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

July 1 through September 30, 1984

Geophysics Program
University of Washington
Seattle, Washington

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INTRODUCTION

This is the third 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. Some earthquake locations may be revised if new data become available, such as P and S readings from Canadian seismic stations. 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 and Northern Oregon

Seismographs in western Washington generally operated well in the third quarter. Three stations near Mount St. Helens (KOS, ASR, and RED) still require repair. One station on the northern Olympic peninsula, STW, was accidently destroyed by heavy equipment. Late in the third quarter a station was installed in the middle of the Olympic Peninsula on the flanks of Mount Olympus. This station (OSD) began operating in the fourth quarter.We have plans to establish stations in two caitical areas of the Puget sound: the northern tip of the Kitsap peninsula northwest of Seattle and the southern Puget sound southwest of Tacoma. We also plan to

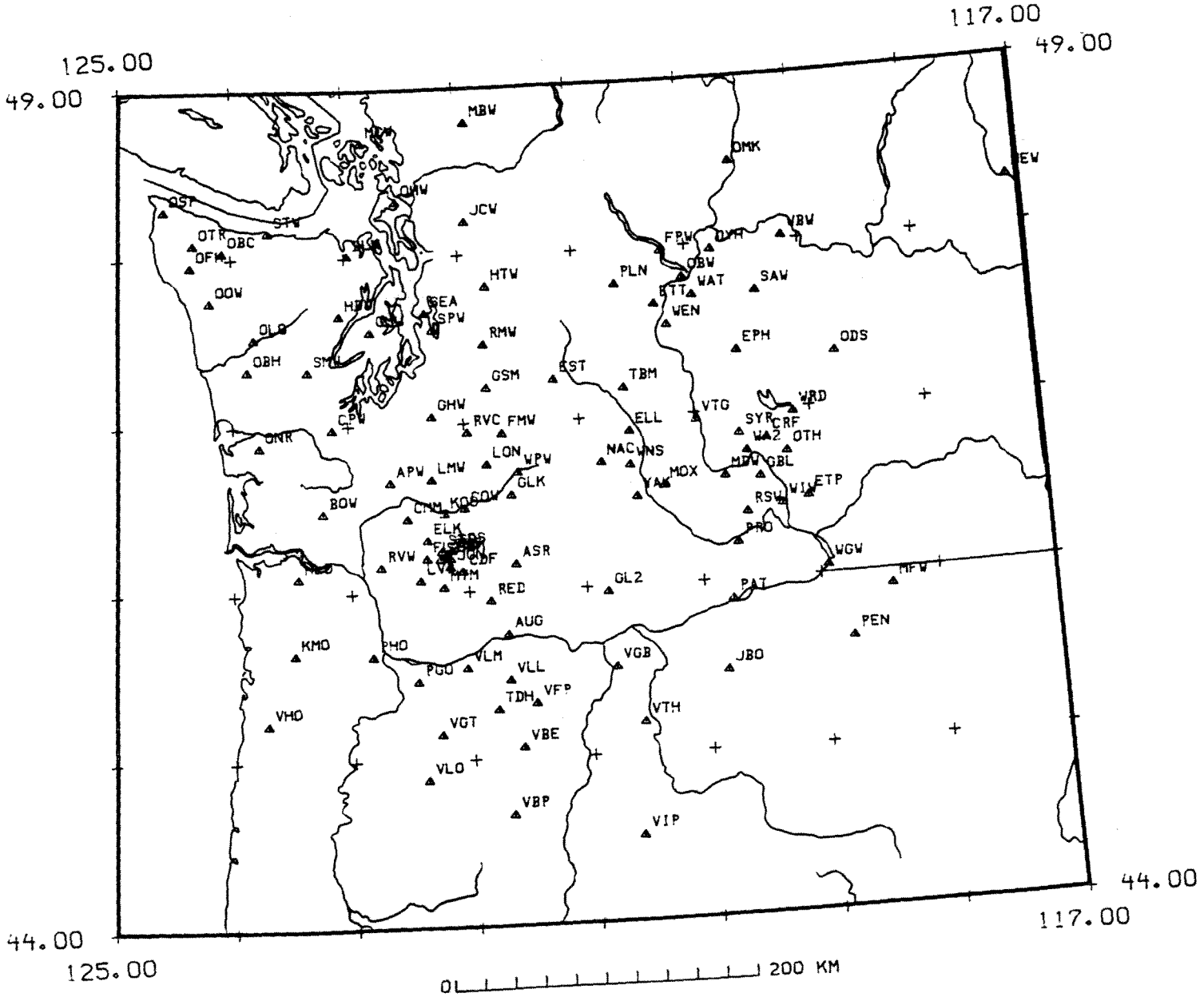

Figure 1. Seismograph stations operating during the third quarter 1984.

reestablish stations in the Skagit valley of northwest Washington. We hope to utilize microwave links for transmitting signals from most of the new stations to the University of Washington.

The major problem during this quarter was the poor operation of stations in northern Oregon. Of the nineteen stations there seven did not function and 6 others operated sporadically. At this time we do not have sufficient personnel to maintain these as well as the other stations in the network.

Eastern Washington

Stations in eastern Washington operated well during the third quarter. In August the University of Washington and the U. S. Geological Survey participated in a large scale refraction experiment near the Hanford reservation. The University of Washington installed two dozen temporary stations to supplement the permanent network in order to record blasts which occurred on August 19 and 23. Two of the stations, now called MOX and WNS, became part of the permanent network. These stations utilize solar cells and low capacity rechargeable batteries for power. We are evaluating this power source as a less expensive alternative to the traditional use of non-rechargeable high capacity batteries.

