101.2/JANTONNEN 7/1/87

7-7-87

Mr. John H. Antonnen
Assistant Manager for Commercial
Nuclear Waste
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, WA 99352

Dear Mr. Antonnen:

Enclosed for your information are the following NRC staff document reviews:

- Review of "Crustal Structure of the Columbia Basin, Washington, from Borehole and Refraction Data", by David W. Glover, a Master of Science Thesis, University of Washington, September 1985.

- Review of "Acoustic Televiewer and Acoustic-Waveform Logs Used to Characterize Deeply Buried Basalt Flows, Hanford Site, Benton County, Washington", USGS Open File Report 85-419, 1985, by F.L. Paillet.

If you have any questions concerning these documents please contact Paul Hildenbrand (FTS-427-4672).

Sincerely,

/s/

John J. Linehan, Acting Chief
Operations Branch
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures:
As stated

cc: J. Knight, DOE/HQ
S. Price, RHO

WM Record File 101.2
WM Project 10
Docket No. —
PDR ✓ w/o encl.
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LETTER TO: Mr. John H. Antonnen
Assistant Manager for Commercial
Nuclear Waste
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, WA 99352

FROM: John J. Linehan, Acting Chief
HLOB/NMSS

SUBJECT: REVIEW OF "CRUSTAL STRUCTURE OF THE COLUMBIA BASIN, FOR BOREHOLE AND RETRACTION DATA," AND "ACOUSTIC TELEVIEWER AND ACOUSTIC-WAVEFORM LOGS USED TO CHARACTERIZE DEEPLY BURIED BASALT FLOWS, HANFORD SITE

DATE: 7-7-87

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JUN 5 1987

WMGT DOCUMENT REVIEW SHEET

FILE NUMBER: 413.2

DOCUMENT: Crustal Structure of the Columbia Basin, Washington, from Borehole and Refraction Data by David W. Glover, A Master of Science Thesis, Geophysics Program, University of Washington, Seattle, Washington, September 1985.

REVIEWER: A. K. Ibrahim

DATE REVIEW COMPLETED: May 12, 1987

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

A good knowledge of the geology and tectonic features of a region is needed for the construction of a nuclear waste repository. The information provided in this paper will help in understanding the general structural characteristics of the area and the thicknesses of the different formations present at the Hanford site.

BRIEF SUMMARY OF DOCUMENT:

Introduction:

The main purpose of this work is to use seismic refraction and borehole data to provide information on:

1. The depth of the bottom of the basalt,
2. The existence of low velocity sediments beneath the basalt, and
3. Determination of the depth to the crystalline basement.

In August 1984, the USGS, BWIP and the University of Washington collected data from a long refraction line in eastern Washington figure (1). Charge sizes ranging from 900 kg to 2300 kg were used. The USGS refraction line was 260 km long with station spacing of 0.9 km. Also data from several blasts from the Cannon mine near Wenatchee were also collected for this study. In total, the author used thirteen refraction lines for the interpretation of the crustal structure in eastern Washington. The long USGS refraction line was a reversed profile while the other twelve refractor lines were not reversed profiles and had station spacing ranging from 5 km to 15 km. Using the ray tracing approach the author interpreted the data and provided a three dimensional model for the study area. The interpretation based on the seismic refraction data were supported by borehole well log information.

Results of the study:

The author derived a structural model for the study area consists of 5 layers. The surfacial layer has a constant thickness of 0.5 km with an average velocity of 3.7 km/sec. The second layer is the Columbia River Basalt (CRB) which is approximately 5 km thick in the center of the basin and extends to a depth of 5.4 km. Northward, the basalt thins out to about 1.3 km and extends to a depth of 1.8 km. The velocity of CRB ranges from 5.00 km/sec at the top of the basalt to 5.4 km/sec at the bottom of the layer. Underlying the CRB are Tertiary sedimentary layers of 4.6 km thickness in the center of the basin. South of the basin the sediments thin to 3.6 km and north of the basin they thin to 2.1 km. The Tertiary sediments have an average velocity ranging from 4.6 km/sec to 5.00 km/sec. These velocities are lower than those in CRB formation which makes it impossible to observe refracted arrivals from this tertiary sediments.

Layer No. 4, which underlay the Tertiary sediments represents the crystalline basement rock. It has an average velocity of 6.2 km/sec. Near the center of the basin the crystalline basement lies at a depth of 10.0 km and thins northward to about 3.9 km.

