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TABLE OF CONTENTS

TABLES

FIGURES

ANNUAL TECHNICAL REPORT
USGS Joint Operating Agreement 04HQAG005
PACIFIC NORTHWEST SEISMOGRAPH NETWORK (PNSN) OPERATIONS

ABSTRACT AND NON-TECHNICAL SUMMARY

This is the annual technical report for USGS Joint Operating Agreement 04HQAG005 *"Pacific Northwest Seismograph Network (PNSN) Operations"*. The PNSN operates seismograph stations in Washington and Oregon, and collects and analyzes earthquake data. Between Jan. 1, 2004 and Dec. 31, 2004 the PNSN analyzed 7,219 events. Of these, 4,498 were earthquakes located within the network. Mount St. Helens began an eruptive episode with vigorous seismic activity starting on September 23, 2004. The eruption included about 500,000 earthquakes, of which only a sample were located. The counts given here include only a small percentage of the earthquakes at Mount St. Helens. West of 120.5 degrees west longitude, 4,030 earthquakes were located in Washington and Oregon (including 2,771 tectonic events in the general vicinity of Mount St. Helens). East of 120.5 degrees W longitude in Washington and Oregon, 468 earthquakes were located. The remaining 2,721 events include located or unlocated blasts (436), regional earthquakes (306) or teleseisms (619), and small unlocated earthquakes within the network; including 275 low frequency events near the summit of Mt. Rainier (probably icequakes), and a number of typical surficial events near the summit of Mt. St. Helens (probably rockfalls) before the eruptive activity began.

Between Jan. 1, 2004 and Dec. 31, 2004, 27 earthquakes were reported felt in Washington or Oregon west of the Cascades, ranging in magnitude from 1.8 to 4.9. A meteor burst over western Washington was also seen and recorded. Eighteen earthquakes (magnitudes 1.8 to 4.4) were reported felt east of the Cascades.

SUMMARY

USGS Joint Operating Agreement 04HQAG005 "*Pacific Northwest Seismograph Network (PNSN) Operations*" covered network operations in western Washington and northern Oregon, routine data processing, and preparation of bulletins and reports. PNSN stations in southern and central Oregon were maintained by the University of Oregon under Cooperative Agreement 04HQAG006, and this report also covers the work undertaken under that agreement. The objective of our work under this operating agreement was to gather seismic data, and to analyze and interpret them for use in evaluation of seismic and volcanic hazards in Washington and Oregon. This report includes an update on recent changes in our data acquisition and processing system, a review of station operations during 2004, an overview of our public information program, and a summary of 2004 seismicity. Since 1984, we have issued quarterly bulletins for all of Washington and Oregon. These include catalogs of earthquakes and blasts located in Washington and Oregon.

CURRENT INITIATIVES

Introduction

The PNSN is continuing the long process of upgrading operations. Upgrades include enhancement of the emergency information distribution system, installation of seismic sensors that can accurately capture the full range of earthquake amplitudes and frequencies, implementation of a data recording system that fully supports multi-component data, and near-real-time data exchange with neighboring networks.

PNSN Instrumentation

Since 1996, the PNSN has installed digital strong-motion instruments, mostly in the Puget Sound urban area. There are now 57 ANSS instruments in the Pacific Northwest, and a total of 96 strong-motion real-time stations in our network. Data from strong-motion stations are sent continuously to the PNSN via Internet or lease-line modems, but the instruments also have a trigger set to record stronger events on-site. If continuous data transmission fails, the data will still be available via dial-up retrieval or site visit. Two additional dial-up stations are operated by the USGS in the Portland area. These are in addition to approximately 30 other strong-motion instruments operated independently by the National Strong Motion Project.

The strong-motion installation priority during 2004 was an array across and along the Duwamish Valley near downtown Seattle. Liquefaction has occurred in the Duwamish during earthquakes in 1949, 1965, and 2001, and instrumental records of the shaking that produces liquefaction are of interest to engineers. Deep layers of sediment below the valley may also amplify shaking; and the array is designed to sample sites on the valley floor as well as on harder ground on either side of the valley. The borehole array installation (stations SSS1 and SSS2) was completed in the last quarter of 2004 at Seattle School District's John Stanford Center at 4th and Lander. A total of 4 tri-axial Kinemetrics Episensors are deployed at depths of 0. 11.5, 43.9 and 50.6 m.

The PNSN operates a total of 16 PNSN CREST (Consolidated Reporting of EarthquakeS and Tsunamis) stations, and receives data from 4 additional northern California CREST stations.

Emergency Notifications

A PNSN seismologist is always available on-call, and our standard procedure is to respond to pager messages from our automatic earthquake detection process (initiated for any earthquake within our network of magnitude 2.9 or larger), or calls from Washington or Oregon emergency management agencies or the UW police. Information for well-located earthquakes is sent out automatically by the event detection process to selected recipients including the National QDDS system. Emergency managers and other high-priority information users receive very rapid notification through the RACE pager-PC system, faxes, e-mail, and the national QDDS earthquake message system. Simultaneously, an automatic website is created for the event.

EARTHWORM Progress Report

The *Pigia* computer continues to be the digitizer for analog data. Data acquisition is divided among three computers; *scossa*, *verme*, and *milli*; which subsequently exchange and share the acquired data. This year, due to the extensive seismicity at Mount St. Helens, a new computer, *tremito,* was acquired. *Scossa* continues to be our main data collection computer, and it exports data to *tremito*, which provides additional computational power for manual processing of earthquakes. *Tremito* also acts as a fileserver for all the other networked computers in the group.

A high-speed 2 CPU Linux box with RAID disc storage, *grasso*, is used for research purposes and online storage of historical waveforms of frequent interest. *Grasso* is also used for non-time-critical processing to reduce the load on our primary processing computers. Additional hard drives for temporary data storage were acquired during the third quarter for *scossa* and *hozameen* (a USGS Linux machine).

"Miniworm"systems (computers in the field that run EARTHWORM and digitize data and send it to the UW via Internet, eliminating expensive long-distance leased phone-lines) are running in Klamath Falls, Bend, Eugene, and Portland, OR and Forks and Richland, WA.

OPERATIONS

Seismometer Locations and Network Maintenance

Figure 1 shows seismograph stations operated by the PNSN at the end of 2004, when the PNSN EARTHWORM SYSTEM was digitally recording over 500 channels of real-time or near-real-time seismic data. Stations available include a total of 159 short-period stations, 45 broad-band, and 104 strong-motion stations. The Pacific Northwest Seismograph Network (PNSN) operates 187 short-period, broad-band, or strong-motion seismic stations west of 120 degrees west longitude under this agreement. The supported stations cover much of western Washington and Oregon, including the volcanoes of the central Cascades. Some stations include up to 12 channels of seismic data. PNSN stations in southern and central Oregon are maintained by the University of Oregon under Cooperative Agreement 04HQAG006.

Forty additional stations are operated under other support, and stations funded by other contracts or telemetered in real or near-real time from adjacent networks are also used in event locations. Station Tables 1A-1C list the locations of various types of stations. Quarterly reports provide additional details of station operation. Quarterly reports from January 1, 2004 through December, 2004 are included as Appendix 2. Aside from station outages, normal maintenance includes a visit to each site at least once every two years to replace batteries and do preventive maintenance. In addition seismometers must be replaced every 4-6 years. More than 30 radio telemetry relay sites are also maintained independently of the seismograph stations.

Table 1A lists short-period, mostly vertical-component stations used in locating seismic events in Washington and Oregon. The first column in the table gives the 3-letter station designator, followed by a symbol designating the funding agency; stations marked by a percent sign (%) were supported by USGS joint operating agreements 04-HQAG005 or 04-HQAG006. A plus (+) indicates support under Pacific Northwest National Laboratory, Battelle contract 259116-A-B3. Stations designated "#" are USGS-maintained stations recorded at the PNSN. Stations designated by letters are operated by other networks, and telemetered to the PNSN. "M" stations are received from the Montana Bureau of Mines and Geology, "C" stations from the Canadian Pacific Geoscience Center, "U" stations from the US Geological Survey (usually USNSN stations), "N" stations from the USGS Northern California Network, and "H" stations from the Hanford Reservation via the Pacific Northwest National Labs. Other designations indicate support from other sources. Additional columns give 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 1A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
ALKI	%	47 34 30.4	122 25 03.4	0.001	Alki Wastewater Plant, ANSS-SM
ASR	%	46 09 09.9	121 36 01.6	1.357	Mt. Adams - Stagman Ridge
ATES	%	48 14 10.9	122 03 33.0	0.062	Arlington Trafton ES ANSS-SMO
AUG	%	45 44 10.0	121 40 50.0	0.865	Augspurger Mtn
BBO	%	42 53 12.6	122 40 46.6	1.671	Butler Butte, OR
BEN	H	46 31 12.0	119 43 18.0	0.335	PNNL station
BEND	%	44 04 00.8	121 19 36.0	1.141	UO Bend Office, DOGAMI SMO
BHW	%	47 50 12.6	122 01 55.8	0.198	Bald Hill
BKC	%	44 17 57.9	121 41 45.6	1.208	Black Crater, OR
BLIS	#	46 11 51.5	122 11 07.3	2.116	Blister St. Helens Dome
BLN	%	48 00 26.5	122 58 18.6	0.585	Blyn Mt.
BOW	%	46 28 30.0	123 13 41.0	0.87	Boistfort Mt.
BPO	%	44 39 06.9	121 41 19.2	1.957	Bald Peter, OR
BRO	%	44 16 02.5	122 27 07.1	0.135	Big Rock Lookout, OR
BRV	+	46 29 07.2	119 59 28.2	0.92	Black Rock Valley
BSMT	M	47 51 04.8	114 47 13.2	1.95	Bassoo Peak, MT
BUO	%	42 16 42.5	122 14 43.1	1.797	Burton Butte, OR
BURN		43 34 23.0	119 07 49.0	1.615	Burns, OR SMO
BVW	+	46 48 39.5	119 52 56.4	0.67	Beverly
CBS	+	47 48 17.4	120 02 30.0	1.067	Chelan Butte, South
CDF	%	46 07 01.4	122 02 42.1	0.756	Cedar Flats
CHMT	M	46 54 51.0	113 15 07.0	-	Chamberlain Mtn, MT
CMW	%	48 25 25.3	122 07 08.4	1.19	Cultus Mtns.
CPW	%	46 58 25.8	123 08 10.8	0.792	Capitol Peak
CRF	+	46 49 30.0	119 23 13.2	0.189	Corfu
DPW	+	47 52 14.3	118 12 10.2	0.892	Davenport
DY2	+	47 59 06.6	119 46 16.8	0.89	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	1.27	Elk Rock
ELL	+	46 54 34.8	120 33 58.8	0.789	Ellensburg
EPH	+	47 21 22.8	119 35 45.6	0.661	Ephrata
ET3	+	46 34 38.4	118 56 15.0	0.286	Eltopia (replaces ET2)
ETW	+	47 36 15.6	120 19 56.4	1.477	Entiat
FHE	+	46 57 06.9	119 29 49.0	0.455	Frenchman Hills East
FL2	%	46 11 47.0	122 21 01.0	1.378	Flat Top 2
FMW	%	46 56 29.6	121 40 11.3	1.859	Mt. Fremont
FRIS	%	44 12 44.0	122 06 01.8	1.642	Frissel Point, OR
GBB	H	46 36 31.8	119 37 40.2	0.185	PNNL Station
GBL	+	46 35 54.0	119 27 35.4	0.33	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	New Goldendale
GLK	%	46 33 27.6	121 36 34.3	1.305	Glacier Lake

TABLE 1A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
GMO	%	44 26 20.8	120 57 22.3	1.689	Grizzly Mountain, OR
GMW	%	47 32 52.5	122 47 10.8	0.506	Gold Mt.
GPW	%	48 07 05.0	121 08 12.0	2.354	Glacier Peak
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.
H2O	H	46 23 44.5	119 25 22.7	0.175	Water PNNL Station
HAM	%	42 04 08.3	121 58 16.0	1.999	Hamaker Mt., OR
HBO	%	43 50 39.5	122 19 11.9	1.615	Huckleberry Mt., OR
HDW	%	47 38 54.6	123 03 15.2	1.006	Hoodsport
HOG	%	42 14 32.7	121 42 20.5	1.887	Hogback Mtn., OR
HSO	%	43 31 33.0	123 05 24.0	1.02	Harness Mountain, OR
HSR	%	46 10 28.0	122 10 46.0	1.72	South Ridge, Mt. St. Helens
HTW	%	47 48 14.2	121 46 03.5	0.833	Haystack Lookout
HUO	%	44 07 10.9	121 50 53.5	2.037	Husband OR (UO)
IRO	%	44 00 19.0	122 15 15.4	1.642	Indian Ridge, OR
JBO	+	45 27 41.7	119 50 13.3	0.645	Jordan Butte, OR
JCW	%	48 11 42.7	121 55 31.1	0.792	Jim Creek
JORV	%	42 58 40.0	117 03 10.0	1.338	Jorden Valley, OR SMO
JUN	%	46 08 50.0	122 09 04.4	1.049	June Lake
KMO	%	45 38 07.8	123 29 22.2	0.975	Kings Mt., OR
KOS	%	46 27 46.7	122 11 41.3	0.61	Kosmos
KTR	N	41 54 31.2	123 22 35.4	1.378	CAL-NET
LAB	%	42 16 03.3	122 03 48.7	1.774	Little Aspen Butte, OR
LAM	N	41 36 35.2	122 37 32.1	1.769	CAL-NET
LAS	N	41 35 57.6	121 34 36.0	-	CAL-NET
LBC	N	40 50 12.3	121 20 59.8	-	CAL-NET
LCCM	M	45 50 16.8	111 52 40.8	1.669	Lewis and Clark Caverns, MT
LCW	%	46 40 14.4	122 42 02.8	0.396	Lucas Creek
LHE	N	41 37 42.6	122 13 49.8	-	CAL-NET
LMW	%	46 40 04.8	122 17 28.8	1.195	Ladd Mt.
LNO	+	45 52 18.6	118 17 06.6	0.771	Lincton Mt., OR
LO2	%	46 45 00.0	121 48 36.0	0.853	Longmire
LOC	+	46 43 01.2	119 25 51.0	0.21	Locke Island
LON	%	46 45 00.0	121 48 36.0	0.853	Longmire CREST BB LONLZ SMO
LTI	N	41 10 34.0	121 29 19.6	-	CAL-NET
LVP	%	46 03 58.0	122 24 02.6	1.13	Lakeview Peak
MBW	%	48 47 02.4	121 53 58.8	1.676	Mt. Baker
MCMT	M	44 49 39.6	112 50 55.8	2.323	McKenzie Canyon, MT
MCW	%	48 40 45.1	122 49 52.9	0.693	Mt. Constitution
MDW	+	46 36 47.4	119 45 39.6	0.33	Midway
MEW	%	47 12 07.0	122 38 45.0	0.097	McNeil Island
MJ2	+	46 33 27.0	119 21 32.4	0.146	May Junction 2
MOON	%	44 03 06.2	121 40 06.0	2.24	Moon Mt, OR
MOX	+	46 34 38.4	120 17 53.4	0.501	Moxie City
MPO	%	44 30 17.4	123 33 00.6	1.249	Mary's Peak, OR
MTM	%	46 01 31.8	122 12 42.0	1.121	Mt. Mitchell
NAC	+	46 43 59.4	120 49 25.2	0.728	Naches
NCO	%	43 42 14.4	121 08 18.0	1.908	Newberry Crater, OR
NED	#	46 12 01.5	122 11 03.4	2.06	NE part of old Dome, St. Helen
NEL	+	48 04 12.6	120 20 24.6	1.5	Nelson Butte
NLO	%	46 05 21.9	123 27 01.8	0.826	Nicolai Mt., OR
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
OCP	%	48 17 53.5	124 37 30.0	0.487	Olympics - Cheeka Peak

TABLE 1A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
OD2	+	47 23 15.6	118 42 34.8	0.553	Odessa site 2
ON2	%	46 52 50.8	123 46 51.8	0.257	Olympics - North River
OOW	%	47 44 03.6	124 11 10.2	0.561	Octopus West
OSD	%	47 48 59.2	123 42 13.7	2.008	Olympics - Snow Dome
OSR	%	47 30 20.3	123 57 42.0	0.815	Olympics Salmon Ridge
OT3	+	46 40 08.4	119 13 58.8	0.322	New Othello (replaces OT2 8/26
OTR	%	48 05 00.0	124 20 39.0	0.712	Olympics - Tyee Ridge
PAT	+	45 52 55.2	119 45 08.4	0.262	Paterson
PCFR	%	46 59 23.3	122 26 27.4	0.137	PC Firing Range ANSS-SMO
PCMD	%	46 53 20.9	122 18 00.9	0.239	PC Mountain Detachment ANSS-SMO
PGO	%	45 27 42.6	122 27 11.5	0.253	Gresham, OR
PGW	%	47 49 18.8	122 35 57.7	0.122	Port Gamble
PRO	+	46 12 45.6	119 41 08.4	0.553	Prosser
RCM	%	46 50 08.9	121 43 54.4	3.085	Mt. Rainier, Camp Muir
RCS	%	46 52 15.6	121 43 52.0	2.877	Mt. Rainier, Camp Schurman
RED	H	46 17 51.0	119 26 15.6	0.33	Red Mountain PNNL Station
RER	%	46 49 09.2	121 50 27.3	1.756	Mt. Rainier, Emerald Ridge
RMW	%	47 27 35.0	121 48 19.2	1.024	Rattlesnake Mt. (West)
RNO	%	43 54 58.9	123 43 25.5	0.85	Roman Nose, OR
RPW	%	48 26 54.0	121 30 49.0	0.85	Rockport
RRHS	%	46 47 58.6	123 02 25.4	0.047	Rochester HS ANSS-SMO
RSW	+	46 23 40.2	119 35 28.8	1.045	Rattlesnake Mt. (East)
RVC	%	46 56 34.5	121 58 17.3	1	Mt. Rainier - Voight Creek
RVW	%	46 08 53.2	122 44 32.1	0.46	Rose Valley
SAW	+	47 42 06.0	119 24 01.8	0.701	St. Andrews
SBES	%	48 46 05.9	122 24 54.2	0.119	Silver Beach ES ANSS-SMO
SEA	%	47 39 15.8	122 18 29.3	0.03	UW, Seattle (Wood Anderson BB)
SEP	#	46 12 01.4	122 11 21.8	2.116	September lobe, Mt. St. Helens
SFER	%	47 37 10.4	117 21 55.7	0.715	Spokane Schools, Ferris High A
SHW	%	46 11 37.1	122 14 06.5	1.425	Mt. St. Helens
SLF	%	47 45 32.0	120 31 40.0	1.75	Sugar Loaf
SMW	%	47 19 10.7	123 20 35.4	0.877	South Mtn.
SNI	H	46 27 50.4	119 39 35.1	0.323	Snively PNNL station
SOS	%	46 14 38.5	122 08 12.0	1.27	Source of Smith Creek
SSO	%	44 51 21.6	122 27 37.8	1.242	Sweet Springs, OR
STD	%	46 14 16.0	122 13 21.9	1.268	Studebaker Ridge
STDM	%	46 14 16.0	122 13 21.9	1.268	Studebaker Ridge Microphone
STW	%	48 09 03.1	123 40 11.1	0.308	Striped Peak
SVOH	%	48 17 21.8	122 37 54.8	0.022	Skagit Valley CC ANSS-SMO
TBM	+	47 10 12.0	120 35 52.8	1.006	Table Mt.
TDH	%	45 17 23.4	121 47 25.2	1.541	Tom,Dick,Harry Mt., OR
TDL	%	46 21 03.0	122 12 57.0	1.4	Tradedollar Lake
TRW	+	46 17 32.0	120 32 31.0	0.723	Toppenish Ridge
TWW	+	47 08 17.4	120 52 06.0	1.027	Teanaway
UWFH	%	48 32 46.0	123 00 43.0	0.01	UW Friday Harbor ANSS-SMO
VBE	%	45 03 37.2	121 35 12.6	1.544	Beaver Butte, OR
VCR	%	44 58 58.2	120 59 17.4	1.015	Criterion Ridge, OR
VDB	C	49 01 34.0	122 06 10.1	0.404	Canada
VFP	%	45 19 05.0	121 27 54.3	1.716	Flag Point, OR
VG2	%	45 09 20.0	122 16 15.0	0.823	Goat Mt., OR
VGB	+	45 30 56.4	120 46 39.0	0.729	Gordon Butte, OR
VIP	%	44 30 29.4	120 37 07.8	1.731	Ingram Pt., OR
VLL	%	45 27 48.0	121 40 45.0	1.195	Laurance Lk., OR
VLM	%	45 32 18.6	122 02 21.0	1.15	Little Larch, OR

TABLE 1A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
VSP	%	42 20 30.0	121 57 00.0	1.539	Spence Mtn, OR
VT2	+	46 58 02.4	119 59 57.0	0.385	Vantage2
VTH	%	45 10 52.2	120 33 40.8	0.773	The Trough, OR
VVHS	%	47 25 25.1	122 27 13.1	0.095	Vashon HS ANSS-SMO
WA2	+	46 45 19.2	119 33 56.4	0.244	Wahluke Slope
WAT	+	47 41 55.2	119 57 14.4	0.821	Waterville
WIW	+	46 25 45.6	119 17 15.6	0.128	Wooded Island
WPO	%	45 34 24.0	122 47 22.4	0.334	West Portland, OR
WPW	%	46 41 55.7	121 32 10.1	1.28	White Pass
WRD	+	46 58 12.0	119 08 41.4	0.375	Warden
WRW	%	47 51 26.0	120 52 52.0	1.189	Wenatchee Ridge
YA2	+	46 31 36.0	120 31 48.0	0.652	Yakima
YEL	#	46 12 35.0	122 11 16.0	1.75	Yellow Rock, Mt. St. Helens
YPT	+	46 02 55.8	118 57 44.0	0.325	Yellepit

Table 1B lists broad-band stations used in locating seismic events in Washington and Oregon, and Table 1C lists strong-motion stations. The format for station locations is the same for all station tables, as described above.

TABLE 1B - Broadband Stations

STA	F	LAT	LONG	EL	NAME
A04A	E	48 43 12.6	122 42 20.5	0.024	Lummi Island, WA
BRKS	%	47 45 19.1	122 17 17.9	0.02	Brookside ANSS-SMO BB
COR	U	44 35 08.5	123 18 11.5	0.121	Corvallis, OR (USNSN) BB
D03A	E	47 06 58.3	123 46 11.0	0.049	Wishkah, WA
DBO	%	43 07 09.0	123 14 34.0	0.984	Dodson Butte, OR (UO CREST BB)
ELW	%	47 29 39.4	121 52 17.2	0.267	EchoLakeBPA BB-SMO-IDS20
ERW	%	48 27 14.4	122 37 30.2	0.389	Mt. Erie SMO-IDS24 BB
EUO	%	44 01 45.7	123 04 08.2	0.16	Eugene,OR U0 CREST BB SMO
GNW	%	47 33 51.8	122 49 31.0	0.165	Green Mt CREST BB SMO
GRCC	G	47 18 42.5	122 10 46.0	0.13	Green River CC BB
HAWA	U	46 23 32.3	119 31 57.2	0.367	Hanford Nike USNSN BB
HEBO	%	45 12 49.2	123 45 15.0	0.875	Mt. Hebo, OR CREST BB SMO
HLID	U	43 33 45.0	114 24 49.3	1.772	Hailey, ID USNSN BB
HOOD	%	45 19 17.8	121 39 07.8	1.52	Mt Hood Meadows, OR CREST BB SMO
HUMO		42 36 25.6	122 57 24.1	0.555	Hull Mountain,OR BB from UCB
JRO		46 16 31.0	122 12 59.7	1.28	Johnston Ridge Observatory
KBO	N	42 12 45.0	124 13 33.3	1.008	Bosley Butte, OR CREST BB
KEB	N	42 52 20.0	124 20 03.0	0.818	Edson Butte, OR CREST BB
KRMB	N	41 31 22.6	123 54 28.7	1.265	CAL-NET Red Mtn, OR CREST BB
KSXB	N	41 49 49.4	123 52 36.8	-	CAL-NET Camp Six, OR CREST BB
LON	%	46 45 00.0	121 48 36.0	0.853	Longmire CREST BB LONLZ SMO
LTY	%	47 15 21.2	120 39 53.3	0.97	Liberty BB CREST SMO
MEGW	%	46 15 57.4	123 52 38.2	0.332	Megler, WA CREST BB SMO
MOD		41 54 08.9	120 18 10.6	1.555	Modoc Plateau, CA from UCB
NEW	U	48 15 50.0	117 07 13.0	0.76	Newport Observatory USNSN BB
OCWA	U	47 44 56.0	124 10 41.2	0.671	Octopus Mtn. USNSN BB
OFR	%	47 56 00.0	124 23 41.0	0.152	Olympics - Forest Resource Center
OPC	%	48 06 01.0	123 24 41.8	0.09	Olympic Penn College CREST BB
OZB	C	48 57 37.1	125 29 34.1	0.671	Canada BB
PFB	C	48 34 30.0	124 26 39.8	0.465	P.Renfrew, Canada BB
PIN	%	43 48 40.0	120 52 19.0	1.865	Pine Mt., OR (U0 CREST, BB, SMO)
PNLK	%	47 34 54.5	122 02 01.0	0.128	Pine Lake JH ANSS-SMO BB
PNT	C	49 18 57.6	119 36 57.6	0.55	Canada, BB

TABLE 1B - Broadband Stations

STA	F	LAT	LONG	EL	NAME
SNB	C	48 46 33.6	123 10 16.3	0.408	Canada BB
SP2	%	47 33 23.3	122 14 52.8	0.03	Seward Park, Seattle SMO-IDS24
SQM	%	48 04 39.0	123 02 44.0	0.03	Sequim, WA (CREST BB SMO)
STD	%	46 14 16.0	122 13 21.9	1.268	Studebaker Ridge
TAKO	%	43 44 36.6	124 04 52.5	0.046	Tahkenitch, OR CREST BB SMO
TOLO	%	44 37 19.3	123 55 16.6	0.021	Toledo BPA, OR CREST BB SMO
TTW	%	47 41 40.7	121 41 20.0	0.542	Tolt Res, WA CREST BB SMO
WIFE		44 03 35.4	121 48 58.7	1.955	Wife at 3-Sisters from CVO
WISH	%	47 07 01.8	123 46 11.6	0.045	Wishkah CREST BB SMO
WVOR	U	42 26 02.0	118 38 13.0	1.344	Wildhorse Valley, OR (USNSN BB)
YBH		41 43 55.3	122 42 37.4	1.06	Yreka, CA from UCB BB

Table 1C lists strong-motion, three-component stations operating in Washington and Oregon that provide data in real or near-real time to the PNSN. Several of these stations also have broad-band instruments, as noted.

