

QUARTERLY NETWORK REPORT 88-D

on

Seismicity of Washington and Northern Oregon

October 1 through December 31, 1988

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 operation in Washington and northern Oregon is supported by the following contracts:

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INTRODUCTION

This is the fourth quarterly report of 1988 from the University of Washington Geophysics Program covering seismicity of all of Washington and northern Oregon. These comprehensive quarterlies have been produced since the beginning of 1984. Prior to that we published quarterlies for western Washington in 1983 and for eastern Washington from 1975 to 1983. Annual reports covering seismicity in Washington since 1969 are available from the U.W. Geophysics Program. In collaboration with the University of Washington, the State Department of Natural Resources (DNR) has published catalogs of earthquake activity in western Washington for the period 1970-1979. The DNR has published earthquake catalogs for the whole state for the period 1980-1986.

This quarterly report discusses network operations, seismicity of the region, and unusual events or findings. This report is 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. Fig. 1 shows major geographical features in the state of Washington and northern Oregon and seismograph stations now in operation.

NETWORK OPERATIONS

Table 1 gives approximate periods of time when stations were inoperable. Data for Table 1 are compiled from weekly plots of network-wide teleseismic arrivals, plus records of maintenance and repair visits. Fig. 1 shows a map view of stations operating during the quarter.

There were only two station changes within the network this quarter. On December 1, station OTH in eastern Washington was replaced by a new station and moved slightly, then renamed OT2. On December 5, station WPO was moved in an attempt to eliminate radio interference associated with the building that it occupied. It was renamed WP2.

