# Quarterly Technical Report 77 - A

for

Hanford Seismic Network

January 1, 1977 through March 31, 1977



Geophysics Program

University of Washington

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## Data

Beginning with this quarter we are using a different velocity model for the northern half of the array than the one used in the south. Examining quarry shot data leads us to feel that the major crustal arrivals are from waves traveling in the sub basalt basement rock with a P-wave velocity of 6.05 km/sec. The basalt is thin and plays only a minor role in the velocity structure. The complete velocity models are given in Table I. The epicentral data lists are divided into the two groups north and south. The dividing line between the two groups is roughly the $47^{\circ}$N line and is shown on the map with this quarter's epicentral determinations.

The seismicity during this quarter is little different from previous quarters. The lull in the activity around the Hanford region appears to be ending with several earthquakes just north of the Saddle Mountains filling in the seismicity pattern of several years ago. The largest of these was on January 27 just north of Smyrna with $M_L = 3$. The other event larger than magnitude 3 is a possible explosion near Blalock Island on the Columbia River.

## Velocity Models

Seven quarry blasts sites in the north part of the array are being used to determine the major crustal velocity more precisely and individual station delays. What appears to be reflected arrivals from the lower crust will be used to determine crustal thickness. When this is complete all previously located earthquakes will be relocated and published in the annual technical report with all known explosions removed.

## Lake Chelan Study

The area just south of Lake Chelan continues to be the most active area in Eastern Washington. The two new stations are helping with the focal determination by reducing the probable errors to a fraction of a kilometer in epicenter and around 1 km in depth. Composite focal mechanism solutions are still not consistent; however, we are awaiting the final revision in the velocity model before attempting to resolve the inconsistencies. A number of these earthquakes and other near regional events have been recorded on magnetic tape for attenuation studies.

## Cascade Seismicity Study

The search of Eastern and Western Washington scanning catalogs for events occurring between them has been completed for November and December 1976. Only one event in the West Central Cascades was located which was not included in the normal locations produced by each net. The work is slow and time consuming because of the numerous quarry blasts which must be detected and deleted from the list. Weston Geophysical, Inc. is funding the search in the Northern Cascades while the current ERDA contract is funding the search to the south.

## Attenuation Study

We have completed the first data gathering phase in the Chelan Area. The data is presently being analyzed.

## Tilt Study

The instrumentation is ready to be installed. The actual installation will take place this spring.

## Magnitude Study

The Wood-Anderson instruments are operating properly and the drift problem has been resolved. We are continuing to gather data.

## Operational Status

There have been no major operational problems during this quarter. Plans have been made for extending the seismic coverage to the northeast. New station sites near Lake Wenatchee and Winthrop have been selected, and permanent station sites for the recently added sites EMT and WAT have been selected. The electronic equipment and enclosures have been fabricated and tested. We are only awaiting the phone connections before proceeding with installation. Part of the costs of the new stations is being covered by a grant from Washington Public Power Supply System.

## Publications

Two papers pertinent to eastern Washington tectonics were given by University of Washington personnel at the spring meeting of the G.S.A. Cordilleran section in Sacramento, California. Copies of the abstracts are included.

Crustal Model Table 1

South of 47°N

| P - Velocity* (km/sec) | Depth to top of layer (km) |
|---|---|
| 3.7 | 0.0 |
| 4.7 | 0.8 |
| 5.1 | 1.5 |
| 6.1 | 7.5 |
| 6.8 | 15.0 |
| 8.0 | 28.0 |

North of 47°N

| P - Velocity (km/sec) | Depth to top of layer (km) |
|---|---|
| 6.1 | 0.0 |
| 7.1 | 21.0 |
| 8.0 | 26.5 |

*S - arrival times are computed by using the P-wave model and dividing the resulting travel time by 1.72.

