INTERPRETATION REPORT

RIVER SEISMIC REFLECTION SURVEY

LINE WO-05X

STATE OF WASHINGTON

FOR

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

BY

WESTERN GEOPHYSICAL COMPANY OF AMERICA

MAY, 1983

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I. Introduction

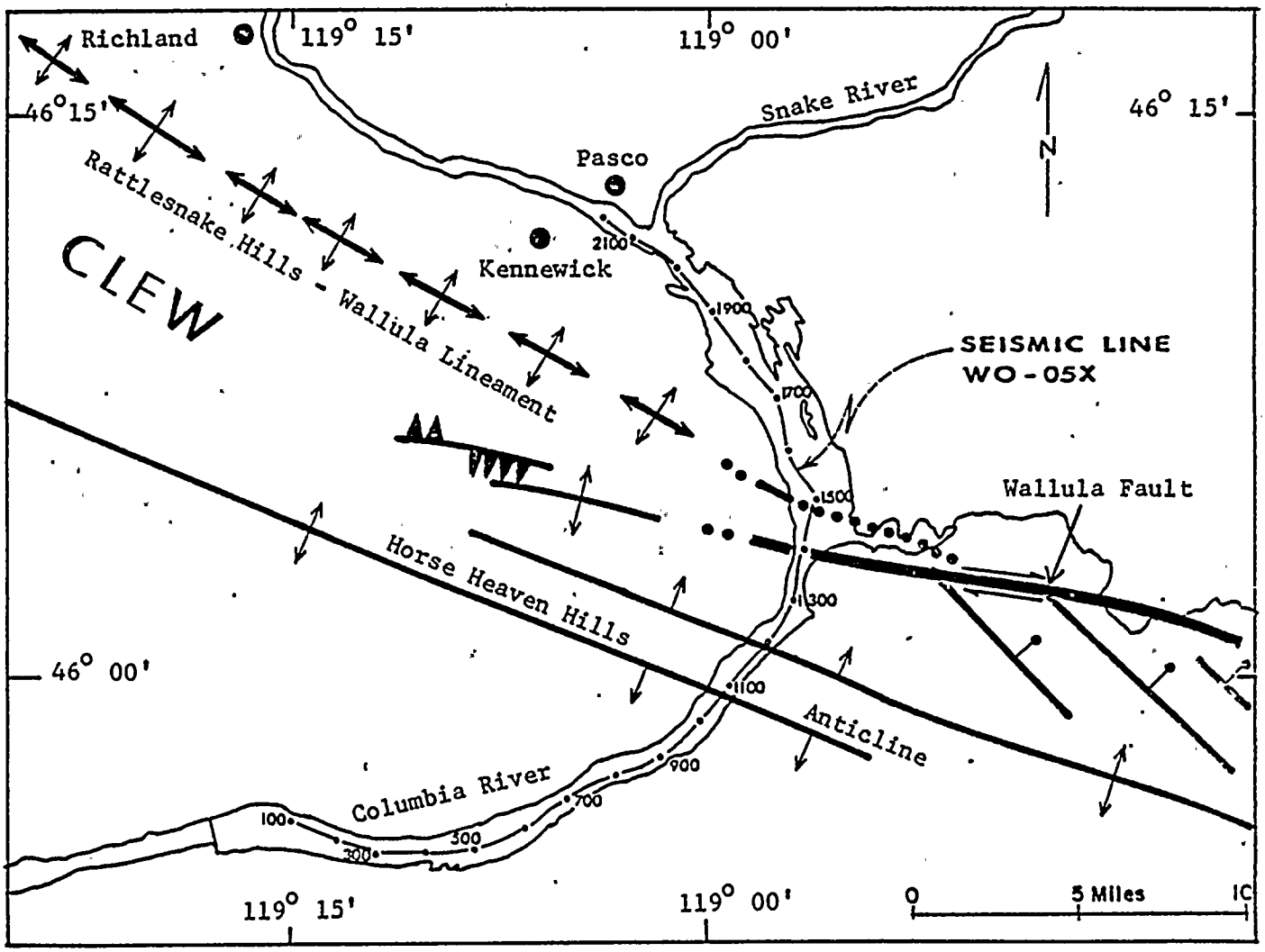
In February, 1980, Western Geophysical Company of America obtained a proprietary marine seismic line, designated as Line WO-05X, of approximately 35 miles along the Columbia River in the State of Washington. The surface configuration of this line is of a semi-circle as dictated by the river boundary. Its location and the local geologic features are shown on Figure 1. This seismic section was obtained from multiple channel recordings of 1200% fold. The detailed field parameters used are listed in Appendix I.

