CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Field Examination of Lithophysal Rocks at Yucca Mountain
Project No. 20.06002.01.262
AI No. 20.06002.01.262.609

DATE/PLACE: July 17–18, 2006
Yucca Mountain, Nevada

AUTHOR(S): Kevin Smart [Geosciences and Engineering Division (GED)] and
Randy Fedors [U.S. Nuclear Regulatory Commission (NRC)]

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PERSONS PRESENT:

Kevin Smart (GED), Randy Fedors (NRC), Jack Parrott (NRC), Drew Coleman [U. S. Department of Energy (DOE)], Chris Lewis (Bechtel SAIC Company, LLC), Dave Buesch (United States Geological Survey), Alan Mitchell (Yucca Mountain Project Technical Coordination Office), and various Yucca Mountain Project operations staff

BACKGROUND AND PURPOSE OF MEETING/TRIP:

The purpose of this field work was to examine surface and subsurface exposures of Topopah Spring Tuff lower lithophysal rocks in the enhanced characterization of the repository block and Exploratory Studies Facility in the context of fracture mapping by the DOE. It is expected that the seepage conceptual model and rubble pile characterization will both benefit from the site visit.

SUMMARY OF PERTINENT POINTS:

(1) Staff encountered some logistical problems (detailed in the Problems Encountered section below).

(2) Staff compared surface and subsurface exposures of both upper and lower lithophysal rock and concluded that it would be inappropriate to use upper lithophysal rock samples as a proxy for the lower lithophysal interval in future seepage or infiltration experiments.

(3) Staff concluded that a semiquantitative understanding of rubble size distributions could be achieved by examining fractured outcrops of lower lithophysal rock and nearby talus piles on the southern end of Fran Ridge.

(4) Staff observed that the unventilated portion of the enhanced characterization of the repository block (beyond the bulkhead at station 17 + 63) is very damp. Yucca Mountain Project staff reported that this interval has 100-percent humidity and a high mold spore count that required staff to use full-face powered air portable respirators.

(5) Staff observed fractures in the enhanced characterization of the repository block and Exploratory Studies Facility that were marked as terminating blindly in solid rock but that appeared to extend farther or were connected to other unmarked fractures. Staff concluded that fracture connectivity in the enhanced characterization of the repository block and Exploratory Studies Facility may be greater than previously portrayed in Yucca Mountain Project reports.

(6) Staff learned that Yucca Mountain Project operations personnel periodically remove fallen rock from behind the wire mesh in the Exploratory Studies Facility and enhanced characterization of the repository block, but it is unclear whether DOE has communicated this to the NRC or if the locations, timing, and extent of rockfall have been documented.

(7) The location of a small scale thermal test in the lower lithophysal section (station 57 + 80 m) of the Exploratory Studies Facility was observed. Apparently, rock moisture was also monitored, thus providing information on changes of effective thermal conductivity with rock saturation. Similar tests may be performed in the enhanced characterization of the repository block. The intent of the test was apparently to estimate in situ effective thermal conductivity including the effect of lithophysae at a scale of slightly more than 1 cubic meter [33 ft]. The effect of lithophysae on heat transfer has not been factored into thermal conductivity distributions used for DOE thermohydrological simulations. Hence, the results of these tests, when documented, should be reviewed by NRC.

SUMMARY OF ACTIVITIES:

The importance of observing the lower lithophysal unit in the enhanced characterization of the repository block is that it contains a complete section of the unit; the Exploratory Studies Facility only contains a small portion of the lower lithophysal unit. The afternoon of July 18 was spent in the main drift and south ramp of the Exploratory Studies Facility where a very short section of lower lithophysal rock is exposed. Staff also observed the area in the south ramp where the unexpected seepage event occurred in the spring of 2005.

Given the limited time available, staff made the following observations:

(1) Staff compared surface exposures of the Topopah Spring Tuff upper and lower lithophysal rocks on Fran Ridge and concluded that these two intervals were distinctly different in terms of both lithophysal and fracture characteristics. As such, staff believe that it would be inappropriate to use upper lithophysal rock samples as a proxy for the lower lithophysal zone in future seepage or infiltration experiments. However, staff feel that it may be possible to gain a semiquantitative understanding of rubble size distributions by examining talus piles of lower lithophysal rock adjacent to fractured exposures and comparing the fracture characteristics to the clast size distribution (Figures 1, 2). Staff noted that the majority of clasts were inequant or platy in shape.

