

QUARTERLY NETWORK REPORT 89-D

on

Seismicity of Washington and Northern Oregon

October 1 through December 31, 1989

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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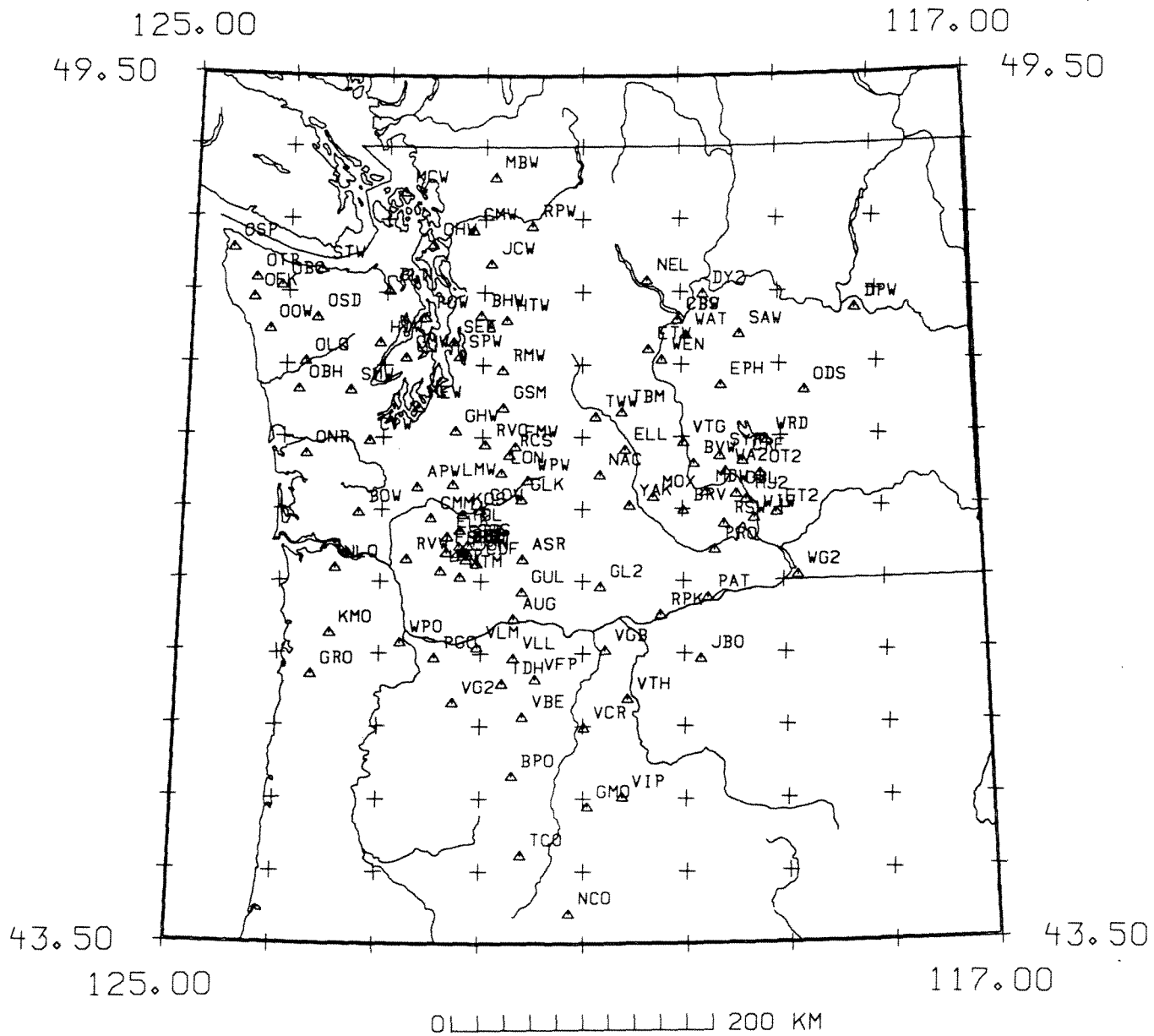


Figure 1. Seismograph stations operating during the fourth quarter 1989.

TABLE 1
Station Outages 4th quarter 1989

Station	Outage Dates	Comments
CBS	December 5-December 8	Dead;Bad batteries
CDF	December 12-December 14	Dead;receiver at BPA
CMM	October 1-October 29	Dead;radio station interference
EDM	December 12-December 14	Dead;receiver at BPA
ELK	November 14-November 26;Dec.9-End	Intermittent;radio interference
ELL	December 26-End	Dead
EPH	November 30-December 15	Dead
GHW	November 26-November 30	Dead
GL2	October 7-October 16	Dead
GRO	October 1-October 4	Dead;bulldozer accident
HDW	December 2-December 6	Dead
KMO	October 1-October 4	Dead;bulldozer accident
KOS	November 14-November 26	Dead;antenna realigned
MTM	December 12-December 14	Dead;receiver at BPA
NEL	December 5-December 8	Dead
OBH	October 1-December 18	Dead;moved seismometer
OFK	October 1-December 13	Dead
OTH	December 22-December 27	Dead
PGW	November 8-End	Dead;batteries
RVW	December 10-December 13	Battery failure
SMW	November 26-December 1	Dead;off center frequency
SOS	December 9-End	Intermittent;radio interference
STD	December 9-End	Intermittent;radio interference
TBM	December 26-End	Dead
VCR	October 1-October 3	Dead
WAT	December 5-December 8	Dead;Bad batteries
WIW	December 22-December 27	Dead
WP2	December 12-December 14	Dead;receiver at BPA
WPW	December 23-December 28	Battery failure