REDEFINITION OF THE COLUMBIA RIVER BASALT GROUP BASED ON MAJOR SEQUENCE BOUNDARIES

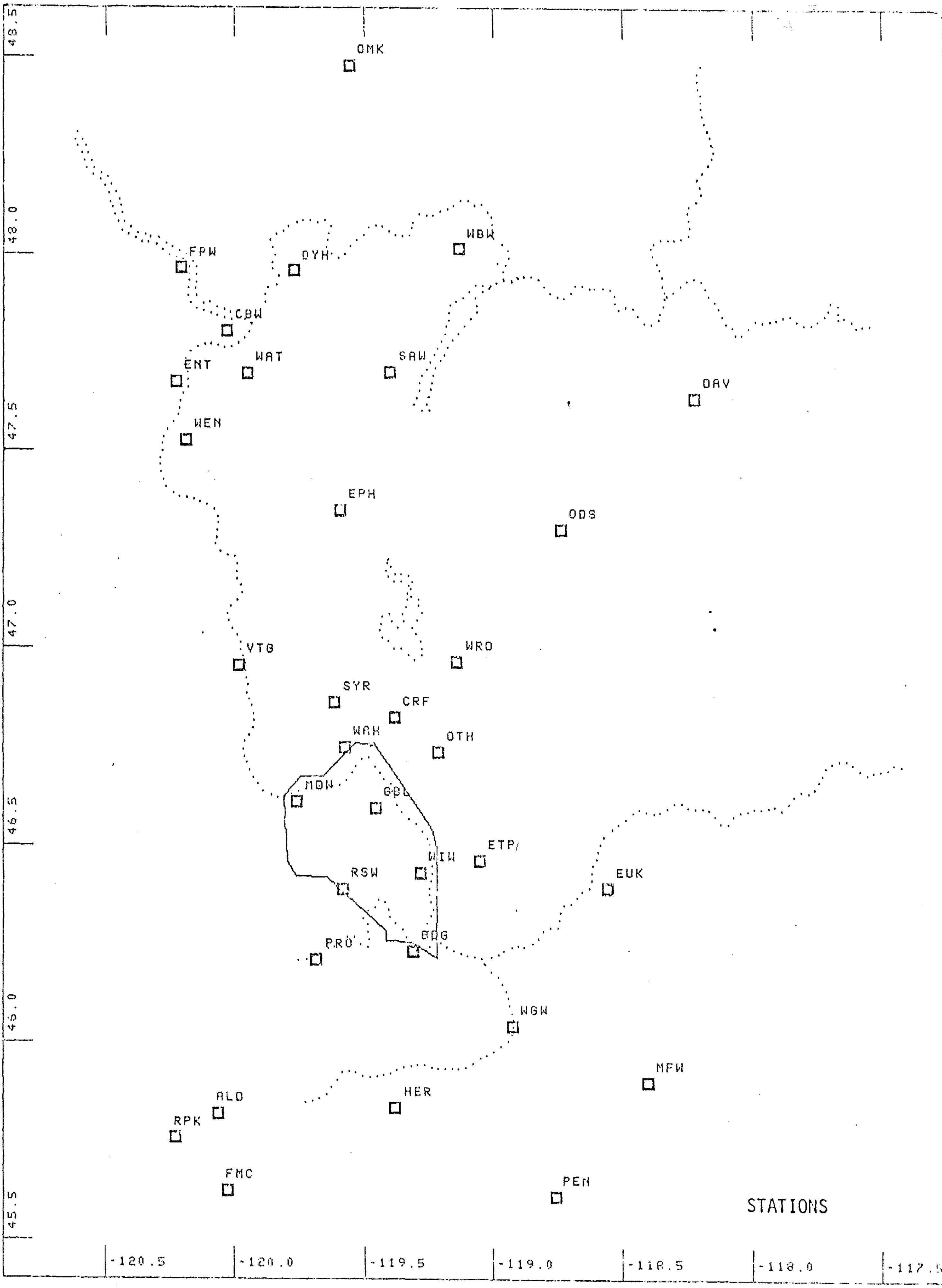
Leo, Sandra R., Department of Geology, University of Washington, Seattle, Washington 98195; Ralston, June K., Department of Geology, University of Washington, Seattle, Washington 98195; Whitney, Barbara L., Department of Geology, University of Washington, Seattle, Washington 98195