The quality of data is poor as it is affected by the near surface formation which consists of basalt or weathered basalt. The state-of-the-art processing was applied to improve the signal-to-noise ratio. However, the final result is still far from satisfactory. The detailed processing procedures are listed in Appendix II.

II. Local Geology

Regional stratigraphy and structures are discussed in detail elsewhere and shall not be repeated here. Only important features related with the interpretation of this seismic line are briefly discussed.

Stratigraphically, geologic units exposed in this area range in age from Late Miocene Columbia River Basalt series to Holocene Aluuvium.



LEGEND

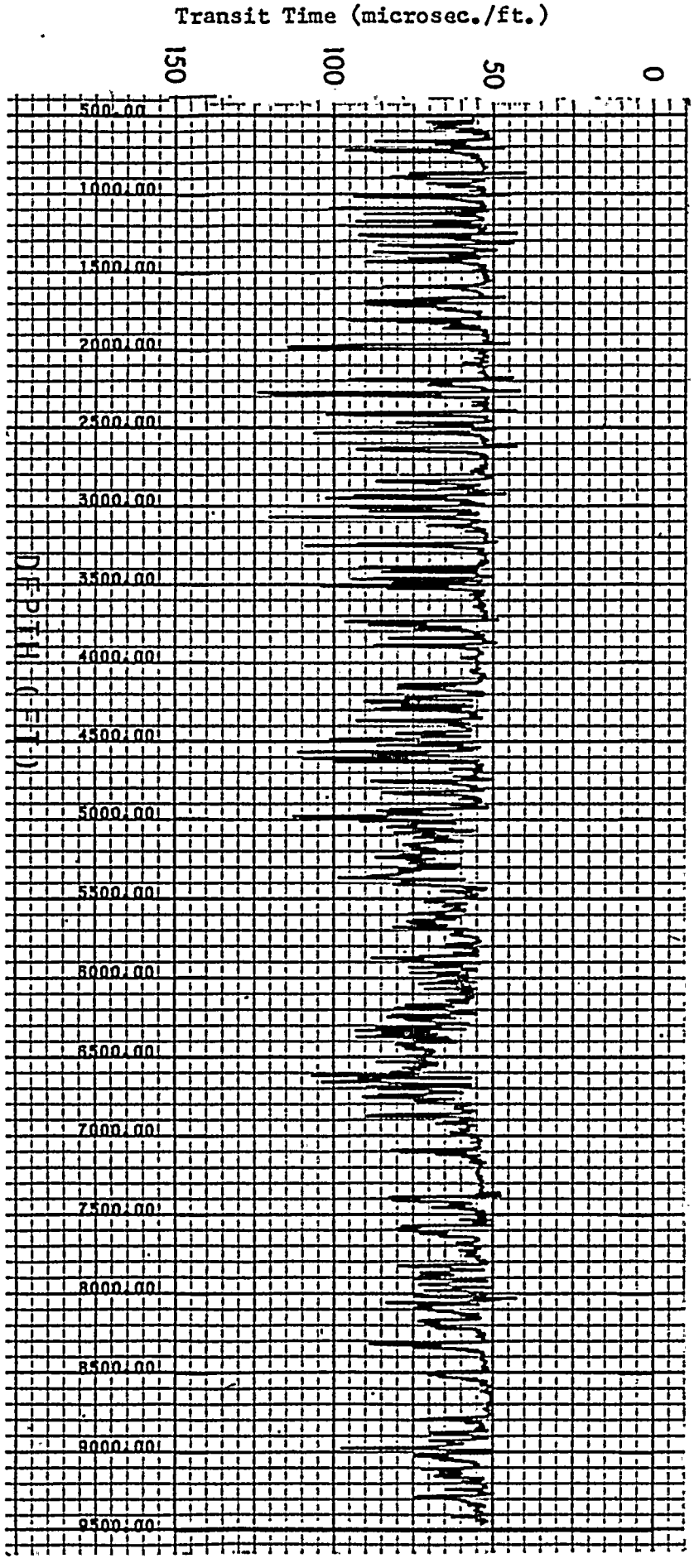
Anticline showing direction of plunge

Thrust Fault

Oblique Slip Fault; arrows show direction of motion; ball on down-thrown side; dotted where concealed

Figure 1 Location and Regional Structural Map of Line WØ-05X (after Shannon and Wilson, 1979a.).

Underlying the Columbia River Basalt is the unexposed Pre-Columbia River Basalt series. The Rattlesnake Hills No. 1 well (RSH-1), located approximately 40 miles northwest of Line WO-05X, was drilled to a depth of 10,655 feet and bottomed out in basalt rock. The digitized sonic log of this well is shown in Figure 2. Based on transit time, sidewall neutron porosity and transverse resistivity measurements, the section penetrated by RSH-1 can be divided into three distinct units (Raymond and Tilson, 1968; Jackson, 1975). An upper unit, which extends from 500 feet to 4900 feet, is characterized by high interval velocities of 18,000 feet/second, high transverse resistivity values averaging 893 ohm-m, and low sidewall neutron porosity values of less than 10%. The middle unit, which ranges from 4900 feet to 6900 feet, is