The "SENSOR" field designates what type of seismic sensor is used:

A = Terra-Tech SSA-320 SLN triaxial accelerometer/Terra-Tech IDS24

A20 = Terra-Tech SSA-320 triaxial accelerometer/Terra-Tech IDS20 recording system

FBA23 = Kinemetrics FBA23 accelerometers and Reftek recording system

EPI = Kinemetrics Episensor accelerometers and Reftek recording system

BB = Guralp CMG-40T 3-D broadband velocity sensor

BB3 = Guralp CMG3T 3-D broadband velocity sensor

BBZ = Broad Band sensor, PMD 2024, vertical component only

K2 = Kinemetrics Episensor accelerometers and K2 recording system

The "TELEMETRY" field indicates the type of telemetry used to recover the data:

D = dial-up,

E = continuously telemetered via Internet from a remote EARTHWORM system

I = continuously telemetered via Internet

L = continuously telemetered via dedicated lease-line telephone lines

P = continuously telemetered via dedicated lease-line telephone lines using PPP protocol

M = continuously telemetered via BPA microwave

R = continuously telemetered via spread-spectrum radio

TABLE 1C - Strong-motion three-component stations

STA	F	LAT	LONG	EL	NAME	SENSOR	TEL.
ACES	%	47 33 35.0	122 20 23.6	0	Army Corps of Engineers Seattle	CMG5T	I
ALCT	%	47 38 48.8	122 2 15.7	0.055	Alcott Elementary	K2	I
ALKI	%	47 34 30.4	122 25 3.4	0.001	Alki	K2	L
ALST	%	46 6 32.3	123 1 58.5	0.198	Alston	A20	E,M
ALVY	%	43 59 53.2	123 0 57.0	0.155	Alvey	K2	E,M
ATES	%	48 14 10.9	122 3 33.0	0.062	Trafton Elementary	K2	I

TABLE 1C - Strong-motion three-component stations

STA	F	LAT	LONG	EL	NAME	SENSOR	TEL.
BABE	%	47 36 21.0	122 32 7.0	0.083	Blakely Elementary	K2	I
BEND	%	44 4 0.8	121 19 36.0	1.141	U of O Bend Field Office	K2	I
BEVT	%	47 55 12.0	122 16 12.0	0.17	Boeing Plant Everett	K2	I
BRKS	%	47 45 19.1	122 17 17.9	0.02	Brookside Elementary	K2,BBZ	I
BSFP	%	47 31 12.0	122 17 54.0	0.005	Boeing Fire Protection	CMG5T	I
BULL	*	45 26 45.8	122 9 16.9	0.222	Bull Run Dam	A	I
BURN	#	43 34 23.0	119 7 49.0	1.615	Burns Butte Radio Building	K2	M,I
COLT	%	45 10 13.1	122 26 12.8	0.213	Colton High School	CMG5T	I
CSEN	%	47 48 4.5	122 13 6.5	0.055	Crystal Springs Elementary	K2	I
CSO	#	45 31 1.0	122 41 22.5	0.036	Canyon	FBA23	D
DBO	%	43 7 9.0	123 14 34.0	0.984	Dodson Butte (CREST)	EPI,BB3	E,L-PPP
EARN	%	47 44 27.2	122 2 37.7	0.159	East Ridge Elementary	K2	I
EGRN	%	47 4 24.0	122 58 41.0	0.057	Evergreen State College	K2	I
ELW	%	47 29 39.4	121 52 17.2	0.267	Echo Lake	A,BB	D,M,L
ERW	%	48 27 14.4	122 37 30.2	0.389	Mount Erie	A,BB	D,L,M
EUO	%	44 1 45.7	123 4 8.2	0.16	Eugene Golf Course (CREST)	EPI,BB	E,L-PPP
EVCC	%	48 0 27.0	122 12 15.3	0.03	Everett Community College	K2	I
EVGW	%	47 51 15.8	122 9 12.2	0.122	Gateway Middle School	K2	I
EYES	%	45 19 46.5	123 3 23.5	0.061	Ewing Young Elementary	CMG5T	I
FINN	%	47 43 10.2	122 13 55.9	0.121	Finn Hill Junior High	K2	I
GNW	%	47 33 51.8	122 49 31.0	0.165	Green Mountain (CREST)	EPI,BB3	L-PPP
GTWN	%	47 33 4.8	122 19 14.8	0.025	Georgetown Playfield	CMG5T	I,Wireless
HAO	#	45 30 33.1	122 39 24.0	0.018	Harrison	FBA23	D
HEBO	%	45 12 49.2	123 45 15.0	0.875	Mt. Hebo (CREST)	EPI,BB	M,E
HICC	%	47 23 24.4	122 17 52.4	0.115	Highline Community College	K2	I
HOLY	%	47 33 55.4	122 23 1.0	0.106	Holy Rosary School	K2	I
HOOD	%	45 19 17.8	121 39 7.8	1.52	Hood Meadows (CREST)	EPI,BB	L-PPP,I
HUBA	%	45 37 51.0	122 39 4.9	0.023	Hudson's Bay High School	CMG5T	I
JORV	%	42 58 40.0	117 3 10.0	1.338	Jordan Valley High School	K2	I
KCAM	%	47 32 39.0	122 19 2.1	0.005	King County Airport Maintenance	CMG5T	I
KDK	%	47 35 42.7	122 19 56.0	0.004	King Dome	K2	I
KFAL	%	42 15 27.7	121 47 6.5	1.326	Klamath Falls	CMG5T	Serial
KEEL	%	45 33 0.8	122 53 42.4	0.067	Keeler	A20	D,E,M
KICC	%	47 34 37.9	122 37 52.4	0.017	Kitsap County Central Commun.	K2	I
KIMB	%	47 34 29.3	122 18 10.1	0.069	Kimball Elementary	K2	I
KIMR	%	47 30 11.0	122 46 2.0	0.123	Moderate Risk Waste Collection Fac.	K2	I
KINR	%	47 45 6.0	122 38 35.0	0.008	North Road Shed	K2	I
KITP	%	47 40 30.0	122 37 47.0	0.076	Wastewater Treatment Plant	K2	I
KNEL	%	47 22 50.5	122 15 2.5	0.014	Kent Elementary School	K2	I
KNJH	%	47 23 5.0	122 13 42.0	0.014	Kent Junior High	K2	I
LANE	%	44 3 6.5	123 13 54.8	0.12	Lane	K2	E,M
LAWT	%	47 39 23.4	122 23 21.9	0.05	Lawton Elementary	SLN-320	I
LEOT	%	47 46 4.4	122 6 56.2	0.115	Leota Junior High	K2	I
LON	%	46 45 0.0	121 48 36.0	0.853	Longmire Springs (CREST)	EPI,BB3	L-PPP
LTY	%	47 15 21.2	120 39 53.4	0.97	Liberty Heights Mine (CREST)	EPI,BB3	I
MARY	%	47 39 45.7	122 7 11.6	0.011	Marymoor Park	K2	I
MBKE	%	48 55 2.0	122 8 29.0	1.01	Kendall Elementary	K2	I
MBPA	%	47 53 54.7	121 53 20.2	0.186	Monroe	A20	D,M,L
MEAN	%	47 37 21.7	122 18 18.7	0.037	Meany Middle School	K2	I
MEGW	%	46 15 57.4	123 52 38.2	0.332	Megler (CREST)	EPI,BB	M,E
MPL	%	47 28 7.0	122 11 4.5	0.122	Maple Valley	A	D,M,L
MRIN	%	44 48 1.4	122 41 53.8	0.187	Marion	K2	M,E
MURR	%	47 7 12.0	122 33 36.0	0.082	Camp Murray	K2	None
NIHS	%	47 44 29.2	122 13 17.1	0.137	Inglemoore High School	K2	I

TABLE 1C - Strong-motion three-component stations

STA	F	LAT	LONG	EL	NAME	SENSOR	TEL.
NOWS	%	47 41 12.0	122 15 21.2	0.002	NOAA Sand Point	A20	I
OFR	%	47 56 0.0	124 23 41.0	0.152	Olympic Natural Resources Center (CREST)	EPI,BB	I,E
OHC	%	47 20 2.0	123 9 29.0	0.006	Hood Canal Junior High	K2	I
OPC	%	48 6 1.0	123 24 41.8	0.09	Peninsula College (CREST)	EPI,BB	I
PAYL	%	47 11 34.0	122 18 46.0	0.009	Aylen Junior High	K2	I
PCEP	%	47 6 41.8	122 17 24.0	0.16	Puyallup East Sheriff Precinct	K2	I
PCFR	%	46 59 23.3	122 26 27.4	0.137	Roy Training Center	K2	I
PCMD	%	46 53 20.9	122 18 0.9	0.239	Mountain Detachment	K2	I
PERL	%	45 19 42.0	122 46 40.2	0.068	Pearl	K2	M,E
PIN	%	43 48 40.0	120 52 19.0	1.865	Pine Mtn. (CREST)	EPI,BB3	E,L-PPP
PNLK	%	47 34 54.5	122 2 1.0	0.128	Pine Lake Middle School	K2	I
PSNS	%	47 33 32.0	122 38 35.0	0.006	Puget Sound Naval Shipyard	A20	I
QAW	%	47 37 54.3	122 21 15.5	0.14	Queen Anne	A20	L
RAW	%	47 20 14.0	121 55 53.2	0.208	Raver	A20	M,L
RBEN	%	47 26 6.7	122 11 10.0	0.152	Benson Hill Elementary	K2	I
RBO	#	45 32 27.0	122 33 51.5	0.158	Rocky Butte	FBA23	D
RHAZ	%	47 32 24.7	122 11 1.3	0.108	Hazelwood Elementary	A20	I
ROSS	%	45 39 43.0	122 39 25.0	0.061	Ross	A20	E
RRHS	%	46 47 58.6	123 2 25.4	0.047	Rochester High School	K2	I
RWW	%	46 57 53.7	123 32 31.7	0.015	Ranney Well (CREST)	EPI,BB3	L-PPP
SBES	%	48 46 5.9	122 24 54.2	0.119	Silver Beach Elementary School	K2	I
SCC	%	47 44 59.4	122 21 35.3	0	Shoreline Community College	CMG5T	I
SEA	%	47 39 15.8	122 18 29.3	0.03	University of Washington	A20,PMD2023	L
SEAS	%	45 59 51.3	123 55 28.2	0.005	Seaside	K2	I
SFER	%	47 37 10.4	117 21 55.7	0.715	Ferris High School	K2	I
SGAR	%	47 40 37.8	117 24 50.3	0.579	Garfield Elementary	K2	I
SHIP	%	47 39 19.0	122 19 14.4	0.005	WashDOT Lake Union Shop	CMG5T	I,Wireless
SHLY	$	47 42 30.4	117 24 57.7	0.626	Spokane Temp	K2	None
SMNR	%	47 12 16.6	122 13 53.4	0.022	Sumner High School	K2	I
SNIO	$	47 40 46.0	117 24 18.0	0.584	Spokane NIOSH	K2	None
SOPS	$	47 43 40.8	117 18 46.5	0.707	Orchard Prairie Elementary	K2	I
SP2	%	47 33 23.3	122 14 52.8	0.03	Seward Park	A,BB	L
SQM	%	48 4 39.0	123 2 44.0	0.03	Sequim Battelle Properties (CREST)	EPI,BB	I,R
SSS1	%	47 34 55.1	122 19 47.5	0.005	John Stanford Center 1	K2	I
SSS2	%	47 34 55.1	122 19 47.5	0.005	John Stanford Center 2	K2	I
SVOH	%	48 17 21.8	122 37 54.8	0.022	Skagit Valley College Oak Harbor	K2	I
SVTR	%	47 29 45.4	121 46 49.3	0.146	Two Rivers School	CMG5T	I
SWES	%	47 42 51.0	117 27 53.2	0.623	Westview Elementary	K2	I
SWID	%	48 0 31.0	122 24 42.0	0.062	South Whidbey Primary School	K2	I
TAKO	%	43 44 36.6	124 4 52.5	0.046	Tahkenitch (CREST)	EPI,BB	M,E
TBPA	%	47 15 29.0	122 22 1.0	0.002	Tacoma	A20	M,L,D
TKCO	%	47 32 12.7	122 18 1.5	0.005	King County Airport	A20	I
TOLO	%	44 37 19.3	123 55 16.6	0.021	Toledo (CREST)	EPI,BB	M,E
TTW	%	47 41 40.7	121 41 20.0	0.542	Tolt Reservoir (CREST)	EPI,BB3	I
UPS	%	47 15 50.2	122 29 1.1	0.113	University of Puget Sound	K2	I
UWFH	%	48 32 46.0	123 0 43.0	0.01	Friday Harbor Laboratories	K2	I
VVHS	%	47 25 25.1	122 27 13.1	0.095	Vashon High School	K2	I
WISC	%	47 36 32.0	122 10 27.8	0.056	Wilburton Inst. Services Center	K2	I
WWHS	%	46 2 43.5	118 19 2.0	0.01	Walla Walla High School	CMG5T	I

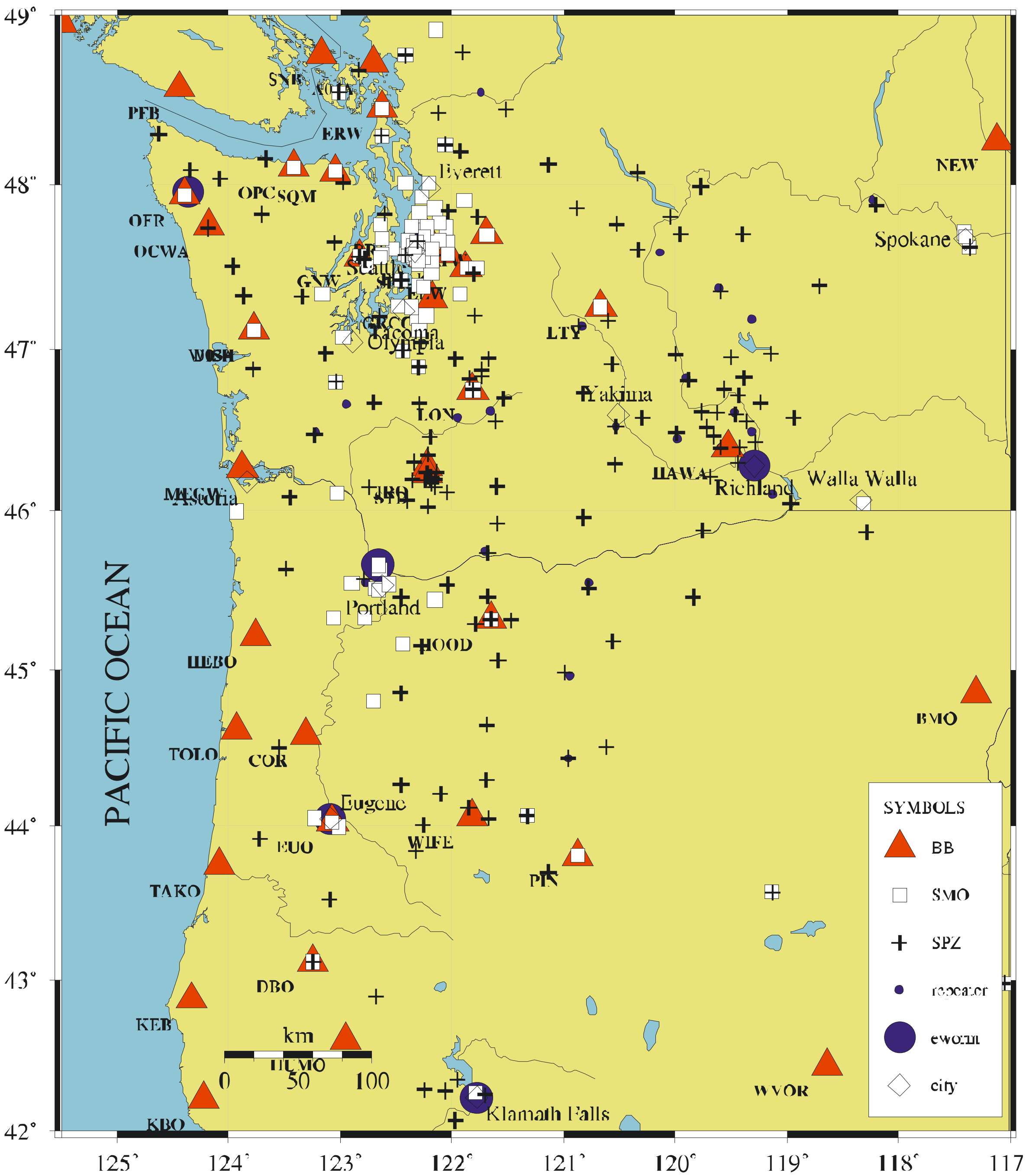

Figure 1. Seismograph Stations.
"BB" indicates broadband stations (Table 1B), "SMO" indicates strong motion stations (Table 1C), and "SPZ" indicates short-period stations (usually vertical component only) (Table 1A). Repeaters are sites with radio receivers and transmitters used in the transmission of seismic data to the UW via FM telemetry. "eworm" represents sites where a "mini-earthworm" system is running on a local computer to collect data for transfer to the UW via the Internet.

Data Processing

The PNSN seismic recording system uses real-time telemetry, and records earthquakes using an 'event trigger'. Analog and strong-motion digital data are recorded at 100 samples per sec., while broad-band digital data are usually digitized at 50 samples per sec. Arrival times, first motion polarities, signal durations, signal amplitudes, locations and focal mechanisms (when possible) are determined in post-processing. Digital data are processed for all locatable teleseisms, regional events, and local events. Each trace data file has an associated 'pickfile' which includes arrival times, polarities, coda lengths, and other data.

EARTHWORM is our main PNSN data-acquisition system. Analog stations, and most digital stations, are continuously telemetered in real time. Three USGS strong-motion stations in Portland record only on-site. Their data are retrieved via dial-up modem, if needed. All of the real-time data are continuously recorded into temporary disk storage areas called "wave tanks" which can accommodate about 24 hours of continuous data for the entire network. Triggering algorithms create individual event files lasting for several minutes depending on the size of the earthquake. In addition, continuous seismic data are permanently archived for about 60 stations, many on volcanoes. We continue to use the UW2 pickfile and data formats, and analysis tools that have been in place for more than a decade.

Unedited network-trigger trace data are stored on ongoing "network-archive" backup tapes. Edited "Master Event" trace data files are kept for all seismic events. These "Master Event" files are also translated to IRIS-SEED format and submitted to the IRIS Data Management Center for archive and distribution. Through EARTHWORM, we exchange real-time data with the University of Oregon, The Battelle Pacific Northwest National Labs, the Pacific Geoscience Centre, the Montana Bureau of Mines, and CALNET (operated jointly by U.C. Berkeley and the USGS). In addition, we send real-time data to the Alaska Tsunami Warning Center, the Pacific Tsunami Warning Center, the Cascade Volcano Observatory, and the National Earthquake Information Center. The entire PNSN catalog has been contributed to the ANSS composite catalog located at the Northern California Earthquake Data Center. The PNSN section of the ANSS catalog is updated daily.

Since 2003, all PNSN traces from all wave servers are sent to the IRIS DMC, which makes complete copies of all our continuous data available through the BUD (Buffer of Uniform Data) system.

Publications

Publications wholly or partly supported under this operating agreement are listed in Appendix 1.

SEISMICITY, EMERGENCY NOTIFICATION, AND OUTREACH

Seismicity

Figure 2 shows earthquakes of magnitude 2.0 or larger located in Washington and Oregon during this reporting period. Table 2 lists earthquakes recorded by the PNSN during 2004 which were reported felt. Table 3 gives information on seismic activity recorded at the PNSN annually since 1980. Between Jan. 1, 2004 and Dec. 31, 2004, 28 earthquakes (plus a meteor burst) were reported felt in Washington or Oregon west of the Cascades, ranging in magnitude from 1.8 to 4.9. Eighteen earthquakes (magnitudes 1.8 to 4.4) were reported felt east of the Cascades in Washington and Oregon.

Significant seismicity in Washington and Oregon in 2004 (see quarterly reports for details) included:

- Near Three Sisters Oregon, a swarm of over a hundred small earthquakes occurred between March 23 and 25.
- Near Lakeview, Oregon (near the Oregon/California border) a swarm of earthquakes began in April and continued through the end of 2004. It included several events of magnitude 4.0 or larger.
- A swarm of earthquakes near Jordan Valley, Oregon (near the Oregon/Idaho border), mostly during the second quarter.
- In central Puget Sound, a meteor-burst was seen, heard, and felt on June 3
- "Episodic Tremor and Slip" (ETS) associated with geodetic changes occurred south (2nd quarter) and north (3rd quarter) of Puget Sound
- Offshore of Newport Oregon , two felt earthquakes larger than magnitude 4 occurred during the third quarter.
- Mount St. Helens' eruption: Starting Sept. 23, Mount St. Helens experienced vigorous seismicity, quickly leading to a dome-building eruption with occasional ash and phreatic emissions, which began in October . Seismicity, dome building and occasional explosive activity are continuing into 2005.

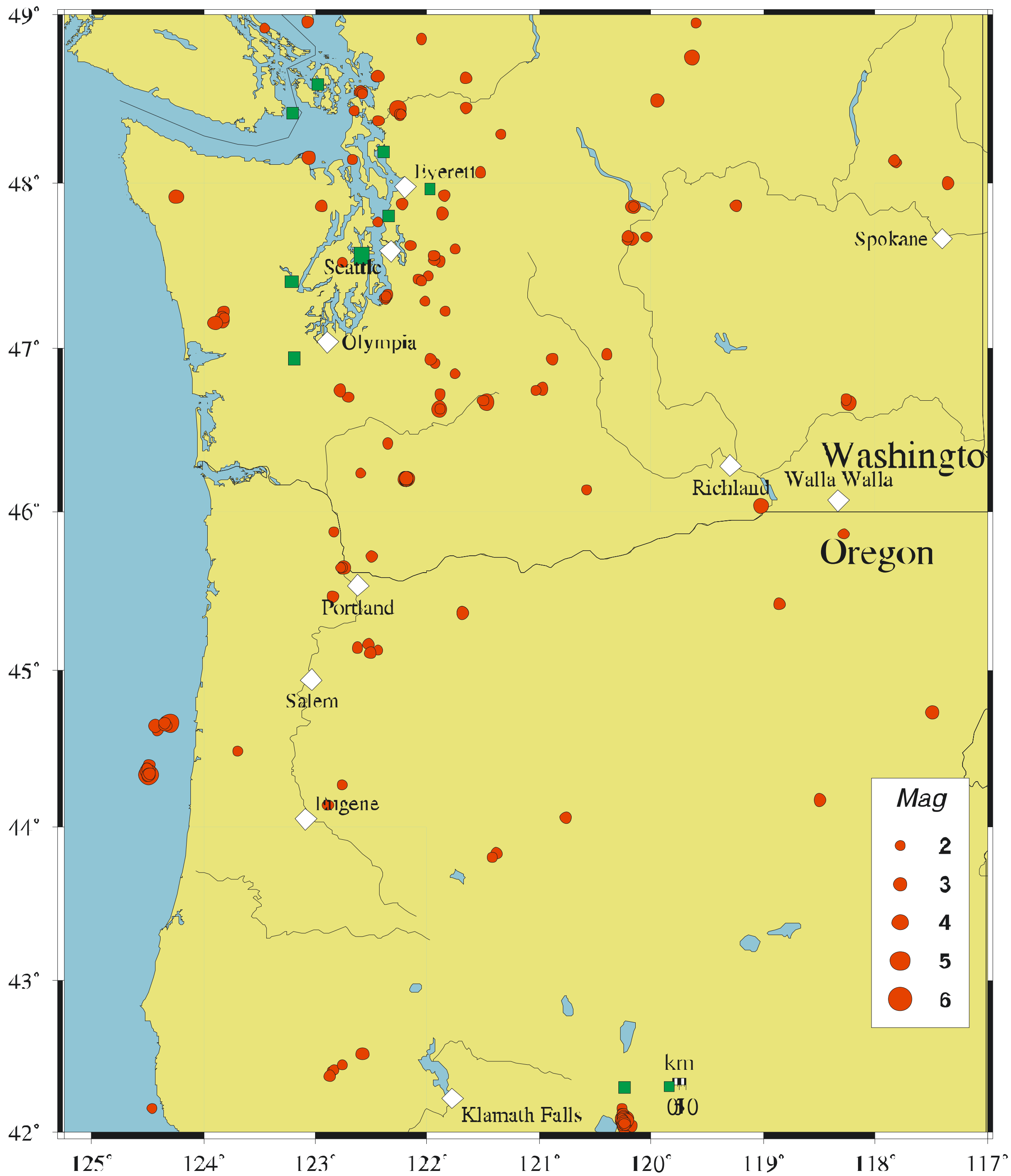

Figure 2. Seismicity 2004

Located earthquakes, magnitude >= 2.0. Green squares indicate earthquakes with depth greater than 30km. Red circles indicate earthquakes with depth <= 30km. White diamonds indicate cities. Area covered is 117W-125.25W, 42N-49N