Underlying the basement is a 7.2 km/sec deep crustal layer. Beneath the center of the basin it is located at 23.5 km to the north and to the south of the basin it shallows up to 22.0 km and 18.3 km respectively.

The author summarized his findings in three contour maps showing the depth to the bottom of the basalt layer figure (2), the thickness of the sediments between basalts and the basement figure (3) and the depth to basement figure (4).

PROBLEMS, DEFICIENCIES, OR LIMITATIONS OF REPORT:

Deficiencies in this report result from not taking into consideration (1) the topographic corrections, (2) the imprecision of the velocity model and (3) the approximation of stations along straight line.

Although these deficiencies exist, in general, the results from the study provided valuable information on the crustal model that may be representative of the Hanford site region.

Also, this study did not provide high resolution information about the layering above and interbedded into the Columbia River Basalt.

ACTION TAKEN:

None.

ACTION RECOMMENDED:

The staff should follow up on future geophysical work in the area and compare the crustal model generated from this study with future seismic reflection surveys proposed in the area.

REFERENCES:

None.

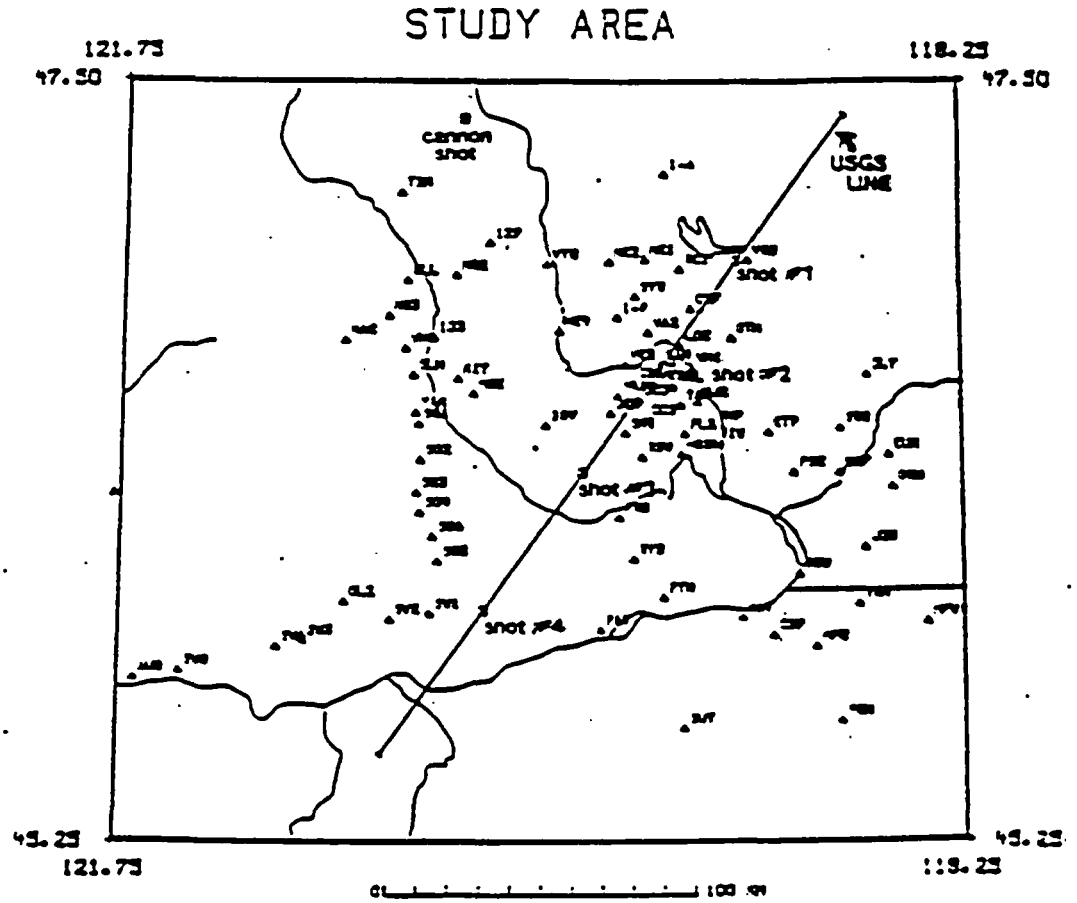

Figure (1) Map of the study area for the experiment is shown with the USGS line. Squares indicate shot points and triangles are seismic stations and deep boreholes.

