GeoTrans

~~Teknekron~~
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per S. Coplan

May 26, 1982 - 01

Mr. Seth Coplan
U.S. Nuclear Regulatory Commission
Washington, DC 200555

Dear Mr. Coplan:

Enclosed is a letter report which summarizes and evaluates our visit to NTS as part of your team last week.

Sincerely,

Benjamin Ross

Enclosure

cc S. Silling, NRC
D. Vogt, Teknekron

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Summary and Evaluation of NTS Site Visit
17-19 May 1982
Benjamin Ross

The Nevada Nuclear Waste Storage Investigations (NNWSI) were organized in 1977 for the purposes of conducting waste-management research at the Nevada Test Site (NTS) and investigating NTS as a potential repository site. I visited NTS on 17-19 May 1982 as part of an NRC team to review the current status of repository investigations at NTS. The purpose of this trip was to prepare NRC staff and contractors to review the Site Characterization Report (SCR) and subsequent licensing documents and to permit exchange of information and ideas between the NRC and DOE programs.

Status of the DOE Program

After examining several areas in the Test Site area, NNWSI has chosen a candidate area on Yucca Mountain, at the southwestern edge of NTS. The candidate area, shown in Figure 1, is a structural block, most of which lies just outside the Test Site. If the repository is located in the vadose zone, another area just to the north may also be considered as part of the repository area.

A drilling program is now under way on the edge of the block. Approximate locations of past and planned future boreholes are shown on the figure. The drilling program is planned to circle the block; locations in the center of the area are being avoided to prevent damage to the integrity of a future repository. Construction of a test shaft, which will be in the central portion of the area, is to begin next year.

Four units are currently under consideration as possible repository host rocks. From shallowest to deepest, they are the Topopah Springs and Calico Hills members within the Paintbrush Tuff, and the Bullfrog and Tramm members of the Crater Flat Tuff. The Lithic Ridge member, a deeper unit, may also be considered. The Topopah Springs and sometimes

also the Calico Hills lie above the water table on Yucca Mountain; the others are in the saturated zone. A decision among these units is scheduled for December; however, it is possible that the choice will be made only after data has been obtained from the exploratory shaft.

The regional hydrology of NTS has been extensively studied and has been the subject of much modeling work. As the system is now understood, ground water from the Yucca Mountain area discharges at Alkali Flats and perhaps also at Furnace Creek Ranch in Death Valley. Water levels observed in test wells in the study area and to the east show no measurable hydraulic gradient (all but one lie within a range of one or two meters), except that the water table at G-2 is about 300 m higher than elsewhere. Hole G-2 was drilled with mud and is to be retested to check the measurement.

Regional data indicates that there should be a substantial gradient from west to east in the area of Yucca Mountain. One hypothesis which would explain the absence of a gradient at the Mountain and to the east is that the hinge line at the western side of the mountain is an impermeable barrier. Hole H-6 is planned to the west of the mountain to test this hypothesis.

No tests have been conducted to measure heads at different depths in Yucca Mountain. However, the uniformity of the composite heads that have been observed, even though wells have been completed to quite different depths, suggests an absence of vertical gradients. It is possible that the regional carbonate aquifer underlies the tuffs of Yucca Mountain; however, it has not been found at depths to 6000' and geophysical evidence indicates that tuffs extend at least to 10,000'.

A final observation concerning the hydrology is that it is suspected that flow is governed more by structural features than by stratigraphy. The same stratigraphic units have been found to have differing hydrologic properties in different boreholes.

While much modeling has been done for the regional hydrology, NNWSI's "performance assessment" program is just beginning. The program was formally begun in January 1982 and is located at Sandia. At the start of FY83, the generic NWTS performance assessment program will be ended, and the NNWSI program will have sole responsibility for modeling at NTS.

More than 400 scenarios which might be studied have been identified. The intention is to analyze the consequences of these scenarios; a probabilistic risk assessment does not seem to be planned. The codes which will be used have not yet been chosen; those under consideration are listed in Table 1. Also yet to be defined are any statistical methods which may be used to evaluate uncertainties.

