Quarterly Technical Report 77 - E

for

Hanford Seismic Network

July 1, 1977 through September 30, 1977

Geophysics Program

University of Washington

November 21, 1977

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Operations

The new stations at ETT, PLN, and WTP have been operating during this quarter and have significantly improved the detection and locating abilities in the northern part of the network. A new station on the west side of the northern Cascades near Marblemount was added toward the end of this quarter and is presently being used for northern Cascade seismicity studies. The Hermiston station in Oregon is being moved to the west about 12 kms to a better, quieter site, and a new locally recording station near Goldendale has been opened toward the end of this quarter. These two stations should improve the sensitivity of the array to events in the southern Cascades.

A major analysis problem developed this quarter when the Varian computer had a breakdown. The computer was down for more than six weeks which slowed our analysis causing the delay in producing this report.

Data

There are several interesting aspects of the seismicity for this quarter (Figure 2). The activity in the Hanford area has returned to an average level after more than a year of comparative quiet. More than 40 events were located in the south, though 9 of these are thought to be explosions. Several events just to the south-west of the tri-cities are particularly suspect because of polarities, time of day and wave form. We are trying to find confirmation for them. The activity to the north of Hanford follows the typical pattern of small swarms or clusters of events along the Saddle Mountains.

There was a magnitude 3-3/4 earthquake on July 13 near Cle Elem on the east flank of the Cascades. This event was lightly felt in the surrounding region and appears to be quite shallow even though our array configuration is not well suited for determining depth in this area. There were several aftershocks of this event most of which occurred during the first few days following

the main shock though there was one event as late as August 23. Earthquakes in this area are not at all common thought the region to the east of Mount Rainier appears to be the most active of any part of the Cascade mountain range.

As in previous quarters there was considerable activity in the Entiat area. With the addition of the new stations in this area the magnitude location threshold has been reduced considerably. One event of only Magnitude -.9 was located. The magnitude threshold for events in the northern Cascades and Okanogan has been reduced to about M_L = 1-1/2 with the new stations on both the east and west sides of the range.

Analysis

Several different projects have preliminary results to report at this time. Focal mechanisms for several classes of earthquakes have been obtained. Two sets of focal mechanism for medium deep events in the Hanford area ($Z \sim 10$ km) confirm that the major mode of fracture is on east-west striking fault planes in a reverse fault type motion in response to generally north-south horizontal compression. A tentative solution for an earthquake in the southern Lake Chelan area shows a similar mechanism though the maximum compression is more NW-SE and about 30^0 from horizontal. The mode of faulting is either high angle reverse or low angle thrust. This mechanism is only tentative at this point and we hope to get additional data to supplement that analyzed thus far.

During this quarter we made a detailed comparison of the data analysis techniques of the U.S.G.S. operated Hanford array and the University of Washington method. Comparisons of reading techniques, reading errors, velocity models, computer location routines, and magnitude determinations were made. A sample of eight specific events analyzed by the two methods are shown in Table 2. Our interpretation is that timing errors and hypocenter determinations between the two groups are quite comparable though there are differences in

magnitude determinations as outlined in our last annual report.

Tiltmeters

Both tiltmeters have been operational and sending data back to the University of Washington since August, 1977. The biaxial tiltmeters are installed within ten meters of each other near the wooded island seismometer site. We are using the original bore holes that U.S.G.S. used a few years ago.. The installation should give data pertaining to the tracking characteristics of tiltmeters. Preliminary results show that the tiltmeters do not track and drift independently of each other. Typical amplitude of the drift is 3 μ radians/month. Observation of short period title shows fluctuations of the order of tidal tilt amplitudes. Currently, we plan to determine the cause of the drift and to verify that each tiltmeter axis does respond to an external load.

Publications

Below are abstracts of papers presented at the Pacific Northwest AGU meeting in Portland, September 30-31, 1977. They will be published in EOS in the spring of next year.