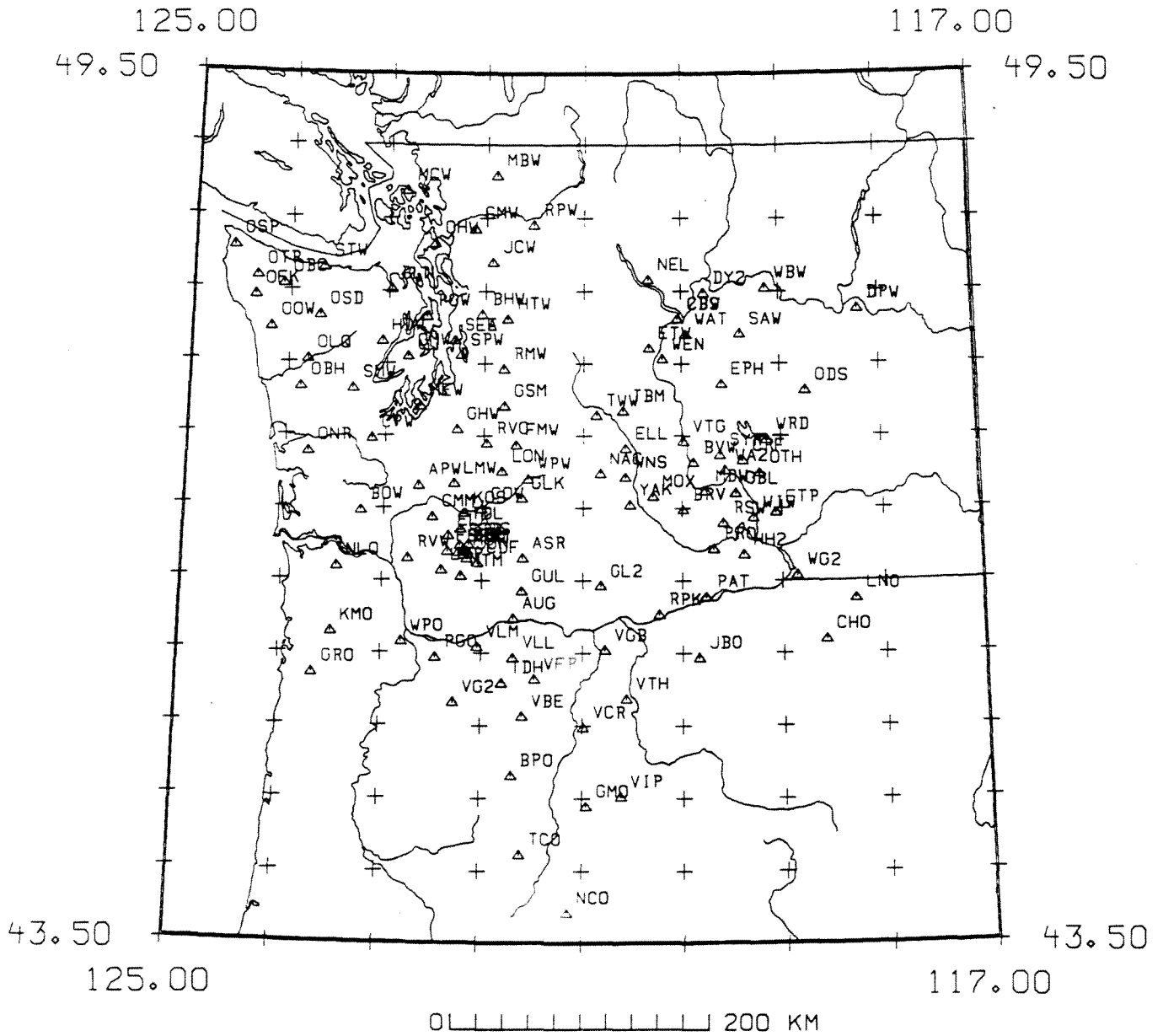


Figure 1. Seismograph stations operating during the 4th quarter 1988.

TABLE 1
Station Problems and Comments, 4th quarter 1988

Station	Outage Dates	Comments
BVW	November 14-December 9	Intermittent
CDF	December 22-December 31	Dead
COW	October 14-December 8	Periodic telemetry Prob Ⓞ WPW
EDM	December 23-December 27	Snow covered solar panel
ELK	December 22-December 27	Dead
ETW	Whole Period	Fire damage
GHW	October 21-October 31	Intermittent
GLK	October 14-December 8	Intermittent, Prob Ⓞ WPW
GMW	October 1-December 8	Seis tilted
HSR	November 21-December 2	Dead
LNO	October 21-November 3	Intermittently noisy
MOX	November 25-December 15	Periodic fog at solar site
MTM	December 23-December 27	Snow covered solar panel
NCO	November 17-November 21	Dead
OBH	November 3-December 31	Intermittent, batteries
OFK	Whole Period	Off center freq, batteries
OLQ	Whole Period	Interference, intermittent
PAT	October 21-November 3	Intermittently noisy
PGW	October 31-November 17	Intermittent, dead, replaced seis
PRO	October 31-November 17	Dead
RC1	November 14-December 9	Intermittent
REM	Whole Period	Dead
SOS	October 21-December 31	Intermittently dead
STD	October 21-December 31	Intermittent, noisy
TCO	December 24-December 31	Dead
WG2	October 31-November 17	Intermittent, dead
WPO	October 31-December 5	Intermittent, replaced by WP2 12/5
WPW	October 14-December 8	Intermittent

STATIONS USED FOR LOCATION OF EVENTS

Table 2 lists stations used in locating seismic events in Washington and Oregon. Stations marked by an asterisk (*) were supported by USGS joint operating agreement 14-08-0001-A0622. Stations marked by (\$) were supported by USGS contract 14-08-0001-21978. (+) indicates support under Westinghouse Hanford Company Contract PMM-RJU-505. All other stations were supported from other sources.

The first column in the table gives the 3-letter station designator. This is followed by a symbol designating the funding agency, station north latitude and west longitude (in degrees, minutes and seconds), station elevation in km, and comments indicating landmarks for which stations were named.

STA	F	LAT	LONG	EL	NAME
APW	*	46 39 06.0	122 38 51.0	0.457	Alpha Peak
ASR	\$	46 09 02.4	121 35 33.6	1.280	Mt. Adams - Stagman Ridge
AUG	\$	45 44 10.0	121 40 50.0	0.865	Augsburger Mtn
BHW	*	47 50 12.6	122 01 55.8	0.198	Bald Hill
BLN	*	48 00 26.5	122 58 18.6	0.585	Blyn Mt.
BOW	*	46 28 30.0	123 13 41.0	0.870	Boistfort Mt.
BPO	\$	44 39 06.9	121 41 19.2	1.957	Bald Peter, Oregon
BRV	+	46 29 07.2	119 59 29.4	0.925	Black Rock Valley
BVW	+	46 48 37.8	119 52 54.1	0.707	Beverly
CHO	+	45 35 27.0	118 34 45.0	1.076	Cabbage Hill, Oregon
CBS	+	47 48 16.7	120 02 27.6	1.073	Chelan Butte, South
CDF	\$	46 06 58.2	122 02 51.0	0.780	Cedar Flats
CMM	\$	46 26 07.0	122 30 21.0	0.620	Crazy Man Mt.
CMW	*	48 25 25.3	122 07 08.4	1.190	Cultus Mtns.
COW	\$	46 29 27.6	122 00 43.6	0.305	Cowlitz River
CPW	*	46 58 25.8	123 08 10.8	0.792	Capitol Peak
CRF	+	46 49 30.6	119 23 18.0	0.260	Corfu
DPW	+	47 52 14.3	118 12 10.2	0.892	Davenport
DY2	+	47 59 06.9	119 46 13.0	0.884	Dyer Hill 2
EDM		46 11 50.4	122 09 00.0	1.609	East Dome, Mt. St. Helens
ELK	\$	46 18 20.0	122 20 27.0	1.270	Elk Rock
ELL	+	46 54 35.0	120 34 06.0	0.805	Ellensburg
EPH	+	47 21 12.8	119 35 46.2	0.628	Ephrata
ETP	+	46 27 53.4	119 03 32.4	0.250	Eitopia
ETW	+	47 36 16.2	120 19 51.6	1.475	Entiat
FL2	\$	46 11 47.0	122 21 01.0	1.378	Flat Top 2
FMW	*	46 55 54.0	121 40 19.2	1.890	Mt. Fremont

