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QUARTERLY NETWORK REPORT 84-B
on
Seismicity of Washington and Northern Oregon

April 1 through June 30, 1984

Geophysics Program
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This report is prepared as a preliminary description of the seismic activity in the state of Washington and northern Oregon. Information contained in this report should be considered preliminary, and not cited for publication. Seismic network operations in Washington and northern Oregon is supported by the following contracts:

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INTRODUCTION

This is the second quarterly report of 1984 from the University of Washington Geophysics Program covering seismicity of all of Washington and northern Oregon in one comprehensive report. From 1975 through 1983 seismicity in eastern Washington has been covered in quarterly and annual reports. Quarterly reports for western Washington and the northern Cascades have been produced since 1983, and annual catalogs covering western Washington since 1969. This report discusses network operations, seismicity of the area, and any unusual events or findings. These reports are preliminary, and not a substitute for detailed technical reports, a regional catalog, or technical papers. In particular, event magnitudes are preliminary, and subject to revision. Findings mentioned in these quarterly reports should not be cited for publication. Figure 1 shows the major geographical features in the state of Washington and northern Oregon and the seismograph stations currently in operation.

NETWORK OPERATIONS

Western Washington

Network operations were at a low point during the second quarter, as abnormally late snow cover rendered many sites inaccessible for nearly two months longer than usual. Battery life at several stations had been very tightly calculated, with the result that both stations and important repeaters went out for as long as a few weeks.

Part of the Olympic Peninsula network was moved in order to avoid use fees charged for maintaining equipment on state DNR lands. The Ellis Mountain station, OEM, has been replaced by OTR (Tyee Ridge). The Mt. Octopus station, OCT, has been replaced by OOW (Octopus West). Both new stations are within a few kilometers of the old ones, and thus the overall network detection and location capabili-

