QUARTERLY NETWORK REPORT 84-A

on

Seismicity of Washington and Northern Oregon

January 1 through March 31, 1984

Geophysics Program

University of Washington

Seattle, Washington

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 first quarterly report from the University of Washington Geophysics Program covering seismicity of all of Washington and northern Oregon in one comprehensive report. Quarterly and annual reports have been produced since 1975 covering the seismicity of eastern Washington, quarterly reports have been produced since 1983 covering the Washington and northern Cascades, and annual catalogs have been produced since 1969 covering the seismicity of western Washington. This and subsequent quarterly reports will replace the eastern Washington and Cascades quarterly reports. This report covers network operations, seismicity of the area, and a brief discussion of any unusual events or findings. These reports are to be considered preliminary, and are not a substitute for detailed technical reports, a regional catalog, or technical papers. 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

The effects of the storms around Christmas time lingered on into the new year, but an early January thaw melted ice on antennas and many stricken stations came to life once again. Late in January, the unseasonably warm weather and low snowpack permitted access to some high mountain stations where serious problems existed. The Tradedollar Lake repeater site was revived, restoring the Mount St. Helens crater stations to the network just in time to record the major swarm prior to the February eruption. Other stations were visited as well, with the result that for most of the quarter virtually no area of the western network was suffering grievously from down-time. Several stations remain out since access was still impossible because of snow.

On the minus side, the MOW station, near Seattle, was vandalized in February, and we have concluded that it needs to be moved if we are to prevent further vandalism. The re-siting has proven a difficult task, because suburban sprawl has encroached upon the station area over the last several years. A number of possible locations were checked with portable seismographs, but no better site could be found within the boundaries of where we need the station to be. We have settled on a somewhat poorer site, near the original station but more secure.

Eastern Washington

The eastern Washington network fared well in this reporting period. A new station (BRV) was installed in late December 1983 at a point between MDW and YAK stations; operation of the new station was stabilized in January. By mid-March, an operational status of 100% was achieved -- very unusual for winter operations.

Northern Oregon

Operations in northern Oregon were not particularly good, and little could be done about most problems because of station inaccessibility. Connections were tightened up and batteries changed at Augspurger Mountain, bringing many of the errant northern Oregon and southern Washington Cascade stations back on line. After the main phone drop was repaired, reasonable coverage was reestablished despite several stations remaining out.

During the reporting period, it was learned that NRC support for continued operations in northern Oregon would be discontinued in late 1984. Considering the large amount of technical staff time and effort expended upon the net in 1982 and 1983, additional effort to upgrade or improve the data from this area will not be made.

DATA

There were 1076 events processed by the network during the time period January 1 through March 31, 1984. 758 of these were events located in the state of Washington and northern Oregon. Of these, 86 were known or suspected blasts, and 672 were earthquakes. 47 of the earthquakes were handpicked from film records, because they did not trigger the online computer system. 471 of the earthquakes located under the cone of Mt. St. Helens. Table 1 is the event catalog for this quarter. Of events located outside the Mt. St. Helens area, only those with magnitudes 1.0 or greater are included in the catalog. Only earthquakes of magnitude 2.0 or greater in the Mount St. Helen's area are included in the table. Figure 2 shows all earthquakes greater than magnitude 1.0. Figure 3 shows blasts and probable blasts. Figure 4a shows all earthquakes located in western Washington and figure 5 shows all earthquakes located in eastern Washington. Figure 6 shows earthquakes with magnitude 2.2 or greater in the Mt. St. Helens area.

Eastern Washington

In eastern Washington, there were no notable events. Activity continued in the area of the two M=3.8 earthquakes which occurred near Yakima on November 14 and December 5, 1983. Fifteen earthquakes occurred in this area; the largest had a magnitude of 2.4. The cluster of activity south of Lake Chelan continued at a rate similar to the past year's activity. Twenty-five earthquakes were located in this region during the quarter; the largest was a magnitude 2.3 on January 29,1984. The Pasco basin was noticeable in its lack of seismic activity.

Northern Oregon

There were 5 earthquakes located in northern Oregon during the first quarter of 1984. The largest was a magnitude 2.8 which occurred 30 kilometers east of Salem on March 4,1984.