Validation of models is seen by the program as a major issue. NNWSI believes (and we agree) that it will not be possible to have a repository performance model which is fully "validated" by comparison to field data - certainly not by the time models would be used in the licensing process. The question still to be decided is how one demonstrates that a model gives results which are reliable enough. NNWSI's intention is to employ some as-yet-undefined combination of benchmarking, code verification, and field validation.

If the repository is located above the water, another important issue must be addressed: what is the physics of flow and transport in the deep unstaurated zone. The NNWSI staff feels that the usual theories of unsaturated flow were developed for near-surface soils and their applicability to a repository hundreds of meters below must be reconsidered. A particular concern in this evaluation will be the importance of fracture flow in some tuff units.

Evaluation

The NNWSI performance assessment program is in a very early stage, and at this point it is possible only to comment on general directions rather than specifics. In general, the project management seems to appreciate the limitations of complex repository performance models and to understand the degree to which the inevitable limitations on availability of data will affect modeling strategies. It is yet to be seen how well this philosophic approach will be translated into a modeling program.

A critical determinant of the future success of the performance assessment program will be how well it is integrated with the hydrology program and with the development of arguments for licensing the site. The U.S.G.S. hydrology program is already engaged in modeling the regional flow. Close cooperation between the two program elements (something not yet evident) will be needed to ensure that the data and interpretations developed by the hydrology staff are fully reflected in performance assessments.

It is particularly important that the performance assessment program reflect a coherent strategy adopted by overall NNWSI management for proving that the site is safe. Otherwise, the results of its calculations might be of limited relevance to the licensing process. As an example, consider the modeling that might be done if the repository were to be located above the water table. Several comments made by senior management suggested that in this case a good deal of reliance would be placed on extreme bounding calculations to demonstrate safety. (In our opinion, such an approach would not be unreasonable in view of the unknowns and uncertainties associated with the vadose zone.) If the program moves in this direction, it would be important to orient the performance assessment activities toward yielding reliable bounding calculations rather than toward detailed modeling of unsaturated flow and transport. Much of the data required by unsaturated-zone models is very difficult, if not impossible, to obtain. Use of models which require large amounts of data might detract from confidence in bounding arguments rather than strengthen it.

The foregoing discussion should by no means be taken as an argument against acquisition of more data on the unsaturated-zone hydrology of the area. The hydrological exploration program to date seems to have concentrated almost entirely on the saturated zone. Even if licensing is to be based on simple limiting arguments, more data on the hydrology of the vadose zone seems necessary to provide an adequate understanding of the site. In contrast to the saturated zone, where a reasonably coherent and thorough exploration program seems to be under way, little was said at the meeting about plans for vadose zone investigations. If an unsaturated unit is chosen for repository construction, an expansion of vadose-zone hydrological studies would be called for.

Information Needs

U.S.G.S. has done a considerable amount of further work in modeling the regional hydrology since the published work by Winograd. It would be very useful if the assumptions and results of this work could be obtained.

The NNWSI performance assessment program has not yet generated any results likely to be of much use to NRC. However, two types of information which would be of use to NRC, but probably will not be published with the SCR, are likely to be available within the NNWSI program within a year or two. These are:

- NNWSI's overall strategy for demonstrating that the repository is safe. This would be of great use in guiding NRC's evaluation of NNWSI efforts in performance assessment and many other areas.
- Documentation of computer programs. Many of the codes being considered for use by the NNWSI performance assessment program are undocumented codes available at Sandia. Early documentation and release of those codes which are selected by NNWSI would facilitate NRC documentation and benchmarking efforts.

Conclusion

Except for regional hydrology work being done by U.S.G.S., the NNWSI modeling program is still in a state of infancy. The project management is approaching the problem of predicting repository performance with a realistic philosophy. Whether that philosophy will produce a successful modeling program cannot yet be determined. The outcome will depend largely on NNWSI's success in integrating modeling work with hydrologic data acquisition and interpretation, licensing activities, and project management.

