HLWYM HEmails

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To: dpickett@swri.edu
Subject: NASR review
Attachments: Comments on DOE report.rev.doc

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David,

Attached is my review of the NASR. (Let me know if you want a WordPerfect file or other formatting.) I enjoyed reading it and consider that it is a significant step up from past DOE analogue treatments. Thanks for inviting me to do this work. I spent about 20 hours working on it and I will send an invoice very soon. I understand that my CNWRA contract expires on August 12.

My recommendation for a study to use analogue data to test (validate) existing PA models is not a new one, but it is a serious one. I can imagine that it would make a nice Master's thesis.

The Nopal isotope data need detailed review from us (you) beyond the level I devoted to the report as a whole.

Bill

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Comments on Natural Analogue Synthesis Report (CRWMS M&O TDR-NBS-GS-000027 Rev00 ICN 02, May 2002)

Prepared by William M. Murphy
For CNWRA
August 2002

This commentary provides a brief and somewhat informal review of the Natural Analogue Synthesis Report. The entire report was examined. Comments are mainly directed toward general principles and relevance of individual sections of the report. The main observation of this review is that the report is admirably comprehensive and relevant. The main weakness of the report is that specific applications to performance assessments for Yucca Mountain are absent or weakly developed in most cases. Despite its substantial contributions, it would be inappropriate to regard this report as a conclusion of analogue studies for Yucca Mountain. It is better viewed as a background document, which provides a basis for initiating or developing analogue studies.

A valuable follow-up activity would be to make careful and detailed comparisons of the analogue studies identified in this report (and others) to specific components of performance assessments for Yucca Mountain. Much effort has been devoted in analogue studies to developing the conceptual basis for performance assessments, e.g., identifying what processes should be considered. Without neglecting the continuing role of analogues to provide conceptual model insights, it is possible now and would be productive to use analogue data to evaluate (partially validate) assessments that have been conducted. Are results of existing performance assessment models realistic in the context of analogue data?

This lengthy report provides a broad view of natural analogue studies related to the proposed repository at Yucca Mountain, reflecting a realistic and knowledgeable view of analogue applications. The comprehensive view of potential analogue applications is an important philosophical advance over parochial views of the role of analogue studies advocated previously by the DOE Natural Analogue Review Group.

It is not fruitful to belabor strict distinctions between natural analogue studies and contemporary field or engineering studies. Relations and contrasts between studies at different scales and in different contexts should be exploited, and the report successfully develops these relations in many cases. However, in some cases where traditional natural analogue studies could be conducted, contemporary engineering studies are described as if they were analogue studies. Examples include the Salton Sea corrosion studies and the INEEL waste site tracer tests.

The introduction to the report appropriately recognizes that many natural systems may be irrelevant to specific performance issues for Yucca Mountain. However, a number of apparently irrelevant systems are described in the report. Examples include limestone caves, near surface lava tubes, and wooden underground support which have no clear

mechanical analogy. In general, studies at Oklo are irrelevant to Yucca Mountain despite their broader scientific significance.

Similarly, the general introduction reasonably recognizes limitations in analogue applications, but at some points discussions imply greater significance to analogue studies than is warranted. For example, the Cappadocia excavations are related to Yucca Mountain and provide a reasonable comparison. However, fundamental differences are noted, particularly the degree of welding. Nevertheless, it is concluded that openings in tuff at Yucca Mountain should be stable on the basis of the Cappadocia excavations, which is an overstatement.

In numerous cases potentially valuable analogue studies are noted, but little or no work has been done. For example, the Linwood/Moline analogue is interesting and would appear to provide the opportunity for useful studies. How well do thermal effects models for Yucca Mountain work for the Linwood case? Another example is Los Alamos adsorption beds which are described in the report as analogous. They appear to provide a good opportunity for testing performance assessment transport models; i.e., a real validation study, but apparently the study has not been done.

An excellent use of analogue data noted in the report is to discern and elucidate how mineral alteration can be a sensitive function of environment. However, conclusions regarding schoepite stability at Shinkolobwe appear to be misapplied in the context of Yucca Mountain. Schoepite may not be the stable phase at Shinkolobwe on a long geologic time scale, but schoepite is abundant at Nopal on a time scale relevant to the repository. In fact, if schoepite is a transient metastable phase at Yucca Mountain, it may have more relevance to performance (i.e., radionuclide retention and releases) than the long term stable phase(s) at Shinkolobwe.

A reasonable survey of literature is provided on waste form studies, but the review is mostly uncritical and limited in detail, with loose or even unreasonable applications to Yucca Mountain.