Western Washington

During the first quarter of 1984, two felt events occurred in northwestern Washington. A magnitude 2.6 and magnitude 3.4 were felt in the area of Rockport and Concrete on March 16 at 0235 and 1716 GMT. Thirteen earthquakes were located in the Elk Lake aftershock zone, however they all had magnitudes less than 2.0.

Mt St. Helens Area

Mt. St. Helens changed its eruption pattern in January, 1984. After almost a year of slow, nearly continuous eruption with "slightly elevated" to moderate seismicity, a new period of episodic eruption began accompanied by greatly increased seismicity. By the last week of January, seismicity was markedly different from what it had been during most of 1983. For example, of the 10 countable volcanic earthquakes that occurred on Jan 25, six were medium frequency type "m" events, two of which exceeded 100 seconds in duration. This was the greatest activity seen since the first week of February, 1983. The increasing rates of deformation measured by USGS crews and the unusual seismicity provided strong hints of an increase in volcanic activity on the way. This led to the first USGS-UW Information Statement of 1984, which mentioned the possibility of a large rockfall or a small lateral explosion from the north side of the dome.

The predicted eruption was confirmed on Feb 10 after a classical precursor earthquake swarm. Some similarities with the March 1982 earthquake swarm and reports of significant crater floor deformation from the USGS suggested the likelihood of an explosive onset to the eruption, but the new lobe began life quite meekly. This eruption was followed by the lowest level of seismic activity in more than a year.

The seismically quiet period extended through March 21 after which a new precursory swarm began. This swarm became the most energetic earthquake swarm of any since May 1980. The seismicity that preceded and accompanied the birth of a new lobe ,confirmed on March 29, exhibited two distinct phases. The first one was a 1981-82 style swarm of shallow volcanic earthquakes, consisting of roughly equal numbers of type "m" and "l" events. This first swarm peaked during the early morning hours on March 28 with an average of 16 to 20 countable earthquakes each hour. This was twice the maximum rate seen during the February eruption, although the average event size this time was somewhat smaller. The second and most unusual phase of the eruption seismicity began that same morning as a subtle increase in the rate of small, nearly identical shallow events appearing on the seismogram of the crater station, YEL. By 1030 PST they were increasing rapidly and had become the dominant activity by 1600 PST that day. They merged into a continuous signal which appeared to resemble volcanic tremor. Partial collapse of the north side of the dome began at 0317 PST on March 29 with a 9-minute rockfall series, the first of several over the next few hours. The resulting avalanche scar became the exit path for a new lobe which was confirmed on the morning of March 29. Overall seismicity did not return to background levels until 4 days later.

Catalog

Table 1 is a catalog of located events between January 1, 1984 and March 31, 1984 in the state of Washington and northern Oregon. Of earthquakes located outside the Mt. St. Helens cone only those with magnitudes 1.0 or greater are included. Only earthquakes with magnitudes 2.0 or greater in the Mt. St. Helens area are included in the table. 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 epicenter solutions. 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 the local Richter magnitude as calculated using the coda length-magnitude relationship determined for western 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.

e) NS/NP is the number of station observations and the number of phases used to calculate the earthquake location. A minimum of three stations and four phases are required. Generally the greater the number of observations used, the better the solution quality.

f) The root mean square (RMS) is taken about the mean of the station first-arrival residuals. It is only meaningful as a general statistical measure of the goodness of the solution when 5 or more well distributed stations are used in the solution. Good solutions are normally characterized by RMS values less than about 0.3.

g) QUALITY of the hypocenter indicates the general reliability of the solution. The first quality is rated by the statistical measure of the solution. The second quality is rated according to the station distribution.

h) MODEL refers to the velocity model used in the location calculations.

P1 is the Puget Sound model

C1 is the Cascade model

S1 is used to located events near Mt. St. Helens but outside the crater, including the Elk Lake earthquakes.

S2 has used for events at Mt. St. Helens since February 1, 1984.

