1992: WHEN THINGS BEGAN TO MOVE AT YUCCA MOUNTAIN

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ABSTRACT

Last June 29, Yucca Mountain, Nevada, located 161 kilometers (100 miles) northwest of Las Vegas, sustained a 5.6 magnitude earthquake. Though some of the older buildings erected nearby were damaged, studies of adjacent mines and tunnels revealed that the earthquake had caused little comparable damage underground. There were no immediately apparent reasons to discount the area as a suitable location for a potential geologic repository for high-level nuclear wastes.

The U.S. Department of Energy (DOE) Office of Civilian Radioactive Waste Management (OCRWM) continues its studies of the mountain. Despite concerted and long-standing political opposition within the state of Nevada that has resulted in long delays, the mountain and its environs teemed with scientific activity throughout 1992. This year, 1993, should prove even more eventful for site characterization.

Can Yucca Mountain safely isolate high-level nuclear waste for the next ten thousand years? This is the pressing question DOE was mandated by Congress in 1987 to pursue. Through OCRWM, the DOE is charged with studying the Yucca Mountain regions geologic, hydrologic, seismologic and meteorological region's properties. Additionally, there are a number of environmental, socioeconomic and transportation studies planned or underway. This paper will examine progress made on the Yucca Mountain Site Characterization Project (YMP) during 1992 and continuing into 1993. Additionally, it will discuss and describe design work on the underground exploratory studies facility (ESF).

The following represent noteworthy milestones achieved in the field in 1992:

- Environmental permits received from the state of Nevada
- Groundbreaking work on the ESF
- Trenches excavated and test pits completed
- Work completed on wells
- Boreholes drilled

EXPLORATORY STUDIES FACILITY (ESF)

The ESF is an underground laboratory designed to enable Project scientists to examine, at depth, the geologic, hydrologic, geo-engineering and geochemical characteristics of the potential repository host rock. The ESF, as planned, will consist of two mined ramps, both excavated down to various levels, 22 kilometers (14 miles) of tunnels, and 173 hectares (70 acres) of surface facilities. YMP engineers have begun ESF site preparation for the installation of Tunnel Boring Machine (TBM) pads. They will begin by drilling ramp boreholes and analyzing core samples. Other activities will include developing ESF geology and stratigraphy mapping methods and procedures.

In 1992, an access road and pad were laid in at NRG-1, the north ramp geologic hole for the ESF. Data from this borehole will assist in the design of high-wall excavation and the design of the tunnel launch chamber for the TBM, which should move into action in 1993. Knowledge of the mountain should increase exponentially when this happens. The TBM, and hopefully several more like it, will cut a 7.6-7.9 meter (25-30 feet)-in-diameter swath through the mountain. Scientists studying the tunnel walls should be able to learn much more than they now know about faulting, water penetration and other features of Yucca Mountain when they complete their research.

Trenches and Test Pits

Since July 1991, 32 trenches have been completed at the Lathrop Wells Volcanic Center, and five more at the Cima Volcanic Field. Lathrop Wells has experienced intermittent periods of volcanic activity. However, rock studies indicate that volcanism is waning throughout the Yucca Mountain area. Trench excavation at Lathrop Wells in September 1993 will provide information on the relative age of lava flows.

During 1992, Project engineers and geologists embarked on other exploratory trenching to evaluate faulting and seismicity in and near the mountain. Four trenches were dug in Midway Valley (where a detailed geologic map is now being prepared) and at Exile Hill; three were excavate across faults in Crater Flat in August, and three more across the Stagecoach Road fault are planned for September 1993. In June 1992, a trench was dug where surface facilities for the ESF might be installed to determine the presence of faults. A map

of the trench is now in progress, and other trenches are being excavated.

Drilling Boreholes

It is not feasible to dissect Yucca Mountain for mapping purposes. One cannot simply lay out the fault lines that may be running through the mountain, or the water table nearly 610 meters (2,000 feet) below. The mountain must be probed succinctly and selectively. Special equipment has been designed for this task, including drill rigs that do not inject water into the ground and dust-suppression systems that keep air pollution to a minimum. Project scientists need to be able to draw accurate inferences about the mountain as a whole. But they also need to be able to restore it as close to its original condition as possible if it does not prove suitable.

Among the drilling programs begun in 1992 was the drilling of neutron access boreholes. Their purpose is to determine the extent to which precipitation penetrates the soil and bedrock on and near the mountain. Between 1983 and 1986, 72 neutron access boreholes were drilled to determine whether the mountain merited further study. Since then, moisture measurements have been taken intermittently in these boreholes, as well as core and cutting (rock fragment) samples.