characterized by lower interval velocities averaging 14,500 feet/second, transverse resistivity values averaging 150 ohm-m, and higher sidewall porosity values of 20-40%. The lower unit resembles the upper unit and extends from 6900 feet to the bottom of the borehole at 10,655 feet. This lower unit has interval velocities averaging 18,000 feet/second, transverse resistivity values averaging 634 ohm-m, and sidewall porosity values of less than 10%. From this information it is hypothesized that the upper and lower units are basalt sequences and the middle unit is a weathered basalt sequence. The top of the middle zone is considered to be the lower boundary of the Columbia River Basalt making its thickness of about 5000 feet (Raymond and Tilson, 1968). The rest of the penetrated section is considered as the Pre-Columbia River Basalt series of



SONIC LOG
RATTLE SNAKE HILLS No. 1
Sec. 15, T 11 N, R 24 E
BENTON COUNTY
WASHINGTON

(Depths are measured from ground level.)

Figure 2.
Digitized Sonic Log of Rattlesnake Hills No. 1.

undetermined thickness at this location. It must be noted that this well was drilled in what is thought to be the thickest part of the Columbia River Basalt in this area.

The Columbia River Basalt series, which is made up of nearly 100 basalt flows and interflow zones, is known to be Mid-Miocene in age. It can be divided into the Grande Ronde (oldest), Wanapum, and Saddle Mountains (youngest) formations. These formations can also be divided into individual members according to petrographic, paleomagnetic, and stratigraphic similarities.

Above the Columbia River Basalt series are thin layers of Plio-Pleistocene sedimentary rock sequences, Pleistocene glaciofluvial deposits, localized fine-grained lake beds, and Quaternary-Holocene alluvial deposits (Shannon & Wilson, 1979 B).