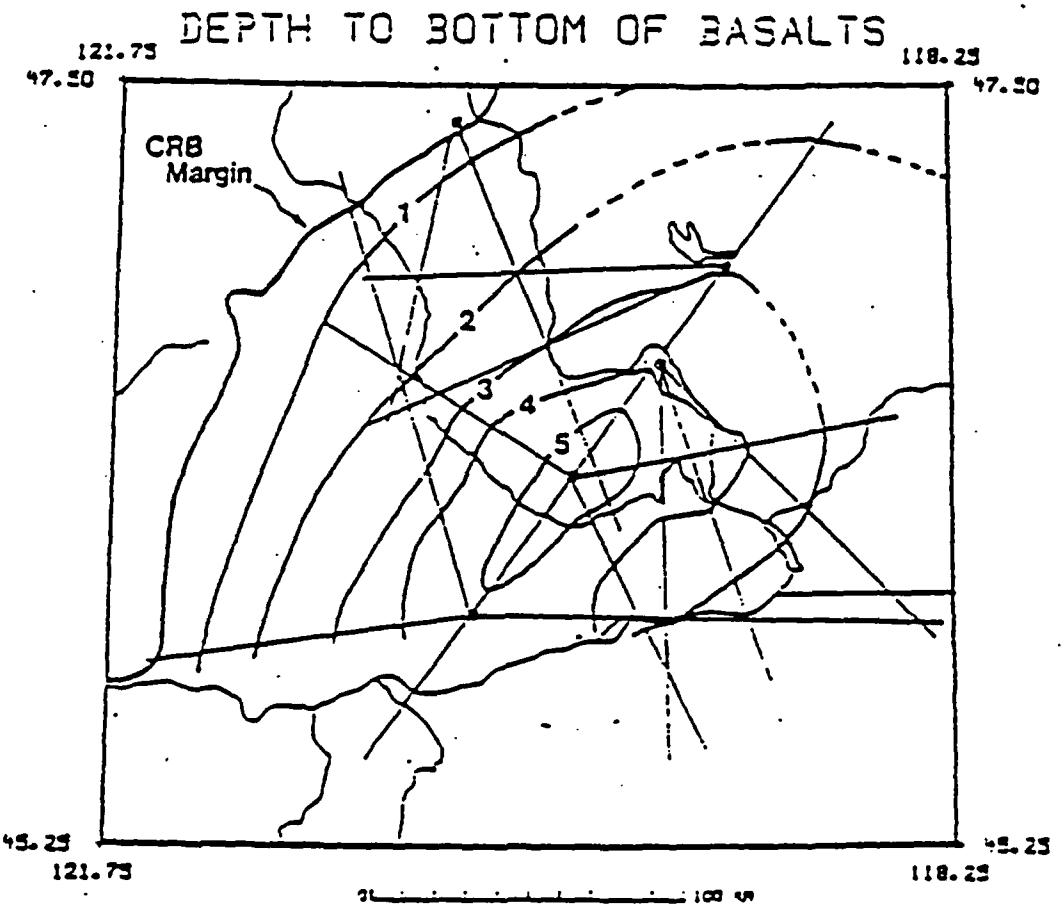

Figure (2) Contour map showing depth to bottom of basalt and refraction lines. Contours are in kilometers. The 0.5km surface layer is included in the calculation of this depth.