INTRODUCTION

This is the fourth quarterly report of 1989 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 no station additions or deletions within the network this quarter. Station visits were primarily for preparation of the winter months and for minor repairs.

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-A0623. (+) 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
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
ET2	+	46 27 53.4	119 03 32.4	0.250	Eltopia
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	0.508	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	Hoodsport
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.
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 (DWWSSN)
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
MJ2		46 33 28.0	119 21 50.0	0.150	Rockwell Station
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
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)
RCS		46 52 15.6	121 43 52.0	2.877	Mt. Rainier, Camp Schurman
REM		46 11 57.0	122 11 03.0	2.102	Rembrandt (Dome station)
RER		46 49 09.2	121 50 27.3	1.756	Mt. Rainier, Emerald Ridge
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	0.690	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	Teaway
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
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
WP2	+	45 33 57.20	122 47 06.90	0.341	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 810 events processed by the University of Washington digitally recording seismic network between October 1 and December 31, 1989. Locations were determined for 607 of these in Washington and Northern Oregon; 537 were classified as earthquakes and 70 as known or suspected blasts. The remaining 203 processed events include teleseisms (132 events), regional events outside the U. W. network (31), 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 kept, and none are located.

Table 4 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

501 earthquakes were located between 43.5° and 49.5° north latitude and between 121° and 125° west longitude during the fourth quarter of 1989. 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. This quarter, there were six events that located below 30 km depth.

During this quarter, there were two earthquakes that were reported felt in Western Washington and one felt event just across the International boundary between the San Juan Islands and Vancouver Island in British Columbia. The first Washington event was a small ($M_c = 2.2$) earthquake that was felt in Carnation, Wa. on November 30. It had a depth of 13 km, and was reported by only one person.

The second felt event in Washington was the most significant event anywhere in the state during the fourth quarter. On December 24, at 12:45AM local time, (2045 UTC), a $M_c = 4.9$ earthquake occurred at a depth of 18 km near the town of Morton, Wa., a town to the southwest of Mt. Rainier. (Note: A Wood-Anderson magnitude was determined, and was calculated to be

$M_L = 5.1$). This event was widely felt, and is the largest earthquake in Washington since February 14 (UTC), 1981. The earthquake is being called the "Storm King Mountain" earthquake, named after the closest prominent geographical feature. This is in keeping with the convention established at the University of Washington for moderate to large quakes. This event was reported felt from as far south as Vancouver, Wa, to as far north as North Seattle. One report included broken windows in Kirkland, Wa, a distance of 113 km. to the north of the epicenter. Many reports described about 15 seconds of shaking, with no damage, and most reporters experienced no more than having been woken by one quick jolt. By the end of the quarter, there were only 5 aftershocks, which is considered unusually few for an event of this magnitude in the shallow crust. All of these aftershocks occurred within 12 hours of the main shock.

Lastly, the Canadian event near the border occurred on October 14, and had a $M_c = 2.9$, at a depth of 18km. It was reported felt in Victoria, British Columbia. (The exact epicenter was 9 km east of Victoria, B.C.)

For the last year or so, activity has increased in the vicinity of Mt. Rainier. There have been more earthquakes during this time than during the previous years since 1980. The year 1980 is used since this is when digital seismic recording began. This quarter there were 21 earthquakes near the summit of Mt. Rainier, where there were 22 last quarter. Activity both under the summit and to the west of the mountain appears to be quite steady, with no clear evidence that it follows "swarm-like" patterns, where activity is compressed temporally and lacks a dominant or large event. All events under the summit continued to be quite small, most less than $M_c = 1.3$.

Eastern Washington and Oregon

During the fourth quarter of 1989, 36 earthquakes were located in eastern Washington and Oregon. This is fourteen fewer than were recorded last quarter. This is very few earthquakes, averaging just twelve events per month. There was just one area of concentrated activity, centered around the town of Entiat. This activity is normal, with frequent activity over the last twenty years. There were nine events in this area for the fourth quarter. There were no events above $M_c = 2.7$

anywhere in eastern Washington during the quarter.