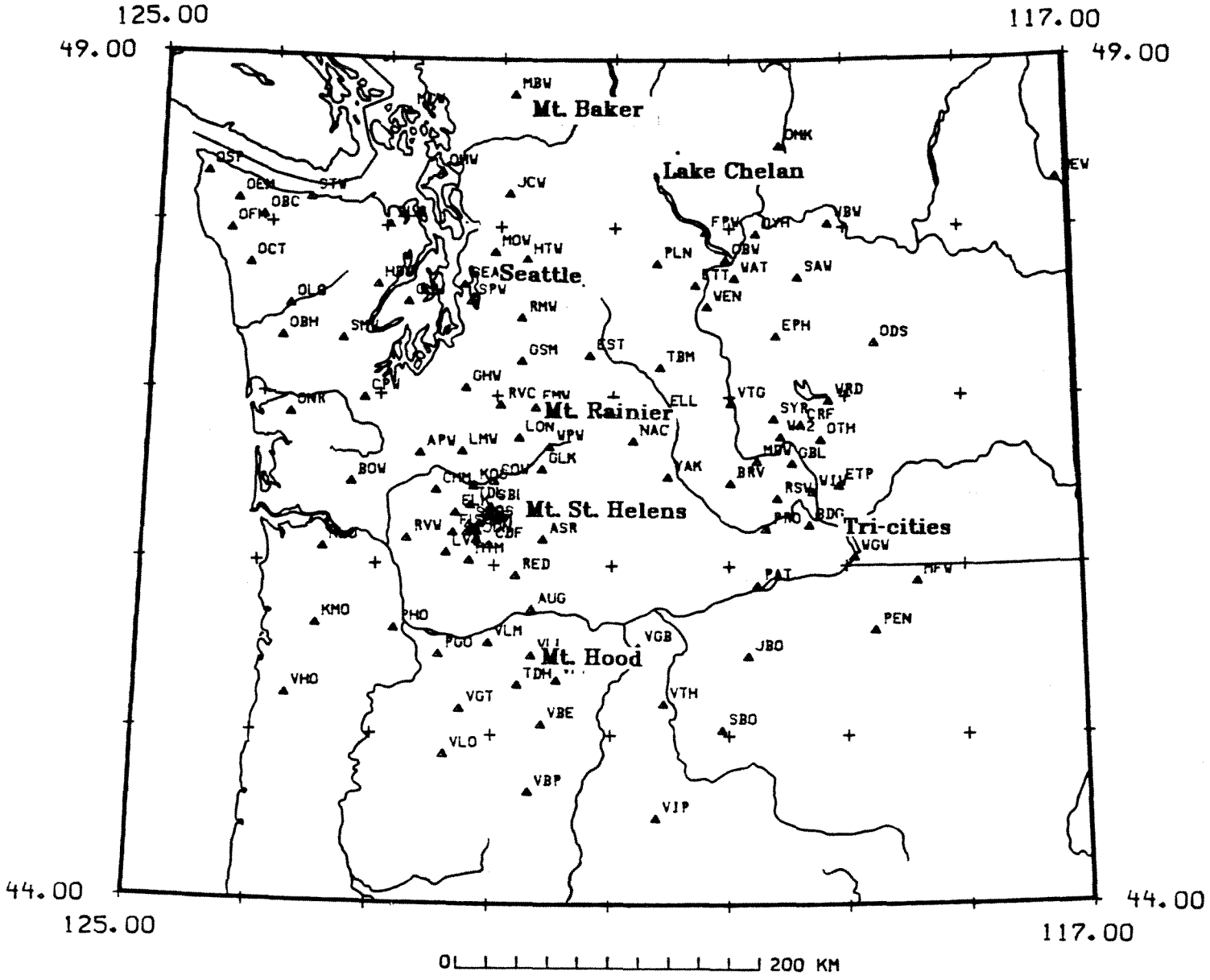

Figure 1. Major geographical features in the state of Washington and northern Oregon and seismograph stations currently in operation.
Stations OEM and OCT were replaced during this quarter by stations OTR and OOW.

ties have been little affected.

In Puget Sound, plans were made to replace the Monroe station (MOW) which was vandalized in February. The new site is BHW, at Bald Hill about 3 km away in a somewhat noisier but more secure location. Long-standing problems with radio interference on the South Mountain - Seattle link were largely resolved by changing the frequency and increasing the power. South Mountain is a repeater for a number of stations, including St. Helens West (SHW). Site studies for a new installation on the Kitsap Peninsula near Port Gamble were completed, and permission obtained from the landowner.

Eastern Washington

In eastern Washington, operations continued with some down-time but generally good data quality. Network changes there were delayed until early in the third quarter.

Northern Oregon

Operations in Oregon were at a low level. As weather permitted late in the quarter, access was gained to a few sites. However, maintenance will mainly be done in the 3rd and 4th quarters due to other priorities on equipment and technician time.

DATA

There were 467 events processed by the University of Washington Seismic network between April 1 and June 30, 1984. 317 of these events were located in Washington or Northern Oregon. Of these, 94 were known or suspected blasts, and 223 were earthquakes. 59 of the earthquakes were hand-picked from film records, because they did not trigger the online computer system. 43 of the events located under the cone of Mt. St. Helens. Table 1 is the event catalog for this quarter. Fig-

ure 2 shows all earthquakes greater than magnitude 1.0. Figure 3 shows blasts and probable blasts. Figure 4 shows all earthquakes located in western Washington. Figure 5 shows all earthquakes located in eastern Washington. Figure 6 shows earthquakes located in the Mt. St. Helens area.

Eastern Washington

The largest event in Washington was a M_C 4.3 event felt on April 11 at 0307 GMT in Grand Coulee, Wenatchee, Entiat, and Yakima. Slight damage was reported in Grand Coulee. The event was located near Wenatchee at a depth of approximately 5 km. and had one aftershock on April 11 at 1402 GMT. A preliminary fault plane solution indicates a thrust event with a small strike-slip component, and an E-NE striking fault plane. This event occurred about 20 km south of Lake Chelan, a few kilometers south of a persistent cluster where about 40 events of M_C 1.0 or greater have occurred each year since 1969. These events are generally shallower than 10 km. Of a total of 40 events located in eastern Washington during the second quarter of 1984, 12 (including the M_C 4.3 event) were part of this cluster, located in a quadrangle with corners at 119.6°W, 47.5°N, and 120.4°W, 48.°N. Ten earthquakes occurred in the Pasco Basin during this quarter, the largest were two M_C 2.8 events on April 29 and April 30.

Northern Oregon

There were 9 earthquakes located in northern Oregon during the second quarter of 1984. The largest was a M_C 3.1 which occurred about 20 km south-west of Pendleton on June 18 (GMT), at about 3 km depth.

Western Washington

During the second quarter of 1984 183 events were located between 44° and 49° N latitude and between 121° and 125°W longitude. The largest event was a M_C 3.7 event felt in Longview and Centralia on June 4, and located at a depth of 50 km

below Longview, near the confluence of the Cowlitz and Columbia Rivers. A preliminary fault plane solution indicates a strike-slip event, with approximately north-south maximum compression. No events of comparable depth have previously been located in this area, although deep events about 50 km to the north have occurred. In fact, another unusually deep event occurred about seventy km northeast of Longview on April 8, 1984 at 1256 GMT. This M_C 3.1 earthquake was located at a depth of 65 km near Rainier, Washington. This event is deeper than events previously located in the vicinity.

At 2306 GMT on April 4, 1984, an event of M_C 2.9 was felt at Fall City, WA. The event was located at a depth of about 8 km. A preliminary fault plane solution indicates a strike slip fault with a NW-SE axis of maximum compression.