Arrangements are now underway to shift much of the the network from phone-line to microwave transmission using equipment operated by the Bonneville Power Administration. This will require some rearrangement of the University of Washington network and future modifications to seismograph sites will be made with this goal in mind.

EARTHQUAKE DATA

There were 1170 events processed by the University of Washington seismic network between July 1 and September 30, 1984. We determined locations for 400 of these in Washington and Northern Oregon; 310 were classified as earthquakes

and 100 as known or suspected blasts. 43 of the earthquakes were hand-picked from film records because they did not trigger the on-line computer system (see the section on completeness of the earthquake catalog). Although we list the locations of 113 earthquakes near Mount St. Helens for this period we do not report locations for about 500 events which occurred under the volcano, principally during the eruption of September 9-12. Table 1 is the event catalog for this quarter. Figure 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 near Mount St. Helens.

Western Washington and Oregon

During the third quarter of 1984 302 events were located between 44° and 49° latitude and between 121° and 125° longitude. The largest event was a magnitude 3.1 event on August 5 located 30 km. northwest of Mount St. Helens near the town of Morton. One event (M_c 2.9) was reported felt in northwest Washington near Mt. Vernon on August 10. In general the activity was concentrated in the Puget lowland and in the Cascades. There was a clear concentration of earthquakes along a line extending NNW from Mount St. Helens.

Eastern Washington and Oregon

The greatest activity occurred in a cluster near Entiat on the Columbia river just south of lake Chelan. Just to the west of this cluster a M_c 3.0 earthquake occurred on August 24 which was reported felt in the Cascades west of Cle Elum.

A number of small earthquakes occurred just north of the Hanford reservation and several others occurred southwest of Richland.

