GEOHYDROLOGIC ISSUES SUMMARY

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GEOHYDROLOGY
EXECUTIVE SUMMARY OF MAJOR ISSUES

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No meaningful assessment of groundwater travel time has been made.

One of the most critical considerations in siting a High Level Nuclear Waste Repository (HLNWR) is the release of radionuclides to the accessible environment through groundwater transport. Because of this, the qualifying, favorable, potentially adverse, and disqualifying conditions of the Geohydrology Guideline 10 CFR, 960.4-2-1 are based on groundwater travel times.

To determine whether the conditions are met the Department of Energy (DOE) contractors developed a conceptual model of the geohydrologic system in the Gibson Dome region. The model that was used for estimating pre-waste emplacement groundwater travel times and flow paths for the different hydrostratigraphic (water containing) layers of interest was a three dimensional regional groundwater flow model. One of the most fundamental assumption underlying all analyses and computations in the model, is that flow velocity can be derived by averaging the volume of flow per unit time that crosses a unit area, by that area, ($ft^3/sec \div ft^2 = ft/sec$). This is known as a Darcy flux model (Chapman et al., 1984, page 5). Conceptually, this is equivalent to treating flow as though it were through primary porosity, (the rock matrix), rather than through secondary porosity (the cracks and dissolution features in the rock), (ONWI-503, 1984). This is shown graphically in Figure (1) taken from Freeze and Cherry (1979). The DOE used a model that assumed conditions like 1.a) rather than 1.b).

Whether flow is through primary or secondary features, this model may be suitable for a first estimate of flow volume in a regional groundwater resource problem. However, if flow through secondary porosity is important, this model is not at all appropriate for the local problem of defining groundwater travel times from a HLNWR. The reason for this is that in a homogeneous granular porous media a contaminant travels as a predictable, probabalistically defined plume, where the average linear velocity adequately characterizes the velocity of the contaminant. In a fractured or dissolved media, on the other hand, contaminants will travel at much higher velocities through those secondary features even though the flux of water (volume of water per unit time passing through a specified cross-sectional area), in either case is the same (Freeze and Cherry, 1979, page 409).

Contaminant transport and velocity in a fractured or dissolved media is a very complex, difficult to model, phenomenon with the complexity being a function of the insitu fracture network. In

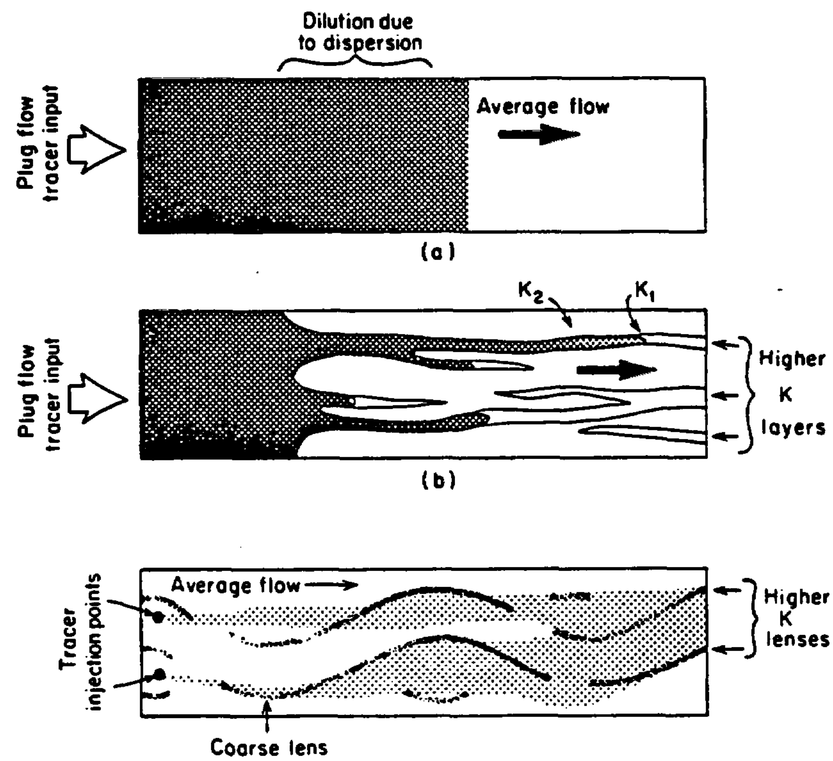

Figure 1 Comparison of advance of contaminant zones influenced by hydrodynamic dispersion. (a) Homogeneous granular medium; (b) fingering caused by layered beds and lenses; (c) spreading caused by irregular lenses.