TABLE 2 - Felt Earthquakes during 2004

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	CIIM	Shake Map
yy/mm/dd hh:mm:ss	deg.	deg.	km				
04/01/06 22:45:52	48.64	122.45	0.0	2.1	14.3 km S of Bellingham, WA		
04/01/07 00:11:51	48.64	122.44	0.1	2.7	14.0 km SSE of Bellingham, WA	✔	
04/01/09 09:08:18	45.63	122.76	17.4	2.1	15.8 km NW of Portland, OR		
04/01/14 12:13:39	47.86	120.16	2.5	3.3	11.5 km WNW of Chelan, WA	✔	✔
04/01/14 12:39:54	47.86	120.16	0.7	2.1	11.5 km WNW of Chelan, WA		
04/01/16 03:19:71	47.33	122.36	24.5	2.4	12.1 km NNE of Tacoma, WA		
04/01/16 08:18:18	47.57	122.59	55.6	3.6	3.0 km E of Bremerton, WA	✔	✔
04/01/26 16:43:11	47.10	122.21	10.7	1.8	20.2 km SW of Enumclaw, WA		
04/02/09 14:33:12	47.67	120.18	0.7	2.9	3.7 km E of Entiat, WA		
04/02/09 20:04:27	48.38	122.44	0.0	2.4	8.9 km WSW of Mount Vernon, WA		
04/02/26 01:51:54	45.65	122.75	18.9	3.0	16.2 km NW of Portland, OR	✔	✔
04/02/28 02:01:48	46.04	119.02	1.0	3.3	20.2 km SSE of Kenewick, WA		✔
04/03/17 11:34:27	48.45	122.27	0.1	3.8	6.0 km ENE of Mount Vernon, WA	✔	✔
04/03/19 05:41:35	45.15	122.63	26.1	2.4	14.0 km SSE of Canby, OR	✔	
04/04/15 06:32:14	46.93	121.97	12.6	2.3	18.8 km WNW of Mt Rainier, WA		
04/04/25 14:42:33	47.82	121.86	17.7	2.5	8.7 km ESE of Monroe, WA		
04/05/10 13:22:59	47.67	120.27	0.0	1.8	4.2 km WNW of Entiat, WA		
04/05/13 19:43:14	47.91	124.24	0.0	3.1	10.9 km ESE of Forks, WA		✔
04/05/17 13:03:37	46.94	123.18	41.6	2.7	23.3 km ESE of Satsop, WA		
04/06/03 09:45:00	46.94	123.18	41.6	2.7	Meteor Burst - not earthquake 43 km over Snohominsh, WA	✔	
04/06/10 18:09:06	47.18	123.83	0.1	2.3	23.6 km N of Aberdeen, WA		
04/06/12 15:12:09	47.22	123.81	0.0	2.6	28.1 km N of Aberdeen, WA		
04/06/17 09:16:42	46.67	118.23	17.6	3.4	67.2 km N of Walla Walla		
04/06/20 19:32:12	46.62	121.88	4.0	2.6	26.8 km SSW of Mt Rainier, WA		
04/06/24 07:57:52	48.54	122.60	19.9	2.8	24.1 km NW of Mount Vernon, WA		
04/06/25 01:41:32	42.04	120.25	13.4	3.0	17.8 km SSE of Lakeview, OR		
04/06/25 21:48:31	46.62	121.89	0.2	3.9	27.0 km SSW of Mt Rainier, WA	✔	✔
04/06/27 03:24:42	42.07	120.24	11.4	3.2	15.6 km SSE of Lakeview, OR		
04/06/27 07:00:14	42.09	120.24	11.6	3.9	13.9 km SE of Lakeview, OR	✔	
04/06/27 07:03:16	42.07	120.24	10.4	3.2	15.7 km SSE of Lakeview, OR		
04/06/27 11:32:37	42.07	120.24	6.9	3.0	15.2 km SE of Lakeview, OR		
04/06/27 11:40:37	48.41	122.24	0.0	2.2	6.9 km E of Mount Vernon, WA		
04/06/28 03:58:48	48.41	122.23	1.5	2.0	7.4 km E of Mount Vernon, WA		
04/06/29 01:38:49	42.05	120.23	14.3	2.7	17.3 km SSE of Lakeview, OR		
04/06/30 12:21:45	42.03	120.23	13.8	4.4	19.6 km SSE of Lakeview, OR	✔	
04/06/30 18:59:45	42.07	120.25	3.6	2.5	15.4 km SSE of Lakeview, OR		
04/07/05 05:42:09	42.06	120.23	8.7	3.2	16.7 km SSE of Lakeview, OR		
04/07/12 16:45:00	44.33	124.48	29.2	4.9	48.4 km SW of Newport, OR	✔	✔
04/07/22 20:26:26	42.09	120.24	1.1	4.3	14.3 km SE of Lakeview, OR	✔	
04/07/26 06:40:46	47.17	123.83	12.4	3.5	22.7 km N of Aberdeen, WA	✔	✔
04/08/16 21:05:53	46.67	121.47	0.3	4.0	17.5 km N of Goat Rocks, WA	✔	✔
04/08/19 06:06:03	44.66	124.30	27.9	4.7	19.9 km W of Newport, OR	✔	✔
04/08/21 19:43:33	47.15	123.89	15.5	3.2	21.1 km NNW of Aberdeen, WA		✔
04/08/31 16:58:00	46.72	121.88	7.4	2.2	17.2 km SW of Mt Rainier, WA		
04/09/24 07:10:04	48.15	123.05	7.2	3.1	28.9 km E of Port Angeles, WA	✔	
04/10/30 06:47:03	42.06	120.29	12.2	3.1	15.0 km SSE of Lakeview, OR	✔	
04/11/16 18:21:28	42.06	120.27	12.0	3.5	15.5 km SSE of Lakeview, OR	✔	

TABLE 3 Annual counts of events recorded by the PNSN, 1980-2004

Year	Total #	Out of Net	Inside Net			
			Unlocated	Located		
				Total	EQs(felt)	Blasts
80	4576	253	1075	3246	2874(18)	372
81	5155	291	1474	3385	2672(29)	713
1982	4452	329	1824	2297	1948(20)	349
1983	4489	405	2338	1745	1356(15)	389
1984	3144	267	1095	1780	1409(16)	371
1985	3560	266	1168	2122	1890(16)	232
1986	2554	318	452	1776	1594(21)	182
1987	1981	537	127	1304	966(22)	338
1988	2249	507	114	1624	1263(19)	361
1989	2781	501	137	2136	1835(38)	301
1990	3433	717	204	2505	2096(26)	409
1991	3083	675	315	2085	1687(26)	398
1992	3522	891	235	2381	1993(22)	388
1993	5594	731	626	4224	3877(35)	347
1994	6243	900	1518	3816	3424(28)	392
1995	5354	959	1462	2915	2539(16)	376
1996	4741	911	1192	2628	2214(39)	414
1997	3881	728	904	2239	1992(35)	247
1998	7463	831	2174	4430	4176(11)	254
1999	4505	803	1483	2187	1965(30)	222
2000	5625	1121	1686	2818	2482(18)	341
2001	5945	1090	2106	2730	2258(95)	472
2002	5495	951	1751	2752	2299(39)	453
2003	4863	884	1524	2413	1978(47)	435
2004	7219	306	*	4933	4498(46)	436

* The 2004 eruption of Mount St. Helens produced over 500,000 earthquakes. Only a small fraction of these were located.

Public Information and Outreach

Summary lists for all earthquakes located by the PNSN since 1969 are available via anonymous ftp on **ftp.ess.washington.edu/pub/seis_net**. This information is also available through the PNSN website **http://www.pnsn.org** and selected events are included in the USGS ANSS catalog search: **http://quake.geo.berkeley.edu/anss/catalog-search.html**. The PNSN website offers information about recent earthquake activity, network operations, and earthquake hazards in the Pacific Northwest as well as links to other sources of earthquake information.

The PNSN has an educational outreach program to better inform the public, policy makers, and emergency managers. Outreach includes information sheets, lab tours, lectures, workshops, and media interviews, and an audio library with several tapes. Services for the press and other media include interviews, consultations, referrals and research to provide accurate information to reporters.. Highlights of this reporting period include outreach talks to numerous groups of all types, including state and county officials, representatives of utility and private companies, and engineering and emergency management groups, and 41 Seismology Lab tours and lectures for visiting class groups, serving ~1,000 students; primarily from grades 3-12.

The PNSN hosted several ANSS and CREW committee or subcommittee meetings. PNSN representatives participated in national level ANSS committees and activities throughout the year, and attended a wide variety of other meetings related to earthquake hazards, preparedness, and related information and outreach.

The eruption of Mount St. Helens created an enormous demand for information. Our web-server was quickly overwhelmed and the http://www.pnsn.org URL was moved to a higher-capacity server, where it logged tens of millions of “hits” within a few weeks. PNSN staff handled hundreds of media interviews and several thousand e-mails during the third and fourth quarters.

ACKNOWLEDGMENTS

Seismic stations, telemetry links, and data acquisition equipment were maintained by Allen Strelow at the UW, Patrick McChesney (stationed at CVO in Vancouver, Washington), Pat Ryan (of the University of Oregon in Eugene, Oregon), and Don Hartshorn (of Pacific Northwest National Labs in Richland, WA). Bill Steele provided information to the public, while Amy Wright handled routine data analysis and archiving of digital trace data in UW2 format. George Thomas, Robert Lesley, Lynn Hultgrien and Amy Lindemuth,worked on strong motion instrumentation and software. Ruth Ludwin wrote reports and maintained the PNSN web-pages. The University of Oregon (UO) installed and maintained stations and telemetry links in central Oregon, and operated an earthworm node to transmit data to the University of Washington.

APPENDIX 1 - Publications wholly or partially funded under this agreement.

Publications

Quarterly bulletins from the PNSN (http://www.pnsn.org/REPTS/quarterly.html) provide operational details and descriptions of seismic activity in Washington and Oregon. These are available from 1984 through the third quarter of 2004. Final published catalogs are available from 1970, when the network began operation, though 1989.

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Abstracts

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La Rocca, M., S. Malone, G. Saccorotti, W. McCausland, D. Galluzzo, E. Del Pezzo, 2004, Small Aperture Array Resolution Capabilities for Use in Locating Deep Tremor, EOS Trans. AGU, 85(47), Fall Meeting Suppl, S53A-0190. http://www.agu.org/cgi-bin/sessionsfm04

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APPENDIX 2 - PNSN Quarterly Reports: 04-A, 04-B, 04-C, and 04-D

QUARTERLY NETWORK REPORT 2004-A

on

Seismicity of Washington and Oregon

January 1 through March 31, 2004

Pacific Northwest Seismograph Network

Dept. of Earth and Space Sciences

Box 351310

University of Washington

Seattle, Washington 98195-1310

This report is prepared as a preliminary description of the seismic activity in Washington State and Oregon. Information contained in this report should be considered preliminary, and not cited for publication without checking directly with network staff. The views and conclusions contained in this document should not be interpreted as necessarily representing the official policies, either express or implied, of the U.S. Government**.**

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TABLE OF CONTENTS

FIGURES

TABLES

INTRODUCTION

This is the first quarterly report of 2004 from the Pacific Northwest Seismograph Network (PNSN), at the University of Washington Dept. of Earth and Space Sciences, covering seismicity of Washington and western Oregon.

Comprehensive quarterlies have been produced by the PNSN since the beginning of 1984. Prior to that we published quarterly reports for western Washington in 1983 and for eastern Washington from 1975 to 1983. Annual technical reports covering seismicity in Washington since 1969 are available from the U.W. Dept. of Earth and Space Sciences. The complete PNSN catalog of earthquake locations and magnitudes is available on-line, both through our web-site (**ftp://ftp.ess.washington.edu/pub/seis_net/**) and through the ANSS catalog. In the quarterly reports we provide special coverage (figures, counts, listings, etc.) of earthquake swarms, aftershock sequences, etc. Prior to 2004, each quarterly included station tables. Beginning in 2004, station tables will be included only in the 4th quarter report. Lists of currently operating stations are available on-line through web page **http://www.pnsn.org/OPS/stations.html**.

This quarterly report discusses network operations, seismicity of the region, unusual events or findings, and our educational and outreach activities. This report is preliminary, and subject to revision. The PNSN routinely records signals from selected stations in adjoining networks. This improves our ability to locate earthquakes at the edges of our network. However, our earthquake locations may be revised if new data become available. Findings mentioned in these quarterly reports should not be cited for publication.

NETWORK OPERATIONS

Table 1 gives approximate periods of time when individual stations were inoperable. Data for Table 1 are compiled from weekly plots of network-wide teleseismic arrivals and automated and manual digital and analog signal checks, plus records of maintenance and repair visits.

Strong Motion Instrumentation Update

The first of the Duwamish Valley array stations was installed this quarter. Station ACES is located at the Seattle Field Office of the Army Corps of Engineers. The location was selected based on previous seismic recordings at this site of the 1965 Olympia earthquake.

An additional strong motion station was installed in Oregon. Station SEAS is located at the Seaside Historical Museum in Seaside, Oregon. This is an ANSS station but TrendWest Resorts provided the hardware and installation funding.

Computer Processing and Analysis Update

This quarter, scossa remained our main EARTHWORM computer, with milli serving as our primary backup and verme as the secondary backup. Milli and verme still serve as the principal computers for data acquisition for most of the digital stations. We are currently running EARTHWORM-V6.1. Pigia is our primary digitizer for analog stations.

A high-speed, 2 CPU Linux box with RAID disc storage, grasso, is used for research purposes and online storage of historical waveforms of frequent interest. Grasso is also used for non time-critical processing to reduce the load on our primary processing computers.

Software Update/Product Development

Washington State Department of Transportation has funded a joint PNSN/ UW Civil Engineering proposal to improve ground-motion processing capabilities and develop fast damage estimates that would serve the emergency earthquake information needs of WSDOT. To make rapid notification much more useful for post-earthquake recovery and emergency response, we are working on the following:

- Build the systems needed to provide estimated bridge damage based on ShakeMap ordinates, the Washington State Bridge Inventory, and WSDOT provided bridge fragility information. Based on probability of damage, a ranked list of bridges has been produced to help prioritize bridge inspections. This code has been written and was tested and verified to work this quarter. The automation is currently being tested.
- We are currently running two parallel versions of ShakeMap, our current version 2.4 and also version 3.0, which includes the bridge damage prediction code.

CREST Instrumentation Update

A replacement site for CREST station RWW has been found at Wishkah Valley School where we can use IP connectivity. Unexpected siting problems involving power have delayed installation, but site construction began at the end of the quarter.

Use of PNSN Data

The IRIS Data Management Center reports 581 requests for PNSN trace-data this quarter. Nearly 128,000 traces were requested.

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
ACES	3/9/2004	Installed (SMO)
ALST	02/02/04-End	Bad timing
ASR	01/18/04-02/07/04	Dead
BABE	12/17/03-01/08/04	No communications
BEVT	03/02/04-End	No communications
BHW	03/14/04-End	Very noisy
BOW	12/24/03-02/14/04	Dead
BPO	12/23/03-03/24/04	Dead
BRO	02/04/03-End	Dead
BUO	12/31/03-01/11/04	Dead
COLT	09/11/02-End	Intermittent - Hardware problem, needs repair
COR	02/16/04-End	No communications
EYES	09/11/02-End	Intermittent - Hardware problem, needs repair
FRIS	12/29/03-01/09/04	Dead
GHW	10/09/03-02/09/04	Dead
GHW	02/09/04-03/21/04	Intermittent
GLK	12/09/03-/3/09/04	Very noisy
GPW	01/14/04-02/08/04	Dead
GPW	03/16/04-End	Dead
HBO	02/13/04-End	Very noisy
HDW	12/19/03-End	Very noisy
HUBA	09/12/02-End	Intermittent - Hardware problem, needs repair
HUO	03/12/04-03/28/04	Dead battery, site is now solarized
IRO	12/14/03-01/24/04	Dead
KOS	01/22/04-02/03/04	Dead
LAWT	12/23/03-01/21/04	Bad timing
MBW	01/13/04-End	Dead
MEAN	12/20/03-02/20/04	Bad timing
MEGW	04/01/03-End	Bad timing
MPL	01/01/04-End	Bad timing
NLO	03/17/04-End	Dead
NOWS	11/25/03-02/24/04	Bad timing
OBH	01/31/02-End	Temp. removed for logging
OOW	12/21/03-End	Possible dead battery
OSD	12/21/03-End	Dead because of OOW
OSR	01/06/04-End	VCO may be off-frequency
PGO	09/21/03-End	Dead
PGW	10/08/03-End	Dead
RCM	01/27/04-End	Intermittent
RCS	12/10/03-02/07/04	Intermittent
RER	12/24/03-02/21/04	Very noisy
RMW	03/19/04-End	Dead
RVC	12/05/03-End	Very noisy
RVW	02/26/04-End	Dead
RWW	10/24/02-End	Temporarily removed
SBES	12/19/03-01/13/04	No communications
SCC	01/03/04-02/10/04	Vault needed repair from water damage
SCC	03/03/04-03/25/04	Disconnected for testing
SEA.EN?	01/07/04-02/16/04	Bad timing
SEA.HH?	12/05/03-End	Disconnected for renovation
SEAS	1/31/2004	Installed (SMO)
SEP	01/14/04-02/10/04	Dead
SEP	02/18/04-03/13/04	Dead
SFER	12/30/03-01/11/04	No communications
SLF	01/25/04-02/01/04	Dead

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
SMW	06/20/03-End	Intermittent
SOPS	08/27/02-End	K2 flash problem
SP2	03/04/04-End	Temporarily removed
SQM	08/01/03-End	Channel mix-up
SSO	11/25/03-03/12/04	Very noisy
SVTR	09/20/02-End	Intermittent - Hardware problem, needs repair
TOLO	02/20/04-End	No communications
TRW	07/14/02-End	Fire damage repaired, not seismic
UWFH	12/17/03-03/02/04	Temp. removed for construction
VBE	12/02/03-End	Dead
VG2	12/28/03-02/10/04	Dead
VIP	12/09/03-End	Dead
VTH	12/13/03-02/01/04	Off freq., seis. was changed
WPW	01/01/04-02/28/04	Dead
WRW	01/25/04-02/01/04	Dead
WRD	01/09/04-02/01/04	Noisy
YEL	01/14/04-02/10/04	Dead
YEL	02/18/04-End	Dead
YPT	03/16/04-End	Dead

EARTHQUAKE DATA - 2004-A

There were 937 events digitally recorded and processed at the University of Washington between January 1 and March 31, 2004. Locations in Washington, Oregon, or southernmost British Columbia were determined for 510 of these events; 403 were classified as earthquakes and 107 as known or suspected blasts. The remaining 427 processed events include teleseisms (124 events), regional events outside the PNSN (53), and unlocated events within the PNSN. Unlocated events within the PNSN include surficial events on Mt. St. Helens and Mt. Rainier, very small earthquakes, and blasts. Frequent mining blasts occur near Centralia, Washington and we routinely locate them.

Table 2 lists earthquakes reported to have been felt during this quarter. Events with ShakeMaps or Community Internet Intensity Maps (CIIM) are indicated. This quarter, five events generated ShakeMap. ShakeMap (**http://www.pnsn.org/shake/index.html**) shows instrumentally measured shaking using data from accelerometers in the network. Peak ground acceleration (PGA) values are modeled from accelerometer data, local geology, and distance to the epicenter. CIIM maps (**http://pasadena.wr.usgs.gov/shake/pnw/**) convert "felt" reports relayed via Internet into numeric intensity values. The CIIM map shows the average intensity by zip code.

Table 3 is this quarter's catalog of earthquakes M 2.0 or greater, located within the network - between 42-49.5 degrees north latitude and 117-125.3 degrees west longitude.

Figure 1. Earthquakes with magnitude greater than or equal to 0.0 ($M_c >=0$).

Figure 2. Blasts and probable blasts ($M_c >=0$).

Figure 3. Earthquakes located near Mt. St. Helens ($M_c >=0$).

Figure 4. Earthquakes located near Mt. Rainier ($M_c >=0$).

TABLE 2 - Felt Earthquakes during the 1st Quarter of 2004

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	CIIM	Shake Map
yy/mm/dd hh:mm:ss	deg.	deg.	km				
1/06/2004 22:45:52	48.64	122.45	0.0	2.1	14.3 km S of Bellingham, WA		
1/07/2004 00:11:51	48.64	122.44	0.1	2.7	14.0 km SSE of Bellingham, WA	✔	
1/09/2004 09:08:18	45.63	122.76	17.4	2.1	15.8 km NW of Portland, OR		
1/14/2004 12:13:39	47.86	120.16	2.5	3.3	11.5 km WNW of Chelan, WA	✔	✔
1/14/2004 12:39:54	47.86	120.16	0.7	2.1	11.5 km WNW of Chelan, WA		
1/16/2004 03:19:71	47.33	122.36	24.5	2.4	12.1 km NNE of Tacoma, WA		
1/16/2004 08:18:18	47.57	122.59	55.6	3.6	3.0 km E of Bremerton, WA	✔	✔
1/26/2004 16:43:11	47.10	122.21	10.7	1.8	20.2 km SW of Enumclaw, WA		
2/09/2004 14:33:12	47.67	120.18	0.7	2.9	3.7 km E of Entiat, WA		
2/09/2004 20:04:27	48.38	122.44	0.0	2.4	8.9 km WSW of Mount Vernon, WA		
2/26/2004 01:51:54	45.65	122.75	18.9	3.0	16.2 km NW of Portland, OR	✔	✔
2/28/2004 02:01:48	46.04	119.02	1.0	3.3	20.2 km SSE of Kenewick, WA		✔
3/17/2004 11:34:27	48.45	122.27	0.1	3.8	6.0 km ENE of Mount Vernon, WA	✔	✔
3/19/2004 05:41:35	45.15	122.63	26.1	2.4	14.0 km SSE of Canby, OR	✔	

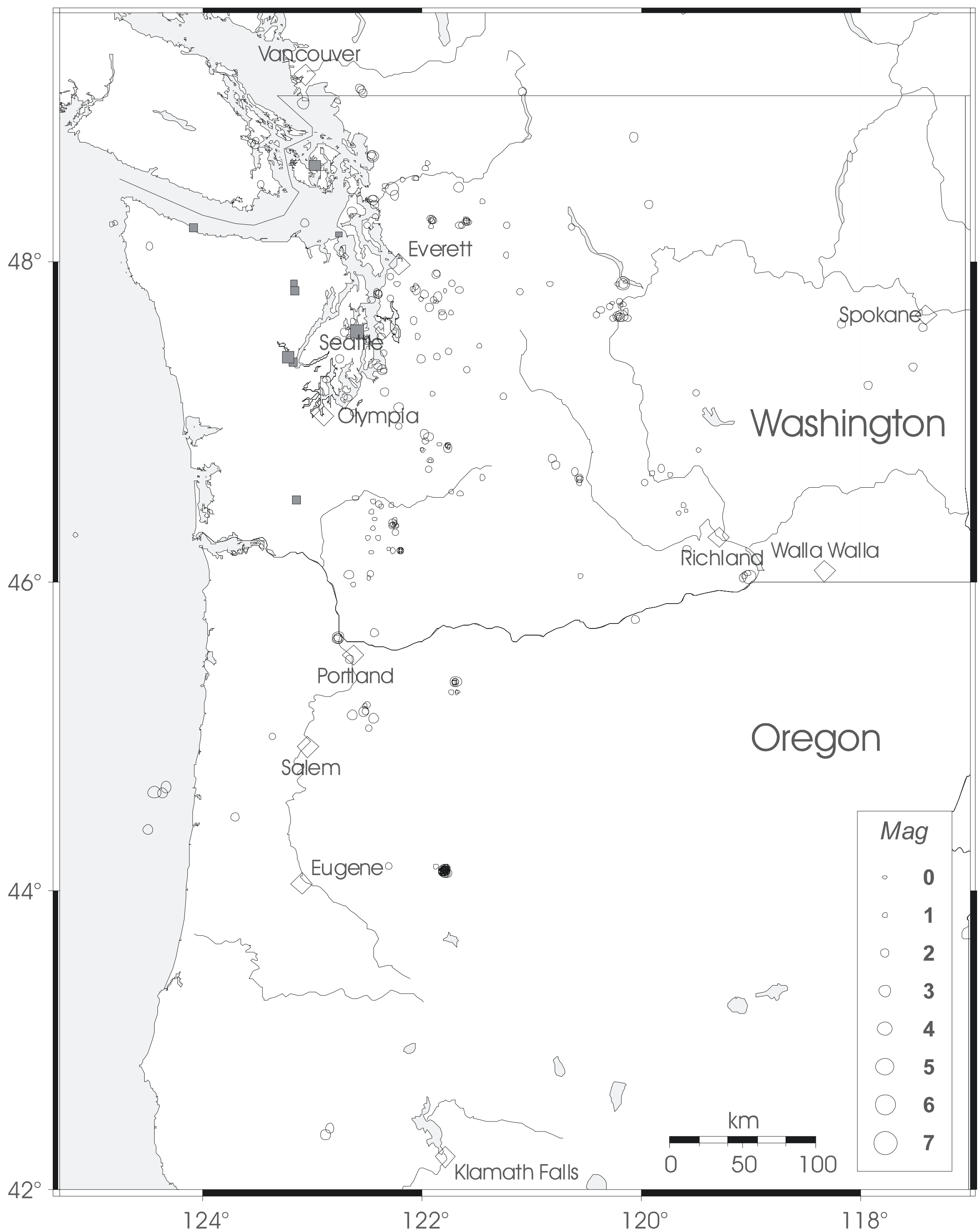

Figure 1. Earthquakes with magnitude greater than or equal to 0.0 (Mc>=0.0).

Unfilled diamonds represent cities. Quakes shallower than 30 km are indicated by circles, and deeper quakes by filled squares.

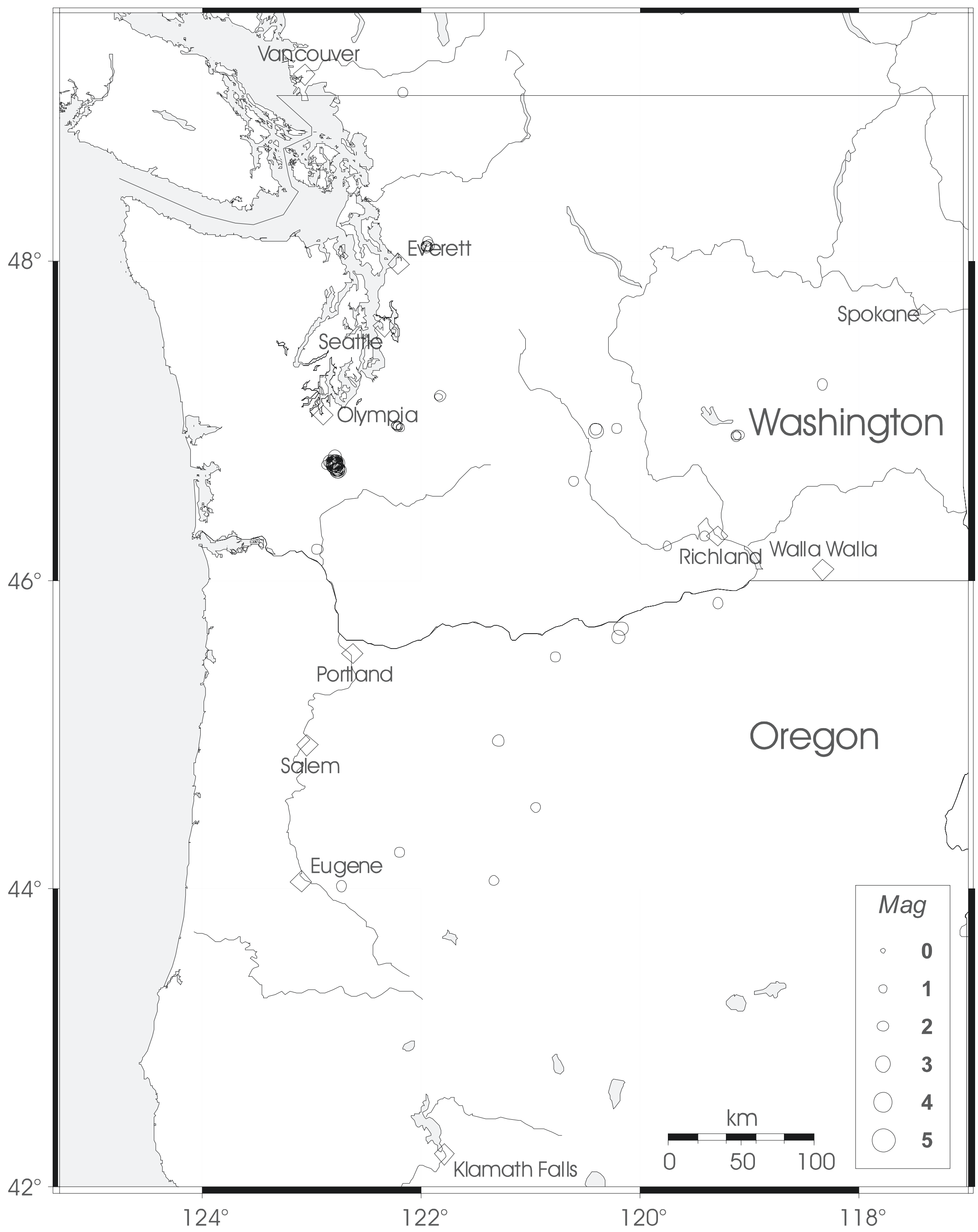

Figure 2. Blasts and probable blasts. Unfilled diamonds represent cities.