(2) Topopah Spring surface exposures at Busted Butte were visited, and other surface exposures sites were discussed with Chris Lewis (Bechtel SAIC Company, LLC) and Dave Buesch (U. S. Geological Society). The area above the adit for the Busted Butte

Figure 1. Surface Exposure of Fractured Topopah Spring Tuff Lower Lithophysal Interval on South End of Fran Ridge

Figure 2. Talus Pile of Lower Lithophysal Rocks Adjacent to Exposure Shown in Figure 1

unsaturated zone transport experiment includes a complete section, but the exposures were limited to wash bottoms. The lower lithophysal unit at this location contained a much smaller percentage of lithophysae (<5 percent per Dave Buesch) as compared to that in the Exploratory Studies Facility and enhanced characterization of the repository block. In addition, sites discussed but not visited include (i) an area near the Sandia Quarry west of the Busted Butte adit where lower lithophysal rocks are juxtaposed with other rocks due to faulting, although the quarry is in the upper lithophysal interval; (ii) Castellated Ridge north of Yucca Mountain nearing Prow Pass which also has a complete section, but the exposure is poor and the character of the unit was said to be different than that near Yucca Mountain; and (iii) exposures in several places on the southern end of Yucca Mountain and in Raven Canyon (west of the Lathrop Wells Cone). These areas may contain some lithophysal layers, but the section of Topopah Spring Tuff is vitric and more crystal-rich, compared to the devitrified and crystal-poor section at the potential Yucca Mountain repository footprint.

(3) Staff observed fractures in the lower lithophysal and middle nonlithophysal intervals in the enhanced characterization of the repository block and Exploratory Studies Facility that were marked during original fracture mapping with spray paint to indicate that the fracture terminated at a particular location (i.e., terminated in solid rock). However, our observations indicate that some of these fractures are more continuous than the markings indicate. Fractures changing orientation or stepping over before continuing were recorded as separate fractures by the Yucca Mountain Project staff. This observation suggests that there may be problems with the original fracture data particularly as it pertains to the degree of fracture connectivity. For example, if two long fractures (trace length >1 m [3 ft]) were connected by a short fracture (trace length < 1 m [3ft]), the original data collection procedure of only mapping long fractures would indicate that the two long fractures were not connected. Fracture connectivity is an important aspect of both geotechnical and hydrogeological conceptual models at Yucca Mountain because it influences processes such as drift degradation and seepage.

(4) Ground support along the lower lithophysal section of the enhanced characterization of the repository block was generally the minimum amount required by the mining rules (i.e., ribs holding up wire mesh immediately above the ventilation duct). However, several locations were noted where more extensive wire mesh was needed (Figure 3). At these locations, sparse loose fragments were resting on the wire mesh and possibly related fragments on the side of the invert. Ground support and spalled rock in the enhanced characterization of the repository block was much less than that in the Exploratory Studies Facility. Sizes varied up to a few tens of centimeters in diameter, but staff noted that most clasts were inequant or platy in shape.

(5) Staff learned that Yucca Mountain Project personnel periodically remove fallen rock from behind the wire mesh in the Exploratory Studies Facility and enhanced characterization of the repository block. This material could be a source for the samples needed for seepage and infiltration experiments. If NRC staff and management are unaware that this activity is taking place at Yucca Mountain, it may be necessary for NRC to seek further clarification including the timing, location, and extent of the rockfall removal.

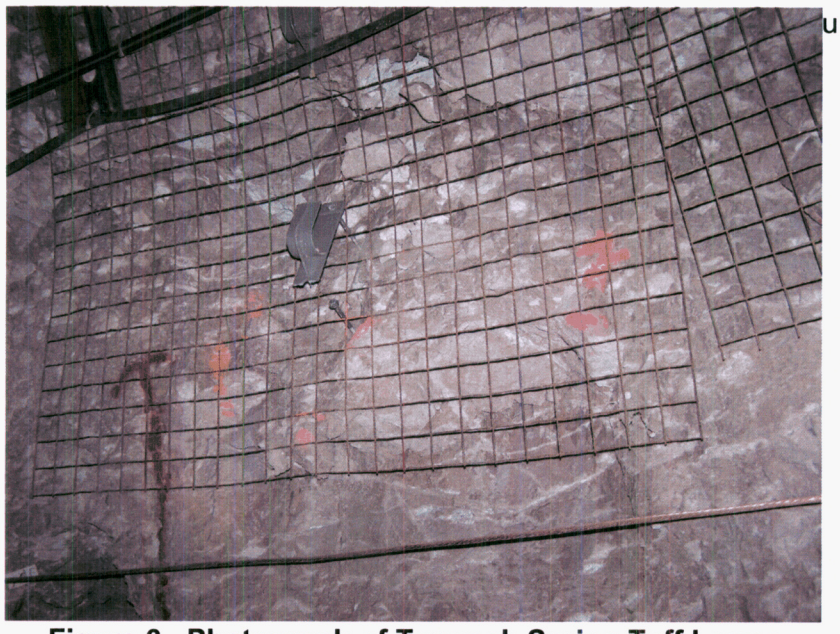

Figure 3. Photograph of Topopah Spring Tuff Lower Lithophysal Rocks That Have Fallen and Are Supported by Wire Mesh in the Enhanced Characterization of the Repository Block

(6) During a discussion of lithophysal rock samples, Yucca Mountain Project personnel stated that they had sent a number of large pieces of Topopah Spring Tuff lower lithophysal rock to NRC in the fall of 2005. After consulting with the personnel at the Yucca Mountain Project Sample Management Facility, it was determined that these samples were sent to Jonathon Icenhower at Pacific Northwest Laboratory, who had indicated to DOE that he was affiliated with NRC.