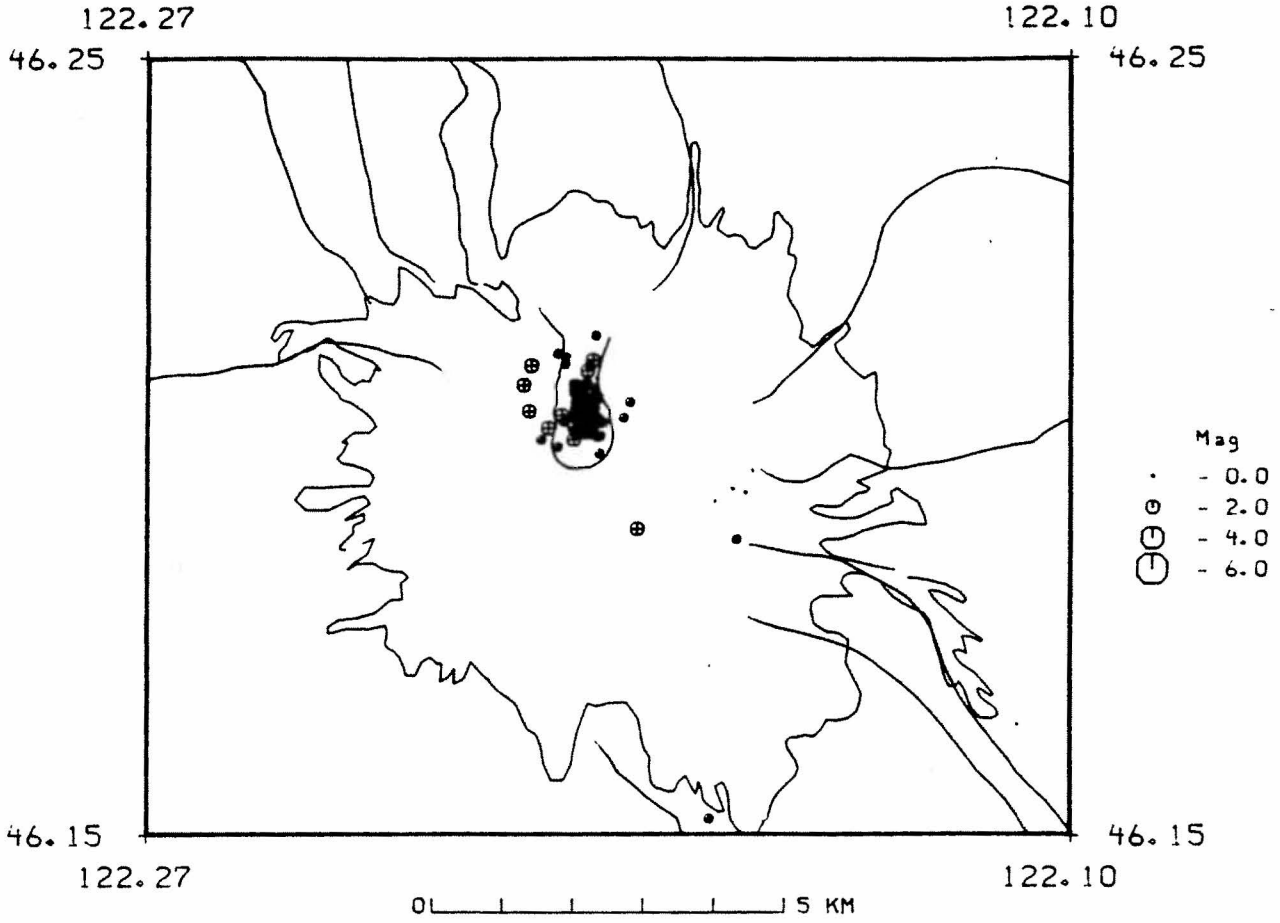

Figure 6a. Earthquakes located in the Mt. St. Helens area. July 1 through September 30, 1984. Locations for about 500 events which occurred during the eruption of Sept. 10 to 12 are not shown.