A set of 12 shallow 18-83 meter (60-272 feet) neutron access boreholes was completed in 1992 to evaluate natural infiltration by rainfall (Fig. 1). Between late September and late June, 512 meters (1,680 feet) were drilled or cored. In July, digging on an additional 12 boreholes began. Three were completed by mid-August, and work on the others accelerated to permit more timely tests of infiltration associated with the abnormally high rainfall at Yucca Mountain last spring. These boreholes yield much useful information about the nature and behavior of underlying water tables.

Water Monitoring

In April, work was completed on well JF-3 as part of the YMPs extensive water monitoring program accepted by the National Park Service and the Nevada State Engineer. The Water Monitoring Program is designed to protect against potentially negative impacts of water withdrawals from wells J-12 and J-13 (both of which will provide water for most site characterization activities).

Earthquakes

Despite the 5.6 magnitude earthquake that rocked the area on June 29, 1992, Yucca Mountain and environs are regarded as relatively stable geologically. Studies of nearby underground mines, tunnels and wells showed that this earthquake wreaked little damage. Even rockfalls appear to have been minimal. Current engineering standards could accommodate significantly greater ground shaking.

The June 29 earthquake was, in fact, a somewhat rare event, exceeded only by two others in the recent historical record (Tonopah in 1910, which registered 6.3 and Caliente, in 1966, with 6.0). The ground shaking is often surpassed in magnitude, it should be noted, by nearby underground nuclear explosions.

Following the earthquake activities, 35 portable seismometers were installed at strategic locations. Several large (greater than 4.0 magnitude) aftershocks were monitored. Activity diminished in mid-July, allowing some portable instruments to be removed. Nine remain for long-term aftershock studies focusing on-site ground motion effects.

Fig. 1. A set of 12 shallow neutron access boreholes was completed in 1992 to evaluate natural infiltration by rainfall.

Early Site Suitability Evaluation (ESSE): Making the Grade

Project scientists have devised a complex and extensive array of criteria Yucca Mountain must meet before it can be adopted as a repository site. An Early Site Suitability Study was completed in January 1992 by nearly two dozen scientists and technicians from a variety of prominent national institutions and companies. The study -- the second of this type thus far undertaken -- tried to identify any features that would point to the mountains unsuitability early in the site characterization program.

The ESSE concluded that 13 of 17 predetermined factors that would make building a repository under Yucca Mountain a bad idea (as outlined in the DOE Siting Guidelines Title 10, Part 960 of the Code of Federal Regulations) were not present. But additional information is still required before a final recommendation as to the sites suitability can be rendered.

Pioneering Activities

Ferreting out the mountains secret, however, is proving to be no mean feat. Very little of this kind of work has been done before. Saturated geological zones have been studied thoroughly around the world. Unsaturated geologic zones, however, have traditionally been of little interest, and were consequently ignored. In many respects, therefore, the science performed at Yucca Mountain is pioneering work that is yielding entirely new information.

DOE's task is compounded by its commitment both to the state and to local American Indian tribes to do as little physical damage to the mountains natural environment as is humanly possible during the site characterization process. And if, at some juncture, the mountain is deemed unsuitable, great efforts are being made to ensure it is returned to as pristine a condition as is possible at the time.

Study Plans in Place

Upward of 60 Study Plans for geology, hydrology, geochemistry, tectonics and climatology have been completed. Air quality, water and other monitoring programs are in place at upward of 600 stations throughout the region. Ongoing investigations of unsaturated zone gas emissions, seismicity, soil conditions, surface flood monitoring, groundwater geochemical sampling, geological mapping and meteorological surveys continue (Fig. 2).

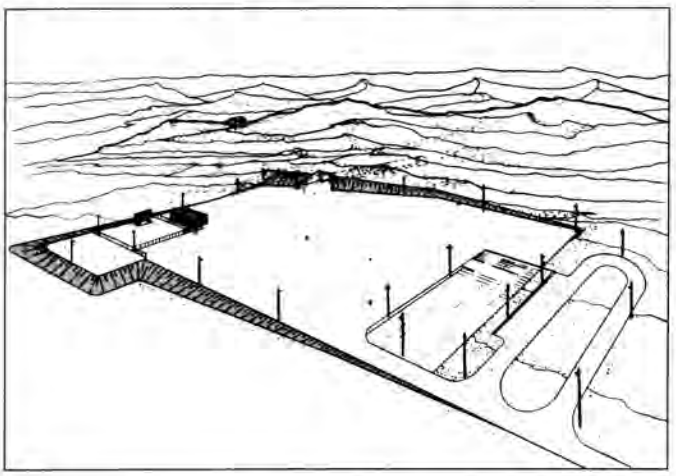

Fig. 2. Conceptual drawing of work taking place on the Exploratory Studies Facility in 1993. The ESF, as planned, will enable scientists to examine, at depth, the geologic, hydrologic, geo-engineering and geochemical characteristics of the potential repository host rock.