O1 is the Olympic model

N1 is the northeastern model

E1 is the southeastern model

i) TYPE of events flagged in Appendix I use the following code:

F - earthquakes reported to have been felt

P - probable explosion

L - low frequency earthquakes

H - handpicked from film records

X - known explosion

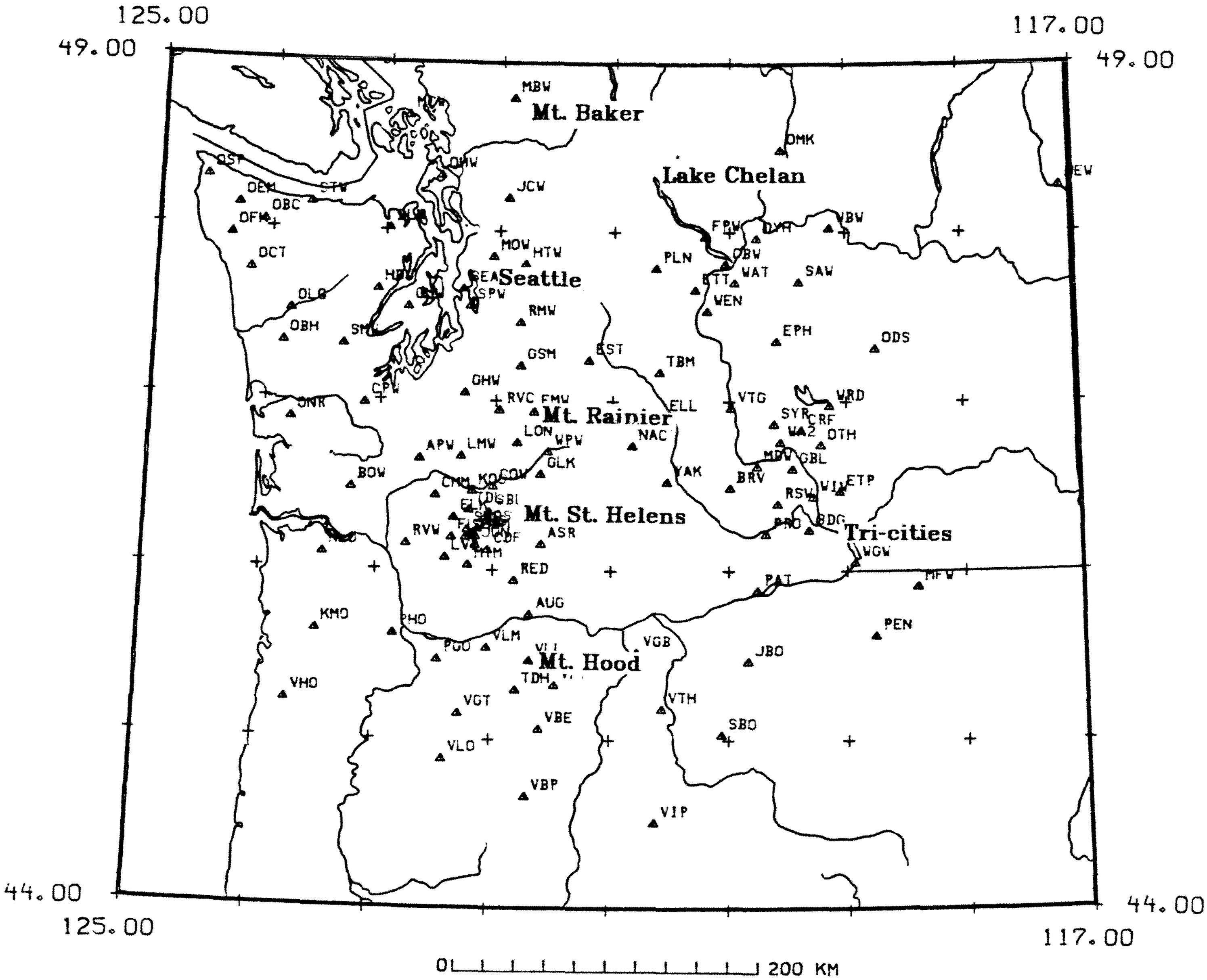

Figure 1. Major geographical features in the state of Washington and northern Oregon and the seismograph stations currently in operation.