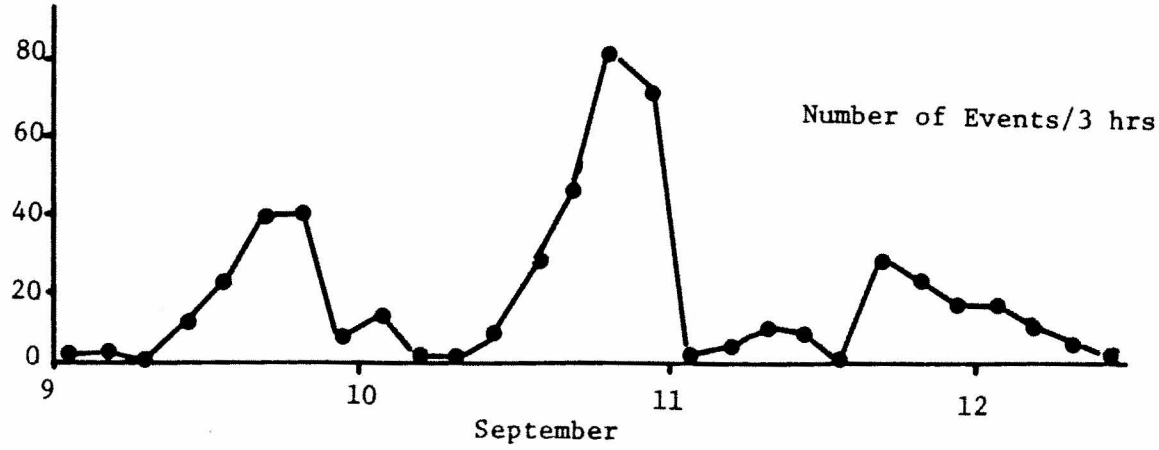

Figure 6b. Number of Mount St. Helens events per 3 hr period which triggered digital system from Sept 9-12.

Mount St. Helens Area

Seismicity at Mount St. Helens decreased in July and early August (less than 5 events per day) after a growth of the crater dome in late June.Then in late August seismicity increased to about 10 events per day and on August 20 the US Geological Survey reported increased deformation rates on the north side of the dome. The number of avalanche and "peppercorn" seismic events (tiny short duration signals) increased significantly between Sept. 7 and 10. The latter events developed into larger relatively high-frequency earthquakes but they ceased abruptly for several hours on Sept. 10 although the intensity of volcanic tremor increased steadily. By the middle of Sept. 10 the tremor was saturating seismographs close to Mount St. Helens and a vigorous growth of the dome was presumably under way. The intensity of the tremor decreased by the end of the day and numerous individual earthquakes could again be distinguished although they had lower frequency content than the earthquakes which preceded the eruption. By Sept. 12 the US Geological Survey visually confirmed a growth of the northwest side of the dome and by Sept. 13 seismic activity had returned to a background level.

Although the digital seismic system was triggered by over 600 St. Helens earthquakes during this period we have not attempted to locate most of them. In fact the catalog given in Table 1 does not list earthquakes which occurred during the period of most intense seismic activity. The digital seismic trace data were saved, however, and the results of analyses of these data will be reported in technical papers. Because of the overwhelming number of earthquakes during the eruption the Saint Helens portion of the digital seismic network was desensitized and resensitized several times in order to limit the number of events to the most significant ones. Figure 6 shows the number of events which actually triggered the system during this time. Locations for only a few of these events are reported in Table 1.

Completeness of Earthquake Catalog

We continue to investigate the completeness of our earthquake catalog in Washington and some results were last reported in Quarterly report 84-B. In the fourth quarter we will no longer routinely scan seismic data on Develocorder films and by the end of the year recording of these films will cease. Presently these films serve as a convenient back-up system for the digital recording and they have the advantage of recording continuously unlike the digital system. However the digital system is sufficiently reliable that the expense of maintaining Develocorders and scanning the films is unwarranted with our present resources.

We have considered the effect of stopping the Develocorder recording on the completeness of our earthquake catalogs. Traditionally we have augmented our catalog with "hand picked" earthquake data read from Develocorder films when the events did not trigger the digital system or when the digital system is not operating. The number of earthquakes missed because of computer failure has been insignificant. The main contribution of the Develocorder data has been to provide additional earthquake locations ("hand picks") for very small events which have not triggered the digital recording system.

Figure 7 shows that below magnitude 1.9 more than 10% of our earthquake data are hand picked. At the magnitude 1.5 level 50% of the earthquakes are hand picked in most areas of western Washington. When the Develocorders are removed most of these data will be lost. Figure 7 also indicates that even *with* hand picked data the catalog has probably not been complete below magnitude 1.7-1.9 except in regions like Mount St. Helens with closely spaced seismograph stations. After we remove the Develocorders our catalogs will report fewer events below this magnitude level but the completeness of the catalog at magnitudes above 2 should be affected little.