SEISMIC ANISOTROPY OF THE COLUMBIA RIVER BASALT

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The Columbia River Basalts consist of flat alternating layers of competent basalt (V_p = 5.26 km/s) and weathered zones (V_p = 2.14 km/s). The layer thicknesses are small compared to seismic wavelengths and can therefore be modelled as a transversally anisotropic half space with a vertical axis of symmetry. The practical effect of this model is to introduce a P delay which increases with the depth of a source within the basalt and to split the SV and SH arrivals. In addition, the SV wavefront has a cusp which predicts up to three SV arrivals for rays with take-off angles of roughly 45° from the source. If this model is realistic it clearly complicates the location of earthquakes within the basalt. Using deep well data near the Wooded Island earthquake swarm on the Hanford Nuclear Reservation, the ratio of vertical to horizontal V_p is 1.56. Many of the stations used to study this swarm are in the appropriate epicentral range to observe the multiple shear wave arrivals and preliminary examination of some of the record seems to indicate that they are indeed present.

1. 24th Pacific Northwest Regional Meeting 29-30 September 1977

2. PNAGU

3. (c) oral only

A SPECTRAL RATIO TECHNIQUE FOR ESTIMATING THE CHARACTERISTICS OF SEISMIC ATTENUATION FOR EASTERN WASHINGTON

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A method of estimating the average crustal Q is developed by measuring ratios of far field seismic spectra which does not require knowing the source spectrum nor the geometrical spreading factor. This technique is applied to a set of small events which occurred in the Chelan area of eastern Washington, during the period of January to March 1977. The data includes sixteen events recorded on FM analog magnetic tapes by nine well calibrated stations. The average crustal Q thus estimated is 300 ± 100 for direct SV waves. This value is higher than that determined for the region near the San Andreas fault in central California but is close to that of the basin and range province. The overall seismic attenuation, where amplitude is proportional to r^{-k}, is also determined with k = 1.40 ± .28 in the frequency range 3-9 Hz, and k = 1.85 ± .45 in 18-24 Hz. Based on this observed data a local magnitude scale is determined and related to the coda length scale:

$$M_L = 2.55 + 2.80 \log (F-P)$$

Table 2

COMPARISON OF FOCAL PARAMETERS
AS DETERMINED BY USGS AND UNIVERSITY OF WASHINGTON

DATE	TIME	SEC	LAT	LONG	ERROR	Z	ERROR	M_A	M_C	#st	RMS	
04/22/74	0049	23.4	46 32.55	119 38.29	4.4	18.2	5.1	1.2	1.2	7	.38	*
		22.7	46 29.57	119 39.99	2.1	19.8	2.1		0.6	11	.07	**
05/22/74	0041	10.6	46 49.44	119 25.03	1.8	0.6	7.0	0.3	1.1	06	.11	*
		10.3	46 49.42	119 25.39	1.1	0.1	3.0		0.6	08	.11	**
09/04/74	0104	28.7	46 52.48	119 21.15	0.5	2.3	0.6		3.0	22	.16	*
		28.3	46 52.60	119 21.44	0.7	0.2	3.0		3.3	16	.20	**
10/28/74	0518	00.9	46 46.58	119 20.00	1.2	5.0	1.5	0.7	1.1	12	.28	*
		00.7	46 46.52	119 20.60	1.5	4.4	0.8		1.1	07	.15	**
12/15/74	1446	48.8	46 50.03	119 30.55	0.5	1.1	0.8	2.1	2.5	17	.13	*
		48.5	46 50.17	119 30.50	0.4	0.9	1.1		2.5	14	.16	**
12/15/74	1534	20.3	46 14.18	119 07.50	1.0	1.0	3.0		1.9	07	.16	*
		20.0	46 14.42	119 07.50	0.8	0.1	3.0		1.7	09	.20	**
12/17/74	2225	03.8	46 44.63	119 21.58	0.5	0.6	3.0		1.6	08	.09	*
		03.5	46 44.77	119 20.33	0.4	0.7	1.1		1.4	10	.31	**
12/21/74	0445	13.1	46 24.06	119 00.73	0.2	0.3	7.0		1.7	08	.06	*
		12.9	46 23.92	119 00.67	0.3	2.1	2.5		1.5	09	.14	**

*USGS
**University of Washington

Average difference between USGS and University of Washington: 0.8 km 1.0 km

M_A Magnitude by amplitude method.
M_C Magnitude by coda length method.
#st Number of stations and location.

