QUARTERLY NETWORK REPORT 89-B

on

Seismicity of Washington and Northern Oregon

April 1 through June 30, 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:

U.S. Geological Survey
Joint Operating Agreement 14-08-0001-A0622
and
Grant 14-08-0001-G1390
and
Contract 14-08-0001-21978

and

Westinghouse Hanford Company
Contract PMM-RJU-505

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INTRODUCTION

This is the second 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 was one station addition within the network this quarter. A station was installed on the northeast flank of Mt. Rainier at Camp Schurman (RCS) on June 27. This station, in addition to a planned installation next quarter on the southwest side of the mountain, should improve detection and location of events occurring near the summit of Mt. Rainier.

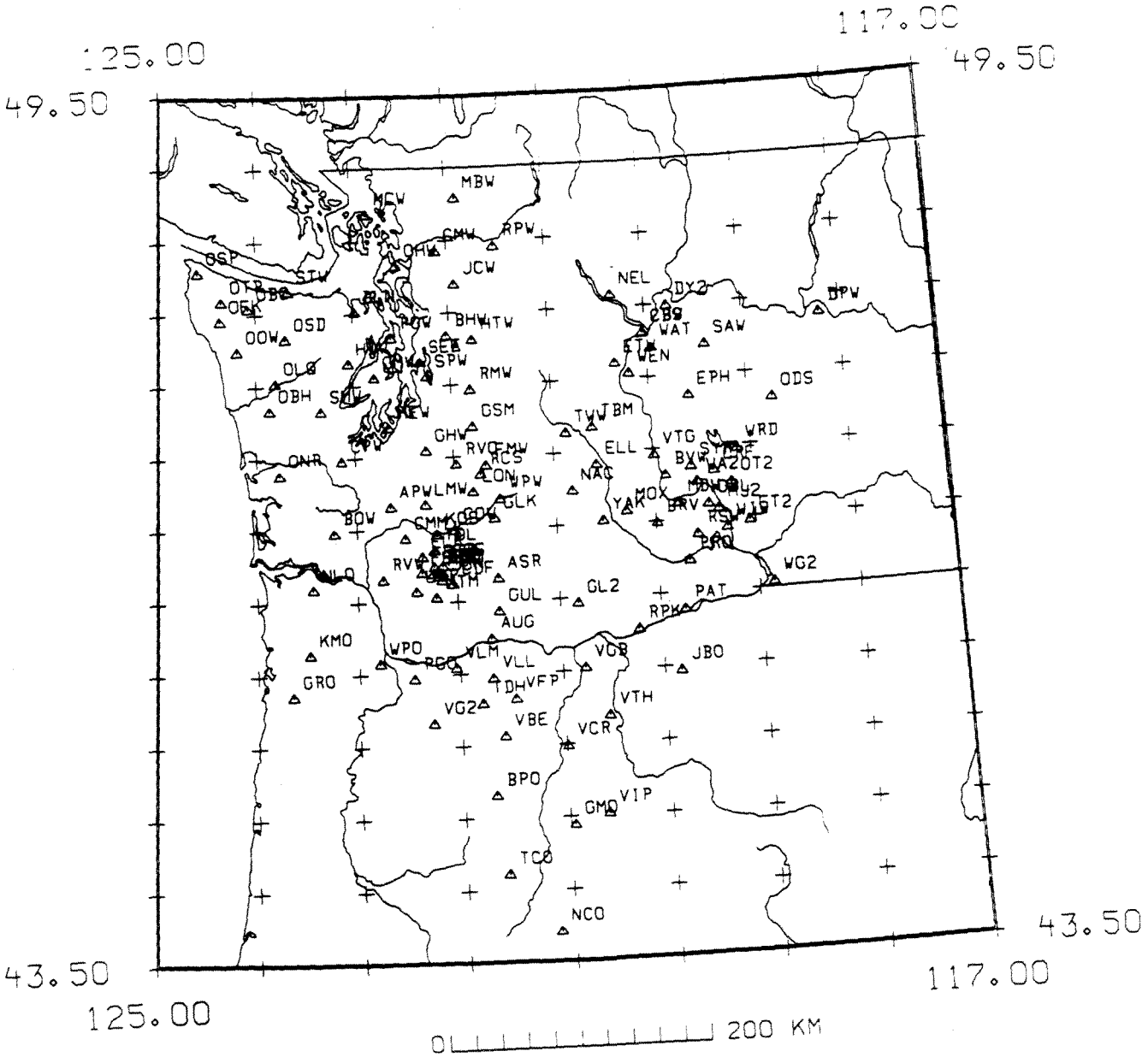


Figure 1. Seismograph stations operating during the second quarter 1989.

