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WM Project 10
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100/KW/84/03/28/0

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DRAFT MEMORANDUM FOR: Philip S. Justus, Section Leader
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FROM: Kristin B. Westbrook, Project Manager
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SUBJECT: TRANSMITTAL OF DRAFT COMMENTS ON DOCUMENT RHO-BW-ST-19P

This draft memo transmits my draft comments on document RHO-BW-ST-19P.

These draft comments represent my interpretations of ST-19P and my interpretations of contractor comments. As we discussed on March 24, 1984, these draft comments only reflect minor changes from the comments I submitted to you for review on March 9, 1984 which was prior to the BWIP Geology Workshop of March 13 through March 15, 1984.

Kristin B. Westbrook 3/5/

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DRAFT
DOCUMENT REVIEW

"PRELIMINARY INTERPRETATION OF THE TECTONIC STABILITY OF THE REFERENCE REPOSITORY LOCATION, COLD CREEK SYNCLINE, HANFORD SITE" (RHO-BW-ST-19P)

INTRODUCTION AND BACKGROUND

The NRC contractors (U. S. Army Corps of Engineers and Lawrence Livermore National Laboratory) and I have reviewed, "Preliminary Interpretation of the Tectonic Stability of the Reference Repository Location, Cold Creek Syncline, Hanford Site", report number RHO-BW-ST-19P, prepared for the U. S. Department of Energy (DOE) by Rockwell International. This document is a DOE progress report of a general nature which summarizes interpretations and data that were available before May 1982.

As explained in RHO-BW-ST-19P on p. 1-7, DOE's report is a general summary and is based on pre-May 1982 data and interpretations. Our summary comments related to tectonics in "Draft Site Characterization Analysis", March 1983, USNRC NUREG-0960, Vol. I, Chapter 4, Geology, pages 4-3 through 4-10, generally share the same data as RHO-BW-ST-19P and remain applicable. NRC contractors comments on RHO-BW-ST-19P, and my evaluations still have the same basic concerns on BWIP tectonics. However, the comments in NUREG 0960 will not be referenced in this document review. DOE should use NUREG-0960 as a reference in planning future tectonic studies.

The following summarizes Lawrence Livermore National Laboratory's, The Corps of Engineer's, and my comments (Ben Rice contributed to the section on Geophysics) on five major areas of concern: 1) Plate Tectonics; 2) Deformation Rates; 3) Geophysical Interpretations; 4) Seismicity; and 5) Tectonic Conceptual Modeling. These five related categories are separated only to organize the comments. The first part of each comment will be a summary of the major conclusions of RHO-BW-ST-19P and their bases, followed by commentary.

- o Plate Tectonics

  Pasco Basin seismicity, deformation, and potential volcanism may relate to plate tectonics. Pasco Basin tectonics have been addressed in many places throughout RHO-BW-ST-19P. Chapter 6 - "Contemporary Deformation in the Pasco Basin Area of the Central Columbia Plateau", Chapter 7 - "A Review of Tectonic Models of the Columbia Plateau and

Pasco Basin", and Chapter 8 - "A Preliminary Assessment of the Tectonic Stability of the Reference Repository Location", of RHO-BW-ST-19P are especially applicable to Pasco Basin tectonic studies. In these chapters, respectively, are: a) studied deformation rates, (b) summarized tectonic models, and (c) preliminary conclusions suggesting tectonic stability exists for the Pasco Basin.

The relationship of Pasco Basin tectonics and Plate movements is not adequately addressed. For example, assessments of tectonic stability appear to be heavily based on local deformation rates in the Pasco Basin (Ref. RHO-BW-ST-19P, Pages 8-4 and 8-5). Part of interpreting tectonic stability involves assessing the relationships between Pasco Basin seismicity, deformation, potential volcanism, and plate tectonics by looking for possible trends. Studying possible trends of plate movements may give indications about the frequency or liklihood of future events that might not be derived from projecting local Pasco Basin statistical data on seismicity and deformation.

o Deformation Rates

Deformation rates may be important modeling inputs for assessing performance of the geologic repository. Information related to deformation in the Pasco Basin is contained in many parts of RHO-BW-ST-19P. Chapter 6 - "Contemporary Deformation in the Pasco Basin Area of the Central Columbia Plateau" is the most applicable section.

