



Lawrence Livermore National Laboratory

NUCLEAR SYSTEMS SAFETY PROGRAM

WM DOCKET CONTROL CENTER

May 10, 1984
EG-84-036/0184m

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WM Project File
A-0294

WM Project
Docket No.

PDR
LPRB P.V.S.

Ms. Kristin B. Westbrook
Project Manager, MS-623ss
Geotechnical Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: Monthly Management Letter Report No. 13
Progress for the Month of April 1984
NRC FIN A0294
Technical Assistance in Seismo-Tectonic Impacts in Repositories

Dear Ms. Westbrook:

1. PROGRAM OBJECTIVES AND DESCRIPTIONS

The objective of this program is provide technical assistance to the U.S. Nuclear Regulatory Commission (NRC) on waste repositories in the following areas:

- a. Reviewing the uncertainties and limitations of the data and methods used in seismo-tectonic investigations completed by the U.S. Department of Energy (DOE).
- b. Identifying and evaluating issues⁽¹⁾ in seismo-tectonics related to design and construction, long-term repository performance and groundwater flow.
- c. Providing input to the technical basis for NRC technical positions in the area of seismo-tectonics.

Our approach to achieve this objective is to evaluate DOE's seismo-tectonic assessments through review of related DOE reports, including Site Characterization Plans (SCP); participation in workshops and site visits; and identification and evaluation of issues in seismo-tectonics related to design and construction, long term repository performance and groundwater flow. We will provide input to the technical basis for NRC technical positions in the area of seismo-tectonics.

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An issue is a question about a site that is critical to determination of site suitability at the construction authorization stage in terms of the performance objectives and requirements of 10 CFR 60, Subpart E.

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Site characterizations review plans for FY'83 and FY'84 include Hanford-BWIP site, NNWSI, and a salt site. In preparing our reviews, we will consider the guidelines found in Regulatory Guide 4.17, "Standard Format and Content of Site Characterization Reports for High-Level Waste Geologic Repositories," "Review Plan for Site Characterization," and 10 CFR 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories: Technical Criteria."

Specifically, the NRC has requested LLNL to assist the NRC in meeting the needs described above by performing independent review and associated studies based upon LLNL's experience and expert knowledge.

Specific Work Requirements

There are two (2) tasks as follows:

Task 1: Review of the DOE Site Characterization Program in Seismo-Tectonics

- 1.1 Preparatory Site Characterization Program Review
- 1.2 Preparatory Site Characterization Analysis
- 1.3 Review of SCP and SCP Biannual Updates
- 1.4 Reivew of Public Comments

Task 2: General Technical Assistance to NRC

With these tasks and subtasks above, four sets of NRC needs are recognized. First, there is the need to assemble existing data base and adequacy of methods used to collect and interpret the data. Second, there is the need to perform site-specific seismo-tectonic issues (in basals at Hanford, tuff at the Nevada Test Site (NNWSI) and a salt site, yet to be determined). Third, there is the need to identify other additional information needed to perform quantitative assessments to determine if there is reasonable assurance that the site will meet the performance objectives of 10 CFR Part 60. The fourth need is to contribute to the technical basis for NRC technical positions or appendices to the Site Characterization Analysis (SCA) in the area of seismo-tectonics.

2. PROGRESS - APRIL 1984

BWIP

Robert A. Whitney, after the Second BWIP Tectonic Workshop on March 12-15, 1984, participated in a weekend-long field trip with NRC staff. A draft report on this field trip by Whitney was submitted on April 18, 1984. The field-trip team, consisting of Kristin Westbrook, Warren Rehfeldt, Steve Reidel, and Bob Whitney, made the following observations of importance to the BWIP site characterization.

First, they observed an evidence of the anticlines marking the RAW structure on the northwest flank of the Badger Mountain. Second, with DOE and RHO personnel, they inspected the Gable Mountain structure within the Hanford Reservation. The team made an inspection of trenching activities on the southern limb of the anticline and those on the Central Fault System crossing the structure. The inspection of the Saddle Mountains structure in the Sentinel Gap revealed that the geometry of anticlines exposed in this area is indicative of folding accomplished by overthrusting on thrusts which decrease in dip with depth. The team did not observe any evidence to surficial geomorphic features indicative of fault displacement of Holocene age. Third, the Yakima River cut through the RAW structure, the Horse Heaven Hills anticline, and the RAW structure southeast of the Yakima River were inspected. The following observations were made: (1) RAW apparently does not affect the uppermost basalt flows in the Yakima River; (2) geomorphic and geometric features indicate both Rattlesnake Mountain and Badger Mountain are overthrust to the northeast, with fault planes decreasing in dip with depth; (3) the largest anticline between these two structures (just southeast of the Yakima River) has a geometry indicative of overthrusting to the southwest (i.e., fault plane dipping NE); and (4) the Horse Heaven Hills anticline in the area immediately south of Rattlesnake Mountain, is overthrust, with the fault dipping southwest.