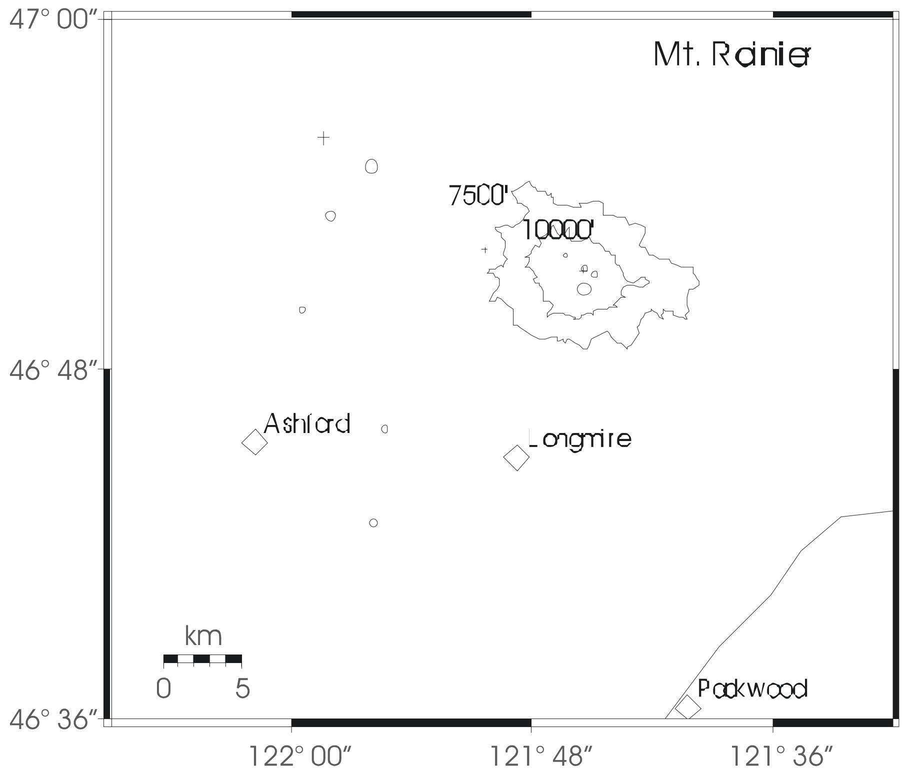

Figure 3. Earthquakes at Mt. St. Helens, M>0.0.

Plus' symbols indicate depth less than 1 km. Circles indicate depth greater than 1 km. Elevation contours shown in feet

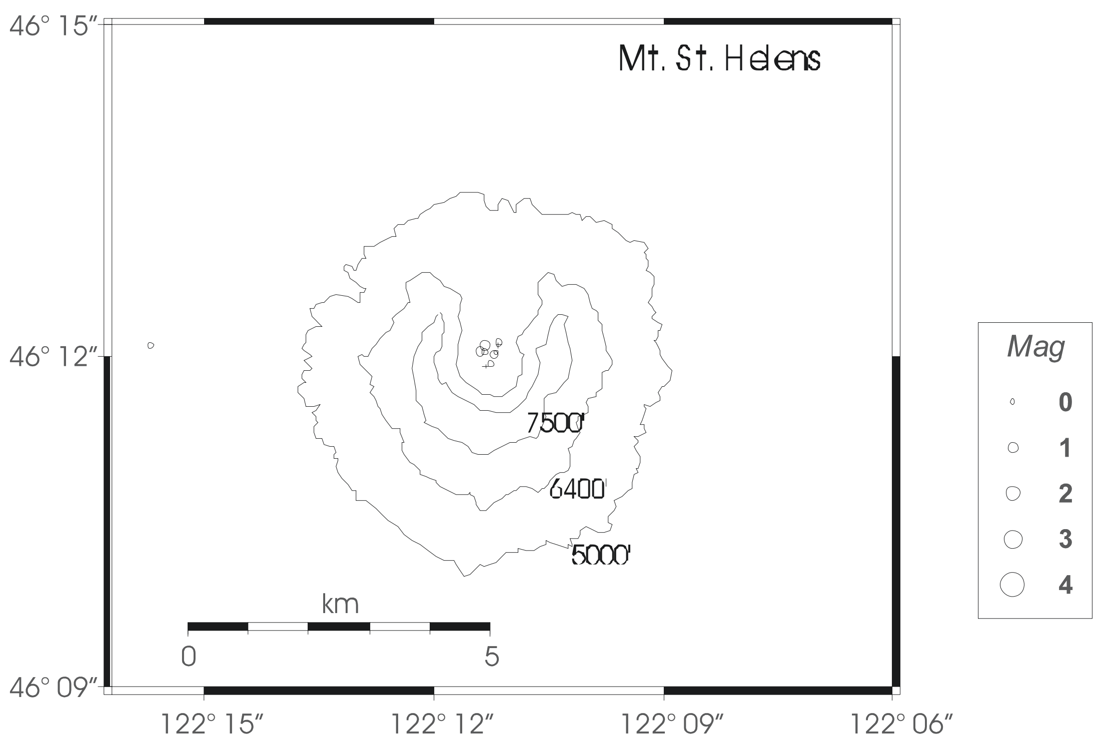

Figure 4. Earthquakes at Mt. Rainier, M>0.0.

OREGON

During the first quarter of 2004, a total of 108 earthquakes were located in Oregon between 42.0 degrees and 45.5 degrees north latitude, and between 117 degrees and 125 degrees west longitude. One earthquake within this area was reported felt within this quarter (see Table 2 for details). A magnitude 2.4 event on March 19, at a depth of about 26 km, located 14 km south-southeast of Canby. Two other felt events northwest of Portland are in the western WA area, below.

OREGON CASCADE VOLCANOES

This quarter a swarm of small earthquakes occurred between March 23 and 25 near the Three Sisters volcanic center in central Oregon. An information statement was issued in cooperation with the USGS Cascade Volcano Observatory: **http://www.pnsn.org/NEWS/PRESS_RELEASES/March242004Info.html**.

The earthquakes occurred in the northeast part of an area centered 5 kilometers (3 miles) west of South Sister volcano where the ground has been uplifted by as much as 25 cm (about 10 inches) since late 1997 see **http://vulcan.wr.usgs.gov/Volcanoes/Sisters/WestUplift/information_18march2002.html**). Over a hundred events were detected, and 78 were located in an area from 44-44.3 N latitude, and 121.5-122.3 W longitude. The largest events were magnitude 1.9 (2 events). The Three Sisters area was poorly instrumented before the summer of 2002 and low magnitude earthquakes, like this quarter's, could have gone undetected in the past. The swarm died down rapidly, and temporary seismometer station BKC was installed at Black Crater in early April. No felt or damaging earthquakes are known in the area.

WESTERN WASHINGTON SEISMICITY

During the first quarter of 2004, 235 earthquakes were located between 45.5 degrees and 49.5 degrees north latitude and between 121 degrees and 125.3 degrees west longitude. Nine earthquakes were felt this quarter in western Washington or the northwestern tip of Oregon. Details are in Table 2.

The largest felt earthquakes in western Washington was a magnitude 3.6 event on Jan. 16 (UTC), located about 3 km east of Bremerton at a depth of about 56 km. This was also the deepest quake in western Washington this quarter.

WASHINGTON CASCADE VOLCANOES

Mount Rainier

The number of events in close proximity to the cone of Mt. Rainier varies over the course of the year, since the source of much of the shallow activity is presumably ice movement or avalanching at the surface, which is seasonal in nature. Events with very low frequency signals (1-3 Hz) believed to be icequakes are assigned type "L" in the catalog. Emergent, very long duration signals, probably due to rockfalls or avalanches, are assigned type "S" (see Key to Earthquake Catalog). There were no located events flagged "L" or "S" at Mount Rainier this quarter although 36 "L" or "S" events were recorded, but were too small to locate reliably. Type L and S events are not shown in Fig. 4.

A total of 27 tectonic events (13 of these were smaller than magnitude 0.0, and thus are not shown in Fig. 4) were located within the region shown in Fig. 4. The largest tectonic earthquake located near Mt. Rainier this quarter was on January 15; a magnitude 2.0 event at a depth of about 14 km located about 15 km west-northwest of the summit. This quarter, 15 tectonic earthquakes were located in the "Western Rainier Seismic Zone" (WRSZ), a north-south trending lineation of seismicity approximately 15 km west of the summit of Mt. Rainier (for counting purposes, the western zone is defined as 46.6-47.0 degrees north latitude and 121.83-122 west longitude). Within 5 km of the summit, there were 9 (4 of them smaller than magnitude 0.0 and thus not shown in Fig. 4) higher-frequency tectonic-style earthquakes, and the remaining events were scattered around the cone of Rainier as seen in Fig. 4.

Mount St. Helens

Figure 5 shows volcano-tectonic earthquakes near Mount St. Helens. Low frequency (L) and avalanche or rockfall events (S) are not shown.

This quarter, 53 tectonic earthquakes were located at Mount St. Helens in the area shown in Fig. 5. Of these earthquakes, 13 were magnitude 0.0 or larger and 4 were deeper than 4 km. The largest tectonic earthquake at Mount St. Helens this quarter was a magnitude 1.3 event at about 2 km depth on January 29 UTC. It was located about 0.4 km north-northeast of the summit.

One type "S" or "L" events was located at Mount St. Helens, and 30 "L" or "S" events too small to locate were recorded.

EASTERN WASHINGTON SEISMICITY

During the first quarter of 2004, 59 earthquakes were located in eastern Washington in the area between 45.5-49.5 degrees north latitude and 117-121 degrees west longitude. One earthquake was recorded near Spokane this quarter. The largest earthquakes recorded in eastern Washington this quarter were magnitude 3.3 (two of them). One occurred on Jan. 14 about 12 km west-northwest of Chelan. The other was on Feb. 28 (UTC), and occurred about 20 km south-southeast of Kennewick. Both events were shallow, within a few km of the earth's surface.

OTHER SOURCES OF EARTHQUAKE INFORMATION

We provide automatic computer-generated alert messages about significant Washington and Oregon earthquakes by e-mail, FAX or via the pager-based RACE system to institutions needing such information, and we regularly exchange phase data via e-mail with other regional seismograph network operators.

Other regional agencies provide earthquake information. These include the Geological Survey of Canada (Pacific Geoscience Centre), Sidney, B.C. **http://www.pgc.nrcan.gc.ca/seismo/table.htm** ; and other regional networks in the United States **http://earthquake.usgs.gov/regional/** The US Geological Survey coordinates earthquake information nationally; **http://earthquake.usgs.gov**.

EARTHQUAKE CATALOG, 2004-A

Complete catalog listings are available on-line through **http://www.pnsn.org/CATDAT/catalog.html** Key to earthquake catalog can be found in the last quarterly report of each year, or at **http://www.pnsn.org/INFO_GENERAL/PNSN_QUARTERLY_EQ_CATALOG_KEY.htm**

TABLE 3. Tectonic earthquakes, 1st quarter, 2004, magnitude 2.0 and larger
Within the area 42-49.5 degrees north latitude and 117-125.3 degrees west longitude

Jan-04

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
6	45:51.9	48 38.19	122 27.12	0.02*	2.1	30/031	104	0.30	BC	P3	F
7	11:51.2	48 38.41	122 26.64	0.05*	2.7	32/033	104	0.33	CC	P3	F
9	08:17.7	45 38.07	122 45.80	17.36	2.1	29/032	63	0.13	AA	C3	F
13	32:29.8	44 29.14	123 41.66	23.14	2.0	11/011	127	0.19	BB	O0	
14	13:38.9	47 51.70	120 09.81	2.53	3.3	36/039	94	0.36	CC	N3	F
14	39:54.0	47 51.87	120 09.81	0.66	2.1	21/023	95	0.35	CC	N3	F
15	30:25.8	45 21.83	121 41.34	3.18	2.5	19/021	75	0.23	BB	O0	
15	32:35.3	46 54.94	121 56.01	13.88	2.0	38/040	43	0.14	AA	C3	
16	20:11.4	47 19.89	122 21.32	24.48	2.4	53/053	39	0.27	BA	P3	F
16	18:18.1	47 34.15	122 35.40	55.63	3.6	92/092	17	0.30	BA	P3	F
19	51:59.9	46 50.76	121 45.41	2.22	2.0	28/031	74	0.12	AA	C3	
30	34:18.0	48 57.72	123 04.48	19.29	2.5	19/020	228	0.22	BD	P3	

Feb-04

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
6	12:36.1	44 40.84	124 19.67	23.41	2.4	13/015	241	0.42	CD	O0	
9	33:11.8	47 40.04	120 10.52	0.74	2.9	35/036	48	0.40	CC	N3	F
9	04:27.4	48 22.60	122 26.35	0.03*	2.4	23/024	59	0.33	CC	P3	F
9	17:48.8	42 25.01	122 49.88	20.73	2.1	4/004	226	0.00	AD	K3	
12	02:20.6	45 10.03	122 31.60	21.71	2.4	34/034	55	0.32	CA	O0	
15	59:43.2	44 38.84	124 26.03	25.33	2.9	16/017	221	0.41	CD	O0	
23	04:32.5	47 24.77	123 12.71	45.64	2.6	49/050	110	0.16	BB	P3	
26	51:54.4	45 38.76	122 45.23	18.88	3.0	62/063	43	0.16	BA	C3	F
27	00:12.9	45 38.87	122 45.68	18.84	2.0	43/046	43	0.16	BA	C3	
28	01:47.9	46 02.18	119 01.23	1.02	3.3	31/031	117	0.33	CB	E3	F

Mar-04

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
15	57:54.3	45 07.71	122 26.30	15.53	2.1	25/027	75	0.21	BA	O0	
16	22:57.1	47 39.83	120 12.81	0.52	2.0	20/024	114	0.29	BC	N3	

Mar-04

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
16	34:59.3	48 35.31	122 58.54	50.27	2.5	24/026	80	0.18	BA	P3	
17	34:27.2	48 26.78	122 16.06	0.05*	3.8	59/059	79	0.48	CC	P3	F
17	50:17.6	48 24.26	122 14.64	0.03*	2.1	16/016	68	0.31	CB	P3	
19	41:34.7	45 08.74	122 37.53	26.12	2.4	50/051	68	0.34	CA	O0	F
21	34:26.6	48 27.17	121 39.42	0.02*	2.2	18/019	119	0.37	CC	C3	
21	35:08.9	44 24.09	124 29.21	22.38	2.2	7/008	301	0.24	CD	O0	
30	45:35.8	42 22.39	122 52.40	6.25#	2.2	6/006	175	0.03	AC	K3	

OUTREACH ACTIVITIES

The PNSN staff and faculty participate in an educational outreach program designed to better inform the public, educators, businesses, policy makers, government agencies, engineers, and the emergency management community about earthquake and related hazards. Our program offers lectures, classes, lab tours, workshops, and consultations and electronic and printed information products. Special attention is paid to the information needs of the media. We provide information directly to the public through information sheets, an audio library, email, and via the Internet at http://www.pnsn.org.

Telephone, Mail, and On-line outreach

The PNSN audio library system received 250 calls this quarter. Our audio library provides several recordings; we have resumed regular updating of messages concerning current seismic activity. There are also recordings describing seismic hazards in Washington and Oregon, and earthquake prediction. Callers to the audio library have the option of being transferred to the Seismology Lab for additional available information.

Internet outreach:

PNSN staff replied to about 100 e-mail messages from the public seeking information on a variety of topics via the **seis_info@ess.washington.edu** email address. Routine questions are typically responded to within a day. Complex or sensitive questions are routed to the appropriate staff person for a more in-depth response. These replies include assistance with hazard assessments and legal issues, consultations with government agencies, and support for engineering issues related to strong motion data.

Changes to our web site this quarter include two new webicorder features. First, current webicorders now have fixed web addresses!! This means you can bookmark your favorite webicorder station., or add a link on your web page for easy monitoring. Secondly. webicorder pages now use two browser windows, one to display the index and the other for viewing a webicorder record. This makes it easier to page through a series of webicorder records, either in time-sequence or across stations. To test-drive this new format, we recommend resizing the index window long and narrow across the top of the page, and placing the webicorder window below it. Scroll the index to a station, and click on successive time periods.

K-20 Education Outreach:

PNSN and USGS staff provided 14 Seismology Lab tours and presentations for K-20 students and teachers serving about 300 people this quarter including participation in UW's Math day attracting middle and High school students from across the State. Ruth Ludwin hosted a middle school job shadow.

- **Educational Resources Page: http://www.pnsn.org/EDHOME/index.html**.

The PNSN maintains an email list-service and distributed monthly newsletters to over 50 local K-20 educators, subscribers interested in earth sciences education.

Media Relations:

PNSN staff frequently provides interviews, research support, and referrals to radio, television, film, and print media. The PNSN organizes press conferences, contributes to TV and radio news programs and talk shows, and provides field opportunities linking reporters with working scientists. Staff members also assist news organizations, authors, television producers, and independent documentary makers to design accurate and informative stories and programs related to earthquake and volcano hazards. PNSN staff work to link reporters and producers developing stories with the appropriate research institutions, agencies, and scientists working in the areas to be covered by the piece.

Meetings, Presentations, and Visitors:

- Steve Malone attended the ANSS regional coordinators meeting in Pasadena.
- Steve Malone gave a general-public presentation on volcanoes to the Emerald Heights activity club.
- Bill Steele and Tony Qamar hosted a meeting for FEMA, WAEMD, Seattle Emergency Management and Ivan Wong of URS, to develop a project proposal to develop a Seattle area ShakeMap and use ShakeMap data to produce information products for the emergency management community.
- The PNSN hosted the Cascadia Region Earthquake Working Group's Workshop, "Planning for Earthquakes in Washington State" attended by 35 land use planners.
- Two separate groups of Italian seismologists visited for several weeks each for seismic research consultation.
- The PNSN hosted a meeting of CPARM (Contingency Planners and Recovery Managers) attended by 45 representatives of Portland and Puget Sound Region corporations. Tony Qamar (PNSN) and Craig Weaver (USGS) made presentations about current research activities and emerging information products.
- Ruth Ludwin provided two general presentations on PNW EQ hazards; at the Port Townsend Marine Science Center and on Whidbey Island at a class for the annual conference of Island County Beach Watchers
- Bill Steele lectured on disaster preparedness for the deaf to residents of Seattle's Lake City neighborhood.

QUARTERLY NETWORK REPORT 2004-B

on

Seismicity of Washington and Oregon

April 1 through June 30, 2004

Pacific Northwest Seismograph Network

Dept. of Earth and Space Sciences

Box 351310

University of Washington

Seattle, Washington 98195-1310

This report is prepared as a preliminary description of the seismic activity in Washington State and Oregon. Information contained in this report should be considered preliminary, and not cited for publication without checking directly with network staff. The views and conclusions contained in this document should not be interpreted as necessarily representing the official policies, either express or implied, of the U.S. Government**.**

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TABLE OF CONTENTS

FIGURES

TABLES

INTRODUCTION

This is the second quarterly report of 2004 from the Pacific Northwest Seismograph Network (PNSN), at the University of Washington Dept. of Earth and Space Sciences, covering seismicity of Washington and western Oregon.

Comprehensive quarterlies have been produced by the PNSN since the beginning of 1984. Prior to that we published quarterly reports for western Washington in 1983 and for eastern Washington from 1975 to 1983. Annual technical reports covering seismicity in Washington since 1969 are available from the U.W. Dept. of Earth and Space Sciences. The complete PNSN catalog is available on-line, both through our web-site and through the ANSS catalog. In these reports we provide special coverage (figures, counts, listings, etc.) of earthquake swarms, aftershock sequences, etc.

This quarterly report discusses network operations, seismicity of the region, unusual events or findings, and our educational and outreach activities. This report is preliminary, and subject to revision. The PNSN routinely records signals from selected stations in adjoining networks. This improves our ability to locate earthquakes at the edges of our network. However, our earthquake locations may be revised if new data become available. Findings mentioned in these quarterly reports should not be cited for publication.

Prior to 2004, each quarterly included station tables. Beginning in 2004, station tables will be included only in the 4th quarter report. Lists and maps of currently operating stations are available on-line through web page **http://www.pnsn.org/OPS/stations.html**.

NETWORK OPERATIONS

Table 1 gives approximate periods of time when individual stations were inoperable. Data for Table 1 are compiled from weekly plots of network-wide teleseismic arrivals and automated and manual digital and analog signal checks, plus records of maintenance and repair visits.

Operations this quarter were affected by a serious malfunction of a RAID disc system maintained by the UW Dept. of Earth and Space Sciences. Although not used for seismic data acquisition or as an internet server, a considerable amount of information was on these discs, including e-mail archives, station maintenance logs, research materials, and other miscellaneous information. The hardware backup to the RAID system had failed not long before the main system failed, and the tape backups available were over a year old. Some information has been retrieved or patched up, but we will likely be feeling the effects of this loss for some time to come. Every effort was made to recover data from the damaged drives, but without success.

Strong Motion Instrumentation Update

The installations in the Duwamish Valley array continued this quarter. Station KCAM is located at the King County Airport. Station ALKI is located at the King County Wastewater Facilities at Alki Point. Both stations were installed in June 2004.

Also, in late June, two stations were installed near Jordan Valley, Oregon to help monitor an earthquake swarm occurring in the area. Station BURN was installed at the ODOT radio facility near Burns, OR. Telemetry is being supplied by ODOT. Station JORV was installed at Jordan Valley High School and telemetered via an IP connection to the internet.

Computer Processing and Analysis Update

Our main operational computers continue with no change from the previous quarter.

Software Update/Product Development

Washington State Department of Transportation has funded a joint PNSN/ UW Civil Engineering proposal to improve ground-motion processing capabilities and develop fast damage estimates that would serve the emergency earthquake information needs of WSDOT. To make rapid notification much more useful for post-earthquake recovery and emergency response, we are working on the following:

- Build the systems needed to provide bridge damage probabilities based on ShakeMap ordinates, the Washington State Bridge Inventory, and WSDOT provided bridge fragility information. Based on probability of damage, a ranked list of bridges has been produced to help prioritize bridge inspections. This code has been written and was tested and verified to work this quarter. The automation was tested and is running.
- We are currently running two parallel versions of ShakeMap, our current version 2.4 and also version 3.0, which includes the bridge damage prediction code.

CREST Instrumentation Update

A replacement site for CREST station RWW has been found at Wishkah Valley School where we can use IP connectivity. Unexpected siting problems involving power were delaying installation, but a temporary new station, WISH, was installed April 2004 in the maintenance facility of the school. Current plans call for a USArray data logger and telemetry to be installed here next quarter.

Use of PNSN Data

The IRIS Data Management Center reports 166 requests for PNSN trace-data this quarter. Nearly 87,000 traces were requested.

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
ALKI	06/24/04	Installed
ALST	02/02/04-05/05/04	Bad timing
ALST	06/02/04-End	Bad GPS antenna
BEVT	03/02/04-04/05/04	No communications
BEVT	06/07/04-End	No communications
BHW	03/14/04-End	Very noisy
BRO	02/04/03-End	Dead
BULL	05/21/04-End	Intermittent
BURN	06/29/04	Installed
COR	02/16/04-03/13/04	No communications
ERW	06/17/04-End	No communications
EYES	06/26/04-End	No communications, possible firewall issue
GPW	03/16/04-End	Dead
HBO	02/13/04-06/04/04	Very noisy
HDW	12/19/03-04/29/04	Very noisy
HOLY	05/15/04-06/04/04	No communications; restarted DSL modem
IRO	05/28/04-End	Dead
JORV	06/30/04	Installed
KCAM	06/22/04	Installed
KDK	05/12/04-05/25/04	No communications; firewall issue
LTY	04/27/04-06/25/04	No communications
MBW	01/13/04-06/02/04	Dead
MEGW	04/01/03-End	Bad timing
MPL	01/01/04-End	Bad timing; removed for repair 4/16/04
NLO	03/17/04-05/13/04	Dead; bad receiver
OBH	01/31/02-End	Temp. removed for logging
OOW	12/21/03-End	Off at night, okay during daytime
OSD	12/21/03-End	Intermittent because of OOW
OSR	01/06/04-End	VCO may be off-frequency
PCFR	03/28/04-04/16/04	No communications; bad power strip
PCMD	06/19/04-06/30/04	No communications; bad terminal server
PGO	09/21/03-End	Dead
PGW	10/08/03-End	Dead
PSNS	04/23/04-End	No comm.; removed for repair 6/30/04
RCM	01/27/04-End	Dead
RCS	06/22/04-End	Dead
RMW	03/19/04-05/0404	Dead
RVC	12/05/03-End	Noisy
RVW	02/26/04-04/04/04	Dead
RVW	05/01/04-05/028/04	Very noisy
RWW	10/24/02-End	Temporarily removed; reinstalled as WISH
SEA.HH?	12/05/03-End	Disconnected for renovation
SGAR	04/30/04-06/14/04	Intermittent communication; replaced terminal server

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
SMW	06/20/03-End	Intermittent
SOPS	08/27/02-End	K2 flash problem
SP2	03/04/04-04/23/04	Temporarily removed, reinstalled 04/23/04
SP2	04/23/04-End	No telemetry
SQM	08/01/03-04/12/04	Channel mix-up
SVTR	04/16/04-05/03/04	No communications
TAKO	07/01/03-End	Bad timing
TOLO	02/20/04-03/13/04	No communications
TRW	07/14/02-End	Fire damage repaired, not seismic
VBE	12/02/03-05/28/04	Dead; bad radio transmitter
VIP	12/09/03-05/18/04	Dead; changed aircells
VTH	04/05/04-05/20/04	Dead; seismometer replaced
VVHS	04/05/04-05/10/04	No communications; firewall issue
WISH	04/20/04	Installed (replacement for RWW)
WPW	05/02/04-End	Intermittent
YEL	02/18/04-05/18/04	Dead; power problem
YPT	03/16/04-04/06/04	Dead

EARTHQUAKE DATA - 2004-B

There were 1,144 events digitally recorded and processed at the University of Washington between April 1 and June 30, 2004. Locations in Washington, Oregon, or southernmost British Columbia were determined for 625 of these events; 490 were classified as earthquakes and 135 as known or suspected blasts. The remaining 519 processed events include teleseisms (160 events), regional events outside the PNSN (79), and unlocated events within the PNSN. Unlocated events within the PNSN include surficial events on Mt. St. Helens and Mt. Rainier, very small earthquakes, and blasts. Frequent mining blasts occur near Centralia, Washington and we routinely locate them.

Table 2 lists earthquakes reported to have been felt during this quarter. Events with ShakeMaps or Community Internet Intensity Maps (CIIM) are indicated. This quarter, two events generated ShakeMaps. ShakeMap (**http://www.pnsn.org/shake/index.html**) shows a map of instrumentally measured shaking using data from accelerometers in the network. Peak ground acceleration (PGA) values on the map are modeled from recorded accelerometer data, known local geology, and distance to the epicenter. Another data product "CIIM" maps (**http://pasadena.wr.usgs.gov/shake/pnw/**) convert "felt" reports sent by the general public (via Internet) into numeric intensity values. The CIIM map shows the average intensity by zip code.

Table 3 is this quarter's catalog of earthquakes M 2.0 or greater, located within the network - between 42-49.5 degrees north latitude and 117-125.3 degrees west longitude.