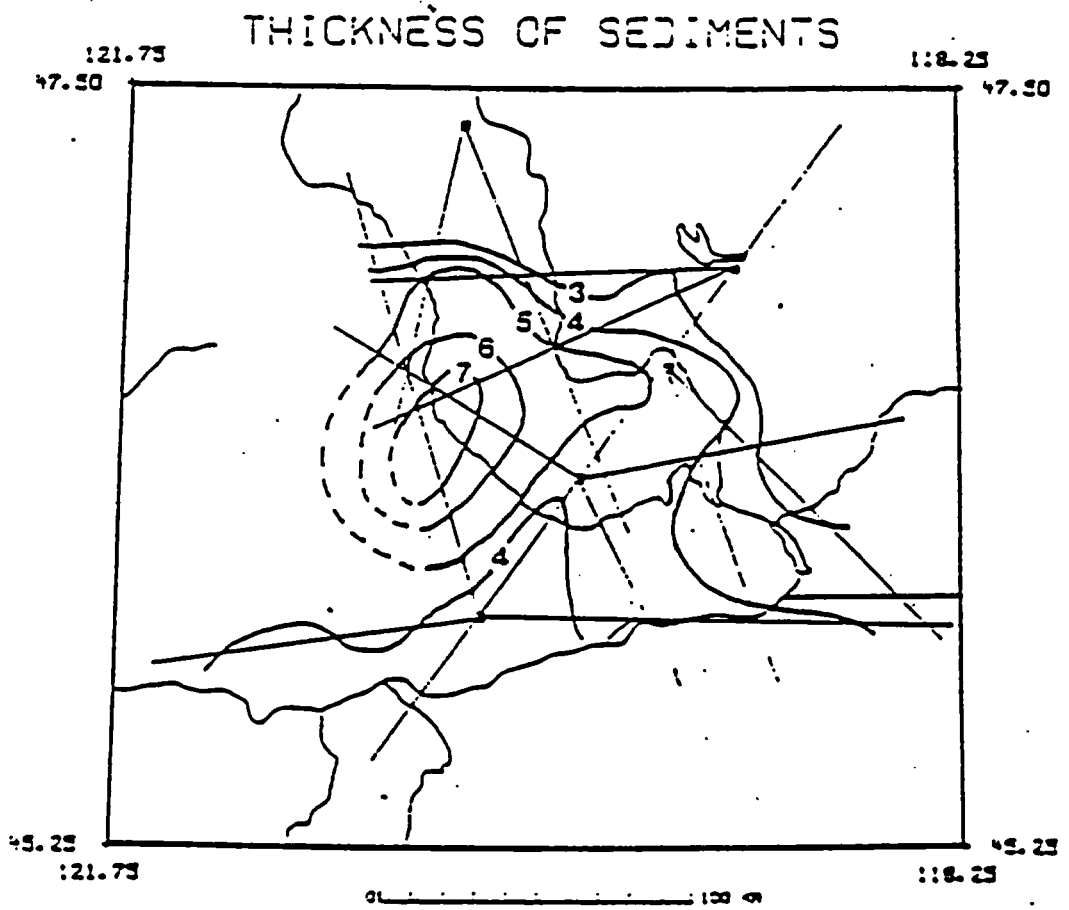

Figure (3) Isopach contour map showing thickness of Tertiary sediments between basalts and basement. Refraction lines are also present. Contours are in kilometers.