In support of Task I, we have prepared the following reading list:

Barrash, W., Bond, J., and Venkatakrishnan, R., 1983, Structural evolution of the Columbia Plateau in Washington and Oregon: American Journal of Science, v. 283, p. 897-935.

Barrash, W., and Venkatakrishnan, R., 1982, Timing of late Cenozoic volcanic and tectonic events along the western margin of the North American Plate: Geological Society of America Bulletin, v. 93, p. 977-989.

Basaltic Volcanism Study Project, 1981, Basaltic Volcanism on the Terrestrial Planets: Pergamon Press, Inc., New York, p. 1286, p. 78-88, 99-105.

Davis, G. A., 1980, Problems of intraplate extensional tectonics, western U.S. in Burchfiel, B. C., Oliver, J. E., and Silver, L. T., co-chairmen, Continental Tectonics, Studies in Geophysics: Washington D.C., National Research Council National Acad. Sci., p. 84-95.

McBirney, A. R., 1978, Volcanic evolution of the Cascade Range: Annual Review of Earth and Planetary Sciences, v. 6, p. 437-456.

Zoback, M. L., and Zoback, M., 1980, State of stress in the Conterminous United States: Journal of Geophysical Research, v. 85, p. 6113-6156

NNWSI

No new progress was made during this reporting period.

SALT SITES

We have identified issues in seismotectonics pertinent to potential nuclear waste management facilities in bedded and domed salts. Issues we identified are necessarily generic in nature because no specific salt sites have yet been determined. However, in our compiling the lists, we have assumed that the bedded salt areas of principal interest are located in western Texas and southern Utah and that the area of interest for domed salt is eastern Texas, Louisiana and Mississippi.

BEDDED SALT SITES

I. Seismic

- A) Seismic Exposure
 - 1) Sources/Strength
 - 2) Frequency of events
 - 3) Attenuation factors
 - 4) Potential for induced seismicity
- B) Fault Movements
 - 1) Activity of "Basement" faults near repository sites.
 - 2) Extent of propagation of faults upward into sedimentary cover near repository sites.
 - 3) Location and tectonic styles of any regional Quaternary faults-evidence regarding extension and changes in frequency of activity with time.
- C) Secondary Seismic Effects
 - 1) Potentials for ground failures (e.g., liquefaction, sliding)
 - 2) Soil/structure interactions
 - a) Surface facilities
 - b) Transitional facilities (e.g., shafts)
 - c) Effects at repository horizon(s)

II. Tectonic

- A) Tectonic Setting - History
- B) Regional Stress Field
 - 1) Directions/magnitudes
 - 2) Role in creating/enlarging salt and related structures (e.g., pillows/anticlines/bedding shears)
 - 3) Potential to mobilize heated salt
 - 4) Potential to further fracture rocks (change characteristics of hydrologic systems)

- C) Uplift/Subsidence
 - 1) Uplift/Subsidence rates at potential repository sites.
 - a) Exposure hazard
 - b) Salt dissolution short of exposure.
 - c) Potential to further fracture rocks (change characteristics of hydrologic systems)
 - d) Risk of fault formation.
 - e) If subsiding - flooding/inundation risks, induced subsidence.
 - 2) Regional uplift/subsidence rates
 - a) Areal warping (changes in patterns/characteristics of hydrologic systems)
 - b) Migrations of dissolution fronts/eroded areas.
 - c) Potentials for "growth faults" in subsiding and hinge areas.
 - d) Regional salt flow

DOMED SALT SITES

I. Seismic

- A) Seismic Exposure
 - 1) Sources/Strength
 - 2) Frequency of events
 - 3) Attenuation factors
 - 4) Potential for induced seismicity } { Recurrence intervals for specified strong motions at repository sites
- B) Fault Movements
 - 1) Boundary and crestal faults at candidate dome(s), ages of last movements, Quaternary history.
 - 2) Areal Quaternary faults, locations, tectonic styles, extension/changes in frequency of activity with time
 - 3) Older faults, locations, ages of last movements, potential reactivation.
 - 4) "Growth Faults" in vicinity of candidate dome(s).
- C) Secondary Effects
 - 1) Potential for ground failures (e.g., liquefactions)
 - 2) Sympathetic movements on boundary and crestal faults.
 - 3) Soil/structure interactions
 - a) Surface facilities
 - b) Transitional facilities (e.g., shafts)
 - c) Effects at repository horizons