The relevance of the specific Yucca Mountain environment is stressed, in principle, in using natural analogue studies. However, a number of studies are discussed without making environmental comparisons. For example, the study of josephinite is interesting, but the conclusion that it is relevant to Yucca Mountain is not based on any evaluation of the environments that led to its stability in comparison to the Yucca Mountain environment.

Relations between chromite (chromium oxide) weathering and the behavior of Cr (chromium metal) in a Ni-Cr alloy are vague at best.

The survey of seepage analogues is a good approach, and the idea to study capillary shadow analogues is a good one and should be pursued as suggested in the report. However, there appears be a bias in the report toward identifying seepage analogues that

show no seepage. Why are the tunnels at Rainier Mesa neglected as seepage analogues? Aren't some closed tunnels at Rainier Mesa now flooded?

The INEEL field test appears to be an interesting study with potentially pertinent results bearing on reliability of flow and transport modeling. Although it is not a natural analogue study in the traditional sense, its value shouldn't be discounted. Do comparisons of the INEEL site and Yucca Mountain include consideration of differences in redox potential of water, particularly with regard to radionuclide transport? The radionuclide transport study suggests reducing conditions are consistent with Am and Pu profiles, but speculates that conditions are more oxidizing at greater depth, and notes there are no redox data in the Table of chemistry for the site. Failure to recognize this critical aspect of transport chemistry detracts from potential applicability of the INEEL study.

Nopal studies are important, but only minimal effort is made to relate the data to Yucca Mountain. Most DOE sponsored Nopal studies noted in the report are yet to be conducted. An important observation is that seasonal variability is a possible explanation for differences between LANL and CNWRA uranium-series isotope data for Nopal. This idea should be pursued further. Seasonal or transient aspects of transport in the Nopal environment could have important implications for open versus closed system behavior and transport modeling in Yucca Mountain performance assessments.

Nice connections are made between hydrothermal fracture flow, Cl-36, and field studies. This kind of integration of analogue studies with field studies and modeling studies is a good development of multiple lines of evidence.

Hydrothermal systems analogues are well described. Basic features related to Yucca Mountain are recognized. Conceptual models for Yucca Mountain are consistent with these systems. Although the coupled thermal-hydrological-chemical section is authoritative, quantitative applications to performance assessment or model validation are very limited. One direct application is testing the FLOTRAN model for Paiute Ridge. Essentially it shows that the modeling fails in important respects, which is a negative but important result. A technical question is: are permeability and porosity coupled to mineral precipitation in the FLOTRAN modeling. The Matyskiela work on Paiute Ridge is cited, but the dramatic variations in permeability reported in that study seem to be neglected.

Marysvale and Long Valley hydrothermal systems studies seem at best to be tangentially relevant because the major observations apply to reducing conditions.

It is stated in the report that models for the Yucca Mountain repository show no effects due to coupled thermal-hydrological-chemical processes. However, the discussion of this modeling seems disconnected from the discussion of natural analogues, and the model results are not apparently supported by analogue results. One main conclusion is that hydrothermal analogues are different than Yucca Mountain in being bigger. The one effort at validation of thermal-hydrological-chemical models with analogues (i.e., Paiute Ridge) generally failed.

Saturated zone transport analogues are good and raise important questions about colloid transport and conservative U transport, but no applications are developed to Yucca Mountain performance assessments.

The dose section makes connections to performance assessment better than other sections in evaluating dose conversion factors as well as confirming conceptual models. In addition to the dose analogue applications, Chernobyl data could be used to test models or at least to make comparisons to models for radionuclide transport and to fuel dissolution rates in oxidizing conditions.

The observation that microorganisms destroy “hot particles” from Chernobyl fallout prompts the conclusion in the report that the biological half life of radionuclides may be less than the nuclear half life, so the latter is conservative for Yucca Mountain. This conclusion could be wrong. Destruction of hot particles does not destroy nuclides; radionuclides could become more available for entry to the biosphere with degradation of hot particles.

Chernobyl data are highly relevant to the volcanic dispersal scenario. (It’s astounding that Yucca Mountain continues be considered seriously even though a volcanic dispersal consequence analysis is required.)

The summaries of volcanism and seismicity analogues are good, although the volcanism section is brief. Seismicity may indeed increase fracturing, but the rocks have been subjected to 12 million years of seismicity, so effects should be apparent already. Generally the conclusion drawn from analogue studies that seismicity is not a serious problem is credible.