Structurally, an anomalous feature in the Pasco Basin area is CLEW. It is a topographic and structural zone, about 25 miles wide, extending from Cle-Elum in the northwest through the Pasco Basin to Wallula Gap in the southeast. CLEW is composed of a system of east-southeast trending brachy anticlines and faults. This anticlinal belt has been postulated in other reports as the surface expression of a deep seated right-lateral shear which acts upon a deformable sequence of partially decoupled layers, namely the Columbia River Basalt series (Washington Public Power Supply System, 1981).

The Wallula Fault zone, which is mapped from surface geology, extends from approximately 2 miles west of Wallula Gap to the southeast for an undetermined distance. This zone is about 300-1000 feet wide with abundant evidence of right-lateral movement. There is also a dip slip component of about 300 feet down in the northerly direction. The thrust faults and folds of the brachy anticlines in CLEW and the right-lateral shear of the Wallula Fault are generated by similar compressive forces from the north. With a reversal of minimum and intermediate stress orientations, strike-slip faults may change to thrust faults and folds. This is apparently what happened in CLEW (Shannon & Wilson, 1979 A). Horizontal extension in the Wallula Fault zone becomes vertical extension in the Rattlesnake Hills brachy anticlines. From the geologic maps of the area it is estimated that Line WO-5X would cross the Wallula Fault zone between Shotpoints 1350 and 1500 (Rockwell International, 1979).

Another structural feature, which may be traversed by Line WO-05X at approximately Shotpoints 1100 to 1200, is the Horse Heaven Hills anticline. This is a gentle anticline which trends east and is deflected to the southeast by CLEW. The south flank dips about 0.5-1.0 degree south and the north dips 3.0-5.0 degrees north. It is a subtle structure lacking in resolution.

III. Interpretation of Seismic Data

The migrated seismic section is used for interpretation. An unmarked print of this section, as well as a print of the previously processed section (1980 vintage), are included for reference. Also an overlay showing the interpretation of the reprocessed section is included in this report.

Based on the overall amplitude and frequency characteristics of reflections with two-way traveltime less than 1.0 sec., the base of the basalt layers at the north end of this line is picked at 0.8 second (approximate thickness is about 6400 ft.) at Shotpoint 2100 and gradually thinning southward to 0.2 second (approximate thickness is about 1600 ft.) at Shotpoint 550. Thereafter its thickness remains fairly constant, extending to Shotpoint 104. The shingle-like alignments of reflections as seen at Shotpoints 890, 1050, 1180, dipping toward the north, could be interpreted as (1) weathered boundaries of different basalt flows from migrating sources, (2) imbricate back thrust planes which are restricted within the basalt layers as their deeper ends tend to merge or terminate against the basalt base reflection. There is a flat reflection at 0.2 sec. (approximately at -1600 ft.) which can be followed from Shotpoints 2150 to 1420. This reflection is interpreted as a reflection from a weathered surface of separate basalt flow or flows.

A poorly defined oblique slip fault is mapped at Shotpoint 1400. This fault cuts the surface at Shotpoint 1400 and is in agreement with the surface mapped Wallula Fault Zone. The downward extension of the fault is uncertain, possibly to 2.1 seconds beneath Shotpoint 1600. The correlation of reflections across this fault is very unreliable, and the estimated displacement is about 800 feet at the -4800 foot level. There are reflections on the downthrown side showing reverse dips which indicate the presence of a fault. If this fault exists, it probably has undergone movement during Post Miocene time, as the basalt layers are offset by it.

The river water bottom profile recorded during the shooting of this line is shown on the top of the processed section. It shows a fairly smooth bottom configuration with a gentle variation in a range of 80 feet over a distance of 35 miles. The only sharp trough is at Shotpoint 1372 and has a magnitude of about 50 feet. It is located in the vicinity of the suspect oblique slip fault, the Wallula Fault. However, on the other hand, this sharp trough is also located at the intersection of the Walla Walla River and Columbia River and could be a geomorphic feature.

