow toward the waste packages gradually vaporize and deposit their dissolved solids.

Eventually the temperatures of waste canisters fall below 100°C, boiling ceases, and (consequently) rates of groundwater vaporization decrease dramatically. At this time, and for the first time, it would be possible for groundwaters to come into physical contact with waste canisters. Moreover, groundwaters that flow toward waste packages at this time would travel through steam-corroded and precipitate-encrusted tuffaceous rocks prior to contacting the waste canisters. These altered rocks would almost certainly contain significant quantities of soluble solids precipitated during earlier boiling/evaporation events and, for this reason, it is likely that the first groundwaters to migrate through these rocks would resolubilize these solids and thus become significantly more saline.

Therefore, in the scenario outlined above, the groundwaters that first contact waste canisters would have compositions significantly different from J-13 well water.

- Wilson, W. E., Hydrologic Investigations to Evaluate a Potential Site for a Nuclear-Waste Repository, Yucca Mountain, Nevada Test Site.

This talk summarized current U.S.G.S. hydrologic investigations at Yucca Mountain. However, the speaker provided no new technical information about the site, and controversial subjects--such as matrix flow versus fracture flow of groundwater in the unsaturated zone--were not discussed.