continued

STA	F	LAT	LONG	EL	NAME
GBL	+	46 35 51.6	119 27 35.4	0.330	Gable Mountain
GHW	*	47 02 30.0	122 16 21.0	0.268	Garrison Hill
GL2	+	45 57 35.0	120 49 22.5	1.000	New Goldendale
GLK	\$	46 33 50.2	121 36 30.7	1.320	Glacier Lake
GMO	\$	44 26 20.8	120 57 22.3	1.689	Grizzly Mountain, Oregon
GMW	*	47 32 52.5	122 47 10.8	0.506	Gold Mt.
GRO	\$	45 21 04.5	123 39 43.0	0.945	Grindstone Mt., Oregon
GSM	*	47 12 11.4	121 47 40.2	1.305	Grass Mt.
GUL	\$	45 55 27.0	121 35 44.0	1.189	Guler Mt.
HDW	*	47 38 54.6	123 03 15.2	1.006	Hoodspport
HH2	+	46 10 18.0	119 23 01.0	0.490	Horse Heaven Hills (moved HHW)
HSR	\$	46 10 22.2	122 10 58.2	1.774	South Ridge, Mt. St. Helens
HTW	*	47 48 12.5	121 46 08.6	0.829	Haystack Lookout
JBO	\$	45 27 41.7	119 50 13.3	0.645	Jordan Butte, Oregon
JCW	*	48 11 36.6	121 55 46.2	0.616	Jim Creek
JUN	\$	46 08 48.0	122 09 10.8	1.049	June Lake
KMO	\$	45 38 07.8	123 29 22.2	0.975	Kings Mt., Oregon
KOS	\$	46 27 40.8	122 11 25.8	0.828	Kosmos
LMW	*	46 40 04.8	122 17 28.8	1.195	Ladd Mt.
LNO	+	45 52 15.8	118 17 06.0	0.768	Linton Mt., Oregon
LOC		46 43 04.8	119 25 54.6	0.201	Rohay Station
LO2		46 45 00.0	121 48 36.0	0.853	Longmire
LON		46 45 00.0	121 48 36.0	0.853	Longmire (WWSSN and D WWSSN)
LVP	\$	46 04 06.0	122 24 30.0	1.170	Lakeview Peak
MBW	*	48 47 02.4	121 53 58.8	1.676	Mt. Baker
MCW	*	48 40 46.8	122 49 56.4	0.693	Mt. Constitution
MDW	+	46 36 48.0	119 45 39.0	0.330	Midway
MEW	*	47 12 07.0	122 38 45.0	0.097	McNeil Island
MOX	+	46 34 38.0	120 17 35.0	0.540	Moxie City
MTM	\$	46 01 31.8	122 12 42.0	1.121	Mt. Mitchell
NAC	+	46 44 03.8	120 49 33.2	0.738	Naches
NCO	\$	43 42 18.2	121 08 06.0	1.908	Newberry Crater, Oregon
NEL	+	48 04 41.8	120 20 17.7	1.490	Nelson Butte
NLO	*	46 05 18.0	123 27 00.0	0.900	Nicolai Mt., Oregon
OBC	\$	48 02 07.1	124 04 39.0	0.938	Olympics - Bonidu Creek
OBH	\$	47 19 34.5	123 51 57.0	0.383	Olympics - Burnt Hill
ODS	+	47 18 24.0	118 44 42.0	0.523	Odessa
OFK	\$	47 57 00.0	124 21 28.1	0.134	Olympics - Forks
OHW	*	48 19 24.0	122 31 54.6	0.054	Oak Harbor
OLQ	\$	47 30 58.1	123 48 31.5	0.121	Olympics - Lake Quinault
ONR	\$	46 52 37.5	123 46 16.5	0.257	Olympics - North River
OOW	\$	47 44 12.0	124 11 22.0	0.743	Octopus West
OSD	*	47 49 15.0	123 42 06.0	2.010	Olympics - Snow Dome
OSP	\$	48 17 05.5	124 35 23.3	-	Olympics - Sooes Peak
OT2	+	46 43 17.0	119 14 05.0	-	New Othello (replaces OTH)
OTH	+	46 44 20.4	119 12 59.4	0.260	Othello
OTR	\$	48 05 00.0	124 20 39.0	0.712	Olympics - Tyee Ridge
PAT	+	45 52 50.1	119 45 40.1	0.300	Paterson
PGO	\$	45 28 00.0	122 27 10.0	0.237	Gresham, Oregon
PGW	*	47 49 18.8	122 35 57.7	0.122	Port Gamble