We will continue to operate visible drums as a continuously recording back-up

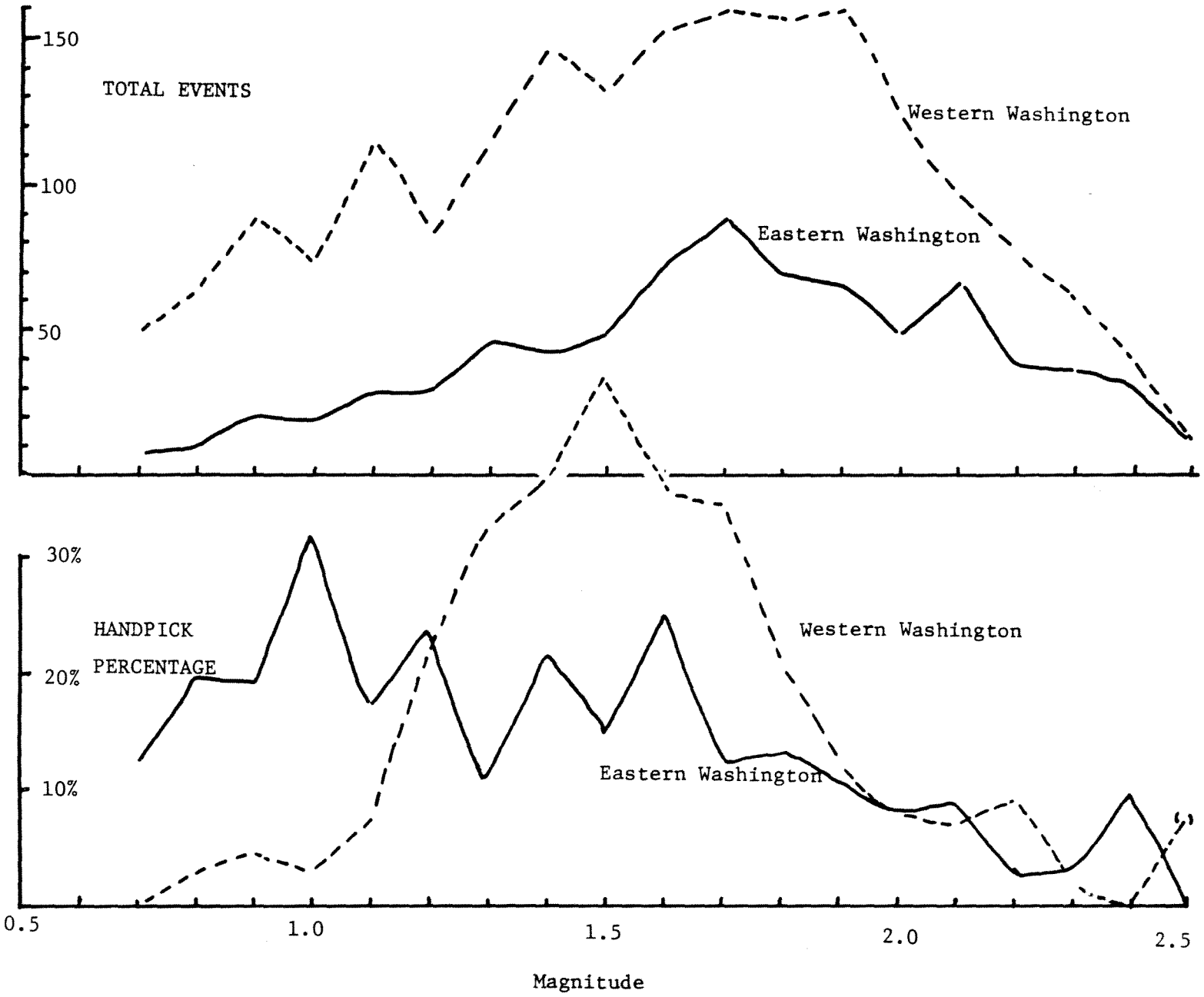

Figure 7. Completeness of earthquake catalog versus magnitude. Top graph shows total number of earthquakes in catalog at each magnitude (±0.05) for the last 32 months. A certain percentage of the earthquakes are handpicks. Bottom graph shows this percentage versus magnitude.

to the digital system. We presently record 15 stations on visible drums. Larger earthquakes missed by the digital system (from computer failure for example) could be located using data from the drums.

Catalog

Table 1 is a catalog of located events between July 1, 1984 and September 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 asterisk (*) 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