The Columbia River Basalts in south-central Washington recently have been defined (McDougall, 1976) as a group extending upward to include the Ellensburg Formation. This stratigraphic treatment fails to consider the presence of a significant unconformity below the Ellensburg. While the flood basalts predate the rise of the Cascade Arch, the unconformity may represent the first pulse of the Cascade Orogeny. A regional stratologic analysis of the unconformity suggests that it should be a major consideration in establishing any widespread stratigraphic units in this area. Unconformable relationships between the Ellensburg and the Middle Yakima Basalts are readily apparent at such localities as the Wenas Valley, northern end; Kelly Hollow Quarry, Wenas Valley; Selah Gap; and Selah Butte Anticline, southern flank. This areally extensive unconformity represents the conclusion of the base level transit cycle during which the Lower and Middle Yakima Basalts were deposited, and the inception of a new cycle during which the Ellensburg and its correlatives were deposited. It is evident, then, that two separate sequences are represented within the Columbia River Basalts as presently defined. We therefore exclude the Ellensburg Formation and its correlatives from the Columbia River Basalt Group.

MICROEARTHQUAKE SWARMS NEAR WOODED ISLAND, WASHINGTON

Rothe, George H., III, Stephen D. Malone, and Stewart W. Smith, all at Geophysics Program, Univ. of Washington, Seattle, Wa.