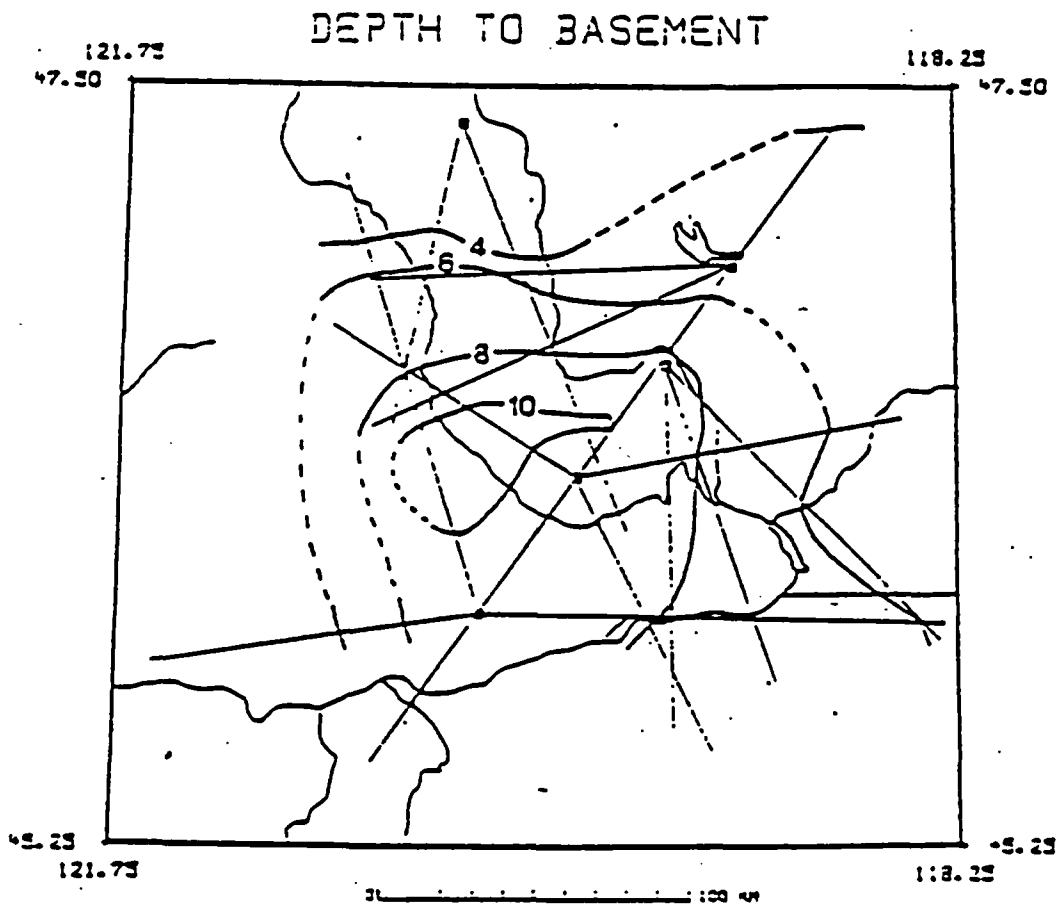

Figure (4) Contour map showing depth to top of crystalline basement and refraction lines. Contours are in kilometers.

413.2 AI/87/05/21

JUN 5 1987

WMGT DOCUMENT REVIEW SHEET

FILE NUMBER: 413.2

DOCUMENT: Acoustic Televiewer and Acoustic - Waveform Logs Used to Characterize Deeply Buried Basalt Flows, Hanford Site, Benton County, Washington. USGS, Open-File Report 85-419, 1985 By F.L. Paillet

REVIEWER: A.K. Ibrahim

DATE REVIEW COMPLETED: May 20, 1987

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

Information about fractures and breakouts in substrata are needed for the characterization and for exploratory shaft design. This report provides an approach for identifying fractures and determination of depth of brecciated rocks in boreholes. Also breakouts and their orientation in the boreholes can be determined using this approach.

BRIEF SUMMARY OF DOCUMENT:

Different geophysical methods are being used for measuring the physical and mechanical properties of rocks. An example of these methods is the acoustic-televiewer-waveform logs. This report describes how the method can be used in: 1. Relating borehole to the geology of the borehole. 2. Correlating induced fractures with pre-existing fractures and 3. Determining the extent of fracturing away from the borehole.

Data from five boreholes located on the Hanford reservation were used in this investigation. The five boreholes are DC-4, RRL-2, RRL-6, DC-12 and DC-7. The total depth of these boreholes are 1219 m, 1211 m, 1231 m, 1358 m and 1526 m respectively. The boreholes intersect multiple flows of the Grand Ronde Basalt formation, including the Rocky Coulee, Cohasset, McCoy Canyon and Umtanum.

Acoustic televiewer and acoustic waveform logging were used in this study. The televiewer used has a 1.25 MHz source transducer with a beam scanning the borehole at a rate of 3r/sec while acoustic waveform log uses frequencies less than a few tens of KHz. The televiewer produces a photographic image of the borehole. The image shows the amplitude of the acoustic energy reflected off the borehole wall. Variation in the reflected energy received by the televiewer can be correlated to variations in fractures and lithology of the boreholes.

RESULTS OF THE STUDY:

The author presented several photographic televiewer images in the report. He showed how natural fractures in the core sample are compared to natural fractures on the televiewer logs. Also a comparison between the televiewer logs and the transit-time logs were made. It showed the fractures identified on the televiewer logs correspond to anomalies in the acoustic transit time. The acoustic transit time logs provided a clear difference in signature at the boundary of the unaltered basalt of the flow interior and the much soften basalt of the brecciated flow tops and bottoms. Figure 1 shows a clear presentation of such difference in the transit time at a depth of about 1132 m. Also on the acoustic televiewer logs the location of the breakouts are identified as vertically continuous or discontinuous dark areas (figure 2). Continuous breakouts occur when the basalt is free of fractures, while discontinuous breakouts occur when fractures are present in the basalt. The length of the breakouts differ from one flow to another. The acoustic waveform logs are another means of providing information about the fracture and the unaltered rock in the borehole. The onset of the waveform measured showed that the unaltered basalt of the flow interiors has a velocity of 6.1 km/sec. Any changes in the physical properties of the basalt will alter the waveform character. For example, figure 3 shows how the waveforms have been distorted as they pass through the altered and brecciated flow tops mean while the waveforms are extremely coherent as they pass through the unaltered flow interiors. From the examples presented in the report, it is clear that the televiewer and acoustic-waveform logs are useful tools for the characterization of the mechanical properties of rocks and should be used at the other reposiotry sites.