Legislative News

Delays on the YMP have consumed several years, during which time high-level wastes continued to pile up nationally. Observers have noted that enough high-level nuclear wastes have accumulated at reactor sites nationwide to guarantee 3.5 shipments a day to a prospective repository -- if one is built -- for the next 20 years.

Individuals and groups who oppose the Project tend to give the impression that their tactics have succeeded -- that little work goes on at Yucca Mountain. This is not the case. The mountain has been teeming with activity for much of the year. Much of this activity, however, proceeds cautiously, and at a pace necessary to ensure thoroughness and conservation.

On the legislative front, progress was made in early October 1992, when Congress drafted a new National Energy Strategy bill designed, in part, to amend health standards on potential carbon-14 dioxide emissions from a prospective repository. The new standards sought by Congress address their real affect upon individuals, rather than an anticipated statistical affect upon the general world population over a period of years. Congress directed the Environmental Protection Agency to set new emission standards at the behest of the National Academy of Sciences and other agencies. Prominent scientists had taken notice of significant disparities in the standards imposed on existing nuclear power facilities within the U.S. and those imposed on potential repositories. These disparities became more glaring in light of largely unregulated $_{14}CO^2$ emissions, most of which do not present a discernible health hazard, from industry worldwide.

Work is slated to begin on the Advanced Conceptual Design (ACD) for a prospective repository. Studies will continue on such repository-related issues as sealing, rock mechanics and high temperature instrumentation.

Quality Assurance (QA)

YMP engineers and administrators intend to issue a revised QA requirement document, while efforts to achieve procedure consolidation and streamlining continue.

Waste Package Design

Efforts will be made to complete the definition of waste package concepts within the framework of the ACD. Work will begin on devising a waste package. Plans will be developed for the Engineered Barrier System that will prevent radionuclides from escaping.

Surface-Based Testing

Project scientists will conduct seismic hazards evaluation and continue seismic monitoring activities. Tectonics studies and trenching of quaternary faults will continue. Drilling of the UZ-16 borehole will be completed, while UZ-14 is begun. Work underway at the Saple Management Facility -- a high technology warehouse for geologic samples collected during site characterization -- will continue. Studies of unsaturated zone hydrology, as well as water table testing will continue. A reduced geochemistry program will be maintained, and the present climatology program will continue.

Conclusion

The rapidly growing body of knowledge coming out of Yucca Mountain is not solely for the benefit of the nation's scientists, engineers and regulators. Project administrators feel a pressing need to keep the public informed about what is found at Yucca Mountain. It is their profound belief that what the public doesnt understand it mistrusts, and what it mistrusts it rejects. Their job is to help the public understand the nature of the work going on at Yucca Mountain.

The hundreds of scientists and engineers working on the Project hail from an impressive array of institutions and organization, among them the U.S. Geological Survey (USGS), which asked to become directly involved in this effort rather than add another layer of oversight.

The DOE and USGS are joined by researchers and technicians from the Lawrence Livermore National Laboratory, the Los Alamos National Laboratory, Sandia National Laboratories, TRW, Science Applications International Corporation, Raytheon Services Nevada and Reynolds Electrical and Engineering Company. Also involved are scientists from a number of prominent universities. Their job is to determine whether Yucca Mountain can be used to isolate radioactive materials.

This Project has generated intense media interest since its inception, most of it highly critical. But there are other facets to the story than are articulated by the Project's critics,

and from time to time the public seems willing to consider them.

To ensure balanced coverage, administrators and scientists take all calls and respond to all queries. Scientists, engineers and administrators deal directly with the media and with the public. They attend public update meetings and field questions at traveling exhibits. Every few weeks, they bus hundreds of people out to the site for a day-long tour of the Project. Most who participate in these weekend tours say they leave convinced that the scientists should be permitted to do their work unimpeded.

Thats all anyone involved in this vital study can ask for.