TABLE 1
Station Outages 2nd quarter 1989

Station	Outage Dates	Comments
ASR	April 1-May 15	Intermittent
ASR	May 31-June 1	Cable cut
BPO	June June 5-End of quarter	
CDF	April 1-May 4	
CMW	June 4-End of quarter	Intermittent
COW	April 7-End of Quarter	Vandalized
ETW	April 1-June 29	Fire damage
FMW	April 18-April 21	Repeater down
GHW	April 18-April 21	Repeater down
GLK	April 12-June 1	Batteries
GSM	April 18-April 21	Repeater down
GUL	May 31-June 1	Cable cut
LMW	April 18-April 21	Repeater down
LNO	May 15-End of Quarter	
MBW	June 13-End of quarter	Intermittent
MJ2	June 6-End of quarter	
MOX	May 19-End of Quarter	
OHW	June 22-End of quarter	Intermittent
OLQ	Whole period	
ONR	June 28-June 30	Cut cable
OOW	April 1-April 10	
OSD	April 1-April 10	
RCS	April 1-June 27	New installation
RMW	April 1-June 6	
RVW	May 6-June 7	Txmitter and VCO
SOS	April 27-May 8	installed solar power
VBE	May 9-May 30	Lightning strike on txmitter
VGB	May 9-May 17	VBE rec'vr interference
VTH	May 13-May 17	Rec'vr tuned
WP2	May 20-June 5	Bad VCO

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.

TABLE 2

Stations Operating at the End of the First Quarter 1989

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	Augspurger 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	0.506	Gold Mt.
GRO	S	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 (WWSSN and 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)
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	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
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 656 events processed by the University of Washington digitally recording seismic network between April 1 and June 30, 1989. Locations were determined for 504 of these in Washington and Northern Oregon; 413 were classified as earthquakes and 91 as known or suspected blasts. The remaining 152 processed events include teleseisms (93 events), regional events outside the U. W. network (26), 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 processed and 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. 4 shows earthquakes located at Mount St. Helens ($M_c \geq 0$).

Western Washington and Oregon

152 earthquakes were located between 43.5° and 49.5° north latitude and between 121° and 125° west longitude during the first 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. There were no unusual deep events.

This quarter, there were nine earthquakes that were reported felt in western Washington. This is a reduction from the unusually high number of nineteen last quarter, but unlike last quarter, these were not concentrated in two epicentral clusters.

The first event felt occurred on April 5, 10 miles east of Deming, Wa., near the Washington-British Columbia border north of Bellingham. It had a M_c 2.8 and located within 5 km of the surface. A week later on April 12, an event near Big Lake in Mt. Vernon was felt. and had a M_c 1.5. This was followed by a M_c 2.7 on April 16. These events are the only two felt in this area this quarter, following last quarter when there were 9 events felt and two had magnitudes greater than 4.0. Activity has appeared to stop this quarter, and the seismic study that began last quarter by the

USGS to monitor activity more closely was terminated the first week of April. These events have near-surface hypocenters. which explains why events of small magnitude in this area are felt.

One event was felt near Kirkland, Wa. this quarter. On April 14, a M_c 1.5 was felt near Juanita Creek. Again, this had a near-surface depth. This was the only event felt in an area which for the last few quarters has had a higher than normal rate of seismicity. Activity began on October 23, 1988, and now appears to have died down to background seismicity.

On April 19, a M_c 2.9 earthquake occurred near Victoria, B.C. It had a depth of 24.5 km, and was felt in the Saanich Peninsula area, including Sidney, Victoria, and Saltspring Island. On April 21, an event was felt in Covington, Wa., east of Everett. It had a M_c 2.8, and a depth of 4.5 km. On May 22, an event occurred just north of the Washington-British Columbia border, north of Bellingham. It was felt in Chilliwack, B.C. and had a M_c 2.1 and a depth of 4.2 km.