PROBLEMS, DEFICIENCIES, OR LIMITATIONS OF REPORT:

The main limitation of applying this approach is the difficulty encountered in estimating the orientation of the breakouts due to the presence of magnetic minerals in the basalt. Also, the inability of the televiewer logs to characterize rocks surrounding the borehole where in-situ conditions have not been affected by drilling and local stress concentrations.

ACTION TAKEN:

None

ACTION RECOMMENDED:

Encourage DOE to use this approach whenever possible at other existing and future boreholes.

REFERENCES:

None

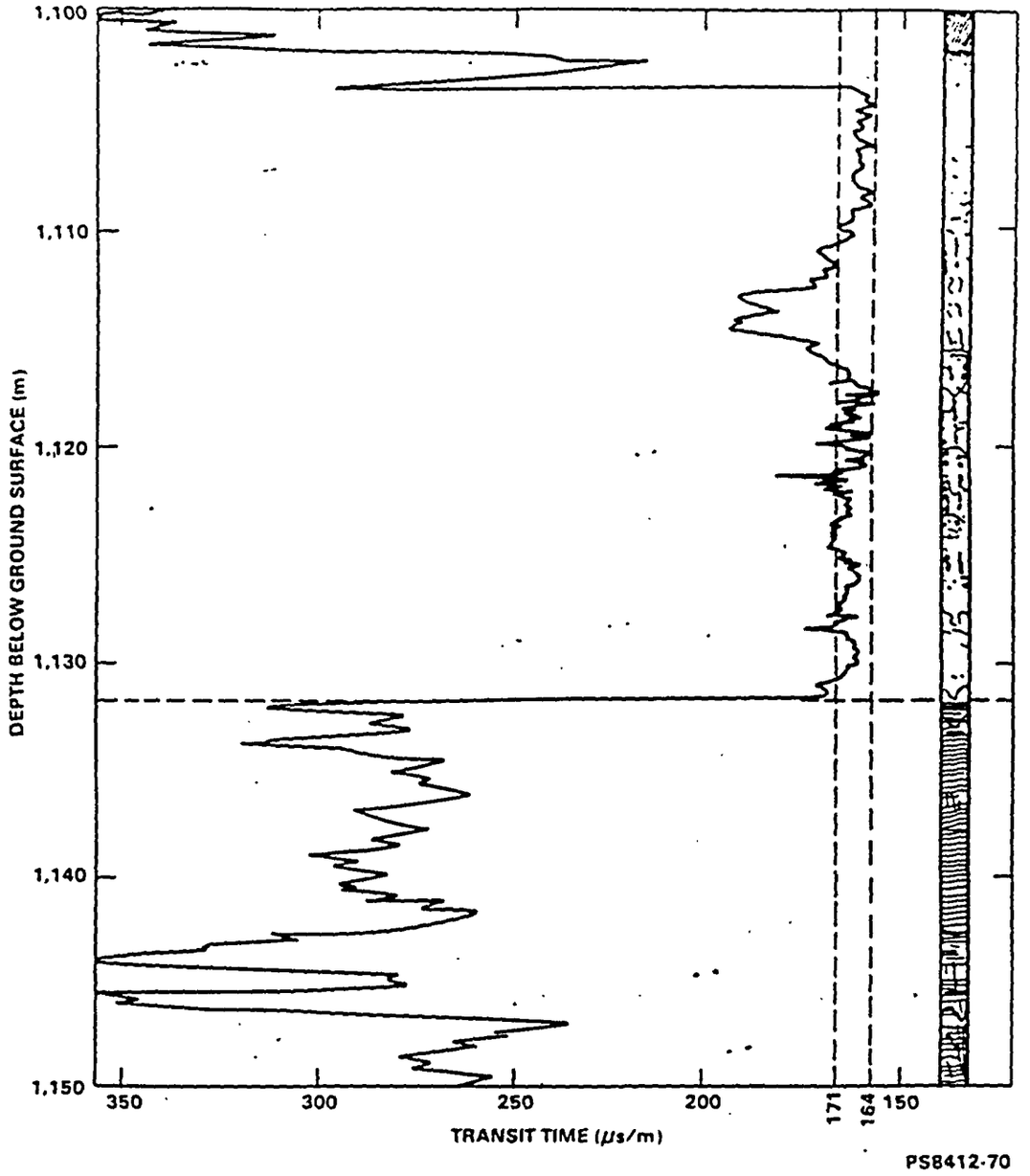

Figure 1 . Acoustic transit-time and televiewer logs for representative interval in borehole RRL-6.