Table 1
Models Under Consideration

Waste Package - ORIGEN, WAPPA

Geochemistry - EQ3/6, PHR81

Flow - MARIAH* (Saturated/Unsaturated), FRACT, TRUST, PATHS, VTT

Heat Transport - COYOTE*, MARIAH*, SHAFT79*, ARRAYF, ADINAT

Solute Transport (near-field) - IONMIG*, MMT, VCB, GETOUT

Geosphere (far-field solute transport and dosimetry) - SWENT, TRACR, WAFE, FEMWATER*, FEMWASTE*, PABLM, DACRIN

Rock Mechanics - SANDIA-ADINA*, NIKE, JAC2D*, DAMSWEL, VISCOT, STEALTH2D

*Codes on line at Sandia

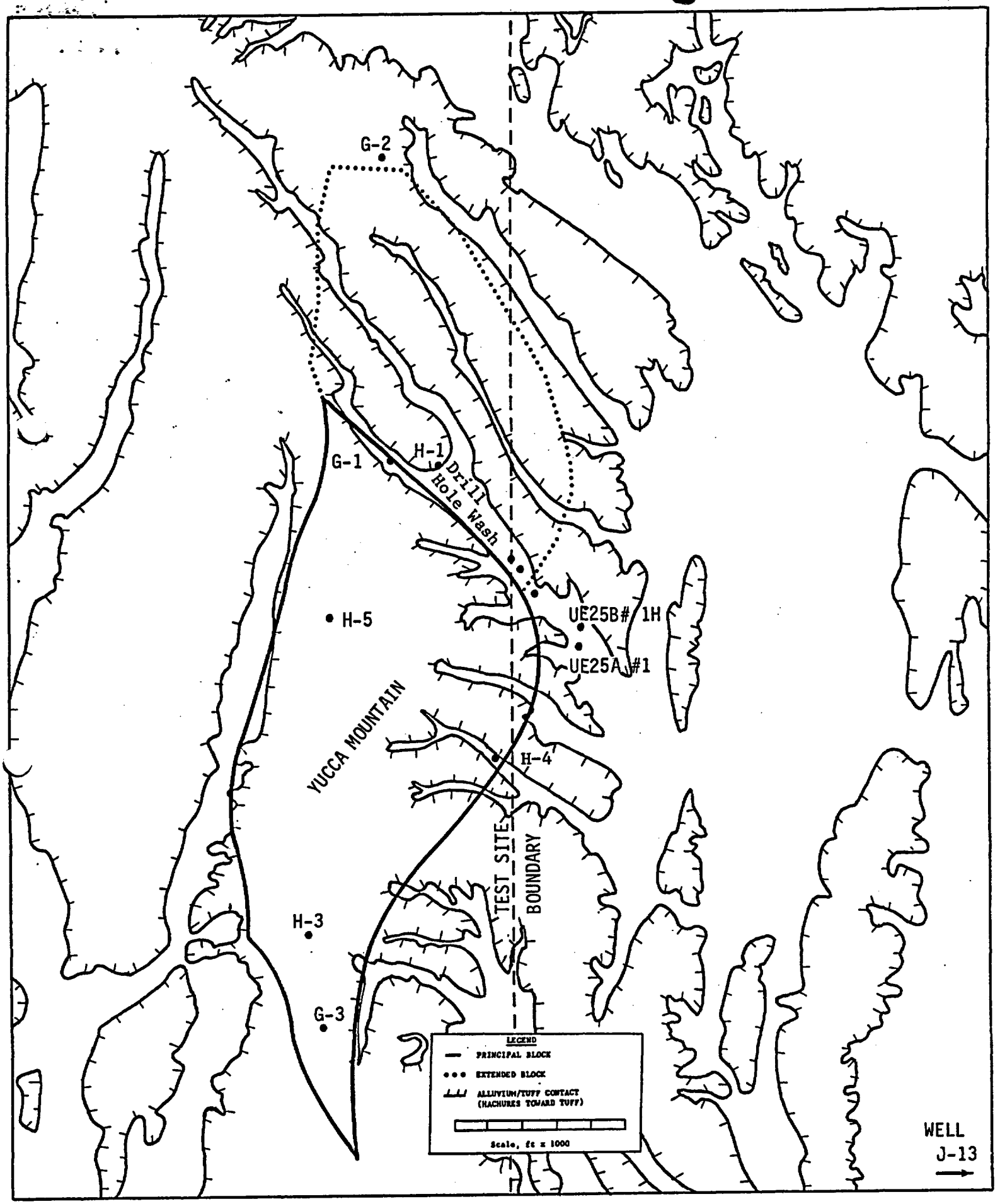

Figure 1. The Candidate Repository Area, Showing Borehole Locations