Two other events were felt this quarter, one on May 31 near Granite Falls, Wa. It had a Mc 2.6, and a depth of 17.8 km. The most widely felt event of the quarter and the largest west of the Cascades occurred on June 18 near the Mason-Kitsap County line west of Port Orchard in south Puget Sound. It had a M_c 4.4 and a depth of 44.7 km. It was reported felt as far north as Sidney, B.C., as well as more locally within Olympia, Tacoma, and Seattle. It is common for events with relatively deep hypocenters to be more widely felt. No damage was reported as a result of this earthquake.

Other notable activity includes a continuation of activity near Mt. Rainier. The seismic zone to the west of Mt. Rainier continued to be active, as well as a slight increase in the number of events near the summit. There were five events last quarter, and this quarter, nine were located above the 7500' elevation contour. All events were quite small, less than M_c 1.2. In an effort to improve the quality of the locations of events on the mountain, a new station was installed on July 27 at the climbers' hut at Camp Schurman. It is called RCS (Rainier Camp Schurman). This site rests at about the 10,000' level on the northeast flank of Mt. Rainier. Since this site was installed just three days before the end of the quarter, the addition of this site does not account for the slight increase in the number or events recorded. It will greatly improve the accuracy of the

epicentral locations and depths. There are plans to install another station early in July in cooperation with the USGS Water Resources Division in Vancouver, Wa. It will be located on the southwest flank of the mountain near Emerald Ridge and will be used both for improving the locations of seismic events and detection of outburst floods that have periodically occurred in this area.

Eastern Washington and Oregon

During the second quarter of 1989, 45 earthquakes were located in eastern Washington and Oregon. This represents about one-half of the number that were recorded last quarter.

One relatively large event was recorded near Omak, Wa. On May 9, a M_c 4.5 occurred at a depth of 15.6 km between Brewster and Omak. (This is approx. 40 km northeast of Chelan). There were many reports from Wenatchee, Chelan, and Douglas County in general. There were no reports of damage from this quake, but many people reported dishes rattling. There were no aftershocks associated with this event.

All areas where clusters of activity are common in Eastern Washington had fewer than average events this quarter. The area centering near the tip of Lake Chelan, for example, only recorded seven events.

The clustering of activity that began on October 2, 1987 near the town of Corfu, Wash. (50 km north of Richland) continued into the second quarter of 1989, but only seven events were recorded, six less than last quarter. The largest event in this area was a M_c 2.4. This event occurred on June 15. All events in this area have depths less than 2 km.