continued

STA	F	LAT	LONG	EL	NAME
PRO	+	46 12 45.6	119 41 09.0	0.552	Prosser
RC1		46 56 60.0	119 26 00.0	0.500	Royal City (3-component)
REM		46 11 57.0	122 11 03.0	2.102	Rembrandt (Dome station)
RMW	*	47 27 34.9	121 48 19.2	1.024	Rattlesnake Mt. (West)
RPK	+	45 45 42.0	120 13 50.0	0.330	Roosevelt Peak
RPW	*	48 26 54.0	121 30 49.0	0.850	Rockport
RSW	+	46 23 28.2	119 35 19.2	1.037	Rattlesnake Mt. (East)
RVC	\$	46 56 34.5	121 58 17.3	1.000	Mt. Rainier - Voight Creek
RVW	*	46 08 58.2	122 44 37.2	0.460	Rose Valley
SAW	+	47 42 06.0	119 24 03.6	0.890	St. Andrews
SEA		47 39 18.0	122 18 30.0	0.030	Seattle (Wood Anderson)
SEE		47 39 18.0	122 18 30.0	0.030	Seattle Pseudo-WA (E)
SEN		47 39 18.0	122 18 30.0	0.030	Seattle Pseudo-WA (N)
SHW	*	46 11 33.0	122 14 12.0	1.423	Mt. St. Helens
SMW	*	47 19 10.2	123 20 30.0	0.840	South Mt.
SOS	\$	46 14 38.5	122 08 12.0	1.270	Source of Smith Creek
SPW	*	47 33 13.3	122 14 45.1	0.008	Seward Park, Seattle
STD	\$	46 14 16.0	122 13 21.9	1.268	Studebaker Ridge
STW	*	48 09 02.9	123 40 13.1	0.308	Striped Peak
SYR	+	46 51 46.8	119 37 04.2	0.267	Smyrna
TBM	+	47 10 10.1	120 35 54.0	1.064	Table Mt.
TCO	\$	44 06 27.0	121 36 00.0	1.975	Three Creek Meadows, Or.
TDH	\$	45 17 23.4	121 47 25.2	1.541	Tom,Dick,Harry Mt., Oregon
TDL	\$	46 21 03.0	122 12 57.0	1.400	Tradedollar Lake
TWW	+	47 08 17.2	120 52 04.5	1.046	Teanaway
VBE	\$	45 03 37.2	121 35 12.6	1.544	Beaver Butte, Oregon
VCR	\$	44 58 58.2	120 59 17.3	1.015	Criterion Ridge, Oregon
VFP	\$	45 19 05.0	121 27 54.3	1.716	Flag Point, Oregon
VG2	+	45 09 20.0	122 16 15.0	0.823	Goat Mt., Oregon
VGB	+	45 30 56.4	120 46 39.0	0.729	Gordon Butte, Oregon
VIP	+	44 30 29.4	120 37 07.8	1.731	Ingram Pt., Oregon
VLL	\$	45 27 48.0	121 40 45.0	1.195	Laurance Lk., Oregon
VLM	\$	45 32 18.6	122 02 21.0	1.150	Little Larch, Oregon
VTG	+	46 57 28.8	119 59 14.4	0.208	Vantage
VTH	+	45 10 52.2	120 33 40.8	0.773	The Trough, Oregon
WA2	+	46 45 24.2	119 33 45.5	0.230	Wahluke Slope
WAT	+	47 41 55.0	119 57 15.0	0.900	Waterville
WBW	+	48 01 04.2	119 08 13.8	0.825	Wilson Butte
WEN	+	47 31 46.2	120 11 39.0	1.061	Wenatchee
WG2	+	46 01 50.25	118 51 19.95	0.511	Wallula Gap
WIW	+	46 25 48.8	119 17 13.4	0.130	Wooded Island
WNS	+	46 42 37.0	120 34 30.0	1.000	Wenas
WP2	+	45 33 57.20	122 47 06.90	0.341	West Portland, Oregon(replaces WPO)
WPO	\$	45 34 24.0	122 47 22.4	0.334	West Portland, Oregon
WPW	+	46 41 53.4	121 32 48.0	1.250	White Pass
WRD	+	46 58 11.4	119 08 36.0	0.378	Warden
YAK	+	46 31 15.8	120 31 45.2	0.619	Yakima
YEL		46 12 35.0	122 11 16.0	1.750	Yellow Rock, Mt. St. Helens