Figure 1. Earthquakes with magnitude greater than or equal to 0.0 (M_c >=0).

Figure 2. Blasts and probable blasts (M_c >=0).

Figure 3. Earthquakes located near Mt. St. Helens (M_c >=0).

Figure 4. Earthquakes located near Mt. Rainier (M_c >=0).

TABLE 2 - Felt Earthquakes during the 2nd Quarter of 2004

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	CIIM	Shake Map
yy/mm/dd hh:mm:ss	deg.	deg.	km				
04/04/15 06:32:14	46.93	121.97	12.6	2.3	18.8 km WNW of Mt Rainier, WA		
04/04/25 14:42:33	47.82	121.86	17.7	2.5	8.7 km ESE of Monroe, WA		
04/05/10 13:22:59	47.67	120.27	0.0	1.8	4.2 km WNW of Entiat, WA		
04/05/13 19:43:14	47.91	124.24	0.0	3.1	10.9 km ESE of Forks, WA		✔
04/05/17 13:03:37	46.94	123.18	41.6	2.7	23.3 km ESE of Satsop, WA		
04/06/03 09:45:00	46.94	123.18	41.6	2.7	Meteor Burst - not earthquake 43 km over Snohominsh, WA	✔	
04/06/10 18:09:06	47.18	123.83	0.1	2.3	23.6 km N of Aberdeen, WA		

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	CIIM	Shake Map
yy/mm/dd hh:mm:ss	deg.	deg.	km				
04/06/12 15:12:09	47.22	123.81	0.0	2.6	28.1 km N of Aberdeen, WA		
04/06/17 09:16:42	46.67	118.23	17.6	3.4	67.2 km N of Walla Walla		
04/06/20 19:32:12	46.62	121.88	4.0	2.6	26.8 km SSW of Mt Rainier, WA		
04/06/24 07:57:52	48.54	122.60	19.9	2.8	24.1 km NW of Mount Vernon, WA		
04/06/25 01:41:32	42.04	120.25	13.4	3.0	17.8 km SSE of Lakeview, OR		
04/06/25 21:48:31	46.62	121.89	0.2	3.9	27.0 km SSW of Mt Rainier, WA	✔	✔
04/06/27 03:24:42	42.07	120.24	11.4	3.2	15.6 km SSE of Lakeview, OR		
04/06/27 07:00:14	42.09	120.24	11.6	3.9	13.9 km SE of Lakeview, OR	✔	
04/06/27 07:03:16	42.07	120.24	10.4	3.2	15.7 km SSE of Lakeview, OR		
04/06/27 11:32:37	42.07	120.24	6.9	3.0	15.2 km SE of Lakeview, OR		
04/06/27 11:40:37	48.41	122.24	0.0	2.2	6.9 km E of Mount Vernon, WA		
04/06/28 03:58:48	48.41	122.23	1.5	2.0	7.4 km E of Mount Vernon, WA		
04/06/29 01:38:49	42.05	120.23	14.3	2.7	17.3 km SSE of Lakeview, OR		
04/06/30 12:21:45	42.03	120.23	13.8	4.4	19.6 km SSE of Lakeview, OR	✔	
04/06/30 18:59:45	42.07	120.25	3.6	2.5	15.4 km SSE of Lakeview, OR		

OREGON

During the second quarter of 2004, a total of 68 earthquakes were located in Oregon between 42.0 degrees and 45.5 degrees north latitude, and between 117 degrees and 125 degrees west longitude. Two areas of Oregon had earthquake swarms this quarter. The first swarm was in April and May near Jordan Valley. The second swarm began in early June near Lakeview, Oregon. There were eight felt earthquakes in Oregon this quarter; all part of the earthquake swarm near Lakeview.

Jordan Valley, Oregon Swarm: On April 22 an earthquake swarm began suddenly just west of Jordan Valley (close to 117 degrees W, 43 degrees N; on the Oregon-Idaho Border about 100 km south-southwest of Boise, Idaho). Swarm activity continued through early June and more than 150 events, most of them magnitude 1.0 or larger, were recorded. The largest event had a magnitude of about 3.4, occurred on 17 May, and may have been felt by a few local residents. Portable seismographs were deployed by Jim Zollweg of Boise State University, and data indicated the earthquakes were occurring beneath Antelope Reservoir west of Jordan Valley at a depth of about 7 km. The Jordan Valley swarm occurred in an area that has been almost completely devoid of located microearthquakes for more than 20 years (The Southwest Idaho seismic network operates a station 58 km away, and earlier activity would have been detected). It is in a transition zone between Basin and Range morphology to the west and the Owyhee Highlands to the east. A Holocene volcanic field is located just north of the swarm area, but there are also possible fault structures in the immediate area.

At the time the Jordan Valley swarm started, the PNSN had no instrumentation in this area and did not record these events. The Southwest Idaho seismic network, operated by Jim Zollweg of Boise State University, did record the sequence but with very poor ability to resolve location or depth of the earthquakes. The Southwest Idaho seismic network has limited resources, does not receive funding from the Advanced National Seismic System (ANSS), and is currently unable to exchange real-time data with the PNSN. Because of concern about a poorly monitored earthquake swarm occurring close to the Antelope Reservoir dam, the Oregon Dept. of Mineral Industries (DOGAMI), in cooperation with the USGS and PNSN, assisted in siting, installation, and telemetry for two instruments; installed at Burns and Jordan Valley at the end of June. This substantially improves monitoring of Jordan Valley, and also coincidentally improved coverage of the second Oregon sequence near Lakeview, which included earthquakes larger than magnitude 4.0. Lakeview is a fair-sized town with many unreinforced masonry buildings.

Lakeview, Oregon Swarm: The swarm near Lakeview, near the California Border, may have begun as early as June 4, when a magnitude 2.5 earthquake was located, apparently about 20 km north of the main cluster. Activity increased on June 25, with 6 located events. The sequence continued to accelerate, producing a magnitude 4.4 earthquake felt earthquake on June 30. A total of 32 earthquakes (8 of them felt, including 6 magnitude 3.0 or larger) were located between 41.6-42.4 N latitude and 120.0-120.7 W longitude.

These earthquakes lie in an area where seismicity is infrequent, and there are few stations nearby. The area is also between the Pacific Northwest and California networks, so two different groups are providing data and analysis. The PNSN and California Integrated Seismic Network **(http://www.cisn.org/**) are exchanging data for these events. Additional information can be found in special web pages: **http://www.pnsn.org/NEWS/PRESS_RELEASES/LAKEVIEW_2004.html** Several portable seismographs are being operated in the area by the Southwest Idaho seismic network with funding from DOGAMI, but data is not telemetered.

An apparent north-south alignment of these earthquakes, seen in our standard network locations, is most likely due to location errors because of the limited number of seismographs in the area. A careful relocation of some of the larger earthquakes suggests that the events likely originate fairly close together. Jim Zollweg of the Southwest Idaho seismic network reports that the events are occurring in the mountain range east of the Goose Lake fault, at depths of 4-8 km, and that microearthquake event rates are high, often 500-1000/day. The sequence is located in the basin and range geologic province, and focal mechanisms indicate normal faulting, typical of the region. The basin and range is capable of producing vigorous earthquake sequences and swarms. The Lakeview swarm is continuing into July, 2004.

WESTERN WASHINGTON SEISMICITY

During the second quarter of 2004, 360 earthquakes were located between 45.5 degrees and 49.5 degrees north latitude and between 121.0 degrees and 125.3 degrees west longitude. Twelve earthquakes were felt this quarter in western Washington. Details are in Table 2.

The largest felt earthquake in western Washington was a magnitude 3.9 event on June 25 (UTC), located about 27.0 km south-southwest of Mt Rainier, WA at a very shallow depth (less than 1 km). The deepest earthquake in western Washington this quarter was a magnitude 0.8 event at 85 km depth located about 13 km west-southwest of Skykomish, WA on June 14 (UTC).

On June 3, 2004 at 9:40 UTC a meteor burst was seen, heard and felt in the central Puget Sound. The PNSN recorded this event on many seismograph stations throughout the area. From what we can see on our records, this appears to be a single explosive source rather than a "sonic boom" type moving source. Our estimate of the location of the "boom" places it at an altitude of 43 km over Snohomish, WA. When it arrived near Snohomish it apparently exploded.

Beginning in late April and ending in mid-May, an “Episodic Tremor and Slip” (ETS) event was recorded in south-western Washington. Although ETS events have occurred in southern British Columbia and northern Washington every 14 months or so over the last 10 years (Science, May 25, 2001, V. 292, pp. 1525-1528), none had previously been noted in southwestern Washington. This quarter’s ETS event began in central Puget Sound and reached as far south as Portland, OR. Recent installation of GPS instruments and heightened alertness to the tremor that accompanies events made it possible to observe the ETS in southern Washington. A brief period of tremor was observed in northern California in late May, but no slip was reported from this area.

Three small research arrays were deployed in northwestern Washington and on Vancouver Island in anticipation of tremor on the northern segment by a group of scientists including Steve Malone and Wendy McCausland of the UW. Additional info is available at: **http://www.pnsn.org/NEWS/PRESS_RELEASES/TREMOR.html**

WASHINGTON CASCADE VOLCANOES

Mount Rainier

The number of events in close proximity to the cone of Mt. Rainier varies over the course of the year, since the source of much of the shallow activity is presumably ice movement or avalanching at the surface, which is seasonal in nature. Events with very low frequency signals (1-3 Hz) believed to be icequakes are assigned type "L" in the catalog. Emergent, very long duration signals, probably due to rockfalls or avalanches, are assigned type "S" (see Key to Earthquake Catalog). Only one flagged "L" or "S" was located at Mount Rainier this quarter although 59 "L" or "S" events were recorded, but were too small to locate reliably. Type L and S events are not shown in Fig. 4.

A total of 66 tectonic events (25 of these were smaller than magnitude 0.0, and thus are not shown in Fig. 4) were located within the region shown in Fig. 4. The largest tectonic earthquake located near Mt. Rainier this quarter was on June 25; a magnitude 3.9 event at a depth of less than 1 km located about 27 km south-southwest of the summit. This quarter, 41 tectonic earthquakes were located in the "Western Rainier Seismic Zone" (WRSZ), a north-south trending lineation of seismicity approximately 15 km west of the summit of Mt. Rainier (for counting purposes, the western zone is defined as 46.6-47.0 degrees north latitude and 121.83-122 west longitude). Within 5 km of the summit, there were 14 (6 of them smaller than magnitude 0.0 and thus not shown in Fig. 4) higher-frequency tectonic-style earthquakes, and the remaining events were scattered around the cone of Rainier as shown in Fig. 4.

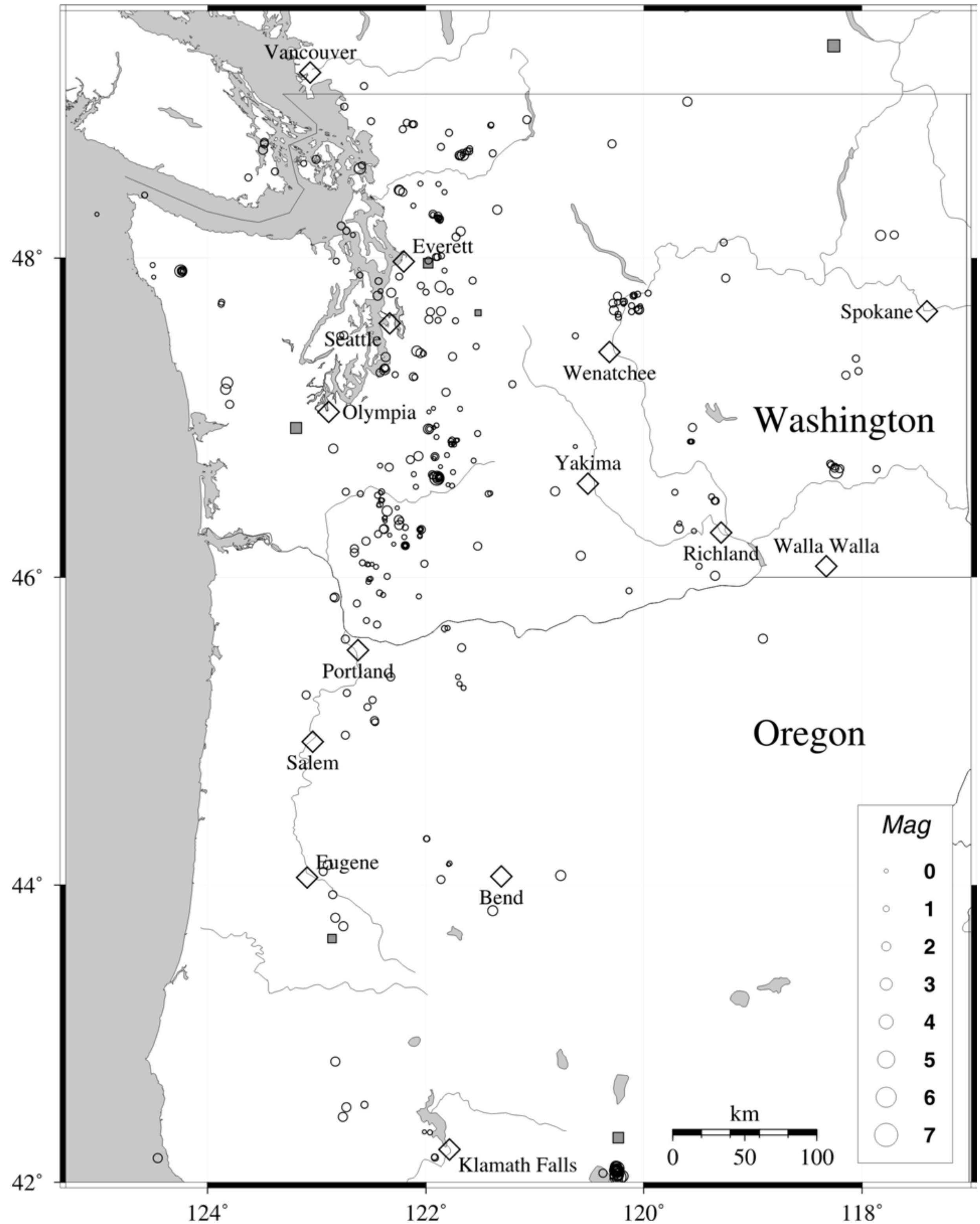

Figure 1. Earthquakes with magnitude greater than or equal to 0.0 (Mc>=0.0). Unfilled diamonds represent cities. Quakes shallower than 30 km are indicated by circles, and deeper quakes by filled squares.

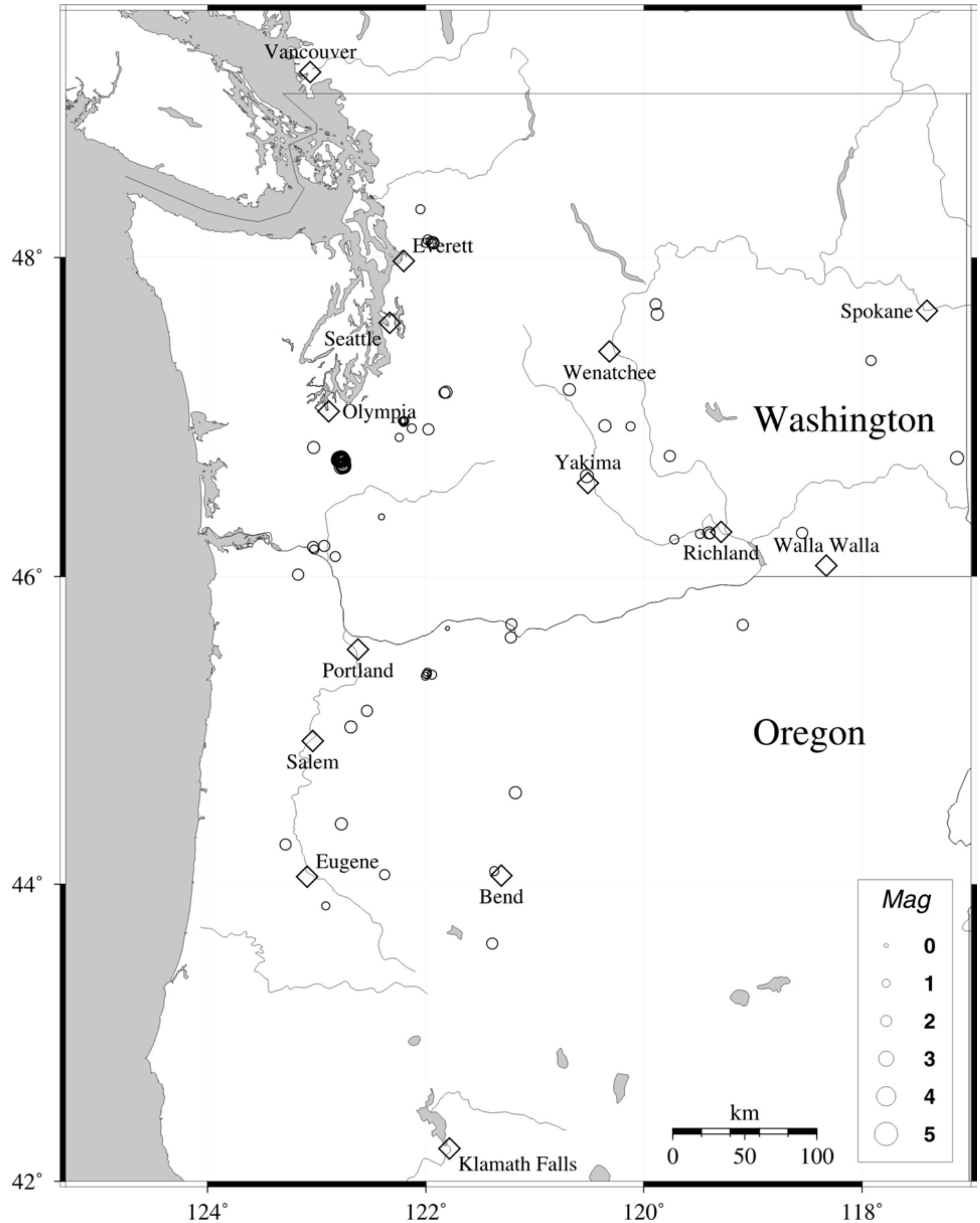

Figure 2. Blasts and probable blasts. Unfilled diamonds represent cities.

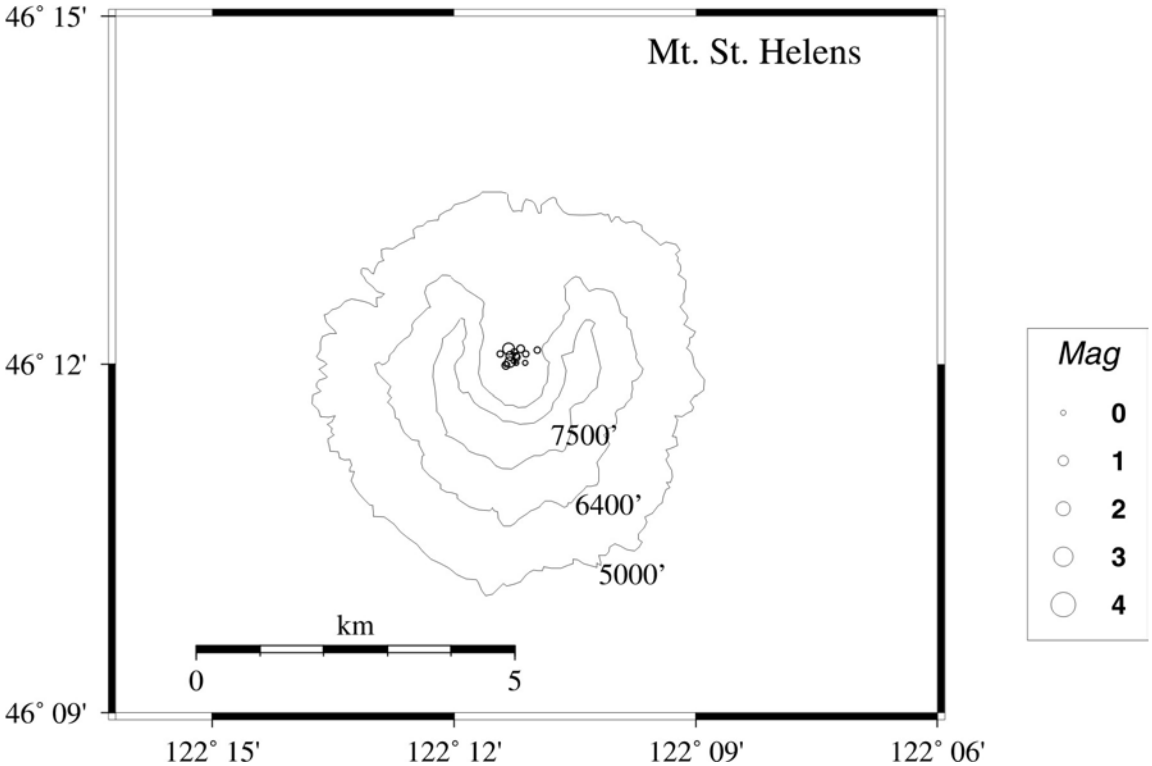

Figure 3. Earthquakes at Mt. St. Helens, M>0.0.

Plus' symbols indicate depth less than 1 km. Circles indicate depth greater than 1 km. Elevation contours shown in feet

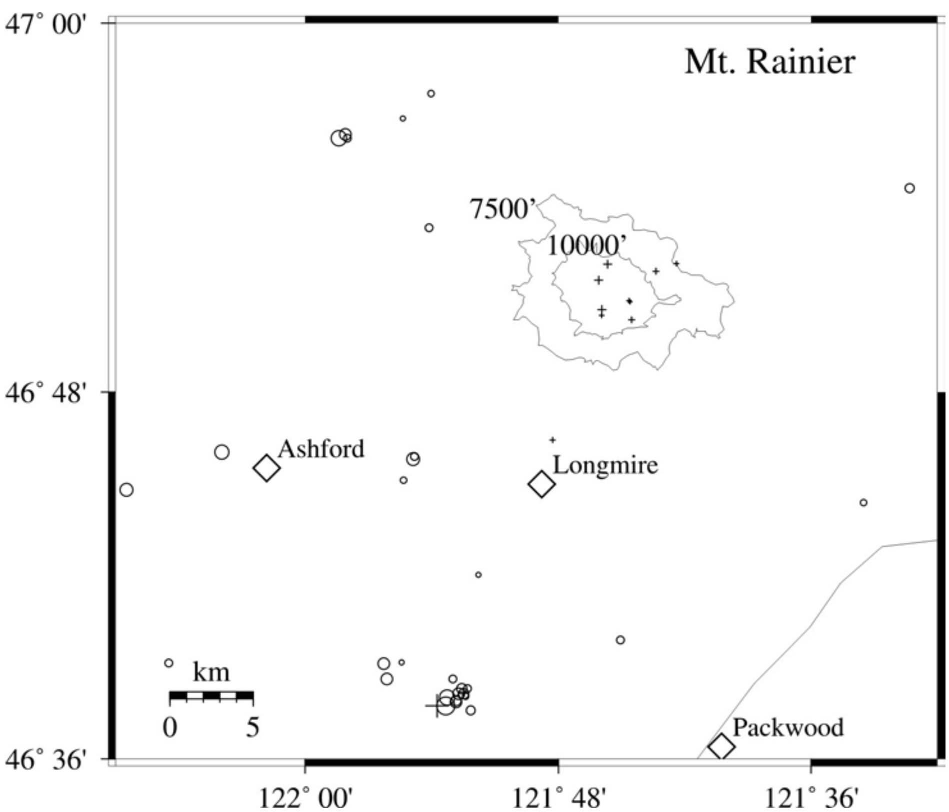

Figure 4. Earthquakes at Mt. Rainier, M>0.0.

Mount St. Helens

Figure 5 shows volcano-tectonic earthquakes near Mount St. Helens. Low frequency (L) and avalanche or rockfall events (S) are not shown.

This quarter, 87 tectonic earthquakes were located at Mount St. Helens in the area shown in Fig. 5. Of these earthquakes, 16 were magnitude 0.0 or larger and 9 were deeper than 4 km. The largest tectonic earthquake at Mount St. Helens this quarter was a magnitude 1.4 event at about 2 km depth on Mayl 24 at 01:38 UTC. It was located about 0.5 km north-northeast of the summit.

No type "S" or "L" events were located at Mount St. Helens this quarter, although 104 "L" or "S" events too small to locate were recorded.

EASTERN WASHINGTON SEISMICITY

During the second quarter of 2004, 61 earthquakes were located in eastern Washington in the area between 45.5 - 49.5 degrees north latitude and 117 - 121 degrees west longitude. The largest earthquake recorded in eastern Washington this quarter was a magnitude 3.4 event on June 17th. It occurred at a depth of about 19 km and was located about 67 km north of Walla Walla. It was reported felt and was part of a small sequence that included 2 foreshocks on the same day and 3 aftershocks over the following week.

OTHER SOURCES OF EARTHQUAKE INFORMATION

We provide automatic computer-generated alert messages about significant Washington and Oregon earthquakes by e-mail, FAX or via the pager-based RACE system to institutions needing such information, and we regularly exchange phase data via e-mail with other regional seismograph network operators.

Other regional agencies provide earthquake information. These include the Geological Survey of Canada (Pacific Geoscience Centre), Sidney, B.C. **http://www.pgc.nrcan.gc.ca/seismo/table.htm** ; and other regional networks in the United States **http://earthquake.usgs.gov/regional/** The US Geological Survey coordinates earthquake information nationally; **http://earthquake.usgs.gov**.