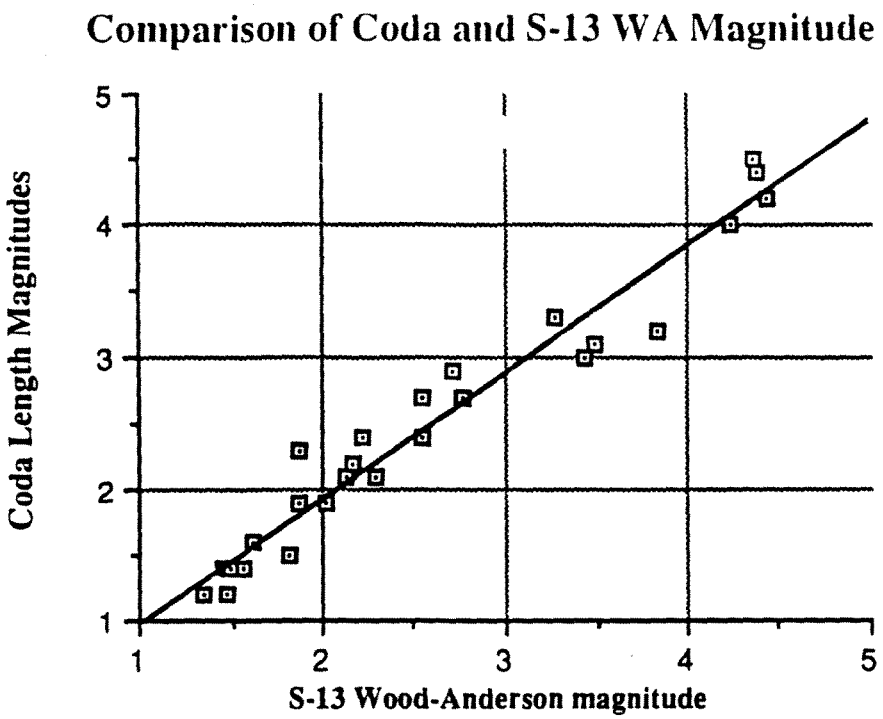
Mount St. Helens Area

There was a slight increase in the number of events located during the second quarter compared to the first quarter. In the first quarter of 1989, 127 events were located at Mt. St. Helens, whereas 164 earthquakes were located at Mt. St. Helens this quarter. The largest event occurred on June 29, had a M_c 2.3, and a near-surface depth. 97 earthquakes below a depth of 4 km. This depth, 4 km, seperates events in the shallow crust from volcanic events from within the deeper

magmatic system.

Comparison of Coda length magnitudes with Richter-like magnitudes

In 1988 we installed two Geotech S-13 seismometers electronically filtered to simulate the response of Wood-Anderson seismometers. Because the output from these seismometers is electric rather than optical (as in the original Wood-Andersons), it can be sampled and recorded digitally along with the rest of the WRSN (Washington Regional Seismographic Network) stations. We present here a comparison of the S-13 Wood-Anderson Richter-like magnitude with the coda length magnitude used as the standard of the WRSN. Magnitudes were determined by both methods for 28 earthquakes between 1/1/89 and 6/30/89. Table 3 gives earthquake times, locations, and magnitudes; M_C denotes coda-length magnitude, while M_L denotes Richter-like magnitudes determined using the digital traces from the S-13s simulating Wood-Anderson response. Figure 2 shows the comparison of magnitudes. The best-fit line shown is $M_C = 0.027 + 0.955 M_L$. It is worth noting that all but 8 of the earthquakes used to determine this fit (Table 3) are magnitude 3. or smaller, and most are also extremely shallow.



Comparison of M_C and M_L

DAY	TIME	LAT	LON	DEPTH	M_C	M_L
89/01/13	04:13:15.58	47 39.55	122 12.78	0.02*	1.4	1.5
89/01/13	05:35:19.56	47 39.93	122 12.35	0.04*	1.4	1.6
89/01/13	06:33:27.41	47 39.58	122 11.71	0.04*	2.1	2.1
89/01/13	06:33:56.80	47 39.65	122 12.27	0.02*	1.9	2.0
89/01/13	06:34:44.93	47 39.86	122 11.60	0.04*	2.2	2.2
89/01/13	06:39:14.73	47 39.77	122 11.79	0.02*	2.4	2.2
89/01/13	09:49:31.98	47 39.93	122 11.81	0.03*	1.4	1.5
89/01/14	04:20:50.68	47 39.73	122 12.21	0.05*	1.9	1.9
89/01/14	04:25:26.66	47 39.72	122 12.50	0.03*	1.2	1.5
89/01/14	06:47:34.24	46 32.82	121 48.70	3.77	3.0	3.4
89/01/17	13:55:28.82	47 39.19	122 11.43	1.53	3.3	3.3
89/01/19	12:21:42.24	47 34.11	121 54.21	2.68	2.7	2.5
89/01/19	12:34:12.68	47 34.16	121 53.97	2.54	2.9	2.7
89/01/20	04:50:26.00	47 39.24	122 13.07	0.03*	1.6	1.6
89/01/20	04:52:33.81	47 39.50	122 12.60	2.09*	1.2	1.3
89/01/29	13:46:06.76	47 39.41	122 12.32	0.04*	1.4	1.4
89/01/31	08:23:44.24	47 57.21	122 22.52	25.84	2.1	2.3
89/02/06	01:25:52.70	48 25.10	122 12.82	0.03*	3.2	3.8
89/02/10	23:49:45.77	47 35.00	122 24.00	9.75	1.5	1.8
89/02/14	21:41:10.59	48 25.73	122 13.68	0.78	4.0	4.2
89/02/15	01:11:29.76	48 25.00	122 13.06	0.04*	2.4	2.5
89/03/06	03:09:54.02	48 25.74	122 13.86	1.53	4.2	4.4
89/03/07	06:40:10.18	47 59.30	124 23.32	28.57	3.1	3.5
89/04/16	15:35:55.10	48 25.25	122 13.52	0.05*	2.7	2.8
89/04/19	02:13:45.05	47 37.26	122 29.70	26.98	2.3	1.9
89/05/09	18:28:46.08	47 49.92	120 07.20	43.61	4.5	4.4
89/06/18	20:38:37.39	47 24.58	122 46.55	44.75	4.4	4.4

Figure 2. Comparison of Coda magnitude and Pseudo Wood-Anderson magnitudes. Events used occurred between January 1 and June 30, 1989.