II. Tectonic

- A) Tectonic Setting - History
- B) Dome Movements
 - 1) Geologic Stability
 - a) Age of youngest affected strata
 - b) Geomorphic patterns/geodetic measurements
 - c) Growth initiation/rates during various time periods.
 - 2) Potential for thermal reactivation
 - a) Salt flow
 - b) Potentials for failure of boundary/crestal faults through thermal stresses
- C) Regional Stress Field
 - 1) Directions/magnitudes
 - 2) Effects on dome growth history/boundary and crestal structures.
 - 3) Potential to mobilize heated salt
 - 4) Potential to further fracture rocks outside of dome(s) (change far field hydrologic systems).
- D) Regional Movements
 - 1) Areal uplift/erosion
 - a) Potential to expose waste and/or contaminate water-bearing zones as result of future contact/salt dissolution
 - b) Fault formation/reactivation, at domes, uplifted/hinge areas.
 - c) Fracture formation/enlargement
 - d) Areal warping (changes in patterns/characteristics of hydrologic systems).
 - 2) Areal Subsidence
 - a) Inundation risk during isolation phase (not credible as operational hazard for Inner Gulf sites, possible operational hazard if near Gulf site nominated).
 - b) Growth fault formation in subsiding areas.
 - c) Flood risk, operational risk/isolation phase.

PROJECT COORDINATION & MANAGEMENT

We received a NRC letter (Westbrook to Chung, dated 5 April 1984) requesting our reply. We submitted our reply (Chung to Westbrook, dated 19 April 1984) with attachments, as requested. We received a NRC telephone conversation record (dated 12 April 1984) on 30 April 1984. We attended a mid-year review meeting with NRC staff on 25-27 April 1984 (Phil S. Justus, Ben Rice, and Mike Blackford were present). We met with Mike Blackford and Phil S. Justus on "Seismotectonic Investigations in the Regulation of Radioactive Waste Disposal" (draft/invited-paper outline), to be presented at the Specialty Seminar on Seismic Design of Hazardous Waste Repositories, 17-20 July 1984. A new project, "Technical Assistance in Geologic Stability Impacts on Uranium Recovery and Low Level Waste Disposal Sites," was discussed with Ben Rice and Mike Blackford, and a draft Statement of Work reviewed jointly on 27 April 1984.

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3. PLANS FOR NEXT MONTH

During the mid-year project review, 26-27 April 1984, the NRC has identified for LLNL a development of a Draft Site Technical Position (Draft STP) document for the Gibson Dome Site, Utah. The NRC has also identified as an action item for LLNL a development of a Draft Generic Technical Position (Draft GTP) document on, "Seismotectonic Impacts on Design Considerations and Performance Assessment on Underground Repositories." This Draft GTP document is to be submitted before 30 September 1984. The NRC requested a continuous LLNL effort in the development of bibliographical lists of papers and reports on various sites of interest to the project.

4. ESTIMATED PROJECT FINANCIAL STATUS

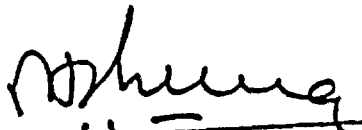
To be submitted separately.

5. LIST OF CONSULTANTS/SUBCONTRACTORS


D. Burton Slemmons, Consulting Geologist (subcontractor).

6. PROJECT CONCERNS

None.



Dae H. Chung
Project Manager



APPROVED
Paul D. Smith
Associate Program Leader
Seismic and Structural Safety

DHC/sr

- cc: W. J. Gallagher, DOE
E. Davis, NRC/NMSS
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H. J. Miller, NRC/NMSS/DWM

ATTACHMENT A

**Project Title: Seismo-Tectonic Impacts in Repositories
 Estimated Monthly Letter Financial Section
 NRC FIN A0294**

A. PROJECT COSTS:

Total Projected Project Cost	Funds Obligated to Date	Balance of Funds by Fiscal Year	
		FY 84	FY 85
\$850K	\$500K	0	\$350K

B. COST ANALYSIS*

	<u>April 1984</u>	<u>Cumulative</u>
Direct Lab Staff Effort - FTE	1.2 FTE-Mo.	1.5 FTE-Yr.
Direct Salaries	8.0	106.3
Materials and Services	0	1.2
AOP Support	0	0
Subcontracts	6.7	40.7
Travel Expenses	1.0	19.2
Indirect Labor Costs	8.2	107.4
Other TID	0	.4
General and Administrative	5.5	37.8
Total Expenses	29.5	313.0
Liens	21.3	21.3
Total Costs and Liens		334.3 (67%) of Funding Available

*Note: These figures are for cost analysis only and may differ slightly from final billing figures.