Figure 1 taken from Freeze and Cherry (1979).

general, depending on the aperture and wall roughness, the velocity of groundwater in a fracture or dissolution feature will be larger than the bulk average velocity by several orders of magnitude (Chapman, et al, 1984).

The DOE's own data indicates that secondary porosity is in fact important in the hydrostratigraphic units being modeled (ONWI 491, Table 4-2). Throughout the text of ONWI 503 and 290, frequent references are made of these secondary porosity effects. In this situation, alternative conceptual models should have been explored, including fracture network models. If all possible conceptual models were to be compared, the model output presented by the DOE as "evidence" of sufficiently long travel times would be the least conservative. In effect, their model could have included a fracture that ran directly from the proposed repository site to the Colorado River and they still would have predicted extremely long travel times because the high velocities in the fracture would be hidden by averaging over large blocks of extremely low permeability.

Eventually these concerns must be addressed. In the NRC's Draft Issue-Oriented Site Technical Position for Salt Repository Project (SRP), Paradox Basin Sites (September 1984), presented by the Nuclear Regulatory Commission, these concerns are all considered in assessing a license application. Specifically, when modeling groundwater flow:

> A range of defensible conceptual models of the groundwater flow systems of the geologic setting should be developed that brackets all reasonable interpretations of data. Subsequent investigations will then be used to rank alternative conceptual models on the basis of relative likelihoods.

Because the DOE relies on only one model, and because their own data indicate its lack of suitability to this site, no meaningful assessment of groundwater travel time was made.

<u>The DOE has not proposed adequate postclosure radiologic monitoring.</u>

Because the groundwater flow assumptions used in predicting "likely flow paths" from the repository do not represent geohydrologic conditions at the site (see above comments and references), any monitoring plan based on these assumptions is necessarily flawed. Low density fractures and dissolution features would be difficult, if not impossible to monitor. If repository failure were to occur in such an environment, isolating the contaminant plume would be very difficult (Duffy and Hall, 1984).

How can a performance assessment of the site be made, or a monitoring network be designed without some knowledge of the local flow system? Fracture density logs of the one DOE core were never mentioned in the EA working papers.

<u>There is an insufficient data base for any reasonable description of the geohydrologic system.</u>

The description of the three hydrostratigraphic units defined in the Environmental Assessment working papers of Davis and Lavender Canyon rely almost entirely on data from the GD-1 borehole. In a 1000

km^2 region south and west of the study site there are no data points in any of the hydrostratigraphic units from which to validate model results (Duffy and Hall, 1984).

The model is essentially driven by generic boundary condition inputs and the output is called a "prediction" of groundwater flow. Without field data any set of assumptions could be called "realistic." Because there is no "ground truth" any performance estimate inferred from this output is meaningless. It is recognized that this kind of generic modeling cannot be expected to produce results that are accurate for any specific site (Anderson, 1983).

Pump test data from the Lisbon Valley wells are either ignored or discounted as "not representative" when parameterizing the groundwater model, (ONWI-503, page 76). Yet these data are the only regional information that could be used in defining a statistically based confidence limit on the parameters. The Pinkerton Trail formation may not be characterized by any reliable field data and yet it is assumed to be an aquitard (flow inhibitor), (ONWI-503, page 40). This assumption was made despite the fact that what data exists, indicated it has a higher measured permeability than the overlying Paradox.

GEOCHEMISTRY SUMMARY

The DOE has not included an assessment of existing critical information.

EA working papers Section 3.2.7 of Chapter 3 attempts to summarize the estimated physical and chemical conditions in the repository. The summary fails to include or reference much available information relevant to characterization of the repository, establishing radionuclide transport mechanisms, determination of retardation mechanisms and the development of an adequate transport model.