Geodetic measurements of deformation rates are reviewed by DOE on RHO-BW-ST-19P, pages 6-21 to 6-29. The geodetic surveys reviewed by DOE result in deformation data within the accuracy of the instruments used or may be attributable to instability of surveying monuments (Ref. RHO-BW-ST-19P p. 6-21 & 6-22). DOE suggests (RHO-BW-ST-19P, p. 6-29) that the geodetic measurements, and the seismic activity being monitored show slow deformation rates that can be averaged as continuous over long periods of time.

Because of the problems with the accuracy of the supporting data and the short time period during which data has been collected, the NRC contractors and I have difficulty making any preliminary interpretations about deformation rates. It is recognized that geologic processes and events may not continue at uniform rates. Ranges of potential deformation rates, which clearly include consideration of unanticipated processes and events affecting the

geologic setting, should be presented in future documents on tectonic stability.

In addition to data from seismic monitoring stations and geodetic surveys, a key to assessing deformation rates is to tie existing stress to anticipated strain. By assessing the stresses which act to cause deformations, indications may be found of types of deformation likely to occur, and indications might be derived on the likelihood of episodic events. For example, high horizontal stress is suggested at BWIP by discing in borehole cores and hydro-fracture tests. Thrust faulting and potential for significant displacements in episodic events is an example of a deformation scenario which should be considered and discussed as a result of the high horizontal stresses at BWIP.

o Geophysical Interpretations

A genetic relationship between structures beneath the Columbia River Basalt Group and the development of the Yakima Fold Belt structures has been hypothesized in several conceptual tectonic models of the Columbia Plateau (RHO-BW-ST-19P, p. 4-1). The pre-Columbia River Basalt Group stratigraphy and deep structures are being interpreted primarily from magnetotelluric data (RHO-BW-ST-19P, p. 4-2). As presently contoured, the magnetotelluric data doesn't show any dominant structures in the basement similiar to the Yakima Fold Belt surface structures. On page 4-13 of RHO-BW-ST-19P, it is concluded that, the lack of structural trends below the Columbia River Basalt Group suggests a change in character of the regional deformation between the features deeper than the Columbia River Basalt Group and the development of the Yakima Fold Belt surface structures.

As mentioned above, report RHO-BW-ST-19P magnetotelluric survey results are being used to arrive at a suggestion (albiet preliminary) that a genetic relationship between structures below the Columbia River Basalt Group and the Yakima Fold Belt doesn't exist. We also have noted that on RHO-BW-ST-19P, page 3-5, it is suggested that a genetic relationship of plateau structures to structures marginal to the plateau exists. However, page 3-5 goes on to conclude that the Yakima Fold Belt is an exception to this genetic relationship. The Yakima Fold Belt genesis and relationships to other structures is not evaluated in report RHO-BW-ST-19P.

The structure below the Columbia River Basalt Group needs additional definition. The magnetotelluric survey results, as presented, do not

accomplish an adequate assessment of the structures below the Columbia River Basalts Group. A major limitation is a lack of borehole control below the Columbia River Basalt Group. Also, the areal extent of the surveys is limited to a small part of the Pasco Basin extending for a maximum distance of about 20 miles from the RRL to a minimum of about 10 miles. The limited coverage of the surveys makes regional geophysically based structural interpretation difficult. The isopach and contour maps of geophysical results, figures 4-3, 4-4, 4-5, and 4-6, do not show the locations of the survey data points.