EARTHQUAKE CATALOG, 2004-B

Complete catalog listings are available on-line through **http://www.pnsn.org/CATDAT/catalog.html** Key to earthquake catalog can be found in the last quarterly report of each year, or at:
http://www.pnsn.org/INFO_GENERAL/PNSN_QUARTERLY_EQ_CATALOG_KEY.htm

TABLE 3. Tectonic earthquakes, 2nd quarter, 2004, magnitude 2.0 and larger
Within the area 42-49.5 degrees north latitude and 117-125.3 degrees west longitude

Apr-04											
DAY	**TIME**	**LAT**	**LON**	**DEPTH**	**M**	**NS/NP**	**GAP**	**RMS**	**Q**	**MOD**	**TYP**
5	29:45.9	47 46.11	122 26.47	25.71	2.1	59/062	40	0.28	BA	P3	
13	02:41.7	42 26.77	122 45.66	0.46	2.0	10/011	141	0.34	CC	K3	
14	11:13.4	46 08.19	120 34.80	11.57	2.1	27/029	81	0.27	BC	E3	
15	32:14.5	46 56.25	121 58.40	12.58	2.3	53/057	24	0.15	BA	C3	F
17	26:15.4	46 25.28	122 21.28	13.01	2.2	39/042	49	0.16	BA	S3	
17	10:47.2	42 09.80	124 27.33	2.76$	2.1	5/006	293	0.47	DD	K3	
25	42:33.3	47 49.41	121 52.01	17.7	2.5	55/058	55	0.22	BA	P3	F
29	45:41.9	47 25.49	122 04.75	21.69	2.3	63/067	40	0.17	BA	P3	
May-04											
DAY	**TIME**	**LAT**	**LON**	**DEPTH**	**M**	**NS/NP**	**GAP**	**RMS**	**Q**	**MOD**	**TYP**
3	10:14.8	45 52.28	122 50.07	21.7	2.1	42/044	54	0.13	AB	C3	
9	49:07.6	47 40.97	120 02.50	5.92	2.1	12/013	90	0.21	BB	N3	
13	43:14.1	47 55.16	124 14.64	0.03*	3.1	22/022	109	0.42	CC	P3	F
15	01:37.2	49 17.44	118 15.48	30.14*	3.1	10/010	273	0.22	BD	N3	
17	03:37.3	46 56.71	123 11.28	41.57	2.7	46/048	69	0.13	AA	P3	F
25	37:00.1	48 57.27	119 36.09	0.05*	2.0	10/010	251	0.29	BD	N3	

TABLE 3. Tectonic earthquakes, 2nd quarter, 2004, magnitude 2.0 and larger

May-04

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
25	21:56.7	48 08.44	117 49.77	2.09	2.2	6/006	182	0.21	CD	N3	
28	41:36.5	48 17.79	121 20.50	10.08	2.0	15/016	211	0.22	BD	C3	
28	56:50.9	44 03.75	120 45.85	21.60$	2.4	10/010	183	0.38	CD	O0	

Jun-04

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
3	51:52.5	43 49.70	121 23.21	4.2	2.2	18/018	100	0.23	BC	O0	
4	53:55.2	42 18.14	120 13.98	30.78	2.5	14/015	103	0.61	DB	K3	
10	09:06.9	47 11.25	123 50.14	0.05*	2.3	27/027	160	0.47	CC	P3	F
11	39:51.7	47 18.66	122 22.58	24.7	2.3	62/065	35	0.15	AA	P3	
11	28:49.7	48 37.89	121 39.34	0.03*	2.8	26/028	159	0.44	CC	C3	
12	12:09.2	47 13.72	123 49.10	0.03*	2.6	35/035	155	0.53	DC	P3	F
17	16:42.5	46 40.25	118 14.19	17.6	3.4	33/033	150	0.27	BD	E3	F
20	32:12.4	46 37.73	121 53.34	3.98	2.6	52/055	48	0.20	BC	C3	F
24	57:52.5	48 32.88	122 36.03	19.89	2.8	48/050	78	0.29	BB	P3	F
25	39:04.0	42 06.38	120 15.22	4.36$	2.6	15/016	141	0.56	DC	K3	
25	41:32.2	42 02.86	120 15.28	13.41	3.0	20/021	121	0.78	DB	K3	F
25	51:39.9	42 04.72	120 15.84	11.21	2.6	15/016	115	0.57	DB	K3	
25	13:19.4	42 04.67	120 15.20	11.36	2.4	16/017	118	0.58	DB	K3	
25	36:01.7	42 04.83	120 14.77	12.34	2.7	15/016	119	0.50	DB	K3	
25	48:31.6	46 37.74	121 53.75	0.18	3.9	99/099	24	0.34	CC	C3	F
25	44:16.7	46 38.00	121 53.26	4.68	2.3	42/045	45	0.12	AC	C3	
26	03:29.9	42 06.09	120 15.10	0.03*	2.2	13/013	140	0.25	BC	K3	
26	06:04.3	42 05.38	120 15.60	25.96	2.2	13/013	140	0.42	CD	K3	
27	24:42.6	42 04.44	120 14.60	11.37#	3.2	18/018	121	0.28	BB	K3	F
27	00:14.9	42 05.50	120 14.72	11.55*	3.9	19/020	118	0.29	BB	K3	F
27	03:16.0	42 04.44	120 14.52	10.37	3.2	20/021	121	0.50	DB	K3	F
27	14:32.1	42 05.77	120 14.89	4.41	2.1	12/013	140	0.29	BC	K3	
27	42:18.3	42 02.44	120 11.73	15.18$	2.7	16/018	138	0.58	DC	K3	
27	36:55.4	42 04.82	120 14.66	7.28	2.6	14/015	120	0.13	AC	K3	
27	26:45.8	42 05.15	120 14.90	0.03*	2.3	10/010	139	0.25	BD	K3	
27	32:37.8	42 04.76	120 14.46	6.89	3.0	16/017	121	0.23	BC	K3	F
27	40:37.4	48 25.07	122 14.69	0.02*	2.2	23/023	54	0.44	CB	P3	F
27	24:15.7	42 04.12	120 15.10	8.63	2.4	15/016	119	0.41	CC	K3	
28	58:48.6	48 24.87	122 14.32	1.47	2.0	10/010	95	0.12	AB	P3	F
28	35:23.5	42 04.82	120 14.00	5.96*	2.4	16/017	122	0.22	BC	K3	
28	48:49.2	42 04.95	120 14.81	0.02*	2.1	10/010	235	0.24	BD	K3	
28	53:17.4	42 05.03	120 15.20	0.03*	2.3	10/010	235	0.17	BD	K3	
29	38:49.8	42 03.59	120 14.19	14.28	2.7	17/018	124	0.57	DB	K3	F
29	14:50.7	47 24.84	122 03.04	6.57	2.0	32/035	50	0.20	BC	P3	
30	18:01.9	42 04.41	120 14.42	4.14	2.5	21/021	134	0.62	DD	K3	
30	20:53.8	42 02.54	120 14.32	1.34$	2.3	23/023	136	0.68	DD	K3	
30	21:45.6	42 02.10	120 14.30	13.78$	4.4	36/036	137	1.08	DD	K3	F
30	23:57.1	42 01.27	120 14.49	1.49$	2.4	16/016	144	0.71	DD	K3	
30	46:39.9	42 03.09	120 16.20	16.65	2.1	11/011	141	0.53	DD	K3	
30	36:00.2	42 03.18	120 14.26	12.11$	2.5	16/016	142	0.43	CD	K3	
30	59:45.2	42 04.24	120 15.33	3.56	2.5	18/018	140	0.37	CD	K3	F

OUTREACH ACTIVITIES

The PNSN staff and faculty participate in an educational outreach program designed to better inform the public, educators, businesses, policy makers, government agencies, engineers, and the emergency management community about earthquake and related hazards. Our program offers lectures, classes, lab tours, workshops, and consultations and electronic and printed information products. Special attention is paid to the information needs of the media. We provide information directly to the public through information sheets, an audio library, email, and via the Internet at **http://www.pnsn.org**.

Audio Library, Phone

The PNSN audio library system received 300 calls this quarter. Our audio library provides several recordings; we have resumed regular updating of messages concerning current seismic activity. There are also recordings describing seismic hazards in Washington and Oregon, and earthquake prediction. Callers to the audio library have the option of being transferred to the Seismology Lab for additional available information.

Internet outreach:

PNSN staff replied to about 135 e-mail messages from the public seeking information on a variety of topics via the seis_info@ess.washington.edu email address. Routine questions are typically responded to within a day; complex or sensitive questions are routed to the appropriate staff person for a more in-depth response. These replies include assistance with hazard assessments and legal issues, consultations with government agencies, and support for engineering issues related to strong motion data.

The California Integrated Seismic Networks (CISN) has developed a product to reliably deliver real-time earthquake hazards information to critical users. The user runs an application called “CISN Display”, which receives and displays information. CISN Display can display many more types of information than the CUBE-based RACE (Rapid Alert for Cascadia Earthquakes) systems currently in use. The CISN Display beta test version was distributed to select users who provide feedback to PNSN staff, CISN Display clients are now receiving PNSN recent earthquake data and links to our ShakeMaps, which are automatically generated following significant earthquakes. Following the scheduled late summer 2004 release of version 1 of the CISN Display, the PNSN plans to repackage the product with additional data layers for wider release within Washington and Oregon.

K-20 Education Outreach:

PNSN and USGS staff provided 12 Seismology Lab tours and presentations for K-20 students and teachers serving about 240 students this quarter. The PNSN also maintains an email list-service and distributed monthly newsletters to over 50 local K-20 educators, subscribers interested in earth sciences education. Bill Steele also provided lectures to a UW Hazard Mitigation Class in the Department of Urban Planning and to the ESS Earthquakes Class.

Media Relations:

PNSN staff frequently provides interviews, research support, and referrals to radio, television, film, and print media. The PNSN organizes press conferences, contributes to TV and radio news programs and talk shows, and provides field opportunities linking reporters with working scientists.. Staff members also assist news organizations, authors, television producers, and independent documentary makers to design accurate and informative stories and programs related to earthquake and volcano hazards. The PNSN often coordinates information releases with other organizations, including the USGS Western Region, the Cascades Volcano Observatory, and the Oregon Department of Geology and Mineral Industries (DOGAMI).

This quarter the PNSN cooperated with DOGAM in responding to numerous requests for information and interviews regarding swarms of earthquakes in southern Oregon. PNSN provided information concerning the swarms to DOGAMI, and they handled media inquiries.

Three unusual events caused some media uproar this quarter. The first was the TV mini-series “10.5” in early May, with a seriously stupid and absurd story line. The second was the June 3, 2004 meteor burst over Snohomish, which was seen, filmed, heard and felt in the central Puget Sound. The third was the onset of an “Episodic Tremor and Slip” (ETS) event in southwestern Washington in late April. Television, radio, and newspaper coverage continued through the quarter, both of the tremor and because three research arrays were deployed (under other funding) by the PNSN’s Steve Malone and Wendy McCausland , to record signals from an expected ETS event in northwestern Washington and southern Vancouver Island. See the seismicity section for western Washington for details.

Meetings, Presentations and Visitors:

- Bill Steele staffed a booth with CREW at the two day annual Washington State Partners in Preparedness Conference attended by over 400 public and private sector emergency managers.
- Meetings were held this quarter with Seattle Emergency Management and Seattle and King County IT staff who offered advice and support for PNSN telemetry projects.
- Steve Malone participated in a meeting and several conference calls regarding ShakeMap, ShakeCast, and the CISN Display. Other participants included FEMA, Washington State EMD, the PNSN, and USGS scientists. The emergency response agencies in the region are anxious to become familiar with these products and to develop software to interface with ShakeCast. The PNSN has not begun to use ShakeCast routinely and does not currently have a programmer on staff to work with counterparts in the emergency management community.
- Steve Malone, Bill Steele, and graduate student Wendy McCausland hosted the UW College of Arts and Sciences Dean's Circle, private contributors to College programs, for an evening of seismology providing an overview of hazards, research activities, and the Seismology Lab.
- Dr. David Applegate and Dr. Mike Blanpied, USGS Earthquake Program representatives from the Survey's National headquarters in Reston Virginia spent a day in meetings with PNSN representatives to discuss network operations and challenges.
- Bill Steele, Craig Weaver, and Kathy Troost of the Seattle Geologic Mapping Project held a half-day workshop on geologic hazards and mapping for the City of Mercer Island department heads.
- Steve Malone, Guy Medema, and Wendy McCausland attended the annual meeting of the SSA

QUARTERLY NETWORK REPORT 2004-C

on

Seismicity of Washington and Oregon

July 1 through September 30, 2004

Pacific Northwest Seismograph Network

Dept. of Earth and Space Sciences

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University of Washington

Seattle, Washington 98195-1310

This report is prepared as a preliminary description of the seismic activity in Washington State and Oregon. Information contained in this report should be considered preliminary, and not cited for publication without checking directly with network staff. The views and conclusions contained in this document should not be interpreted as necessarily representing the official policies, either express or implied, of the U.S. Government.

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U.S. Geological Survey
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TABLE OF CONTENTS

FIGURES

TABLES

INTRODUCTION

This is the third quarterly report of 2004 from the Pacific Northwest Seismograph Network (PNSN), at the University of Washington Dept. of Earth and Space Sciences, covering seismicity of Washington and western Oregon.

Comprehensive quarterlies have been produced by the PNSN since the beginning of 1984. Prior to that we published quarterly reports for western Washington in 1983 and for eastern Washington from 1975 to 1983. Annual technical reports covering seismicity in Washington since 1969 are available from the U.W. Dept. of Earth and Space Sciences. The complete PNSN catalog is available on-line, both through our web-site and through the ANSS catalog. In these reports we provide special coverage (figures, counts, listings, etc.) of earthquake swarms, aftershock sequences, etc.

This quarterly report discusses network operations, seismicity of the region, unusual events or findings, and our educational and outreach activities. This report is preliminary, and subject to revision. The PNSN routinely records signals from selected stations in adjoining networks. This improves our ability to locate earthquakes at the edges of our network. However, our earthquake locations may be revised if new data become available. Findings mentioned in these quarterly reports should not be cited for publication.

Prior to 2004, each quarterly included station tables and maps. Beginning in 2004, station tables and maps will be included only in the 4th quarter report. Lists of currently operating stations are available on-line through web page http://www.pnsn.org/OPS/stations.html.

NETWORK OPERATIONS

Table 1 gives approximate periods of time when individual stations were inoperable or when new stations were installed. Data for Table 1 are compiled from weekly plots of network-wide teleseismic arrivals and automated and manual digital and analog signal checks, plus records of maintenance and repair visits.

2004 Mt. St. Helens sequence data processing

Beginning on September 23, 2004 seismic activity significantly increased beneath Mt. St. Helens generating a much larger volume of event data than is typical. It became apparent within the first two days that routine processing methods would be insufficient to keep up with data flow (approximately 40,000 events were detected between Sept. 23 and Oct. 1). It should be noted that the seismic analyst, Amy Wright, had begun her maternity leave the week prior. It had been agreed that graduate student Guy Medema would do the daily processing in her absence with help from Tony Qamar and other PNSN affiliated graduate students. The volume of data combined with the absence of the primary analyst created the challenges described here.

Volume and Space - An 8 Gb file system on the main earthquake processing computer scossa, **/wormdata2**, had been used as the initial location for unprocessed events. As activity increased, data accumulation reached a rate of ~0.5 Gb/hour, rendering this disk space insufficient. A 30Gb file system, **/scossahuge** was designated as the initial location for new triggers. Because of processing complications described in later sections, data files could not be reduced (squashed) fast enough to keep this new space from filling up as well, despite around the clock efforts by faculty, staff and students. An attempt was made on 10/1 to hang an external drive onto an external computer, grasso, without success. Beginning on 10/4, we began sending data via ftp to IRIS where the data were written to DLT tapes as an emergency measure. On 10/10, a 250Gb disk was installed on a Linux machine, hozomeen, as directory **/wd3** and designated as a storage and processing site for MSH data, ending the need for transfer to IRIS. Initially, data were moved by hand from **/scossahuge** to **/wd3** for processing and then this process was automated. Data were <u>copied</u> to **/wd3** automatically then removed by hand from **/scossahuge** when it was confirmed that copying was successful for a given time-block of triggers. Finally, a new server, tremito was installed on 10/21. The file system **/twd1** became the primary data storage and processing location. Additionally, net backup tapes began filling up at nearly one (5 Gb) per day.

Processing - Several factors affected routine analysis including volume of data, multiple events in each trigger and non-MSH events buried in MSH triggers. The primary goals considered in all processing procedures were to maintain the integrity of new data and to provide current information regarding seismic activity. Mount St. Helens activity included many subsets of similar events, and not all triggers needed to be analyzed to provide a representative sample of earthquake activity.

Multiple events –During this period, nearly all triggers contained multiple MSH events (there was an earthquake about every 18 seconds) that would ordinarily be separated manually and processed individually. This was done during the first two days of activity but was abandoned in the routine processing because the time required to separate events was prohibitive, and codas often extended into subsequent events

Non-MSH events – Mount St. Helens earthquakes interfered with the processing of ordinary earthquakes occurring elsewhere. Because Mt. St. Helens earthquakes occurred every 18 seconds on average, most small earthquakes were buried within Mt. St. Helens triggers. It was therefore necessary to carefully examine each trigger to look for non-MSH events. This also proved to be more time-consuming than was practical with the staff available. However, data files could not be squashed until any non-MSH events were located and manually separated.

Preliminary processing **-** To provide current seismicity information, keep all significant data and prevent overfilling disk space, a preliminary processing scheme was developed and modified as necessary.

1) Individual analysts were assigned 4-hour blocks of triggers. As seismicity decreased, this was extended to 6 then 12-hour blocks.
2) Pickfiles were tagged to denote the status and initial fate of the triggers as follows:
   'b' trigger contains non-MSH event. Will be moved to **/stor/seis/P/YYMM**
   'x' trigger contains no useful data and is marked for deletion
   'g' Small/moderate MSH events only. A subset of channels on or near the mountain will be saved. All others will be squashed.
   'a' Only strong-motion stations are to be squashed. This tag was used for either very large MSH events that recorded on distant stations, or events that have not been examined for small non-MSH events.
3) After moving 'b' and 'x' events, some of the well-recorded 'a' and 'g' events were located and tagged with the usual 's'. Only a few (1-5) events per hour were located. The rest were saved for future analysis.
4) All pick and data files were moved to semi-permanent storage (IRIS, **/wd3 or /twd1** file systems) in **/<filesystem>/REVIEW/B_STOR/DYYMM$DD**
5) Links to located events were placed in **/<filesystem>/REVIEW/A_QUICK_PIK/LOC/LYYMM**
6) Summary files for each processing session were created in **/<filesystem>/REVIEW/A_QUICK_PIK/Summaries**

Update and sendevent **-** The scripts 'update' and 'sendevent' were problematic. These scripts update our earthquake data-base and web pages and send earthquake information to other institutions. Both scripts were written to look only in /stor/seis/P/YYMM for new events. Both scripts were eventually modified to look also in new directories where Mount St. Helens events were processed. 'Sendevent' was temporarily decommissioned and then modified to prevent large numbers of MSH events from being broadcast to the world. Duplicate listings in the yearly summary file, loc.04, were an issue resulting primarily from some confusion caused by multiple people processing data amid ever-changing procedures. Clean-ups were conducted to remove any duplicate event listings.

Strong Motion Instrumentation Update

Several of the Duwamish Valley stations were completed this quarter. Station GTWN, in the Georgetown Playfied, was installed on August 8. This station was a replacement of a USGS Urban Ground Motion Studies station. GTWN uses wireless telemetry to Cleveland High School, in the Seattle School District. GTWN has a Guralp CMG-5TD accelerograph.

Two of the new Duwamish stations are located within 200 m of locations of liquefaction features that occurred during the 2001 Nisqually earthquake: stations BSFP and SSS. Station BSFP is located at the Boeing Fire Station at Boeing Field. This station has a Guralp CMG-5TD accelerograph. Station SSS is located at Seattle School District's John Stanford Center, located at 4th Ave S and S Lander Street. A surface reference station, SSS2, was installed at John Stanford Center in September. SSS2 has a K2 with an internal Episensor. Steve Palmer, of Washington State Department of Natural Resources, coordinated the drilling of 3 boreholes in the parking lot of the John Stanford Center. An array of subsurface accelerometers will be placed in these boreholes, with depths varying between 40 and 175 feet. Kinemetrics Shallow Borehole Episensors will be installed at depth and will be digitized by a Kinemetrics K2.

Station PSNS, located at the Puget Sound Naval Shipyard in Bremerton was completed on September 14. The previous instrument, a Terra Technology IDS-24, had failed and it was replaced with a Guralp CMG-5TD accelerograph.

Green River Community College purchased and installed an education-grade vertical component broadband seismograph. Amy Lindemuth of the PNSN assisted with the seismograph installation. The instrument is a Guralp EDU-V. An early prototype of the EDU-V was installed by Amy Lindemuth at PNSN station PNLK in Issaquah and the data has been available on the PNSN Webicorders. Data from Green River College is being collected at the UW under the station designation of GRCC.

Computer Processing and Analysis Update

Our main operational computers continue to operate with no change from the previous quarter. The processes that create the Webicorder web pages were initiated on grasso in anticipation of moving all webicorder processes off of scossa.

CREST Instrumentation Update

The EarthScope USArray transportable seismic station D03A was installed at Wishkah Valley School on September 17th, 2004. This first Pacific Northwest USArray station includes a Streckeisen STS-2 broadband seismometer, Kinemetrics Quanterra Q330 seismic data acquisition system, and Kinemetrics Baler recording instrument. On September 22 the strong motion Kinemetric EpiSensor ES-T from the temporary WISH CREST station was removed and installed in the D03A vault. The temporary WISH station continues to operate with a Guralp CMG40T broadband seismometer. The USArray equipment will be removed after the completion of the 18-24 month deployment at which point the rest of the original CREST RWW station will be installed permanently at this site. The USArray installation was headed by Robert Busby of IRIS and assisted by Lynn Simmons, PNSN and Mike Flannigan. Wishkah Valley School provided a great deal of support, in particular, staff members Don Hay and Craig Gallington. The event was covered by both Seattle TV news KING5 reporter Glen Farley and Grays Harbor “The Daily World” writer Paula Horton.

Use of PNSN Data

The IRIS Data Management Center reports 414 requests for PNSN trace data this quarter. More than 367,000 traces were requested.

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
ALKI	08/02/04-End	No timing; needs GPS
ALST	06/02/04-07/30/04	Bad GPS antenna
BEVT	06/07/04-07/01/04	No communications
BHW	03/14/04-End	Very noisy
BRO	02/04/03-07/01/04	Dead; changed seismometer
BSFP	07/08/04	Installed
BSFP	07/08/04-08/16/04	No communications
BULL	05/21/04-End	Intermittent
EDM	08/12/04	Replaced seismometer & VCO
EGRN	07/26/04-08/27/04	Intermittent
ERW	06/17/04-07/30/04	No communications
EYES	06/26/04-End	No communications, possible firewall issue
GHW	07/20/04-08/05/04	Dead
GNW	07/28/04-08/28/04	Very noisy
GPW	03/16/04-End	Dead
GRCC	09/21/04	Installed
GTWN	08/19/04	Installed
IRO	05/28/04-07/15/04	Dead; water in VCO
JCW	09/16/04-End	Dead; construction at site
JORV	08/18/04-09/26/04	Dead; broken K2
SSS1	09/27/04	Installed
SSS22	09/27/04	Installed
KEEL	08/18/04-End	No communications
KICC	09/13/04-09/28/04	No communications; replaced MSS
KNEL	08/12/04	Installed; replaced KNJH
KNEL	08/12/04-End	No communications; firewall config.
KNJH	07/07/04-End	Removed due to bldg being demolished
LTY	08/16/04-End	Dead horizontal components
MBKE	07/20/04-08/04/04	No communications; firewall issues
MCW	08/31/04-End	Dead
MEGW	04/01/03-08/02/04	Bad timing

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
MPL	01/01/04-08/19/04	Bad timing; removed for repair 4/16/04
NLO	08/20/04-End	Dead; aircells died
OBH	01/31/02-End	Temp. removed for logging
OOW	12/21/03-08/03/04	Off at night, okay during daytime
OSD	12/21/03-08/03/04	Intermittent because of OOW
OSR	01/06/04-End	VCO may be off-frequency
PGO	09/21/03-07/09/04	Dead; station was rebuilt
PGW	10/08/03-End	Dead
PSNS	04/23/04-09/13/04	No comm.; removed for repair 6/30/04
PSNS	09/13/04-End	Bad timing; needs GPS
RCM	01/27/04-09/03/04	Dead; new antenna cable & antenna
RCM	09/08/04-09/11/04	Dead; rangers stopped station due to interference
RCS	06/22/04-08/11/04	Dead
RVC	12/05/03-End	Noisy
SBES	06/30/04-08/20/04	No communications
SEA.HH?	12/05/03-End	Disconnected for renovation
SEAS	07/09/04-09/10/04	Intermittent; K2 resetting itself
SGAR	08/09/04-End	Removed
SMW	06/20/03-End	Intermittent
SOPS	08/27/02-End	K2 flash problem
SP2	04/23/04-End	No telemetry
SSO	08/28/04-End	Intermittent
SWES	08/09/04-End	Removed
TAKO	07/01/03-08/10/04	Bad timing
TBPA	09/01/04-End	Intermittent; bad N component
TRW	07/14/02-08/11/04	Fire damage repaired, not seismic
WIFE	09/14/04	Installed
WPW	05/02/04-End	Intermittent
YEL	08/28/04	Replaced seismometer

EARTHQUAKE DATA - 2004-C

There were 2,077 events digitally recorded and processed at the University of Washington between July 1 and September 30, 2004. Locations in Washington, Oregon, or southernmost British Columbia were determined for 1,433 of these events; 1,321 were classified as earthquakes and 112 as known or suspected blasts. The remaining 644 processed events include teleseisms (155 events), regional events outside the PNSN (104), and unlocated events within the PNSN. During this quarter, an eruption at Mount St. Helens began with vigorous seismic activity on September 23 that quickly overwhelmed our processing capabilities. Only a representative sample of Mount St. Helens seismicity was located. Other unlocated events within the PNSN normally include surficial events on Mt. St. Helens and Mt. Rainier, very small earthquakes, and blasts. Frequent mining blasts occur near Centralia, Washington and we routinely locate them.

Table 2 lists earthquakes reported to have been felt during this quarter. Events with ShakeMaps or Community Internet Intensity Maps (CIIM) are indicated. This quarter, five events generated ShakeMaps. ShakeMap (**http://www.pnsn.org/shake/index.html**) shows a map of instrumentally measured shaking using data from accelerometers in the network. Peak ground acceleration (PGA) values on the map are modeled from recorded accelerometer data, known local geology, and distance to the epicenter. Another data product "CIIM" maps (**http://pasadena.wr.usgs.gov/shake/pnw/**) convert "felt" reports sent by the general public (via Internet) into numeric intensity values. The CIIM map shows the average intensity by zip code.

Table 3 is this quarter's catalog of earthquakes M 2.0 or greater, located within the network - between 42-49.5 degrees north latitude and 117-125.3 degrees west longitude.

Figure 1. Earthquakes with magnitude greater than or equal to 0.0 (M_c >=0).

Figure 2. Blasts and probable blasts (M_c >=0).

Figure 3a. Seismographs located near Mt. St. Helens.

Figure 3b. Earthquakes located near Mt. St. Helens (M_c >=0).

Figure 4. Earthquakes located near Mt. Rainier (M_c >=0).

TABLE 2 - Felt Earthquakes during the 3rd Quarter of 2004

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	CIIM	Shake Map
yy/mm/dd hh:mm:ss	deg.	deg.	km				
04/07/05 05:42:09	42.06	120.23	8.7	3.2	16.7 km SSE of Lakeview, OR		
04/07/12 16:45:00	44.33	124.48	29.2	4.9	48.4 km SW of Newport, OR	✔	✔
04/07/22 20:26:26	42.09	120.24	1.1	4.3	14.3 km SE of Lakeview, OR	✔	
04/07/26 06:40:46	47.17	123.83	12.4	3.5	22.7 km N of Aberdeen, WA	✔	✔
04/08/16 21:05:53	46.67	121.47	0.3	4.0	17.5 km N of Goat Rocks, WA	✔	✔
04/08/19 06:06:03	44.66	124.30	27.9	4.7	19.9 km W of Newport, OR	✔	✔
04/08/21 19:43:33	47.15	123.89	15.5	3.2	21.1 km NNW of Aberdeen, WA		✔
04/08/31 16:58:00	46.72	121.88	7.4	2.2	17.2 km SW of Mt Rainier, WA		
04/09/24 07:10:04	48.15	123.05	7.2	3.1	28.9 km E of Port Angeles, WA	✔	

OREGON

During the third quarter of 2004, a total of 164 earthquakes were located in Oregon between 42.0 degrees and 45.5 degrees north latitude, and between 117 degrees and 125 degrees west longitude. The most notable earthquakes in Oregon were two felt earthquakes, M 4.9 and 4.7, in distinctly different but close-together locations offshore of Newport Oregon. There were four felt earthquakes in Oregon this quarter; the two near Newport, and two others as part of an earthquake swarm that began last quarter near Lakeview. Nine small earthquakes were recorded in the Mount Hood area, and 3 in the vicinity of Three Sisters.