The seismicity of Eastern Washington is characterized by numerous microearthquake swarms which may be related to ongoing folding of the flood basalts. These swarms follow a classic pattern, isolated in space and time, building up in number of events and then decaying away with no outstanding principal event. The Wooded Island Area on the Hanford Reservation has shown great persistence in seismicity over the past six years, although the level of its activity fluctuates. A portable seismic array consisting of up to eight stations was used to study in detail the second half of a swarm at Wooded Island during the summer of 1975. Examination of joint P and S location of over 200 events of magnitude, $M_C = -0.5$ to 2.0, as a function of time and space has revealed details not observed in previous studies of microearthquake swarms. The hypocenters are all less than 4 km deep with most located within a 2.5 km cube, whose upper side is the ground surface. The activity during the recorded period consists of a major burst of activity (sub-swarm) from each of several source regions within the general swarm area, superimposed on a base level of about one event per day. Composite focal mechanisms for events occurring during each of the sub-swarms are basically oblique thrust striking NW, but differ in their strike-slip component. These differences in epicentral source region, time of occurrence, and focal mechanisms suggest that more than one shear plane is responsible for each of these sub-swarms.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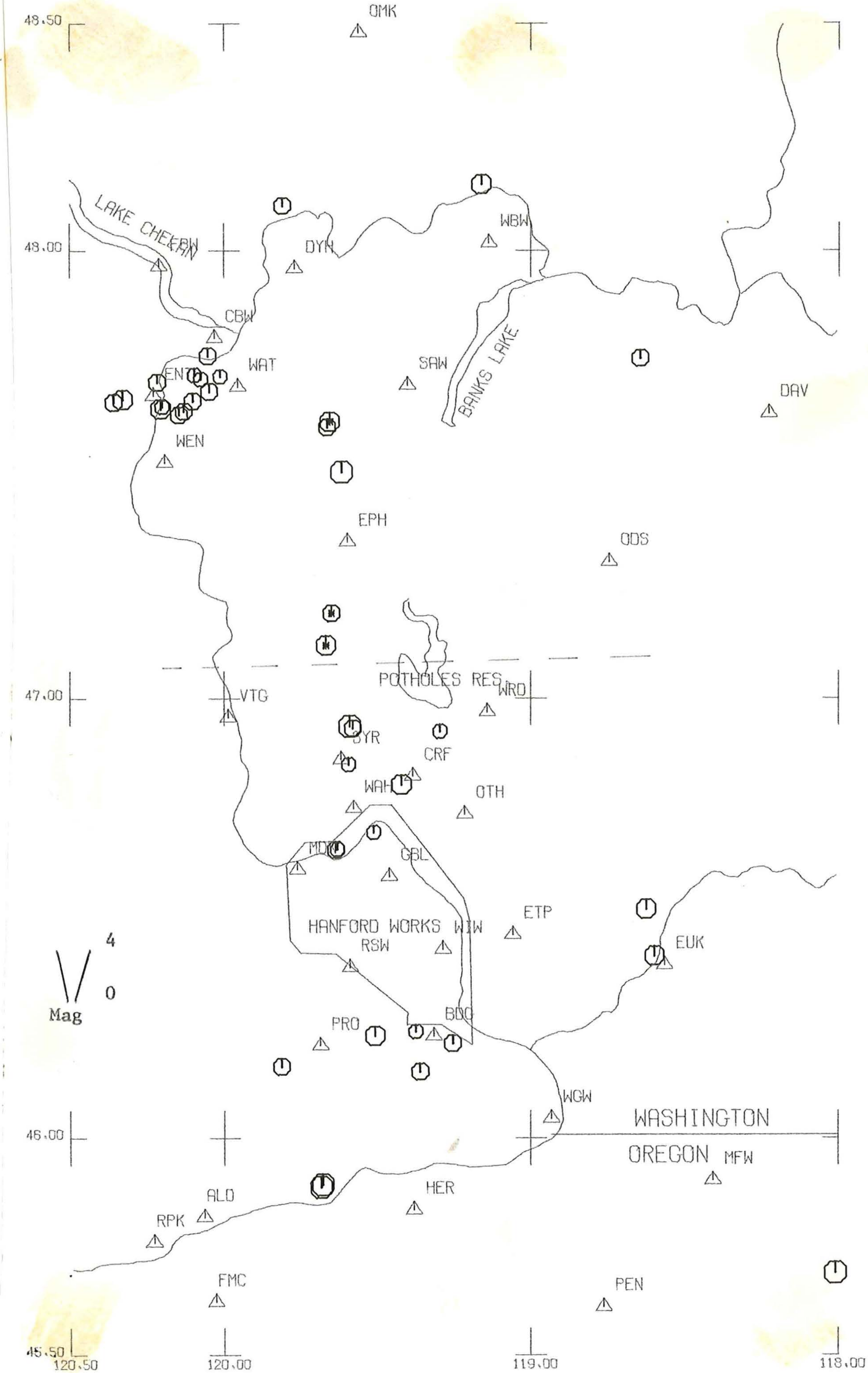
STATIONS