The existing magnetotelluric data can be used to give more results for use in structural interpretations. This could be accomplished by integrating the geoelectric layer structure into gravity and aeromagnetic inversion schemes. The results of the gravity and areomagnetic inversion schemes should be compared to the original magnetotelluric results as a means of validating the previous magnetotelluric interpretations. The NRC staff believes that additional plans are needed for assessing the structure below the Columbia River Basalt Group.

o Seismicity

Seismicity monitoring results can indicate patterns of deformation. A seismic monitoring network exists in the Hanford area having the capability to locate earthquakes larger than 1.5 to 1.8 magnitude for the area around the RRL (RHO-BW-ST-19P, p. 6-1). Earthquake swarms are the predominant characteristic of Columbia Plateau Seismicity (RHO-BW-ST-19P, Page 6-9). Earthquake swarms are relatively diffuse without significant concentration of events on single planes (RHO-BW-ST-19P, p. 6-9). An exception is the Saddle Mountains, where swarms coincide with the anticline (RHO-BW-ST-19P, p. 6-7).

Deep earthquakes occur as far down as about 28 Kilometers. They are more infrequent than shallower swarm events (RHO-BW-ST-19P, p. 6-9). Except for possibly the Horse Heaven Hills structure, relationships between presently mapped structures and deep earthquakes have not been observed (RHO-BW-ST-19P, p. 6-12). Also, deep seismicity is not observed to correlate with swarm activity except near the Saddle Mountains Structure, especially the eastern end.

Low deformation rates of 0.02 to 0.04 mm/yr. are estimated for North - South contraction and vertical uplift. These rate estimates are based on studies of focal mechanisms, recurrance relationships, and

seismic moment - average displacement relationships. Chapter 8 of report RHO-BW-ST-19P, p. 8-5 indicates that analysis of local Pasco Basin seismicity is continuing along with additional data collection.

The NRC contractors and I do not believe that the lack of epicenter alignments on a map shows a lack of event concentrations on single planes. Epicenter alignments on maps show up best for steeply dipping fault planes. There is no indication in report RHO-BW-ST-19P of cross sections having been used to determine alignment of hypocenters on faults with moderate, low, or no dip. An examination of various ways to perform more in depth analysis of the spacial & temporal relationships of both shallow and deep earthquakes is suggested to help determine the degree to which seismic events, especially swarms, are related to structure.

o Conceptual Tectonic Modeling

Report RHO-BW-ST-19P tabulates and briefly discusses regionally based conceptual tectonic models, which have been postulated by many independant investigators, in Chapter 7, "A Review of Tectonic Models of the Columbia Plateau and Pasco Basin". Two important conclusions based on the models are in RHO-BW-ST-19P, page 7-22: 1) the suggestion that strain within the Yakima Fold Belt subprovince is concentrated near the anticlines whereas the synclines are relatively undeformed; and 2) the suggestion that tectonic conditions over the past 15 m.y. are expected to continue over the next 1 m.y.

A comprehensive evaluation of the potential impacts of tectonic processes necessitates conceptual models in which all available data are applied to alternative interpretations, both favorable and potentially adverse to site suitability. The summary of regional tectonic models is useful reference material. Intergration of data on seismicity, deformation, stratigraphy, structure, geophysics and plate tectonics which support or invalidate ideas in the models is not presented for various models. I am unable to agree that the tectonic conditions over the past 15 m.y. will continue over the next 1 m.y. because there is not an assessment of the past 15 m.y. based on the data integration of tectonically relevant data and alternative interpretations which could be facilitated by tectonic models. The data on high horizontal stress (see discussion of discing and hydrofracturing in the item on Deformation Rates above) in the Cold Creek Syncline may not support future scenarios of relative non deformation in synclines. Additional plans for formulating, assessing, and presenting tectonic models are needed.

- Additional Comment:

  DOE's report ST-19P has no maps summarizing all the borehole locations, the major outcrops examined, or trenches studied. Clearly identifying the locations of direct observation points of major interest can be referenced to evaluate alternative conclusions and inferences.