Newport, Oregon Offshore Earthquakes: Two felt earthquakes larger than magnitude 4.0 in distinctly different but close-together locations occurred offshore of Newport Oregon.

The first Newport earthquake, a M 4.9 event on July 12, occurred about 50 km SW of Newport. It was preceded by a magnitude 2.9 foreshock about 4 minutes earlier, and followed by 11 aftershocks in the magnitude 1.5-3.3 range occurring over the next month. Earlier small (most smaller than magnitude 2.9) events nearby included one or two events per year in 2004, 2003, and 2001, and 1994, and three events in 1996.

The second Newport earthquake, M 4.7 on August 19, occurred 25 km west of Newport and was followed by three aftershocks in the M 2.0-2.5 range. Earlier small (none larger than magnitude 2.9) events nearby included 3 earlier in 2004, 3 in 2003, and one or two events in 2000, 1998, 1996, 1995 and three in 1992 (this may be a spatially distinct group).

Both Newport mainshocks were located deeper than 25 km, and this estimate appears to be robust and in agreement with depths estimated independently by Doug Dreger and David Dolenc of U.C. Berkeley using moment-tensor inversion. The Berkeley group used Green's functions derived from California earthquakes, and the velocity model used by the PNSN is inaccurate in this region. Therefore, there is almost certainly some error in both PNSN and Berkeley depth determinations. The crustal structure in the area of these earthquakes is fairly well studied, lying close to where line P8 of ocean-bottom seismometers were deployed in 1996 during a wide-angle refraction and reflection experiment (Gerdon, M., Trehu, A.M., Flueh, E.R., and D. Klaeschen, 2000, *The continental margin off Oregon from seismic investigations*, Tectonophysics 329, pp. 79-97. The source area of the earthquakes appears to be within or just beneath the subducting oceanic plate. Gerdon et al. (2000) place the top of the subducting plate at around 20 km in this area, and the bottom at somewhere around 25 km.

The July 12 event had a strike-slip focal mechanism, with planes striking N81E and N9W The Aug. 19 event had a thrust mechanism, with best-fit fault planes striking N28E or N 24W. Both mechanisms were determined by Dreger & Dolenc at U.C. Berkeley using moment tensor inversion and agree with PNSN first-motion focal mechanisms. Given the depths of the events, which appear to place them below the subduction interface, the hazard implications of the Aug. 19 thrust focal mechanism are unclear.

Jordan Valley, Oregon Swarm: An earthquake swarm active last quarter of Jordan Valley (close to 117 degrees W, 43 degrees N; on the Oregon-Idaho Border about 100 km south-southwest of Boise, Idaho) quieted down this quarter. Only one small earthquake was recorded (in August) by the Southwest Idaho seismic network, operated by Jim Zollweg of Boise State

University. The UW net did not trigger on it, and neither of the 2 UW stations installed in eastern Oregon at the end of last quarter was operating properly at the time.

Lakeview, Oregon Swarm: The swarm near Lakeview, near the California Border, may have begun as early as June 4, when a magnitude 2.5 earthquake was located, apparently about 20 km north of the main cluster. However, it was not noticed until many events began occurring on June 25. During the last week of June, over thirty earthquakes, three of them magnitude 3.0 or larger, were located between 41.6-42.4 N latitude and 120.0-120.7 W longitude, including a magnitude 4.4 earthquake felt earthquake on June 30. This quarter, 109 earthquakes were located in the swarm area, including 5 magnitude 3.0 or larger. The largest event was a felt event on July 22, magnitude 4.3 at a depth of about 1 km. Swarm activity decreased through August and September.

Lakeview is a town of about 2,500 residents, and has unreinforced masonry buildings in an area where seismicity is historically infrequent. Few seismic stations are nearby, and the area is between the Pacific Northwest and California networks. Therefore, the PNSN and California Integrated Seismic Network **(http://www.cisn.org/)** are exchanging data for these events. Each organization analyzes the earthquakes independently. Based on Berkeley moment tensor solutions, the USGS assigned Mw 4.7 to the June 30 main shock and Mw 4.6 to the July 22 event. Both caused minor structural damage at Lakeview. These earthquakes and a Mw 4.1 event 6/27/04 all had normal faulting solutions consistent with motion on fault planes parallel to the Goose Lake Fault, which is the western boundary fault of the Warner Mountains. Additional information can be found in special web PNSN pages:
http://www.pnsn.org/NEWS/PRESS_RELEASES/LAKEVIEW_2004.html

Three 3-component broadband digital seismographs were deployed 17-18 July by the Southwest Idaho seismic network, operated by Jim Zollweg of Boise State University. At least one continues in operation, but all will be removed in early November. Three MEQ-800s were operated by BSU 15-19 July and four were operated 5-7 August. At least 15,000 events were recorded in the first three weeks of operation, with event rates as high as 2,000 per day. The data is being analyzed at BSU. Analysis is very incomplete, but preliminary results confirm that most of the events are beneath the Warner Mountains at depths of 4-8 km. Locations from the PNSN, without data from the temporary array, are usually biased 2-3 km to the SSE. Better location estimates for the entire swarm will result when the data from the temporary stations are used to establish station corrections for the stations recorded at UW.

WESTERN WASHINGTON SEISMICITY

During the second quarter of 2004, 1,052 earthquakes were located between 45.5 degrees and 49.5 degrees north latitude and between 121.0 degrees and 125.3 degrees west longitude. Five earthquakes were felt this quarter in western Washington. Details are in Table 2.

The largest felt earthquake in western Washington was a magnitude 4.0 event on July 18 (UTC), located about 57 km north of Goat Rocks at a very shallow depth (less than 1 km). It was followed by half-a-dozen small aftershocks (none larger than magnitude 2.2) over the next week or so. The deepest earthquake in western Washington this quarter was a magnitude 1.3 event at 90 km depth located about 15 km southeast of Bend, WA on August 4 (UTC).

From July 9-24,, an “Episodic Tremor and Slip” (ETS) event was recorded in north-western Washington and southwestern British Columbia. Three small research arrays that the UW’s Steve Malone and Wendy McCausland had deployed in northwestern Washington and on Vancouver Island in anticipation of this tremor recorded the event and then were removed in late July and early August. Additional info is available at:
http://www.pnsn.org/NEWS/PRESS_RELEASES/TREMOR.html

WASHINGTON CASCADE VOLCANOES

Mount St. Helens

Mount St. Helens began an eruptive episode with a vigorous sequence of seismic activity starting on September 23. Activity accelerated through the end of the quarter, culminating in early October in several phreatic explosions and half-hour to hour-long periods of harmonic tremor. The tremor and explosions interrupted and temporarily calmed extremely high rates of magnitude 3+ seismicity. Because of the high rates of seismicity, only a representative sample (less than 10%) of Mount St. Helens events was located. Figure 3a shows seismograph stations operating in September and early October. Station SEP on the old dome was destroyed in the Oct. 1 eruption. An accelerometer, BLIS, was installed on the newly uplifting area just south of the old dome in early October to provide data from the crater. Figure 3b shows located volcano-tectonic earthquakes near Mount St. Helens. Low frequency (L) and avalanche or rockfall events (S) are not shown.

This quarter, 780 earthquakes (the catalog is NOT COMPLETE and Mount St. Helens earthquakes on and after September 23 are NOT listed in Table 3) were located at Mount St. Helens in the area shown in Fig. 5. All well-located earthquakes were at depths of 1.5 km or less, and tightly clustered within the crater. Of the located earthquakes this quarter, 493 were magnitude 0.0 or larger and 14 were deeper than 4 km. Multiple volcano tectonic earthquakes of magnitude 3.0 and larger were occurring by September 30 at Mount St. Helens. Thirty-six type "S" or "L" events were located at Mount St. Helens this quarter, and an additional 310 "L" or "S" events too small to locate were recorded.

Because the eruption began at the very end of the third quarter and continued into October, a more complete analysis of sequence will be provided in the next quarterly report.

Mount Rainier

The number of events in close proximity to the cone of Mt. Rainier varies over the course of the year, since the source of much of the shallow activity is presumably ice movement or avalanching at the surface, which is seasonal in nature. Events with very low frequency signals (1-3 Hz) believed to be icequakes are assigned type "L" in the catalog. Emergent, very long duration signals, probably due to rockfalls or avalanches, are assigned type "S" (see Key to Earthquake Catalog). No events flagged "L" or "S" were located at Mount Rainier this quarter although 70 "L" or "S" events were recorded, but were too small to locate reliably. Type L and S events are not shown in Fig. 4.

A total of 51 tectonic events (20 of these were smaller than magnitude 0.0, and thus are not shown in Fig. 4) were located within the region shown in Fig. 4. The largest tectonic earthquake located near Mt. Rainier this quarter was on August 31; a magnitude 2.2 event at a depth of about 7 km located about 17 km southwest of the summit. This quarter, 29 tectonic earthquakes were located in the "Western Rainier Seismic Zone" (WRSZ), a north-south trending lineation of seismicity approximately 15 km west of the summit of Mt. Rainier (for counting purposes, the western zone is defined as 46.6-47.0 degrees north latitude and 121.83-122 west longitude). Within 5 km of the summit, there were 12 (7 of them smaller than magnitude 0.0 and thus not shown in Fig. 4) higher-frequency tectonic-style earthquakes, and the remaining events were scattered around the cone of Rainier as shown in Fig. 4.

EASTERN WASHINGTON SEISMICITY

During the second quarter of 2004, 91 earthquakes were located in eastern Washington in the area between 45.5 - 49.5 degrees north latitude and 117 - 121 degrees west longitude. The largest earthquake recorded in eastern Washington this quarter was a magnitude 2.9 event on August 28th. It occurred at a near-surface depth and was located about 31 km west-northwest of Okanogan.

OTHER SOURCES OF EARTHQUAKE INFORMATION

We provide automatic computer-generated alert messages about significant Washington and Oregon earthquakes by e-mail, FAX or via the pager-based RACE system to institutions needing such information, and we regularly exchange phase data via e-mail with other regional seismograph network operators.

Other regional agencies provide earthquake information. These include the Geological Survey of Canada (Pacific Geoscience Centre), Sidney, B.C. **http://www.pgc.nrcan.gc.ca/seismo/table.htm** ; and other regional networks in the United States **http://earthquake.usgs.gov/regional/** The US Geological Survey coordinates earthquake information nationally; **http://earthquake.usgs.gov**.

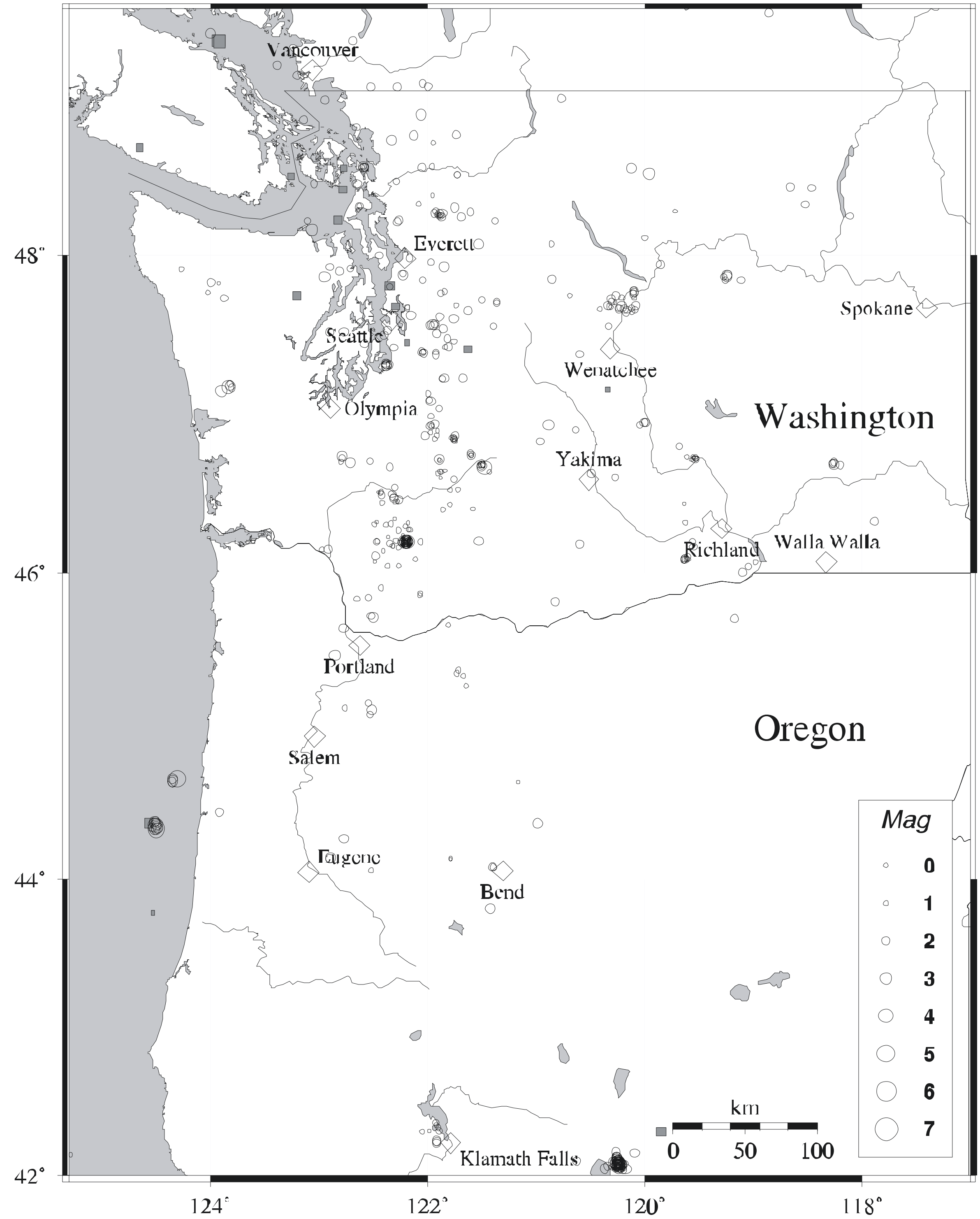

Figure 1 Earthquakes with magnitude greater than or equal to 0.0 (Mc>=0.0). Unfilled diamonds represent cities. Quakes shallower than 30 km are indicated by circles, and deeper quakes by filled squares.

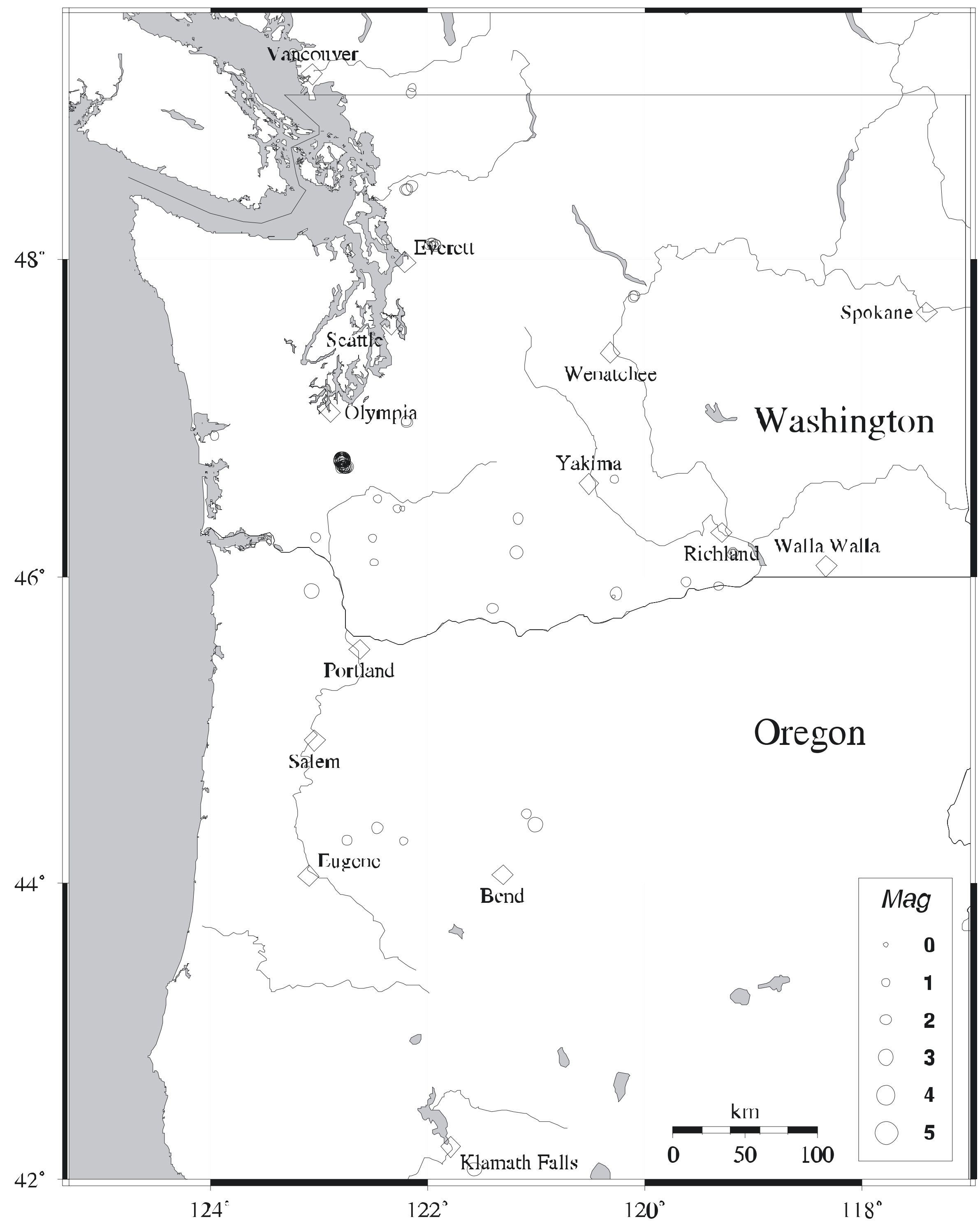

Figure 2. Blasts and probable blasts. Unfilled diamonds represent cities.

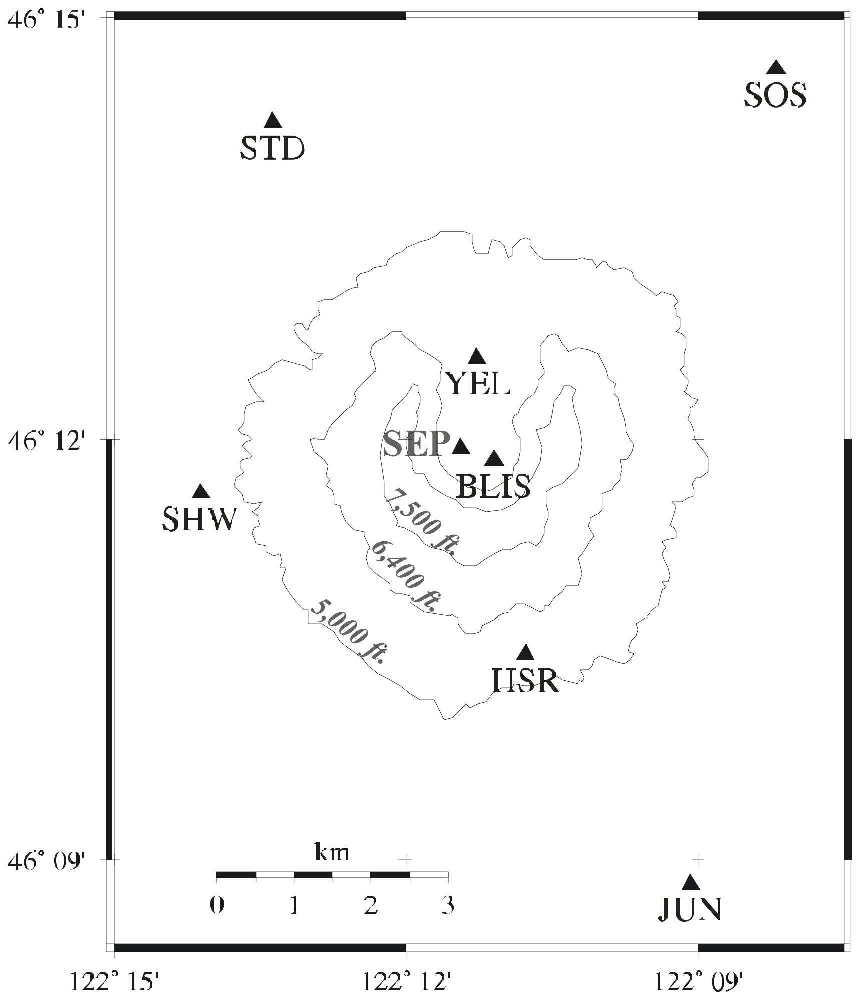

Figure 3 a Seismograph stations near Mt. St. Helens,

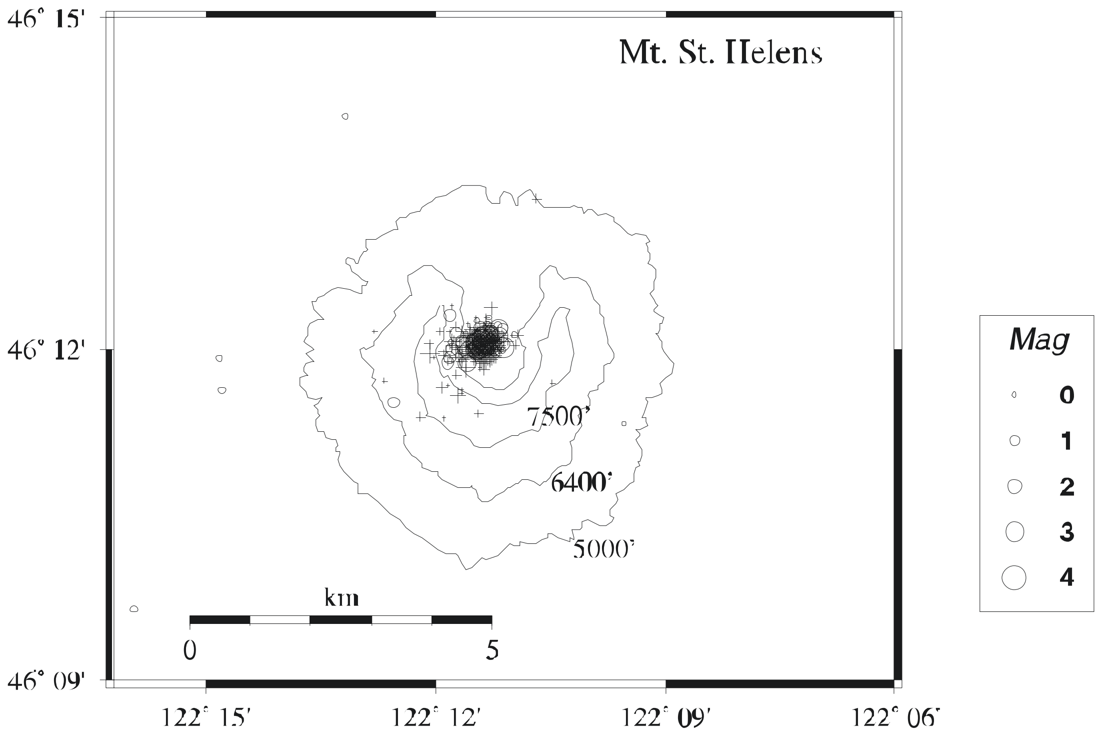

Figure 3 b Earthquakes at Mt. St. Helens, M>0.0.

Plus' symbols indicate depth less than 1 km. Circles indicate depth greater than 1 km. Elevation contours shown in feet

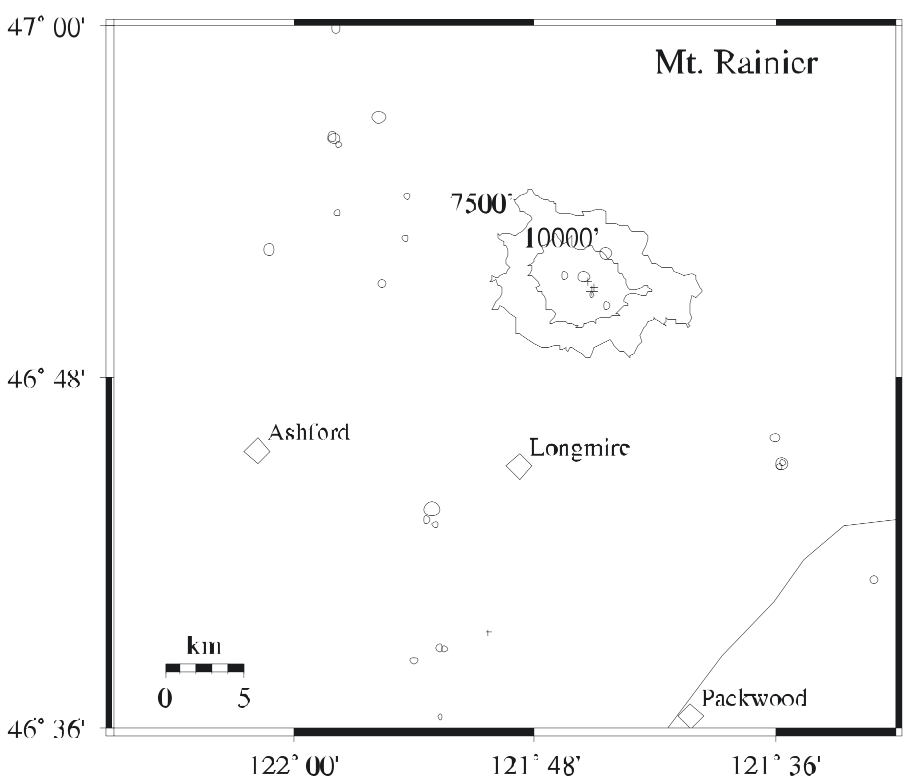

Figure 4. Earthquakes at Mt. Rainier, M>0.0.