Mount St. Helens Area

Rates of activity in the Mt. St. Helens area increased during the fourth quarter, when compared to the third quarter. This quarter, 293 events were located at Mt. St. Helens, where 164 earthquakes were located there last quarter. The largest event occurred on December 8, had a $M_c = 2.6$, and a depth of near 1 km. An interesting aspect of the earthquakes at Mt. St. Helens is that 167 of these occurred below the depth of 4 km. This depth delineates events in the shallow crust and volcanic events from within the deeper magmatic system. The very high percentage of events below 4 km in depth is unusual at Mt. St. Helens when compared to activity for the last few years. Earthquakes are occurring within the entire length of the entire conduit system, from near-surface to depths below 8 km.

On December 7th, Mt. St. Helens experienced its first significant ash emission in over 3 years. It was a very small event that was primarily evident on stations situated very near the dome within the crater. Because of poor weather and visibility, visual confirmation of the emission wasn't possible until December 11th, when an ash layer was uncovered within the crater beneath fresh snow.

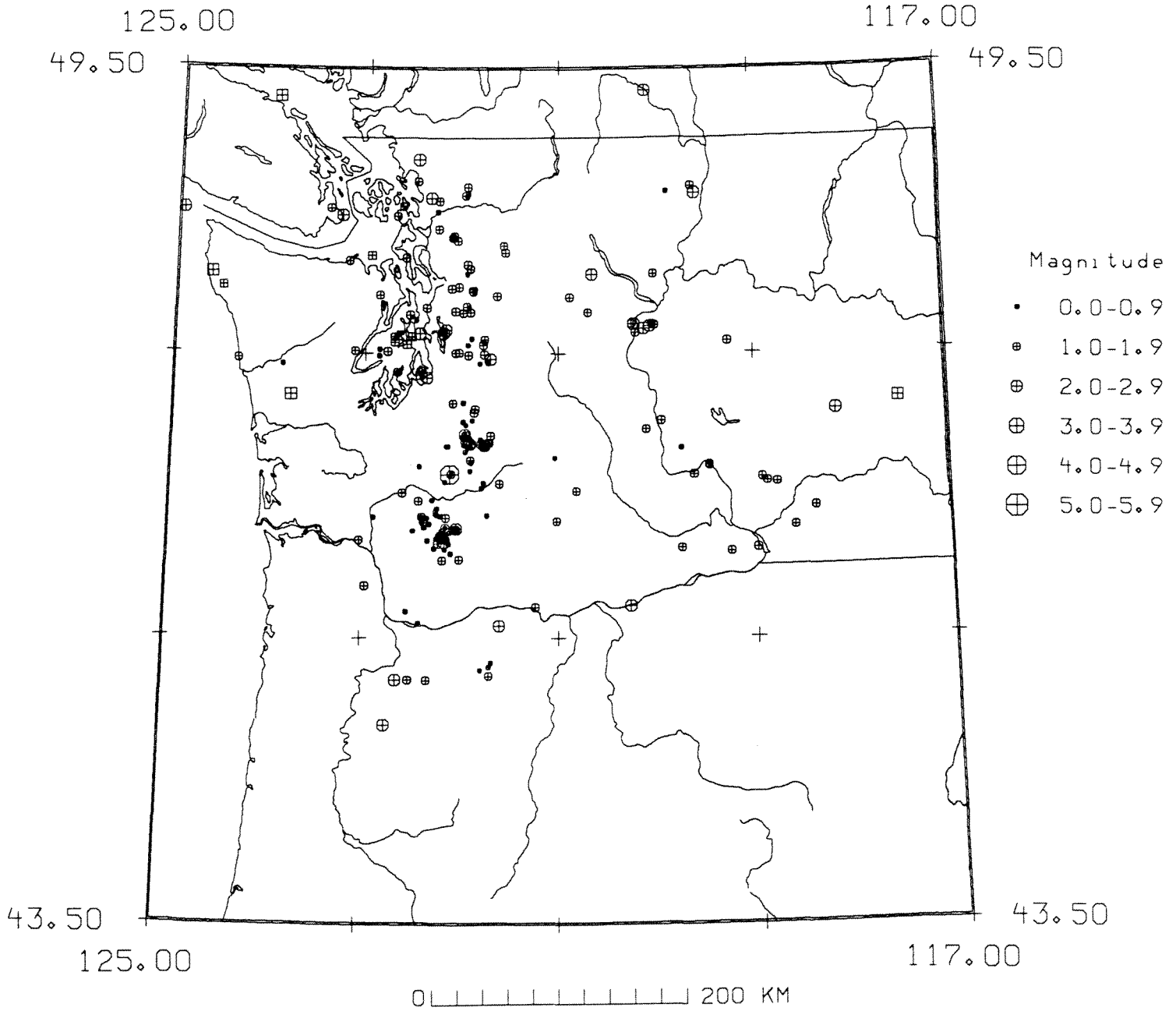


Figure 2. Earthquakes located in Washington and northern Oregon with magnitudes greater than 1.0, fourth quarter 1989. A square symbol indicates that an event located with a depth greater than or equal to 30 km. Octagonal symbols are used for events shallower than 30 km.