Mt St. Helens Area

Seismicity at Mt. St. Helens remained at background level during most of the second quarter. The focus of crater seismicity turned from minor earthquake activity to surficial activity in mid-May. The change was not subtle; it announced itself at 0932 PST on May 14 with a partial collapse of the west side of the dome, followed by a strong gas emission. There was no recognizable seismic precursor to this event. The emission sent an ash-laden plume to 28,000 feet, and included a small laterally directed blast into the west crater wall.

An emission on May 26 sent a gas and ash plume to 22,000 feet and generated a small mudflow that just barely reached Spirit Lake. A third plume at 1320 PST on May 27 apparently did not melt enough snow to generate any significant amount of water or mud flow. A large rock and snow avalanche on the southwest crater wall on May 23 was the largest from that side of the crater since January 1981.

On June 18, a new lobe of lava was observed by USGS field crews during a predawn flight. The growth of the new lobe caused a considerable increase in

avalanche activity. At the end of the quarter seismicity was still at "slightly elevated" levels, and reported deformation was continuing, as was the growth of the new lobe.

Catalog

Table 1 is a catalog of located events between April 1, 1984 and June 30, 1984 in the state of Washington and northern Oregon. The columns are generally self-explanatory except that the following features should be noted:

a) The origin time listed is that calculated for the earthquake on the basis of multistation arrival times. It is given in Coordinated Universal Time (UTC), identical to Greenwich Civil Times; in hours:minutes (TIME); and seconds (SEC). To convert to Pacific Standard Time (PST), subtract eight hours.

b) The epicenter location is given in north latitude (LAT) and west longitude (LONG) in degrees and minutes.

c) In most cases the DEPTH, which is given in kilometers, is freely calculated by computer from the arrival-time data. In some instances, the depth must be fixed arbitrarily to obtain a convergent solution. Such depths are noted by an asterix (*) in the column immediately following the depth. A $ or a # following the depth mean that the maximum number of iterations has been exceeded without meeting convergence tests and both the location and depth have been fixed.

d) MAG is an estimate of local Richter magnitude as calculated using the coda length-magnitude relationship determined for Washington. Where blank, data were insufficient or impossible to obtain for a reliable magnitude determination. Normally, the only earthquakes with undetermined magnitudes are those with very small magnitudes. These magnitudes are preliminary only and may be revised as we improve our analysis procedure.

e) NS/NP is the number of station observations and the number of P or S

MAGNITUDE COMPLETENESS

The area shown in Fig. 1 was evaluated to determine the magnitude levels at which the catalog is complete. The region was divided into one degree quadrangles as shown in Fig. 7, and a magnitude completeness level was determined for each quadrangle where events were located between 1981 and 1983. The number of events per subregion varied from zero (in areas at the edge of the network), to over three thousand, near Mt. St. Helens. Fig. 7 and Table 3 list number of events. Two methods were used to evaluate magnitude completeness, depending on number of located events. In areas where at least 25 events occurred the linear relation;

$$\log N = A - bM$$

where N is the number of earthquakes of magnitude M or greater (A and b are constants) was used. Reduced network sensitivity to events of small magnitude results in a departure from linearity. By plotting log N versus M; the magnitude level of completeness is determined empirically to be the point where the linear relation no longer holds. Where 25 or fewer events occurred the linear relation is difficult to determine, and another method was used.

Using regions where the first method applies, the average difference between the magnitude completeness level and the smallest event located in an area was determined. The difference between completeness and smallest located event had a mean (and mode) of 1.3 magnitude units. In the second method, this value was added to the magnitude of the smallest located event in sub-regions where 25 or fewer events occurred to give an estimate of completeness.