EARTHQUAKE DATA

There were 555 events processed by the University of Washington digitally recording seismic network between October 1 and December 31, 1988. Locations were determined for 396 of these in Washington and Northern Oregon; 326 were classified as earthquakes and 70 as known or suspected blasts. The remaining 159 processed events include teleseisms (71 events), regional events outside the U. W. network (48), and unlocated events within the U. W. network. Unlocated events within the U.W. network include very small earthquakes and some known blasts. For example, only a few of the frequent mine blasts at Centralia are located.

Table 3 is the catalog of earthquakes and blasts located within the network for this quarter. Fig. 2 shows all earthquakes with magnitude greater than or equal to 0.0 ($M_c \geq 0.$) Fig. 3 shows blasts and probable blasts ($M_c \geq 0.$) Fig. 6 shows earthquakes located at Mount St. Helens ($M_c \geq 0$).

Western Washington and Oregon

273 earthquakes were located between 43.5° and 49.5° north latitude and between 121° and 125° west longitude during the fourth quarter of 1988. Most of these occurred at depths less than 30 km with, as usual, a small number of earthquakes in the Puget Sound lowland at depths greater than 30 km.

There were three small earthquakes that were reported felt in western Washington this quarter. The first event occurred on October 25 and was located near the mouth of the Skykomish River, approximately 10 km west of Mount Vernon. It had a $M_c = 2.8$, and was 7 km deep. The second event occurred on October 29 and occurred a few kilometers west of West Seattle, where it was reported felt. This event had a magnitude $M_c = 2.6$. This was followed by another felt event in the same place on December 19 that had a magnitude $M_c = 2.8$. The event on the 19th was the largest of six events that occurred at this location during the fourth quarter. They all had depths between 8 and 12 km. Earthquakes at this location have continued in the first quarter of 1989.

In addition, 10 events occurred near Kirkland, Washington, this quarter. They occurred in a cluster that began on October 23 and ranged in size from $M_c = 0.9$ to $M_c = 1.8$. This activity has continued in early 1989, as well.

Another cluster of earthquakes was centered near the town of Enumclaw, Washington. There were 26 events with magnitudes ranging from $M_c = 0.5$ to $M_c = 2.7$. The seismicity was concentrated in a small area, and most of it (23 events) occurred between December 11 and December 13.

There were no large events during the fourth quarter and none had a magnitude greater than 3. There were two events in western Washington having magnitude $M_c = 2.9$. The first occurred on October 29, at a depth of 47 km, near the town of Seabeck, on Hood Canal. The other occurred on December 30 at a depth of 9 km, approximately 12 km west of the summit of Mt. Rainier. This is the same location where a $M_c = 4.1$ earthquake occurred last quarter. The Mount Rainier area remained relatively active during the fourth quarter. Besides the ten earthquakes that occurred west of the summit, ten earthquakes had epicenters at the summit of Mt. Rainier.

Eastern Washington and Oregon

During the fourth quarter of 1988, 53 earthquakes were located in eastern Washington. None were larger than $M_c = 3.0$ and none were reported felt.

The Entiat area, south of Lake Chelan, was active again, but less so than in previous quarters. There were only nine earthquakes between Chelan and Entiat, where 15-20 events normally occur each quarter. However, the largest earthquake in eastern Washington occurred here on November 19. It had a magnitude of $M_c = 2.8$, and a depth of less than 1 kilometer.