HEAD EASTERN WASHINGTON NORTH JAN - MARCH 77

| DATE | ORIGIN | | LAT | LONG | DEPTH | MAG | NO | GAP | DEL | RMS | REH | ERZ | Q | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77001 | 2156 | 5.30 | 47-45.34 | 120-40.03 | 3.70 | 2.35 | 16 | 134 | 43.6 | .24 | 1.0 | 14.0 | C1 | 1/ 1/77 |
| 77002 | 1650 | 15.28 | 47-42.59 | 120-13.06 | 5.40 | 2.16 | 10 | 235 | 17.6 | .08 | .6 | .6 | C1 | 1/ 2/77 |
| 77011 | 1812 | 3.77 | 47-11.57 | 119-38.90 | 12.20 | 1.89 | 10 | 113 | 18.1 | .37 | 2.0 | 3.9 | C1 | 1/11/77 |
| 77013 | 19 2 | 9.01 | 47-42.97 | 120- 4.61 | 6.73 | 1.63 | 11 | 101 | 9.4 | .11 | .4 | 1.1 | B1 | 1/13/77 |
| 77016 | 1331 | 54.19 | 47-43.33 | 120- .74 | 8.00 | 1.46 | 11 | 92 | 5.1 | .10 | .4 | .7 | B1 | 1/16/77 |
| 77020 | 2111 | 37.76 | 47-46.05 | 120- 3.22 | 4.37 | 1.86 | 12 | 98 | 4.7 | .14 | .5 | 1.1 | B1 | 1/20/77 |
| 77023 | 2320 | 9.19 | 47-40.07 | 120- 6.14 | 4.93 | 1.94 | 10 | 174 | 16.3 | .11 | .6 | 2.2 | C1 | 1/23/77 |
| 77028 | 1119 | 42.47 | 47-38.21 | 120- 8.84 | 6.20 | 2.23 | 17 | 111 | 7.8 | .08 | .3 | .6 | B1 | 1/28/77 |
| 77029 | 411 | 17.49 | 48- 6.00 | 119-48.46 | 4.80 | 1.85 | 8 | 176 | 15.8 | .19 | 1.3 | 7.7 | C1 | 1/29/77 |
| 77031 | 1923 | 11.96 | 48- 8.89 | 119- 9.61 | 1.50 | 2.48 | 13 | 168 | 14.6 | .09 | .5 | 2.4 | C1 | 1/31/77 |
| 77042 | 3 6 | 9.54 | 47-40.30 | 120-19.64 | 8.00 | 2.34 | 11 | 227 | 18.7 | .06 | .4 | .9 | C1 | 2/11/77 |
| 77044 | 056 | .92 | 47-37.27 | 119-39.17 | 11.36 | 2.50 | 12 | 84 | 20.9 | .20 | .8 | 3.4 | B1 | 2/13/77 |
| 77048 | 2133 | 25.47 | 47-39.93 | 120-21.42 | 3.00 | 1.78 | 9 | 237 | 9.7 | .07 | .6 | 2.5 | C1 | 2/17/77 |
| 77054 | 428 | 20.23 | 47-41.34 | 120- 2.84 | 7.13 | 2.17 | 21 | 126 | 7.1 | .10 | .3 | .5 | B1 | 2/23/77 |
| 77055 | 2012 | 25.77 | 47-36.54 | 119-39.71 | 7.20 | 2.12 | 7 | 110 | 22.1 | .20 | 1.6 | 9.3 | C1 | 2/24/77 |
| 77067 | 445 | 11.19 | 48-30.93 | 120-24.79 | 1.50 | 2.80 | 16 | 168 | 62.8 | .25 | 1.1 | 9.2 | D1 | 3/ 8/77 |
| 77067 | 9 9 | 5.99 | 47-45.69 | 118-38.60 | 6.36 | 2.09 | 10 | 166 | 34.2 | .11 | .5 | 4.0 | C1 | 3/ 8/77 |
| 77067 | 22 1 | 44.32 | 47-43.53 | 120- 5.80 | 7.27 | 1.44 | 8 | 99 | 10.3 | .05 | .3 | .8 | B1 | 3/ 8/77 |
| 77069 | 1044 | 53.87 | 47-39.03 | 120-12.32 | 7.42 | 2.45 | 17 | 153 | 3.7 | .10 | .4 | .5 | B1 | 3/10/77 |
| 77074 | 2236 | 36.78 | 47-39.30 | 120-12.05 | 7.30 | 1.66 | 9 | 143 | 3.4 | .05 | .3 | .7 | B1 | 3/15/77 |
| 77074 | 2239 | 33.80 | 47- 7.25 | 119-39.97 | 17.30 | 2.73 | 7 | 206 | 26.3 | .31 | 4.6 | 2.9 | D1 | 3/15/77 |
| 77074 | 2259 | 26.80 | 47-30.50 | 119-36.86 | 8.56 | 2.88 | 16 | 98 | 17.4 | .10 | .3 | .6 | B1 | 3/15/77 |
| 77089 | 438 | 22.46 | 47-38.71 | 120- 7.92 | 9.70 | 1.93 | 11 | 134 | 8.3 | .10 | .5 | .9 | B1 | 3/30/77 |