The Horse Heaven Hills anticline is not recognized on the seismic data in the neighborhood of Shotpoint 1150, probably because this feature has very gentle dips.

The structural configuration for strata below the basalt layers is difficult to determine as the data quality is very poor. Fragments of reflections, either flat or with very minor dips, can be picked at various depths. There are also other poor indications of possible deep seated faultings, such as the inclined alignment of reflections which could be originated from fault planes at 0.4 sec. (Shotpoint 670) to 1.7 sec. (Shotpoint 1050); at 2.7 sec. (Shotpoint 1330) to 3.4 sec. (Shotpoint 1130). These alignments of reflections are all terminated well below the base of basalt layers. Therefore, such faultings, if existing, would have occurred at pre-Miocene time. There is no other good or outstanding evidence to indicate the presence of faultings.

In the future, if new data acquisition is desired, field parameters should be selected with care. A paper entitled "Seismic Data Quality In A Basalt-Covered Basin", which was given at the 52nd Annual International Society of Exploration Geophysicists meeting by Andre L. R. Rosa, et al. in Dallas, 1982, has discussed this matter in detail.

IV. Conclusions

It is very difficult to delineate structures over a large area based only on one seismic line. Also, unfortunately, the available seismic line shows very poor signal-to-noise ratio. The following

conclusions are of speculative nature and must be viewed with reservation.

1) A reflection that might be the base of basalt layers is tentatively determined, which shows its thickness ranges from 6400 ft. in the north to 1600 ft. in the south over a curved distance of 35 miles.

2) Different flows of basalt within the basalt section are postulated with poor to fair seismic evidence. However, these features could also be interpreted as imbricate back thrust planes.

3) One poorly defined fault, which could be the Wallula Fault, is depicted, and its movement could be dated as post-Miocene time.

4) Strata beneath the basalt layers are flat or with very minor foldings. Possible fault plane reflections are noted within these strata, but their upward extensions stopped prior to the deposition of Miocene basalt flows. No other outstanding evidence indicating presence of faults has been recognized.

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APPENDIX I.

FIELD PARAMETERS	
SOURCE	
ENERGY SOURCE	AIRGUNS
TOTAL GUN VOLUME	600 CU. IN.
GUN PRESSURE	4600 PSI
NUMBER OF GUNS	16
GUN DEPTH	20 FT
FIRING INTERVAL	82 FT
SHOTPOINT INTERVAL	82 FT
DISTANCE OF SOURCE TO ANTENNA	119 FT
INSTRUMENTS	
SYSTEM	DFS-V
AMPLIFIER	INST. FLOATING POINT
FILTER	5-128 HZ
SAMPLING INTERVAL	2 MS
RECORD LENGTH	6 SECONDS
FIELD FORMAT	100 CHANNEL SEG-B GAPPED
CABLE	
TYPE CABLE	STREAMER
CABLE LENGTH	1886 FT
CABLE DEPTH	20 FT
LEAD IN	619 FT
GROUP INTERVAL	82 FT
NUMBER OF GEOPHONES PER GROUP	20
NUMBER OF GROUPS RECORDED	24

APPENDIX II.

PROCESSING SEQUENCE AND PARAMETERS

PROCESSING SAMPLING INTERVAL 4 MSEC

1. EDIT
2. F-K FILTER
3. DECONVOLVED BEFORE STACK

TYPE -	MINIMUM PHASE INVERSE FILTER
WINDOW LENGTH	2 EQUAL ZONE
OVERLAP	20% OF ZONE
LENGTH AUTOCORRELATION	2800 MS
LENGTH OPERATOR	200 MS
PREDICTION DISTANCE	4 MS

4. MISER®STATICS
5. NMO STACK 1200%
6. F-K FILTER AFTER STACK
7. BAND PASS FILTER

   0.0-5.0 SEC. 8-25 HZ
8. MIGRATION

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