The cluster of earthquakes that began on October 2, 1987 near the town of Corfu, Wash. (50 km north of Richland) continued in the fourth quarter of 1988. Seven events were recorded this quarter, three less than last quarter. Activity has declined slowly but steadily since it began in 1987. This quarter, the epicenters did not cluster as tightly as in previous quarters, but epicenters were all within 10 km of each other. The largest of the Corfu earthquakes had a magnitude $M_c =$

2.2. It occurred on October 10, and had a shallow depth of focus.

The only other notable earthquake cluster in eastern Washington occurred approximately 20 km north of Richland, near Wooded Island. The earthquakes began on October 16, and they have continued to occur during the first quarter of 1989. Seven events occurred near Wooded island in the fourth quarter of 1988. Their magnitudes ranged from $M_c = 0.9$ to $M_c = 2.2$ and their depths were less than 2 km.

Mount St. Helens Area

Only 55 earthquakes occurred at Mount St. Helens in the fourth quarter of 1988. The largest earthquake, on October 15, had a magnitude $M_c = 2.4$, and a depth of 1.5 km. This earthquake activity is considered typical of Mount St. Helens during its periods of volcanic quiescence following the 1980 eruption, although it is high compared to activity at other volcanoes of the Cascades. The last eruption of Mount St. Helens occurred in October, 1986.