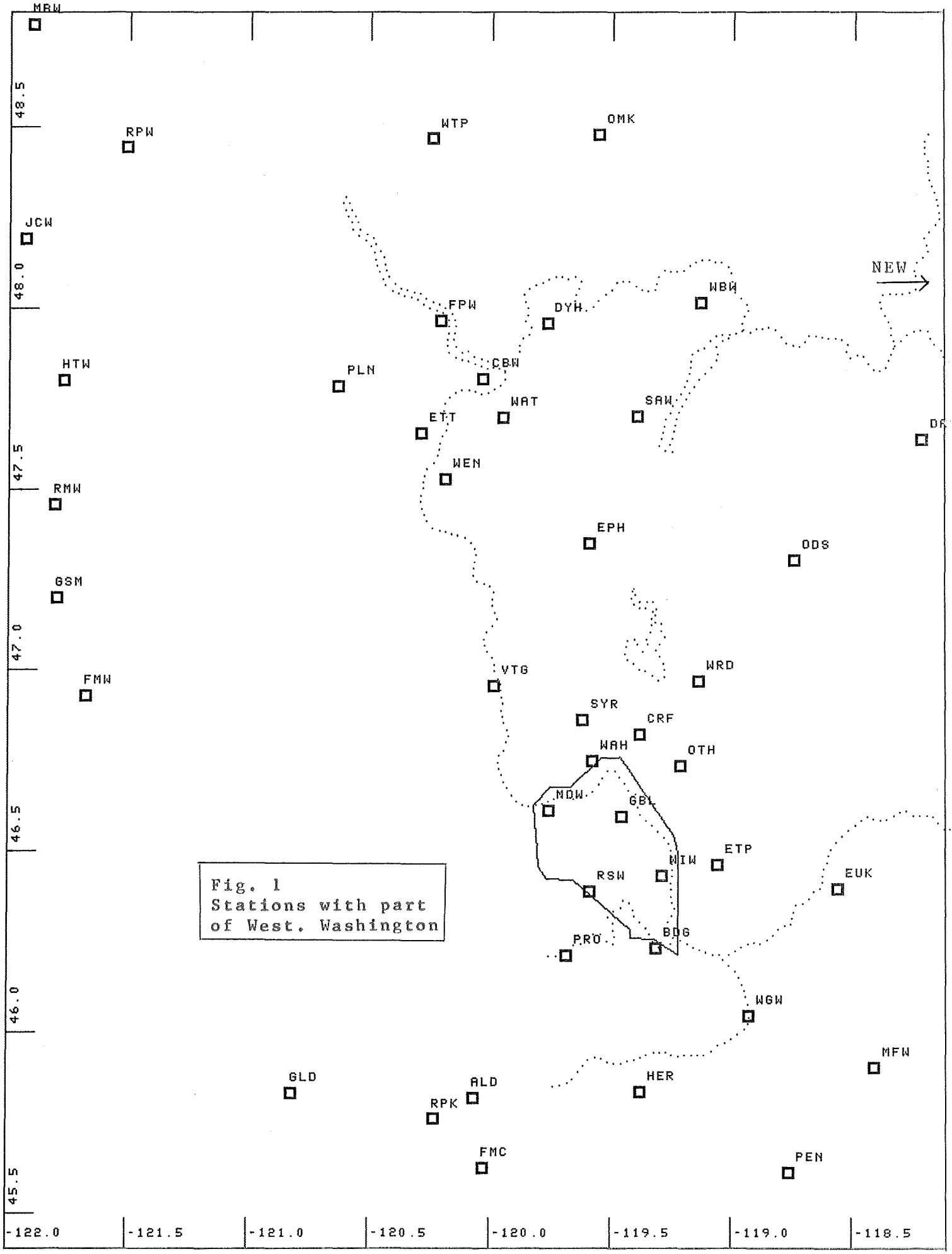
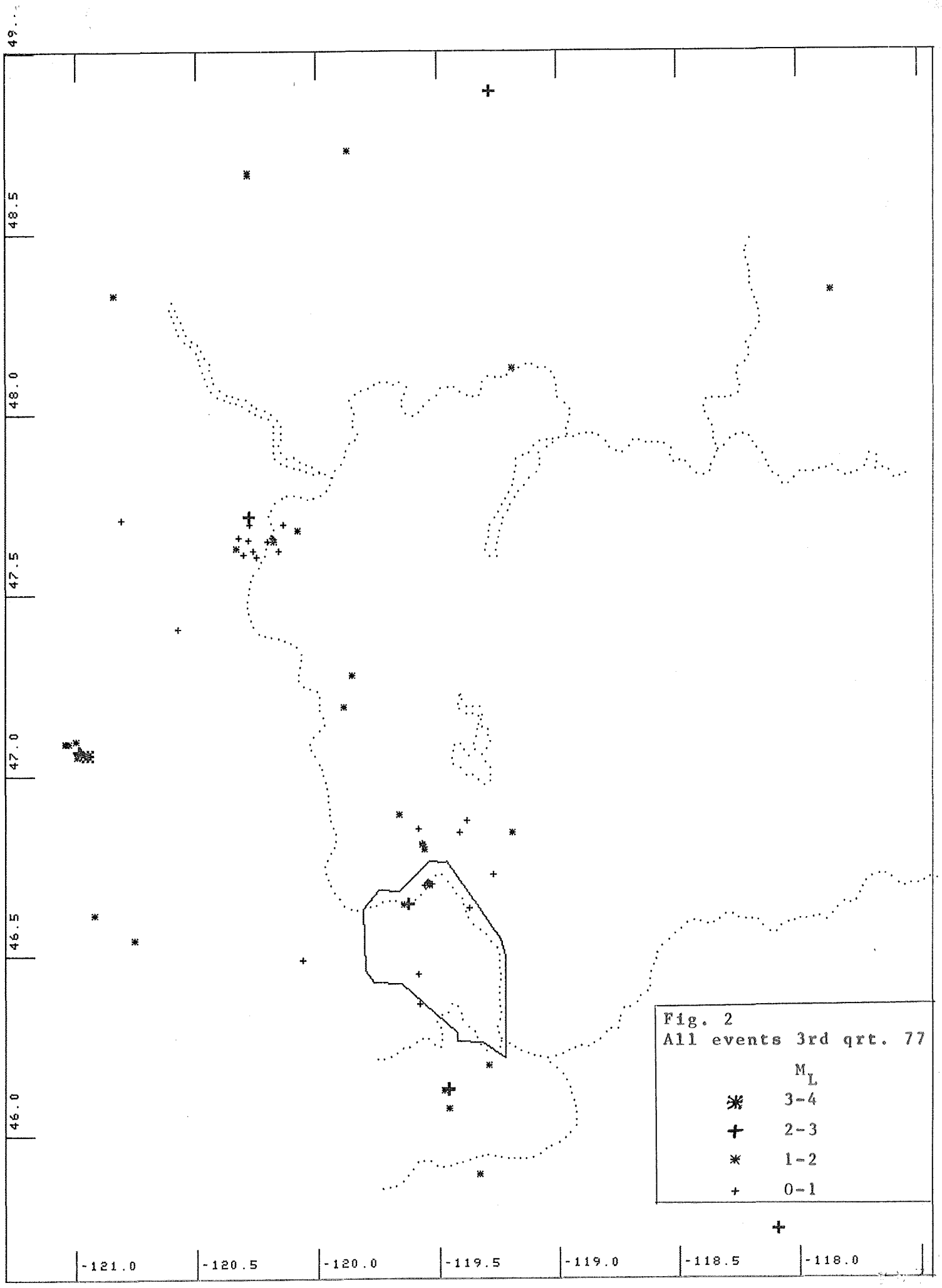


Fig. 1
Stations with part
of West. Washington


49.
48.5
48.0
47.5
47.0
46.5
46.0
-121.0
-120.5
-120.0
-119.5
-119.0
-118.5
-118.0
Fig. 2
All events 3rd qrt. 77
M_L
3-4
2-3
1-2
0-1