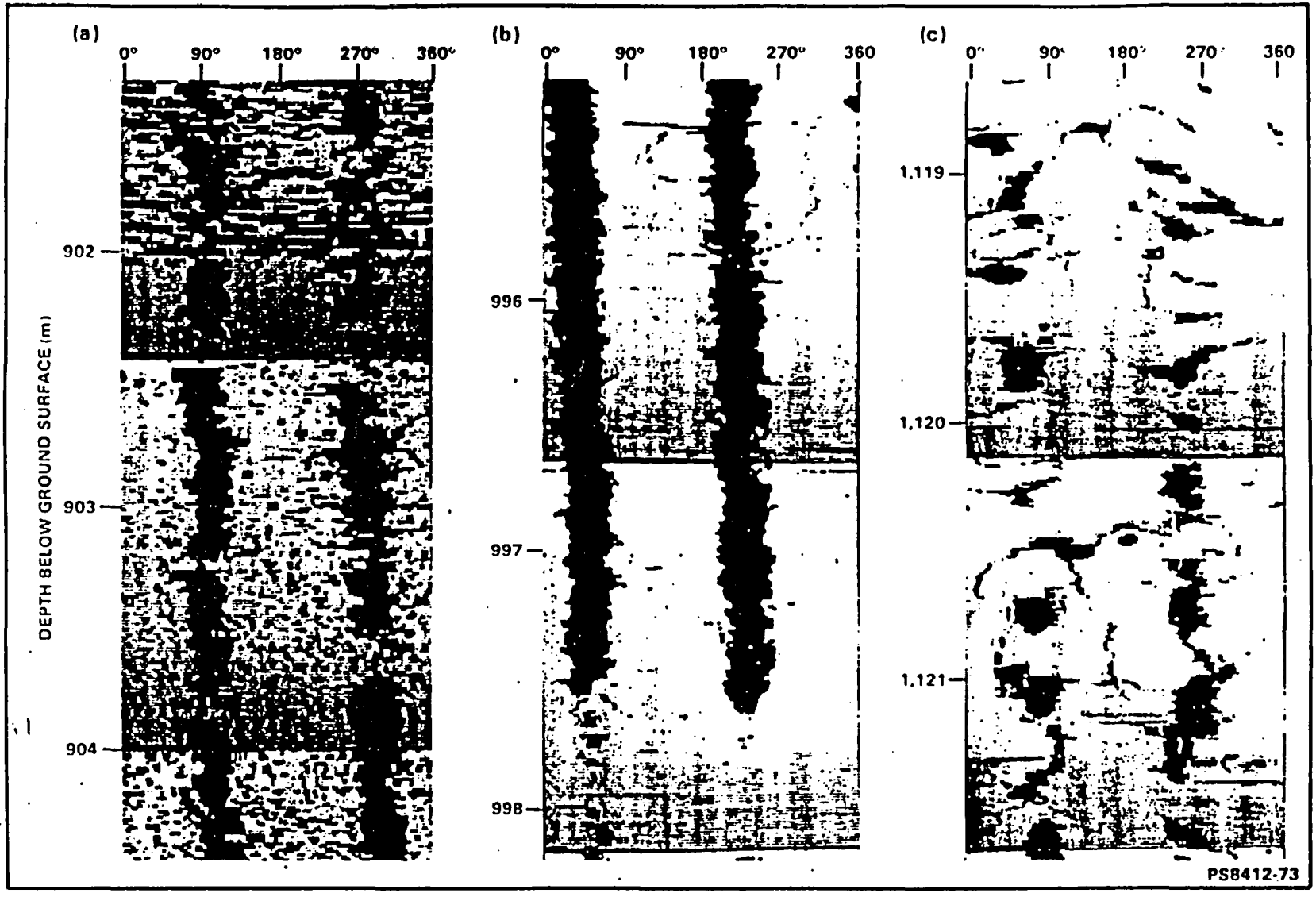

Figure 2 . Televiewer logs showing examples of continuous and discontinuous borehole-wall breakouts in borehole RRL-6.