HEAD EASTERN WASHINGTON SOUTH JAN - MARCH 77

| DATE | ORIGIN | | LAT | LONG | DEPTH | MAG | NO | GAP | DEL | RMS | REH | ERZ | Q | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77010 | 1055 | 14.32 | 46-56.03 | 119-34.74 | 1.80 | 2.23 | 15 | 74 | 8.4 | .28 | 1.0 | 1.9 | B1 | 1/10/77 |
| 77011 | 2214 | 20.78 | 46-51.11 | 119-35.57 | .30 | 1.72 | 8 | 126 | 2.3 | .08 | .3 | .3 | B1 | 1/11/77 |
| 77012 | 722 | 1.52 | 46-55.63 | 119-17.76 | 3.00 | 1.61 | 9 | 96 | 12.6 | .29 | 1.3 | 2.5 | C1 | 1/12/77 |
| 77013 | 2224 | 42.01 | 46-48.41 | 119-25.19 | 1.02 | 2.52 | 11 | 67 | 13.5 | .09 | .4 | 1.0 | B1 | 1/13/77 |
| 77022 | 0 8 | 56.51 | 46-31.42 | 118-37.37 | .67 | 2.42 | 7 | 224 | 15.0 | .09 | 1.3 | .8 | C1 | 1/22/77 |
| 77022 | 2215 | 48.16 | 46- 9.23 | 119-21.66 | 5.40 | 1.94 | 6 | 251 | 9.6 | .07 | 1.1 | .4 | C1 | 1/22/77 |
| 77023 | 2011 | 20.12 | 46-41.93 | 119-30.60 | 1.50 | 1.63 | 12 | 144 | 7.9 | .14 | .5 | .9 | B1 | 1/23/77 |
| 77027 | 747 | 29.04 | 46-56.34 | 119-35.36 | .69 | 3.16 | 15 | 74 | 8.7 | .18 | .6 | 1.6 | B1 | 1/27/77 |
| 77056 | 012 | 20.35 | 46-39.58 | 119-38.13 | 2.00 | 2.02 | 9 | 122 | 10.9 | .15 | .6 | 12.6 | C1 | 2/25/77 |
| 77057 | 421 | 14.66 | 46-39.63 | 119-37.83 | 6.90 | 1.69 | 7 | 120 | 10.9 | .05 | .3 | .3 | B1 | 2/26/77 |