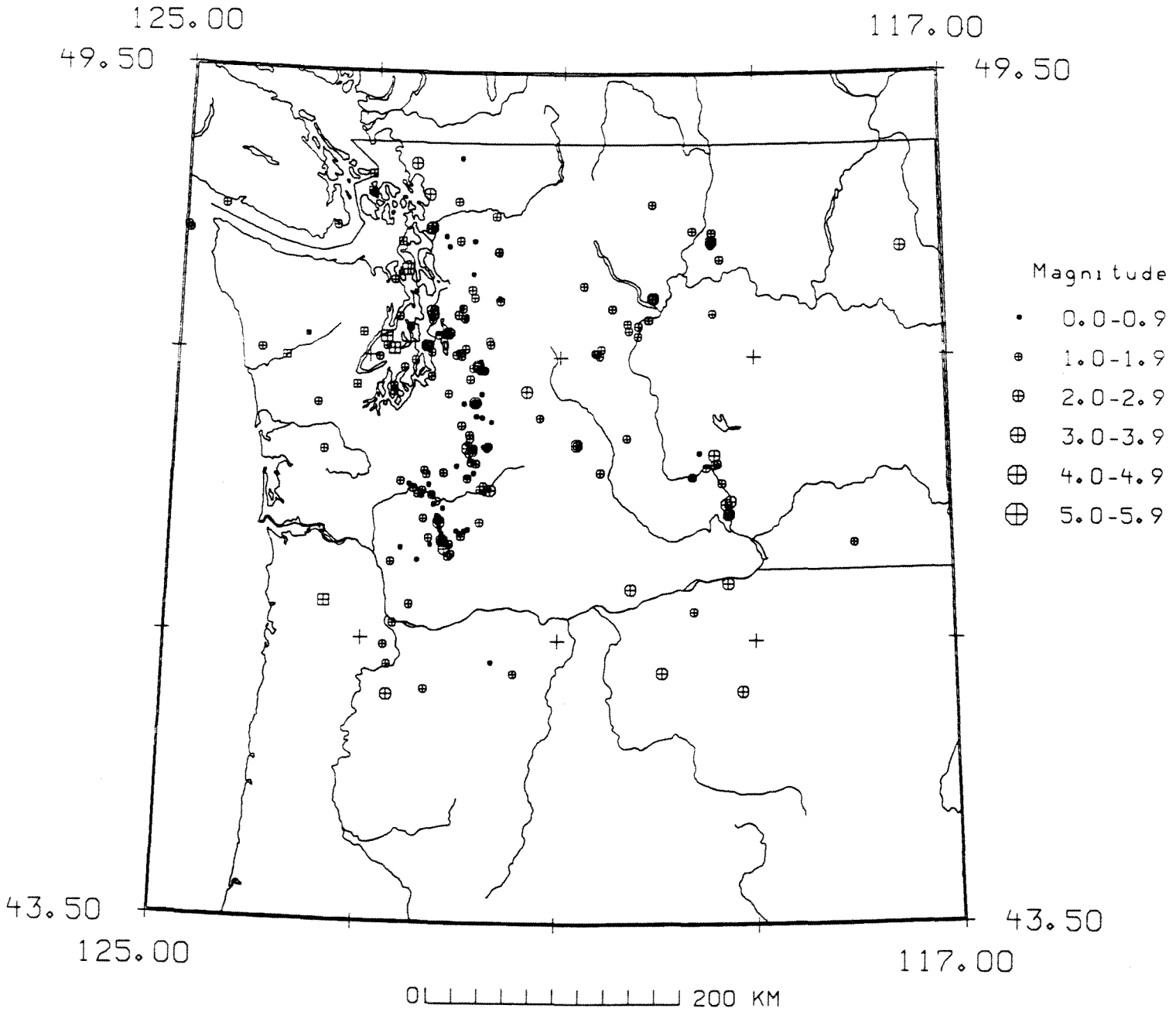


Figure 2. Earthquakes located in Washington and northern Oregon with magnitudes greater than 1.0, 4th quarter 1988. A square symbol indicates that a event located with a depth greater than or equal to 30 km. Octagonal symbols are used for events shallower than 30 km.

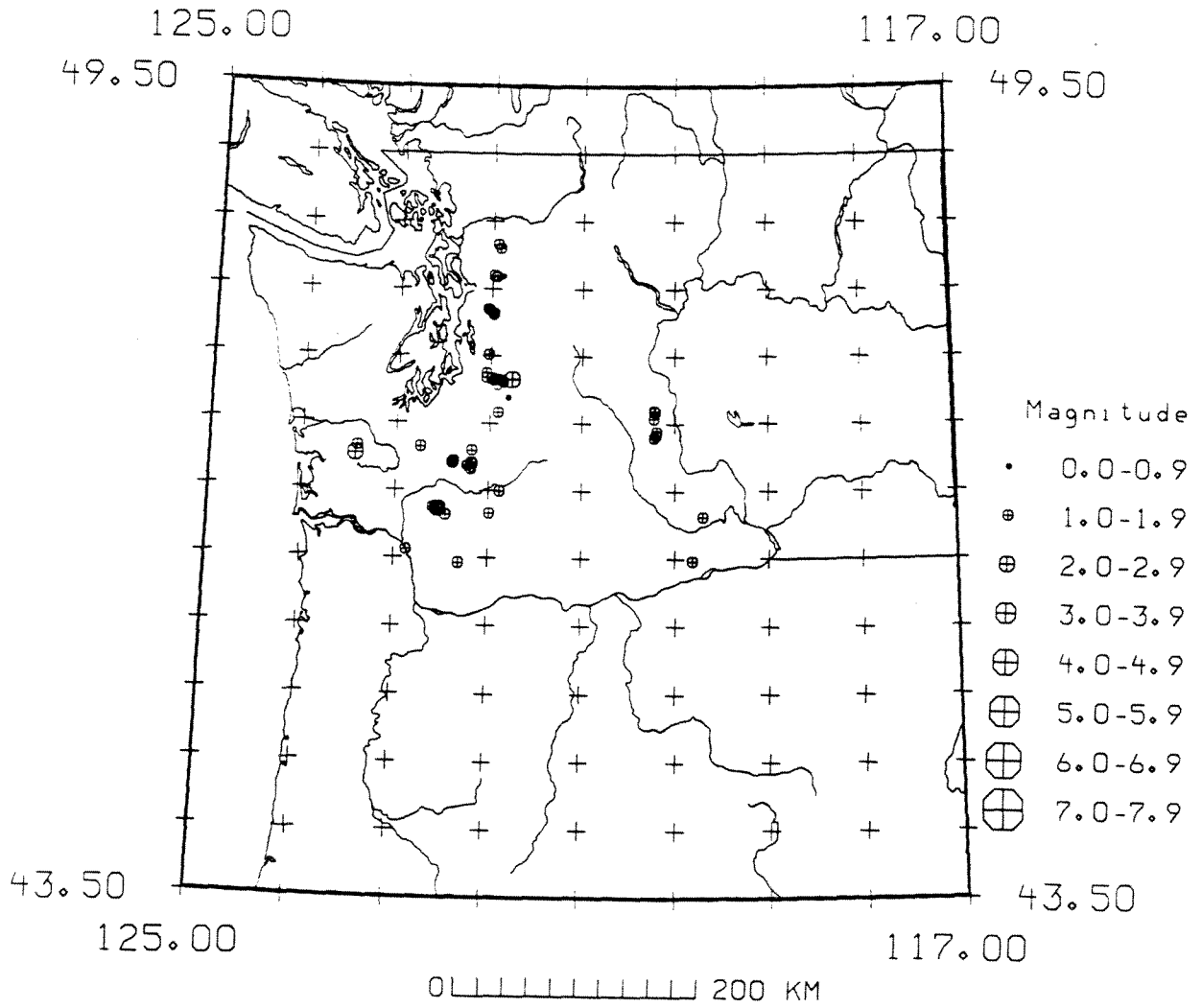


Figure 3. Blasts and probable blasts 4th quarter 1988.