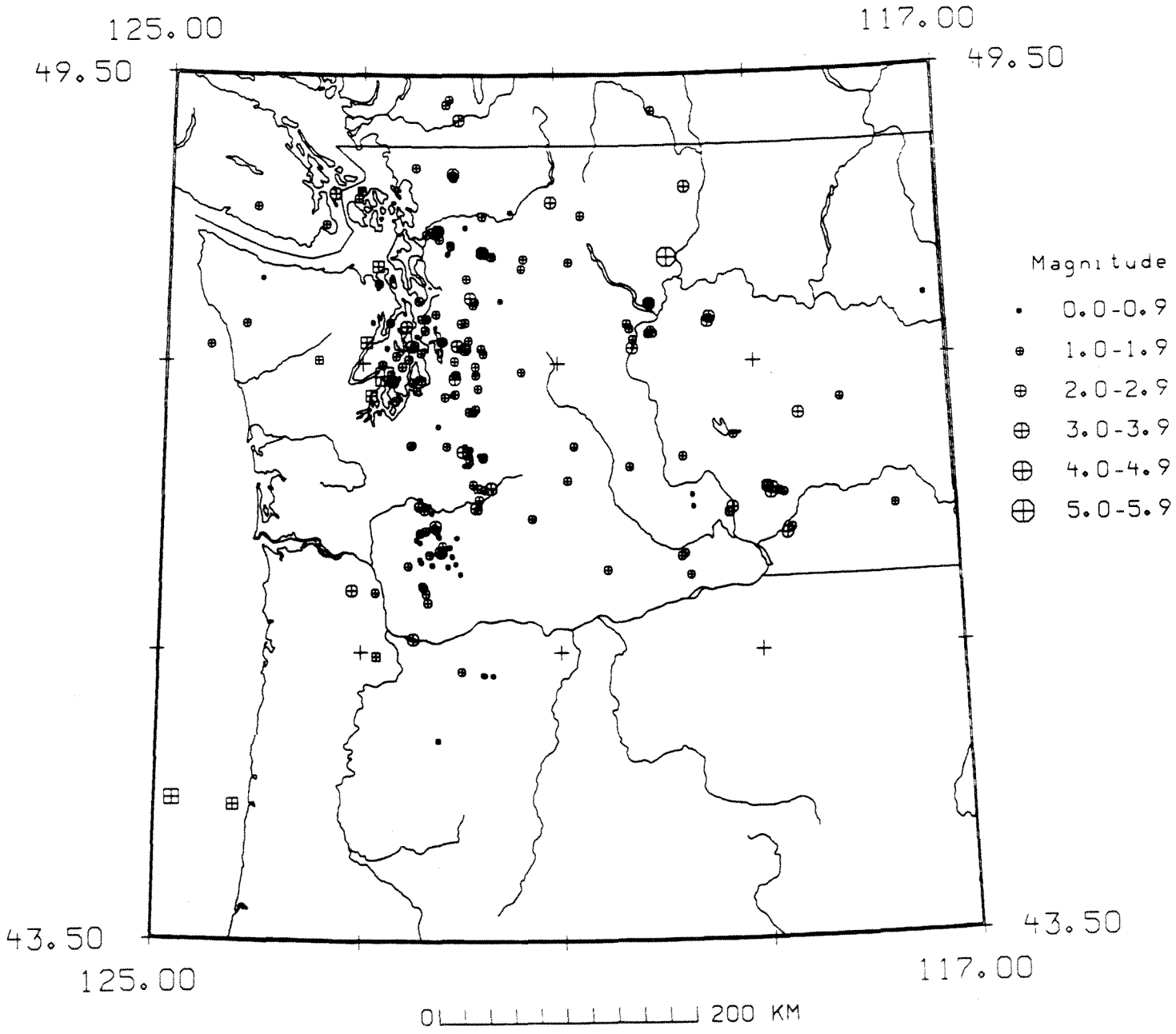


Figure 3. Earthquakes located in Washington and northern Oregon with magnitudes greater than 0.0, first quarter 1989. A square symbol indicates that an event located with a depth greater than or equal to 30 km. Octagonal symbols are used for events shallower than 30 km.

