Lawrence Livermore National Laboratory

NUCLEAR SYSTEMS SAFETY PROGRAM
L-196

October 26, 1987

Mr. Michael E. Blackford, MS-623ss
Project Officer, WMGT
Geology/Geophysics Section
Technical Review Branch
Division of High-Level Management
Office of Nuclear Materials Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Work Proposal for Remote Sensing Analysis of the BWIP Site Geology (Draft)
FIN A0297

Reference: "Remote Sensing Analysis of Faults and Folds of the Yakima Fold Belt, Washington," by D. B. Slemmons. 4 pages.

Dear Mr. Blackford:

For your considerations, I am enclosing a draft version of the reference proposal prepared by D. Burt Slemmons. This proposal was prepared on the basis of Burt's oral presentation made in Spring 1986 and discussions since that time.

The folds, faults and lineaments that will be covered in this proposed work, will include many of the structures that were visited on the August 24, 1987 field trip program sponsored by NRC. Although the main emphasis will be on the site, boundaries to the northern part of Pasco Basin, and fold-faults impinging this on the site. For reference purposes, comparison will be made with all active folds and faults of the region. The subject study as proposed, may lead to a better broad picture of the tectonics of this area.

If you and staff are interested in this proposal, we would be most happy to discuss it with you at any time.

Sincerely yours,

Dae H. (Danny) Chung
Project Leader

DHC/ic
Enclosure as stated.

cc: H. E. Lefevre, NRC/WMGT

REMOTE SENSING ANALYSIS OF FAULTS AND FOLDS OF THE YAKIMA FOLD BELT, WASHINGTON

NEED FOR ANALYSIS:

First, suggestions have been made that faults and folds of the Yakima Fold Belt were active during late Quaternary and Holocene time. Although several remote sensing lineaments and fault evaluations have been made of this region, these were older studies which did not adequately consider the active tectonic character of fold-fault regions, which may have active faults showing relatively subtle geomorphic expression by low angle faults, or by active monoclinal or anticlinal folds. Key major geologic structures that need a new remote sensing analysis include the RAW structure, the Ahtanum-Rattlesnake Hills, Yakima Ridge Anticlines, the Manastash, Umtanum, Selah Butte Anticlines, and the Saddle Mountain Anticline.

Second, studies of recent earthquakes by Berberian (1982) for Tobas-E-Golshan in Iran (Ms = 7.5), by Philip and Meghraoui (1983) and Meghraoui and others (1986) for El Asnam in Algeria (Ms = 7.25), and by King and Stein (1983) for Coalinga in California (Ms = 6.5), both with co-seismic folding and geomorphic evidence for paleoseismic events also. Although the faulting parameters are appropriate for the size of associated earthquake magnitudes, the folding partly to completely obscures the seismogenic faults. To adequately the seismic potential of these areas, the co-seismic character folds should be evaluated. The Yakima Fold Belt needs this type of assessment for detection of landforms that are diagnostic of active tectonic structures.

Third, recent neotectonic studies of the Yakima Fold Belt, show that northwest trending strike-slip faults are believed by Anderson and Tolan (1986) to be contemporaneous with the anticlinal folds. This indicates the need for a broad-scale regional evaluation for faults, folds and lineaments to provide an intertie between the northwesterly trending right-slip faults and the east-west trending anticlines.

Fourth, the site itself should be investigated by low-sun angle aerial photograph and reconnaissance methods for active faults and lineaments. Specific searches will be made for the geomorphic expression of geophysical and groundwater lineaments.

APPROACH:

To quickly, and at relatively low cost, make preliminary evaluations of the neotectonic character of the Yakima Fold Belt, a remote sensing study is recommended for the BWIP site and adjoining and impinging structures. Earlier studies in this area include regional evaluations of this region for lineaments and major structures by Charles E. Glass and David B. Slemmons in about 1978 for the Washington Public Power Supply System. The

low-sun angle aerial photographs of parts of the Columbia Plateau will be acquired and analyzed, along with old and new radar imagery, and conventional aerial photographs. The study will use and revise where necessary the regional fault maps of the U. S. Corps of Engineers (1981) by using the current knowledge of compressional tectonic features and the "multi" methods of remote sensing study (Glass and Slemmons, 1978; Slemmons, 1981). This investigation will focus on specific faults and folds that will provide key information.

DISCUSSION:

The possibility of active (capable) tectonic features in the Yakima Fold Belt was first recognized by Campbell and Bentley in 1981 for late Quaternary fault scarps along a crestal graben, a hinge fault, and a fan along the Mill Creek thrust fault along the northern edge of the Toppenish Ridge Anticline. They measured fault scarps with heights of up to 4 m, presumably from one faulting event, and a zone of faulting of 32 km length. Slemmons (1982a and 1982b) in NUREG-0892, Supplement No. 1 and NUREG-0309, Supplement No. 3, showed that if the scarps were seismogenic and formed during one event, may have been associated with a Ms magnitude of 7.4. This suggests that this may be a possible maximum earthquake for the Yakima Fold Belt Province, since this is along one of the longest and most prominent structures in the province.

The El Asnam earthquake in Algeria was associated with similar fault scarps, grabens, and anticlinal co-seismic folding along the main anticline (Philip and Meghraoui, 19833; Meghraoui and others, 1986). In Algeria, the surface faulting was also over a length of 32 km and the maximum offset was at least 2 to 5 m, depending on the observations used. Another interpretation is noted by Yeats (1986), who discusses the Toppenish features as a zone of flexural slip and remarked that this could be a "low-shake" earthquake effect. The Yakima Fold Belt features that will be examined in the proposed study will provide initial data that can be used to resolve this issue, or to provide the basis by which additional focussed studies could be made.