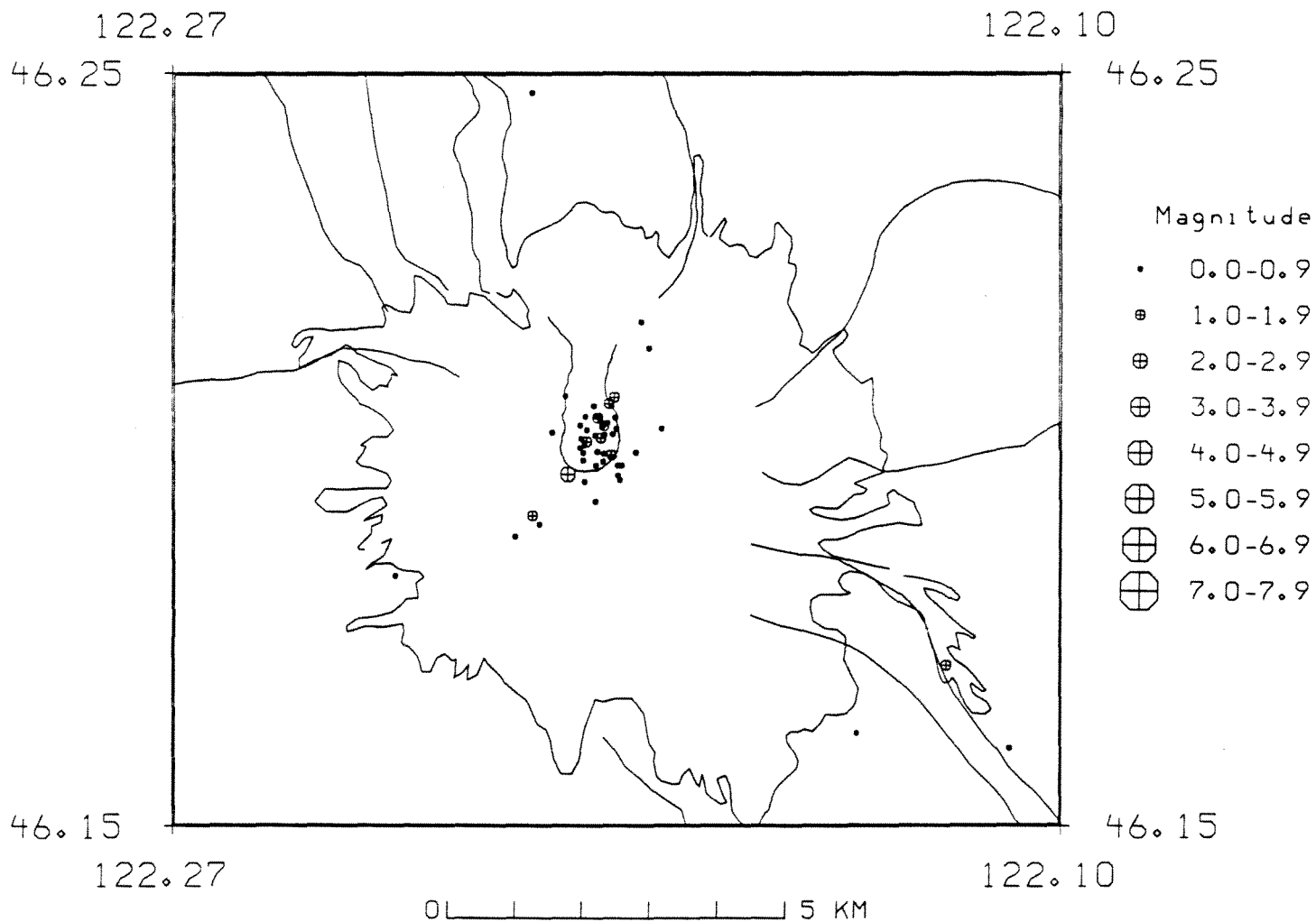


Figure 4. Earthquakes located in the Mt. St. Helens area. 4th quarter 1988. All events were shallower than 30 km.