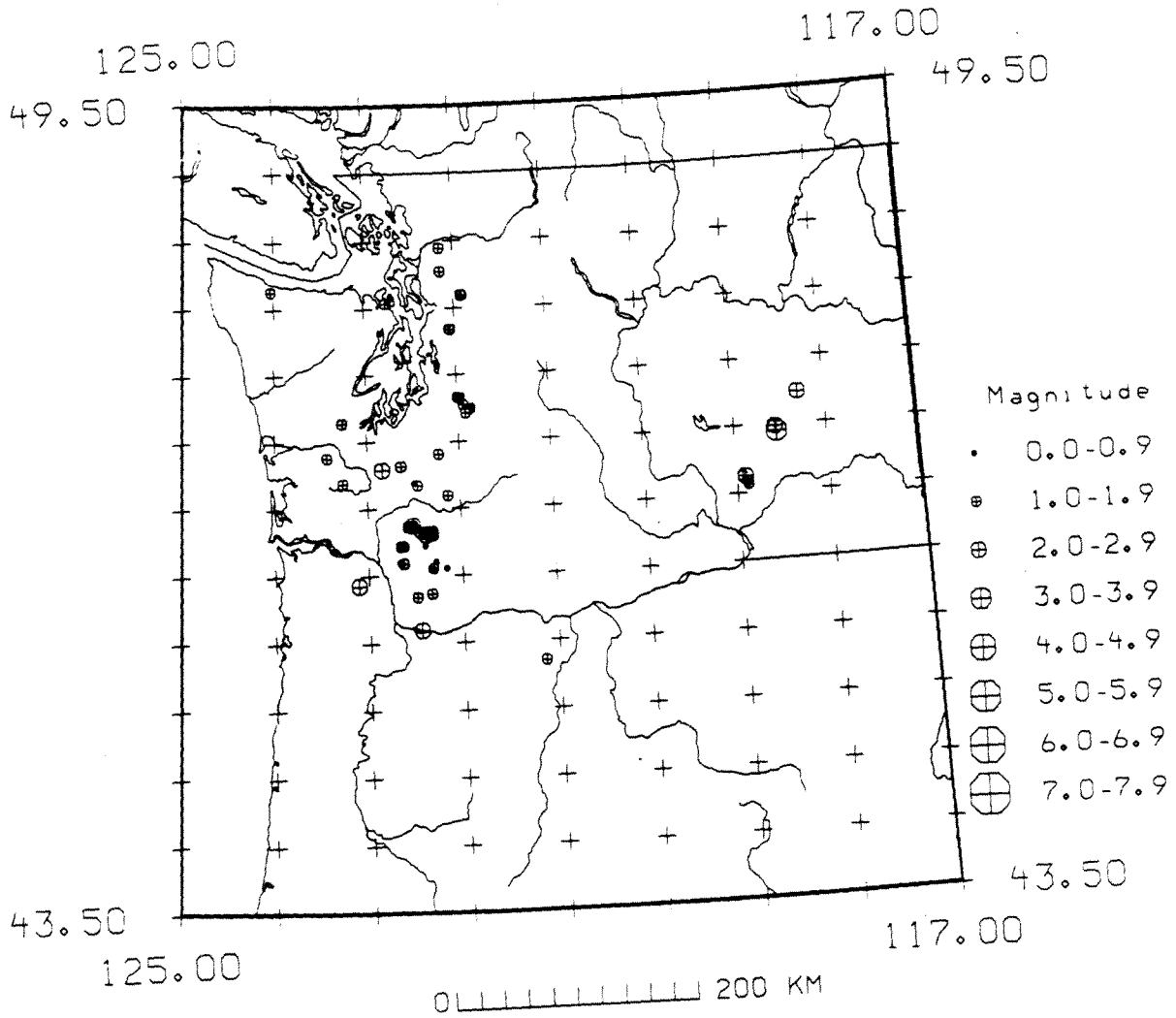


Figure 4. Blasts and probable blasts first quarter 1989.