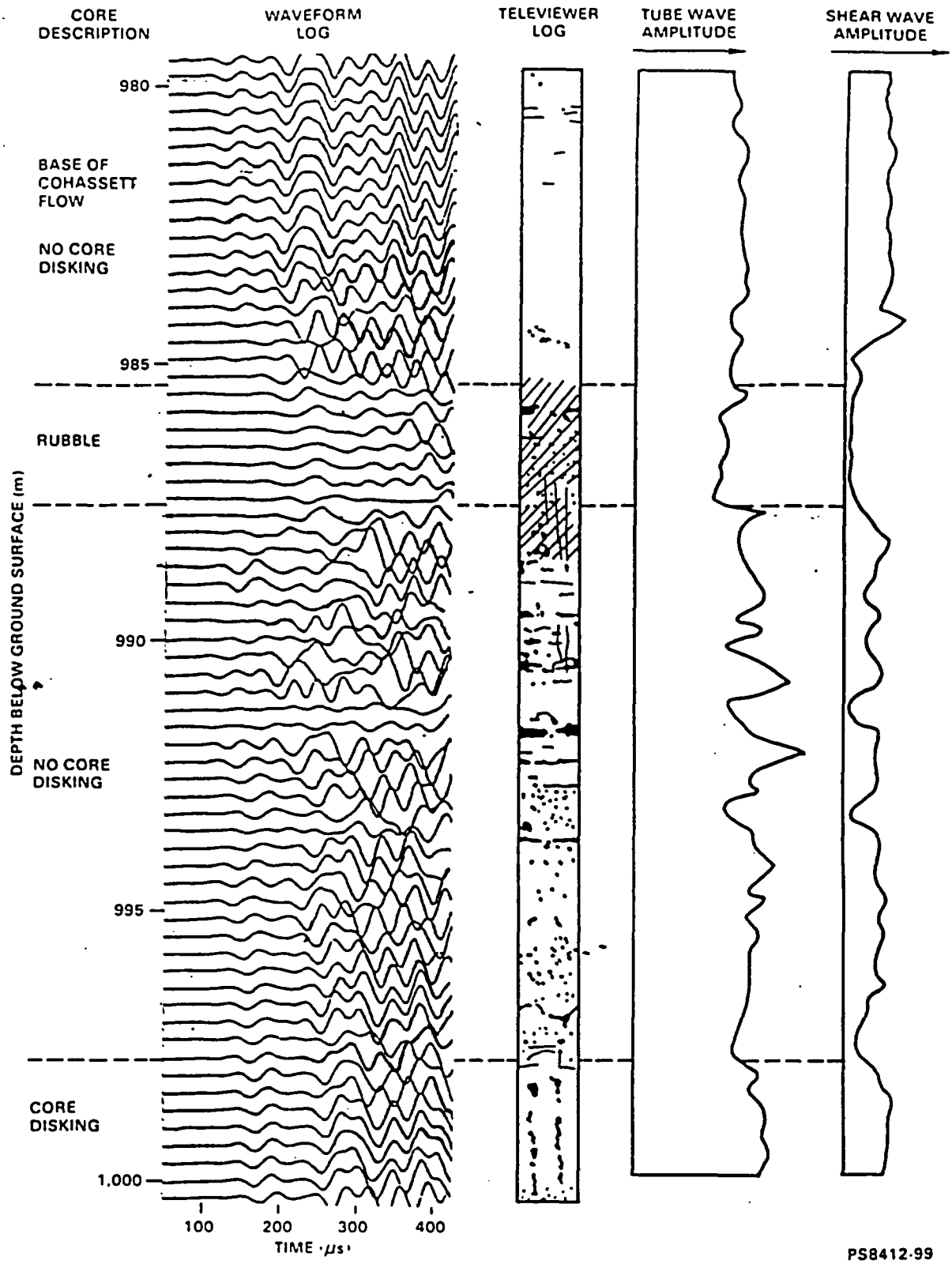

Figure 3 . Acoustic-waveform, televiewer, and waveform-amplitude logs for a representative interval in borehole DC-4; waveforms indicate effects of borehole-wall breakouts, fractures, and altered flow tops on acoustic propagation.

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	RLJohnson		
ENCLOSURES			
	7-7-87		
REMARKS Closed 7-7-87 by letter to J. Antonen fm. JLinehan			

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