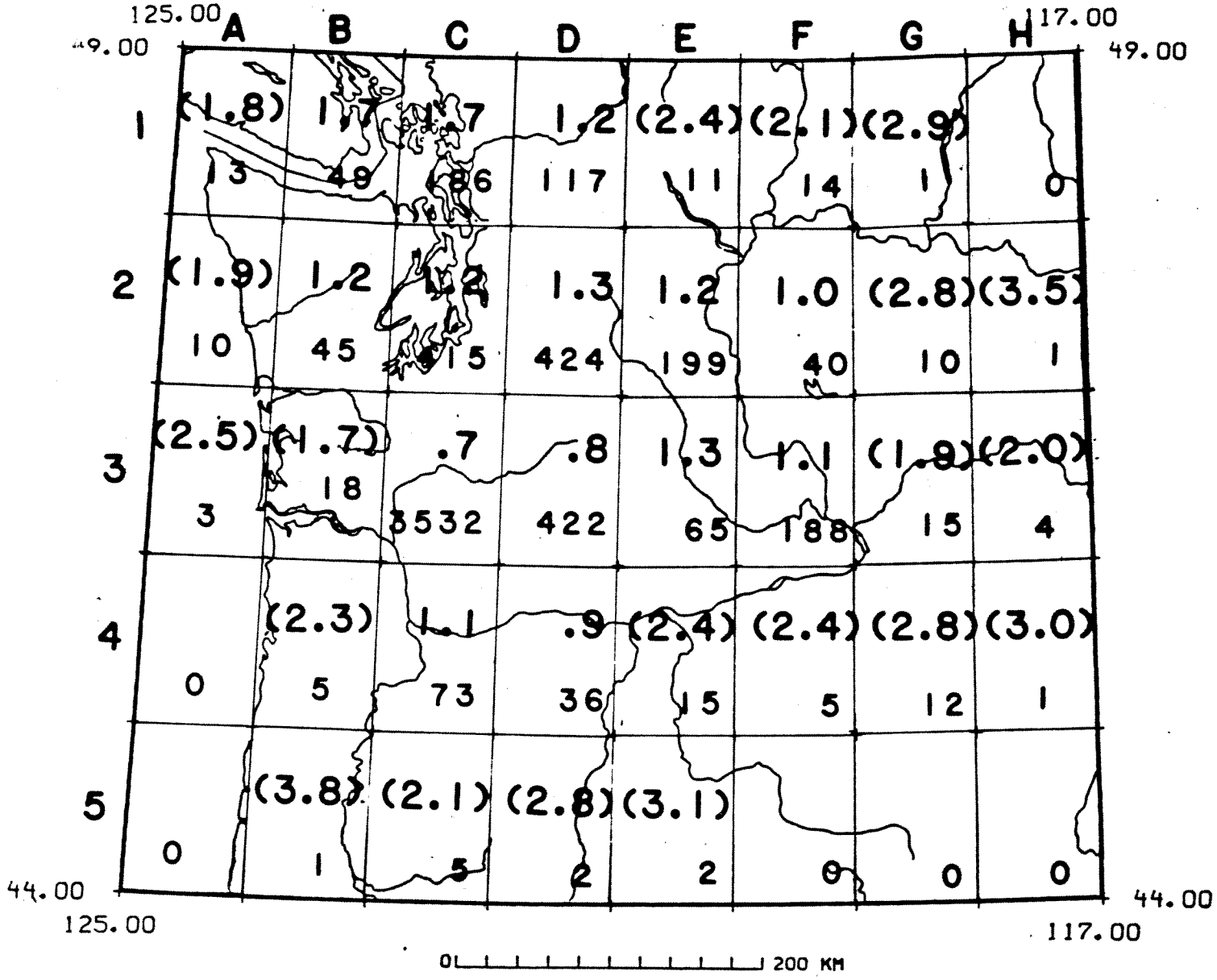

Figure 7 : Estimated magnitude completeness levels (large numbers), and number of located events 1981 through 1983 (small numbers). Magnitude completeness levels were estimated on the basis of linearity of log N vs. M plots when 25 or more events were located in an area. Where less than 25 events occurred, 1.3 magnitude units were added to the smallest located event in the area, and the magnitude completeness level is shown in parentheses. The value of 1.3 magnitude units is an average from the areas with 25 or more events. It represents the difference between smallest event located, and completeness magnitude. Revision in our magnitude scale may produce small differences in these magnitude completeness scales.

Results are shown in Fig. 7 and Table 3. Where 25 or fewer events were located, the magnitude completeness is in parenthesis, and was determined by the second method. No magnitude completeness level is given for areas where no earthquakes were located (1981-1983). Where only one event was recorded (e.g. quadrangles B5, G1, H2, and H4) the method used may not be a reliable indicator of completeness. Revision of our magnitude scale may produce a small difference in these magnitude completeness values.

TABLE 3

DATA USED IN FIGURE 7

AREA	# OF EVENTS	COMPLETE AT	AREA	# OF EVENTS	COMPLETE AT
A1	13	(1.8)	E1	11	(2.4)
A2	10	(1.9)	E2	199	1.2
A3	3	(2.5)	E3	65	1.3
A4	0	-	E4	15	(2.4)
A5	0	-	E5	2	(3.1)
B1	49	1.7	F1	14	(2.1)
B2	45	1.2	F2	40	1.0
B3	18	(1.7)	F3	188	1.1
B4	5	(2.3)	F4	5	(2.4)
B5	1	(3.8)	F5	0	-
C1	186	1.7	G1	1	(2.9)
C2	415	1.2	G2	10	(2.8)
C3	3532	.7	G3	15	(1.9)
C4	73	1.1	G4	12	(2.8)
C5	2	(2.8)	G5	0	-
D1	117	1.2	H1	0	-
D2	424	1.3	H2	1	(3.5)
D3	422	.8	H3	4	(2.0)
D4	36	(.9)	H4	1	(3.0)
D5	2	(2.1)	H4	0	-