The recent abstract of Andersom and Tolan (1986), strongly suggests that there are active E-W folds at the Toppenish Ridge latitude and that they are interconnected with contemporaneous NW-SE trending wrench (right-slip) faults of the Maupin, Laurel, Luna Butte, and Arlington system. These NW-trending strike-slip faults are also mentioned by Plescia and Golombek (1986) as possible tear faults. Their prevalence nd apparent conjugate pattern to folds is summarized in the tectonic map of the region (Fig. 1) from the U. S. Army Engineer District (1981).

The main goal of this study will be to determine the continuity, length, and possible conjugate interrelationship of active-appearing faults and folds.

This study will also focus attention on selection of locations that would be especially appropriate for field checking for "ground truth" or field verification observations.

STUDY METHODS:

1. The imagery will be analyzed by "multi" methods that are described by Glass and Slemmons (1978) and Slemmons (1981). These methods will include regional assessments from synoptic sources plus the high altitude aerial photographs, and the low-sun angle photography.

2. Radar imagery (from presently available U.S. Corps of Engineers sources, plus the new U.S.G.S. images.

3. Landsat imagery (from older imagery that is already acquired). New Thematic Mapper imagery will be added for this project, if it is advisable to add this data. First, imagery at Battelle Northwest, Rockwell International, Geomatrix, and U. S. Corps of Engineers (Seattle, Walla Walla, and Portland offices) will be examined to determine the possible availability of this type of imagery.

4. Low-sun angle photography will be purchased for existing coverage (about 1500 photographs for WPPS) and additional imagery will be flown only for any unphotographed areas that are vital (repository area plus key geologic structures).

5. Imagery analysis of major faults, folds, and lineaments will be recompiled at 1:250,000 scale from the new data from above. Existing mylars of older compilations for WPPS and U. S. Corps of Engineers are available.

6. The imagery analysis will receive a field and aerial reconnaissance check to provide ground verification of key features that show evidence for late Quaternary activity. This stage will include input from Livermore National Laboratory staff and consultants.

7. The compilation of data can be started as soon as existing aerial photographs arrive, in about two months; this is not weather dependent. The acquisition of additional low-sun angle aerial photographs may be weather dependent and may require waiting until near summer months.

REFERENCES:

Anderson, J. L., and Tolan, T. L., 1986, Ages of wrench faulting in interridge basins, southwest Columbia Plateau: Geological Society of America, Abstracts with Programs, v. 18, p. 82.

Campbell, N. P., and Bentley, R. D., 1981, Late Quaternary deformation of the Toppenish Ridge uplift in south-central Washington: Geology, v. 9, p. 5919-524.

Glass, C. E., and Slemmons, D. B., 1978, Imagery in earthquake analysis: State-of-the-art for assessing earthquake hazards in the United States: U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miscellaneous Paper S-73-1, Report 11, 233 p.

King, G., and Stein, R., 1983, Surface folding, river terrace deformation rate and earthquake repeat time in a reverse faulting environment: The 1983 Coalinga, California, Earthquake of May 1983, in the 1983 Coalinga, California, Earthquake, Bennett, J. H., and Sherburne, R. W., editors, California Division of Mines and Geology Special Publication 66, p. 261-274.

Meghraoui, M., Cisternas, A., and Philip, H., 1986, Seismotectonics of the lower Cheliff Basin: Tectonics, v. 5, n. 6, p. 809-826.

Philip, H., and Meghraoui, M., 1983, Structural analysis and interpretation of the surface deformation of the el Asnam earthquake of October 10, 1980: Tectonics, v. 2, p. 17-49.

Plescia, J. B., and Golombek, M. P., 1986, Origin of planetary wrinkle ridges based on the study of terrestrial analogs: Geological Society of America Bulletin, v. 97, p. 1289-1299.

Slemmons, D. B., 1981, A procedure for analyzing fault-controlled lineaments and the activity of faults: in O"Leary, D. W./, and Earle, J. L., editors, Proceedings of the Third International Conference on Basement Tectonics, n. 3, p. 33-49.

Slemmons, D. B., 1982a, Independent assessment of geologic and seismologic data to determine fault capability and earthquake parameters for the Washington, Public Power Supply System Project No. 2, in Safety Evaluation Report related to the operation of WPPS Nuclear Project No. 2, U. S. Nuclear Regulatory Commission, NUREG-0892, p. Hi-H48.

Slemmons, D. B., 1982b, Fault capability and earthquake parameters at the Skagit/Hanford Site of Puget Sound Power and Light and other utilities: in Safety Evaluation Report related to the construction of Skagit/Hanford Nuclear Project, Units 1 and 2, U. S. Nuclear Regulatory Commission, NUREG-0309, Supplement No. 3, p. G1-G56.

U. S. Army Engineer District, 1981, Composite Structure Map of the Columbia Plateau: U. S. Army Engineer District, Seattle, Corps of Engineers, Scale 1:500,000,

Yeats, R. S., 1986, Active faults related to folding: in Wallace, R. E. (editor), National Academy of Sciences, National Academy Press, Washington, D. C., p. 63-79.

WM DOCKET CONTROL
CENTER

'87 NOV -4 A11:10

WM-RES
WM Record File
HH297
LLL

WM Project 10,11,16
Docket No. ✓
PDR ✓
x LPDR (B,H,S)

Distribution:
Blackford

(Return to WM, 623-SS)

4195