(7) Seepage patterns on the tunnel walls near the south portal (Figure 4) were still present from the February 2005 seepage event, which occurred during a particularly strong El Niño-related winter precipitation period (Fedors, et al., 2006). Yucca Mountain Project operations staff indicated that they inspect the Exploratory Studies Facility weekly for spalled rock on the tracks or in the rock support mesh or ribs. Thus, it is unlikely that other seepage events in the tunnel were missed. In addition, the seepage patterns on the walls caused by washing dust buildup are still prominent after more than 1.5 years. These patterns have not been noted elsewhere in the tunnel. It is not known how often the enhanced characterization of the repository block is inspected for spalled rock, particularly the area beyond the 17 + 63 bulkhead.

CONCLUSIONS:

(1) Staff conclude that the upper lithophysal and lower lithophysal zones of the Topopah Spring Tuff are distinctly different from each other and that it is likely inappropriate to use samples from or characteristics of the upper lithophysal interval as an analog for the lower lithophysal interval. Given the clear differences in both fracture and lithophysae

Figure 4. Photograph of Seepage Patterns on the Tunnel Walls at Exploratory Studies Facility Station 75 + 73.6 Produced by the February 2005 Seepage Event

characteristics, this observation applies to all engineering- or geology-related processes but should be especially considered by staff concerned with rockfall and seepage.

(2) Staff conclude that fracture connectivity in the enhanced characterization of the repository block and Exploratory Studies Facility may be greater than previously thought because the original characterization activities may have inappropriately mapped continuous or connected features as discrete (see recommendations below). A greater degree of fracture connectivity could have a direct impact on conceptualizations of both rockfall and seepage in the drifts.

PROBLEMS ENCOUNTERED:

The content and agenda for the site visit was discussed at an onsite meeting during the first week of April 2006. The visit was originally scheduled for the third week of April, but was postponed until July 2006. Staff planned to spend Monday and Tuesday, July 17–18, conducting inspections of the Topopah Spring Tuff lower lithophysal rocks in the enhanced characterization of the repository block and Exploratory Studies Facility, and Wednesday, July 19, examining surface exposures. Logistics were changed by Yucca Mountain Project personnel. Surface outcrop inspection was limited to approximately 4 hours on Monday. Subsurface work was scheduled for Tuesday and was linked to a fracture tour of the enhanced characterization of the repository block held concurrently with the lower lithophysal examination and led by S. Beason (U. S. Bureau of Reclamation). As a result, staff were permitted approximately 2 hours to briefly examine lithophysal rocks in the enhanced

characterization of the repository block.

Staff planned to spend 2 days examining subsurface exposures of lithophysal rock but were limited to approximately 2 hours in the enhanced characterization of the repository block and an additional 3 hours in the Exploratory Studies Facility. Staff planned to spend 1 day examining surface exposures but were limited to approximately 4 hours. A complete section of the Topopah Spring lower lithophysal interval is present in the enhanced characterization of the repository block, but not the Exploratory Studies Facility. The lowermost two-thirds of the lower lithophysal interval is beyond the bulkhead (enhanced characterization of the repository block station 17 + 63) installed for the now-completed Passive Test. Going beyond the bulkhead required more safety precautions.

As discussed above, staff planned to spend 2 days underground and 1 day on the surface examining exposures of the lithophysal rock. The logistics as established by the Yucca Mountain Project staff did not allow for sufficient time to accomplish the goals of this trip (see recommendations below).

PENDING ACTIONS:

None

RECOMMENDATIONS:

(1) Staff recommend that any future field work (particularly field work in the enhanced characterization of the repository block or Exploratory Studies Facility) be carefully explained to DOE and documented so that staff are allowed the time necessary to adequately complete the intended activities. Tasks must be explained in terms of hours needed, not days.

(2) Staff recommend that another notification system needs to be discussed with DOE to avoid NRC visits disrupting or interrupting DOE Yucca Mountain activities. Two new rules significantly affect Exploratory Studies Facility and enhanced characterization of the repository block visits: (i) all Yucca Mountain Project activities must be stopped in the areas of the tunnel or drift visit; these include Yucca Mountain Project operations and science activities and (ii) a dedicated train must be within 600 m of any tunnel or drift activity.

(3) Staff highly recommend that future field work activity be planned to reassess the nature of fracture connectivity in both the lower lithophysal and middle nonlithophysal intervals of the Topopah Spring Tuff. Evaluation of the DOE detailed mapping of panels would be a priority. Spot checks of areas where only data for the detailed line survey were collected would also be useful.

REFERENCES:

Fedors, R., K.J. Smart, and J. Parrott. "Hydrological and Geological Features Contributing to a Seepage Event at Yucca Mountain." EOS Transactions of the American Geophysical Union 87(36), Joint Spring Assembly Supplement abstract H43A-03. 2006.

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8/14/06
Date

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8/15/06
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