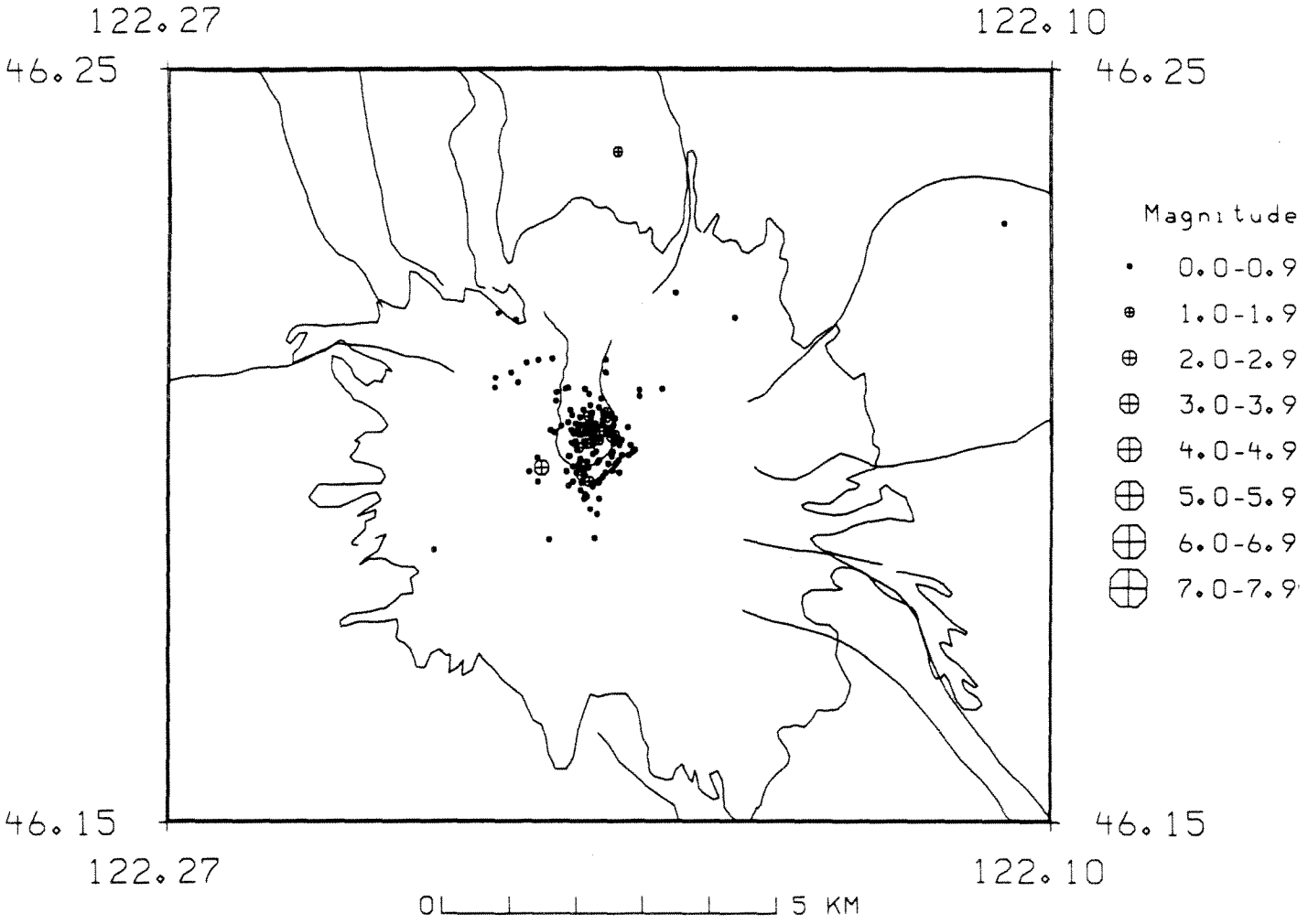


Figure 5. Earthquakes located in the Mt. St. Helens area. first quarter 1989. All events were shallower than 30 km.