| 77061 | 344 | 22.74 | 45-41.44 | 118- .52 | 5.57 | 2.77 | 5 | 290 | 38.9 | .02 | 1.2 | 1.8 | C1 | 3/ 2/77 |
| 77070 | 2250 | 11.51 | 45-53.35 | 119-40.93 | .75 | 3.21 | 12 | 109 | 36.0 | .59 | .7 | 1.0 | D1 | 3/11/77 |
| 77073 | 1434 | 56.36 | 46-14.13 | 119-30.32 | 2.40 | 2.30 | 6 | 169 | 14.2 | .08 | .8 | 1.0 | B1 | 3/14/77 |
| 77076 | 2122 | 29.61 | 46-13.10 | 119-15.32 | .44 | 1.97 | 7 | 275 | 5.1 | .20 | 2.0 | 2.0 | C1 | 3/17/77 |
| 77082 | 042 | 51.37 | 46- 9.91 | 119-48.75 | 1.55 | 1.85 | 5 | 311 | 11.1 | .16 | 3.3 | 3.4 | D1 | 3/23/77 |
| 77082 | 2058 | 8.13 | 46-14.72 | 119-22.38 | 3.00 | 1.71 | 6 | 156 | 4.4 | .10 | 1.1 | 1.6 | C1 | 3/23/77 |
| 77088 | 23 3 | 42.72 | 46-25.07 | 118-35.73 | 5.30 | 2.64 | 12 | 187 | 3.6 | .16 | 1.6 | 1.1 | C1 | 3/29/77 |
| 77090 | 2229 | 4.16 | 45-53.68 | 119-40.65 | 1.50 | 3.06 | 14 | 137 | 23.9 | .61 | 1.2 | 1.7 | D1 | 3/31/77 |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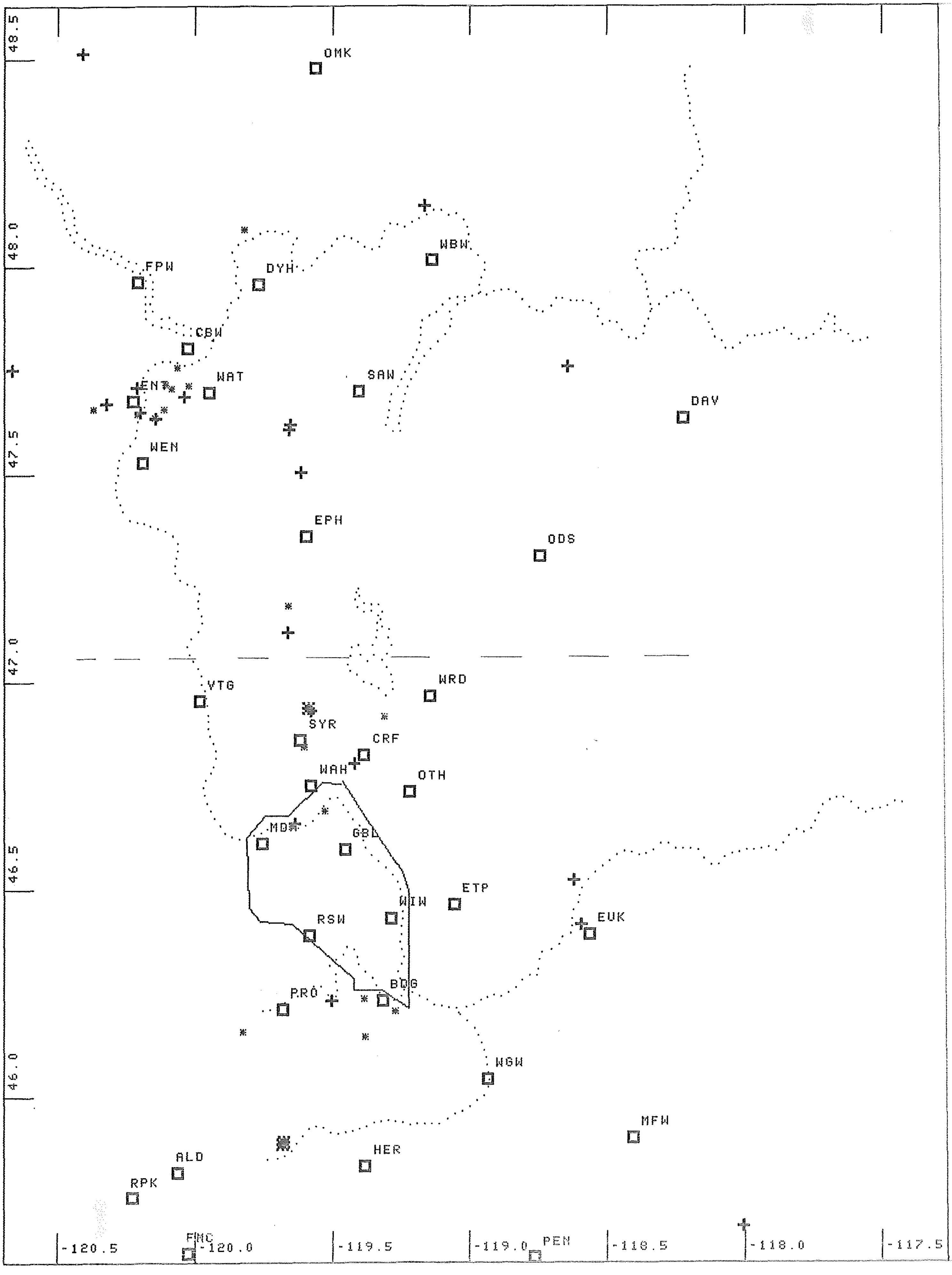
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CRUSTAL MODEL    Table 1

| Velocity in km./sec. | Depth in km. |
|---|---|
| 3.7 | 0.0 |
| 4.7 | 0.8 |
| 5.1 | 1.5 |
| 6.1 | 7.5 |
| 6.8 | 15.0 |
| 8.0 | 28.0 |