The mineralogical and physical properties of adjacent aquifers are not mentioned. Clay mineralogical transformations that substantially decrease sorption characteristics have been documented yet never find their way into the draft EA working papers. Critical chemical and physical variables that affect migration of radionuclides are not mentioned (i.e., pH, temperature, activities of complexing ligands), (Chapman et al., 1984, Section 2).

Data do not support the conclusion in the EA working papers.

EA working papers section 6.3.1.2.4 of Chapter 6 is an assessment of whether or not the qualifying, disqualifying, favorable and potentially adverse conditions are met for the Dissolution Guideline 10 CFR 960.4-2-6.

The data do not support the conclusion that the qualifying condition for dissolution is present. Dissolution of salt in this geologic environment is well known. Chemical analyses of brines in the aquifers adjacent to the Paradox formation indicate that dissolution is occurring near the candidate site. Total dissolved solids data (Thackston, 1981), from the region show extreme scatter which is most likely explained by small scale flow and dissolution through the Paradox formation. The question of how proximate active dissolution is to the proposed repository is conjecture, but a prudent geoscientist would conclude that dissolution is very likely at Davis Canyon and that the Qualifying Condition is not met.

OUTSTANDING QUESTIONS & CONCERNS

The Division of Oil, Gas and Mining has continually commented on the Department of Energy High Level Nuclear Water Repository reports and assessments since 1981. Concern has historically been focused upon the issue of the inadequate geohydrologic data base and the resultant uncertainty and risk associated with decisions based upon this lack of data. The Division has repeatedly questioned the standards governing the comparison of sites with varying data bases and differing analytical assumptions (Testimony of the State of Utah to House Committee on Interior and Insular Affairs, October 8, 1984, Technical Agenda, page 40).

In the past year, the Division and its contractors uncovered fundamental flaws in the DOE's Environmental Assessment working papers of ground water flow velocity (see above comments). Only one conceptual model was used to describe and estimate ground water flow direction and velocity, and GD-1 data indicate that this model may be inappropriate for the geohydrologic conditions. The following is a list of questions and concerns that must be answered before the next phase of site selection. These questions are necessarily related to the basic problems described as "major issues" in this summary and are not mutually exclusive.

1. Will the effect of secondary permeability on groundwater velocity ever correctly be taken into account when modeling travel time? What is the basis for using only one conceptual model and not many?

2. Are small scale heterogeneities that influence groundwater flow velocities to be incorporated into the modeling effort? If so when? At what stage of decision making?

3. Can uncertainty or risk be described quantitatively using standard risk analysis procedures? The scarcity of data coupled with the large variability in existing data points makes accurate prediction improbable. Can a meaningful performance assessment based on these predictions be made?

4. How much data are required as a minimum data base for site selection for characterization? The multiple barrier system concept requires that the geologic subsystem be independently capable of isolating high level nuclear wastes, therefore sufficient data must be gathered to adequately characterize an unknown system.

5. How are site selection (for characterization) decisions made when each potential site has had a different conceptual approach applied to the available data base, (see Geohydrologic Technical Review). Different sites also have differing data bases, even though they may be in the same host rock type.

6. How can postclosure radiologic monitoring guidelines be evaluated when only one conceptual model was used to predict ground water flow?

   What provisions has DOE made for radiologic monitoring of the host rock and surrounding units during waste emplacement and the period of retrievability ? How will DOE provide assurances that radionuclide transport is following the predictions of modeling during the past closure containment period of 10,000 years? Can errors in predictions (leakage) be identified in the geohydrologic environment during post closure? How? If monitoring wells are planned, to what depth/formation will they be drilled and where will they be located? Will the integrity of the host rock be jeopardized through a monitoring effort? Can

DOE avoid drilling in Canyonlands National Park if the radius of the controlled area from the site is in the neighborhood of 10 Km (6.2 miles)? The park boundary is currently 3100 feet from the proposed Davis Canyon repository. How will DOE mitigate radionuclide leakage if detected outside the established control area during the waste emplacement or pose closure containment period.

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