EARTHQUAKE CATALOG, 2004-C

Complete catalog listings are available on-line through **http://www.pnsn.org/CATDAT/catalog.html** Key to earthquake catalog can be found in the last quarterly report of each year, or at:
http://www.pnsn.org/INFO_GENERAL/PNSN_QUARTERLY_EQ_CATALOG_KEY.htm

TABLE 3: EARTHQUAKE CATALOG, 2004-C
Within the area 42-49.5 degrees north latitude and 117-125.3 degrees west longitude

Jul-04											
DAY	**TIME**	**LAT**	**LON**	**DEPTH**	**M**	**NS/NP**	**GAP**	**RMS**	**Q**	**MOD**	**TYP**
2	02:32.6	42 04.08	120 14.70	7.51	2.8	13/014	121	0.53	DC	K3	
2	02:03.0	42 04.90	120 14.66	4.88	2.1	15/016	120	0.30	CC	K3	
2	16:15.1	42 05.80	120 14.32	4.89$	2.0	10/012	149	0.27	BC	K3	
3	31:13.0	47 36.37	121 45.11	14.36	2.1	25/025	93	0.18	BB	P3	
4	25:28.9	42 04.54	120 14.96	2.47	2.2	12/013	119	0.20	BC	K3	
4	45:07.8	42 05.24	120 15.09	11.27$	2.0	12/013	149	0.55	DC	K3	
4	15:17.2	42 17.99	119 50.67	40.31	2.0	8/008	308	0.73	DD	K3	
4	57:39.7	42 05.38	120 15.35	5.02$	2.1	10/011	149	0.40	CC	K3	
5	17:36.3	42 05.47	120 14.59	4.20$	2.2	11/012	149	0.19	BC	K3	
5	42:09.6	42 03.99	120 14.10	8.70	3.2	18/018	124	0.77	DC	K3	F
6	01:22.9	42 03.41	120 13.23	14.41*	2.6	16/017	129	0.46	CB	K3	
6	47:03.0	42 03.99	120 14.34	8.25	2.4	14/017	123	0.47	CC	K3	
7	10:43.6	42 05.77	120 13.62	6.18*	2.0	8/009	149	0.11	AC	K3	
7	10:38.8	42 04.66	120 16.10	1.62	2.8	14/015	114	0.50	DC	K3	
9	27:18.8	42 03.54	120 14.19	11.13	2.7	12/013	125	0.56	DB	K3	
10	34:56.8	47 55.83	121 50.90	15.90	2.2	29/030	73	0.26	BA	P3	
12	41:18.9	44 20.69	124 29.33	29.55$	2.9	14/014	247	0.24	BD	O0	
12	45:00.8	44 20.02	124 29.32	29.20	4.9	22/022	247	0.24	BD	O0	F
13	26:31.2	44 22.00	124 29.32	28.20$	2.7	12/013	273	0.29	CD	O0	
13	56:11.6	44 21.58	124 30.56	29.43	3.3	18/018	214	0.44	CD	O0	
13	54:34.6	42 04.90	120 14.81	4.25	3.3	13/014	119	0.18	BC	K3	
13	00:37.2	44 22.84	124 30.49	26.21	2.2	7/008	302	0.18	BD	O0	
13	23:04.2	42 04.77	120 14.79	1.65*	2.1	9/010	139	0.19	BC	K3	
13	43:29.8	42 03.73	120 14.12	10.88	2.2	11/012	147	0.21	BC	K3	
14	44:04.8	48 26.26	122 38.95	22.76	2.1	22/022	58	0.32	CA	P3	
14	44:38.2	44 19.83	124 30.39	0.03*	2.3	11/011	272	0.41	CD	O0	
15	58:43.2	42 05.35	120 14.37	11.64	2.0	6/006	155	0.07	AD	K3	
19	14:24.5	44 22.22	124 30.09	26.35	2.8	13/014	289	0.27	BD	O0	
19	32:39.2	47 52.83	122 13.43	24.10	2.2	26/029	51	0.15	BA	P3	
19	47:19.9	42 04.31	120 14.32	0.02*	2.0	8/008	141	0.28	BD	K3	
19	39:45.9	42 04.25	120 15.15	0.02*	2.6	10/010	140	0.24	BD	K3	
20	36:35.5	42 04.92	120 15.15	1.77	2.5	11/011	139	0.26	CD	K3	
20	58:48.4	44 20.28	124 29.55	23.70	2.5	12/013	271	0.25	BD	O0	
21	31:21.9	42 04.27	120 14.38	6.47	2.8	14/014	122	0.22	BC	K3	
22	01:07.5	42 05.58	120 14.77	2.19$	2.1	10/010	140	0.30	DD	K3	
22	55:13.3	42 04.50	120 14.62	2.43$	2.1	12/012	140	0.35	DD	K3	
22	40:10.8	42 04.74	120 14.27	6.17	3.1	18/018	121	0.24	BC	K3	
22	47:38.3	42 05.24	120 13.99	5.23	2.2	10/010	140	0.29	BD	K3	
22	21:51.8	42 04.86	120 13.37	1.39$	2.2	10/010	140	0.34	DD	K3	
22	15:47.2	42 05.67	120 14.77	0.04*	2.0	9/009	140	0.20	BD	K3	
22	26:27.0	42 05.43	120 14.40	1.10	4.3	15/015	120	0.13	AC	K3	F
22	34:35.0	42 07.21	120 15.72	1.71	2.2	10/010	142	0.22	BD	K3	
22	40:26.0	42 06.73	120 15.74	22.97	2.4	9/009	158	0.25	CD	K3	
22	42:49.7	42 06.15	120 14.32	1.29$	2.2	12/012	140	0.31	CD	K3	
22	03:27.6	42 09.58	120 15.82	19.42	2.1	5/005	162	0.42	CD	K3	

TABLE 3: EARTHQUAKE CATALOG, 2004-C
Within the area 42-49.5 degrees north latitude and 117-125.3 degrees west longitude

22	16:46.8	42 05.93	120 13.95	10.14	2.0	10/010	150	0.11	AD	K3	
22	18:13.4	42 05.99	120 15.16	5.75	2.2	10/011	140	0.21	BD	K3	
23	01:39.6	42 06.12	120 15.31	1.86*	2.0	9/010	140	0.24	BD	K3	
23	25:49.4	42 07.12	120 15.46	17.63	2.5	13/014	142	0.34	CD	K3	
23	46:14.4	42 07.19	120 15.37	4.49$	2.6	12/012	142	0.27	CD	K3	
23	43:57.8	42 04.86	120 14.92	6.19	2.7	14/015	140	0.61	DD	K3	
23	06:26.9	42 05.93	120 14.72	5.30	2.9	14/016	117	0.26	BC	K3	
24	35:43.7	42 05.54	120 14.64	8.43	2.1	12/013	118	0.22	BC	K3	
24	08:38.4	42 04.31	120 14.77	11.66$	2.2	14/015	120	0.43	CB	K3	
25	34:44.3	42 05.85	120 13.79	4.37*	2.1	13/014	140	0.26	BC	K3	
26	56:05.7	47 18.99	122 22.38	24.23	2.0	36/037	67	0.09	AA	P3	
26	40:46.8	47 10.78	123 50.00	12.42	3.5	42/042	160	0.33	CC	P3	F
26	22:19.8	47 11.25	123 48.99	0.02*	2.2	18/018	156	0.20	BC	P3	
27	28:03.9	47 31.49	122 45.80	10.77	2.0	9/012	139	0.24	BC	P3	
27	35:18.6	44 08.49	122 53.37	5.98	2.3	21/023	78	0.25	BC	O0	
27	28:26.7	44 20.73	124 28.87	25.36	2.3	16/017	271	0.26	BD	O0	
28	24:39.2	47 18.67	122 22.66	26.58	2.1	57/059	35	0.17	BA	P3	
28	10:04.7	42 05.89	120 15.26	0.99$	2.1	10/011	140	0.29	DC	K3	
30	56:16.4	42 04.21	120 14.72	5.10	2.3	12/013	138	0.25	BC	K3	
31	53:56.6	42 04.47	120 14.25	1.45	2.2	8/009	154	0.11	AC	K3	
Aug-04											
DAY	**TIME**	**LAT**	**LON**	**DEPTH**	**M**	**NS/NP**	**GAP**	**RMS**	**Q**	**MOD**	**TYP**
2	27:31.7	42 03.70	120 15.86	0.03*	2.0	8/009	255	0.21	BD	K3	
3	22:53.0	49 18.50	123 54.93	69.85	3.1	24/027	257	0.32	CD	P3	
3	32:44.2	49 18.08	123 54.79	71.43	3.0	26/026	257	0.37	CD	P3	
4	40:41.8	47 51.92	122 56.54	16.03#	2.5	35/038	65	0.33	CA	P3	
5	18:00.9	49 20.86	123 59.69	23.84	2.2	14/014	262	0.41	CD	P3	
6	44:46.6	42 04.67	120 14.89	1.82#	2.1	11/012	139	0.23	BC	K3	
9	23:50.0	47 34.02	121 56.41	1.13*	2.0	33/038	41	0.17	BB	P3	
9	33:57.4	47 34.14	121 56.85	2.37	2.3	42/047	41	0.28	BB	P3	
11	28:16.4	47 52.57	119 14.29	0.35*	2.0	15/016	163	0.17	BC	N3	
11	50:34.5	42 04.74	120 14.34	3.61	2.1	11/012	139	0.17	BC	K3	
12	16:27.2	48 04.06	121 31.78	4.10	2.3	35/038	88	0.48	CC	C3	
14	04:58.4	47 52.05	119 14.37	0.04*	2.3	12/013	161	0.13	AC	N3	
15	01:51.1	42 05.87	120 14.96	1.55$	2.2	13/014	140	0.25	DC	K3	
15	09:10.3	42 04.63	120 15.24	2.11*	2.1	8/009	257	0.28	BD	K3	
16	05:53.8	46 40.36	121 28.34	0.27*	4.0	98/098	37	0.40	CB	C3	F
17	22:32.2	47 37.80	122 08.99	24.15	2.0	24/026	64	0.14	AA	P3	
17	25:42.1	42 02.66	120 10.29	7.84	2.3	8/009	151	0.27	BC	K3	
17	28:24.2	45 28.14	122 50.78	26.27	2.6	49/049	41	0.26	BA	O0	
18	36:52.6	46 41.52	118 15.49	9.53$	2.4	29/034	205	0.36	CD	E3	
19	06:03.6	44 39.87	124 18.01	27.92	4.7	22/028	212	0.30	BD	O0	F
19	26:00.5	44 38.77	124 20.79	24.55	2.0	11/011	267	0.40	CD	O0	
19	54:10.9	44 39.10	124 20.44	24.93	2.5	13/013	267	0.22	BD	O0	
20	29:19.5	47 48.53	122 20.86	31.14	2.1	26/029	43	0.47	CA	P3	
21	43:33.6	47 09.44	123 53.62	15.50	3.2	28/028	157	0.75	DC	P3	F
22	27:52.9	42 03.98	120 13.65	5.94	2.0	10/011	138	0.20	BC	K3	
23	04:44.6	44 40.09	124 20.69	23.61	2.3	9/009	267	0.27	CD	O0	
23	50:12.1	48 32.69	122 35.02	14.97	2.4	32/034	77	0.32	CB	P3	
23	27:06.9	48 32.25	122 35.07	17.78*	2.0	23/024	75	0.29	BB	P3	
23	02:42.3	46 41.17	121 29.94	7.61	2.2	39/042	64	0.24	BA	C3	
28	38:16.8	42 04.70	120 15.66	1.38	2.3	13/014	116	0.25	BC	K3	

TABLE 3: EARTHQUAKE CATALOG, 2004-C
Within the area 42-49.5 degrees north latitude and 117-125.3 degrees west longitude

28	36:04.7	47 19.27	122 22.40	27.74	2.0	42/046	67	0.21	BA	P3	
28	15:18.8	48 30.01	119 57.20	0.03*	2.9	20/020	103	0.30	CD	N3	
28	19:46.8	42 05.73	120 14.59	1.30	2.1	11/012	149	0.23	BC	K3	
31	58:00.7	46 43.50	121 53.11	7.43	2.2	44/050	35	0.12	AA	C3	F
Sep-04											
DAY	**TIME**	**LAT**	**LON**	**DEPTH**	**M**	**NS/NP**	**GAP**	**RMS**	**Q**	**MOD**	**TYP**
1	12:31.5	42 03.21	120 13.40	12.37$	2.0	12/013	137	0.55	DC	K3	
2	46:23.2	42 04.66	120 13.22	11.87$	3.0	15/016	148	0.41	CC	K3	
3	50:39.1	47 14.04	121 50.40	15.23	2.0	37/045	78	0.15	AA	P3	
4	50:45.6	42 03.25	120 14.25	11.91$	2.6	17/018	125	0.51	DB	K3	
6	33:45.6	42 05.05	120 15.40	1.84$	2.2	11/012	139	0.30	CC	K3	
10	06:07.1	48 51.61	122 03.30	0.35	2.2	14/016	137	0.39	CC	P3	
12	42:57.0	45 38.67	122 46.08	20.24	2.1	36/040	63	0.14	AB	C3	
16	45:55.6	42 04.54	120 15.03	1.27	2.2	14/018	119	0.23	BC	K3	
17	30:03.4	46 56.48	120 52.86	4.82*	2.3	33/034	54	0.27	BC	C3	
17	40:37.1	47 40.99	120 12.58	3.89	2.4	17/019	56	0.31	CC	N3	
18	05:54.3	42 04.17	120 14.57	7.88*	2.4	15/017	138	0.22	BC	K3	
20	51:00.1	45 43.14	122 29.89	15.46	2.4	41/043	62	0.14	AA	C3	
20	20:44.3	45 06.77	122 30.43	0.04*	2.2	18/018	99	0.22	BC	O0	
22	30:56.8	42 03.69	120 14.30	10.31	2.1	13/016	138	0.33	CC	K3	
23	06:15.3	46 42.29	122 42.32	0.02*	2.2	8/010	85	0.29	BA	P3	
24	10:04.2	48 09.39	123 03.58	7.23*	3.1	40/040	126	0.46	CB	P3	F
28	32:43.3	46 44.75	122 46.88	0.03*	2.6	32/032	84	0.16	BC	P3	

OUTREACH ACTIVITIES

The PNSN staff and faculty participate in an educational outreach program designed to better inform the public, educators, businesses, policy makers, government agencies, engineers, and the emergency management community about earthquake and related hazards. Our program offers lectures, classes, lab tours, workshops, and consultations and electronic and printed information products. Special attention is paid to the information needs of the media. We provide information directly to the public through information sheets, an audio library, email, and via the Internet at http://www.pnsn.org.

Audio Library, Phone

With the onset of Mt. St. Helens activity the Seismology Lab was flooded with hundreds of calls. UW Computing and Communications donated a bank of 6 digital telephones and a nearby conference room was converted to a call center. Student staff and graduate students assisted PNSN Staff with answering phones and replying to messages. The Seismology Lab responded to ~75 calls from the general public, ~25 calls from Emergency Managers and government agencies, and over 150 calls from the Media. In addition, the PNSN audio library system received 300 calls this quarter. The audio library provides several recordings. We have resumed regular updating of the audio library message concerning current seismic activity, and there are also recordings describing seismic hazards in Washington and Oregon and earthquake prediction. Callers to the audio library have the option of being transferred to the Seismology Lab for additional available information.

Internet outreach:

www.pnsn.org

As earthquake activity at Mt. St. Helens took a sudden upswing on Sept.23,we immediately initiated a page to archive webicorder and spectrograph records for the sequence, and a special "press release" page to connect users to CVO, the Forest Service, PNSN Mt. St. Helens seismicity pages, and other useful sites. As our ability to process the data was rapidly overwhelmed, and attention from the public increased, we faced several challenges in disseminating information through our website.

First, our automatic locations for Mount St. Helens earthquakes generally overestimated the magnitude and substantially mis-located many events. Therefore, a decision was made to stop posting automatic locations for Mt. St. Helens events to http://www.pnsn.org/recenteqs/latest.htm, and all preliminary unreviewed locations were removed through the

QDDS system. Secondly, we were unable to keep up with processing the high rate of seismicity. Thirdly, the scripts that normally send processed locations to "recenteqs" pages stopped working because the large volume of Mt. St. Helens data could not be processed in our regular working directories. We placed a disclaimer on the "recenteqs" pages to notify users that Mount St. Helens locations were incomplete, and by the second week of October the distribution scripts were repaired. Unfortunately, this was not quite seamless, and we recieved many inquiries from people who were puzzled by the disappearance of the preliminary events from our web site, or disturbed by the lack of updating to the local and national "recenteqs" sites.

On the afternoon of Sunday September 26, a "Notice of Volcanic Unrest" was issued jointly by the PNSN and the Cascades Volcano Observatory and posted to the U.S.G.S. Earthquake Program webpage. Attention from local and national media was quickly followed by hundreds of thousands of visits from the general public to the PNSN web pages. By Monday Sept. 27th the UW Dept. of Earth and Space Sciences webserver became totally congested. The USGS earthquake program was able to mirror the PNSN/CVO Mt. St. Helens Volcanic Advisories on their Akami-supported website, making that one page widely accessible, and arrangements were made to move the entire PNSN site and the www.pnsn.org domain name to a central, high capacity, University of Washington server.

The move, implemented on September 28 went relatively smoothly, although differences in the server set-ups caused some pages to become dysfunctional. Most of those problems were fixed by early the Sept. 29th and we continued to repair lower-traffic links as additional problems were noticed. The campus server was able to handle the extremely high volumes of traffic that occurred as seismic activity intensified in late September and early October. By Oct 5th the combined total of traffic on the two servers equaled between 25 and 30 million "hits". Several "hits" may be required for some pages to display as each graphic is counted as a separated "hit". The UW Department of Computing and Communications, which facilitated our greatly improved server capacity and network bandwidth, estimates that over 10 million “pages” of information were accessed.

PNSN staff also replied to about 250 e-mail messages from the public seeking information on a variety of topics via the seis_info@ess.washington.edu email address. Questions related to Mt. St. Helens Activity accounted for 125 of these in the last week of September. Routine questions are typically responded to within a day; complex or sensitive questions are routed to the appropriate staff person for a more in-depth response. Requests may include assistance with hazard assessments and legal issues, consultations with government agencies, and support for engineering issues related to strong motion data.

CISN Display servers are receiving PNSN recent earthquake data and now provide links to our ShakeMaps, automatically generated following significant earthquakes. The CISN Display beta version was distributed for testing to select users who provide feedback to PNSN staff. Anticipation of the release of version 1 of the CISN Display is growing in our region and, depending on demand, new servers may be required to augment those in Pasadena and Berkeley to ensure data delivery in 2005. PNSN staff will also face demands for development of additional data layers of interest to clients within Washington and Oregon. This product will first supplement and later replace the CUBE based RACE (Rapid Alert for Cascadia Earthquakes) systems currently deployed.

K-20 Education Outreach

Green River Community College purchased and installed an education-grade vertical component broadband seismograph. See Operations section for details.

PNSN and USGS staff gave 3 Seismology Lab tours and presentations for K-20 students and teachers, serving about 60 students this quarter. The PNSN also maintains an email list-service and distributed monthly newsletters to over 50 local K-20 educators and subscribers interested in earth-sciences education.

Educational Resources Web Page: http://www.pnsn.org/EDHOME/index.html.

Media Relations:

PNSN staff frequently provides interviews, research support, and referrals to radio, television, film, and print media. The PNSN organizes press conferences, contributes to TV and radio news programs and talk shows, and provides field opportunities linking reporters with working scientists. Staff members also assist news organizations, authors, television producers, and independent documentary makers to design accurate and informative stories and programs related to earthquake and volcano hazards. PNSN staff work to link reporters and producers developing stories with the appropriate research institutions, agencies, and scientists working in the areas to be covered by the piece.

The PNSN coordinates the release of information and media relations with the USGS Western Region, the Cascades Volcano Observatory, and the Oregon Department of Geology and Mineral Industries (DOGAMI). Early this quarter the PNSN and DOGAMI responded to requests for information and interviews following the July 22nd felt event of the ongoing Lakeview sequence. DOGAMI serves as a PNSN information Center for Oregon, PNSN staff consults frequently with DOGAMI concerning Oregon earthquake activity and media inquiries are referred to them for additional information.

With the declaration of "Volcanic Unrest" (Alert Level One) at Mount St. Helens on Sunday September 26th, the intense Media interest in the earthquake swarm that began September 23rd escalated dramatically. Graduate students and PNSN staff worked to ramp up our analysis and processing capabilities while providing information to all 5 Seattle-region TV stations, plus radio and print media. PNSN PIO Bill Steele was in St. Louis and analyst Amy Wright was on maternity leave, further reducing staff available to cope with the demand. Steele canceled his engagements and returned on the 28th. The Seismology Lab remained open from early morning to late evening for the next two weeks.

On Sept. 29, after reviewing with CVO scientists the seismic activity that had accelerated significantly overnight, a decision was made to move to Alert Level 2. UW Computing and Communications, who had already rescued our overburdened web servers, responded to the still escalating information demands by providing a phone bank of 5 digital telephone stations, added two new phone lines to our emergency communications system, and installed fiber optic cable into the Seismology Lab for direct fiber links for television media. All this was accomplished in a day without charge to the PNSN.

In the weeks that followed, PNSN faculty, staff, and students held hundreds of interviews with regional, national and international media providers. National news programs served included ABC News Nightline, CNN, MSNBC, Fox News, and NBC Nightly News. Early morning science conferences with CVO were of critical importance for the sharing of data, discussion of interpretations, and development of "talking points" for use in interviews. Despite our geographical separation, USGS Scientists at CVO, National Forest Service personnel at the Joint Information Center near Vancouver and PNSN staff (with assistance from our colleagues in the USGS Seattle Field Office at UW) provided consistent information to the Media.

Bill Steele participated in making a Global Net Productions 30-minute video "Living with Risk" commissioned for the National Earthquake Conference in St. Louis Mo. Locales in the video included the PNSN Seismology Lab and the Boeing Fire and Rescue Dispatch center at Boeing Field. Boeing managers described how they used products such as ShakeMap and the CISN Display.

Meetings, Presentations and Visitors:

This quarter PNSN staff made presentations to the Sammamish Rotary Club, a State Department sponsored group of International Scholars, and for the annual conference of the Evergreen Safety Council, at Seahawks Stadium. TBS Television's Public Affairs Show interviewed Bill Steele on Earthquake Hazards and preparedness for a special 30 minute show. Bill Steele represented Steve Malone at the PNW Region at the ANSS National Implementation Committee Meeting on September 26th and 27th in St. Louis and at the National Earthquake Conference that followed.

QUARTERLY NETWORK REPORT 2004-D

on

Seismicity of Washington and Oregon

October 1 through December 31, 2004

Pacific Northwest Seismograph Network

Dept. of Earth and Space Sciences

Box 351310

University of Washington

Seattle, Washington 98195-1310

This report is prepared as a preliminary description of the seismic activity in Washington State and Oregon. Information contained in this report should be considered preliminary, and not cited for publication without checking directly with network staff. The views and conclusions contained in this document should not be interpreted as necessarily representing the official policies, either express or implied, of the U.S. Government**.**

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TABLE OF CONTENTS

FIGURES

TABLES

APPENDIX 1 – Station Maps and Lists

INTRODUCTION

This is the fourth quarterly report of 2004 from the Pacific Northwest Seismograph Network (PNSN), at the University of Washington Dept. of Earth and Space Sciences, covering seismicity of Washington and western Oregon.

Comprehensive quarterlies have been produced by the PNSN since the beginning of 1984. Prior to that we published quarterly reports for western Washington in 1983 and for eastern Washington from 1975 to 1983. Annual technical reports covering seismicity in Washington since 1969 are available from the U.W. Dept. of Earth and Space Sciences. The complete PNSN earthquake catalog is available on-line, both through our web-site and through the ANSS earthquake catalog. In these reports we provide special coverage (figures, counts, listings, etc.) of earthquake swarms, aftershock sequences, etc.

This quarterly report discusses network operations, seismicity of the region, unusual events or findings, and our educational and outreach activities. This report is preliminary, and subject to revision. The PNSN routinely records signals from selected stations in adjoining networks. This improves our ability to locate earthquakes at the edges of our network. However, our earthquake locations may be revised if new data become available. Findings mentioned in these quarterly reports should not be cited for publication.

Prior to 2004, each quarterly included station tables and maps. Beginning in 2004, station tables and maps will be included only in the 4th quarter report. Lists of currently operating stations are available on-line through web page http://www.pnsn.org/OPS/stations.html.

NETWORK OPERATIONS

Maps and lists of station locations are in Appendix 1 of this report. Lists of currently operating stations are available on-line through web page http://www.pnsn.org/OPS/stations.html. Table 1 gives approximate periods of time when individual stations were inoperable. Data for Table 1 are compiled from weekly plots of network-wide teleseismic arrivals and automated and manual digital and analog signal checks, plus records of maintenance and repair visits.

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
ALKI	08/02/04-11/02/04	Bad timing prior to installation of GPS
BHW	03/14/04-End	Very noisy
BLIS	10/12/05	INSTALLED – Mt. St. Helens
BRKS	12/23/04-End	No communications
BULL	05/21/04-End	Intermittent
BURN	11/23/04-End	Dead
ERW	10/20/04-12/06/04	No communications
ERW	12/13/04-End	No communications
EYES	06/26/04-12/21/04	No communications, swapped sensor
FL2	11/28/04-End	Dead
GL2	10/21/04-End	Dead
GLK	11/26/04-End	Noisy
GPW	03/16/04-End	Dead
HDW	12/28/04-End	Dead
HSR	10/05/04	Gain lowered by 20 db
JBO	10/15/04-End	Noisy
JCW	09/16/04-09/29/04	Dead; construction at site
JRO	10/30/04	INSTALLED – Mt. St. Helens
KEEL	08/18/04-End	No communications
KICC	10/14/04-11/01/04	No communications
KICC	11/10-04-12/07/04	No communications
KNEL	08/12/04-10/18/04	No communications; firewall config.
KNEL	10/19/04-10/28/04	Bad timing; moved GPS
LTY	08/16/04-11/04/04	Dead horizontal components
MBKE	10/15/04-11/17/04	Dead; sensor voltage problem
MBKE	11/18/04-End	K2 removed for repair
MBW	12/07/04-End	Dead; shut down relay site due to radio interference
MCW	08/31/04-10/20/04	Dead because of radio interference

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
MCW	12/07/04-End	Dead. No telemetry because of radio interference
MPL	09/01/04-11/15/04	Removed K2 for repair
MPL	11/16/04-12/06/04	Removed—needed new GPS antenna
NED	11/04/04	INSTALLED – Mt. St. Helens
NLO	08/20/04-End	Dead; aircells died
OBH	01/31/02-End	Temp. removed for logging
OHC	11/24/04-12/07/04	No communications
OSR	01/06/04-11/05/04	VCO may be off-frequency
PAYL	10/21/04-12/06/04	Intermittent communications
PAYL	12/13/04-End	Intermittent communications
PGW	10/08/03-End	Dead
PSNS	09/13/04-10/07/04	Bad timing; needs GPS
RCS	10/25/04-12/05/04	Dead
RCS	12/25/04-End	Noisy
RER	10/20/04-End	Noisy
RMW	12/07/04-End	Dead
RVC	12/05/03-End	Noisy
RVW	10/05/04-11/08/04	Dead
SEA.HH?	12/05/03-End	Disconnected for renovation
SEAS	11/01/04-12/20/04	Dead; replaced K2
SEP	10/1/04	DESTROYED by Mt. St. Helens eruption
SEP	11/04/04	INSTALLED – Mt. St. Helens
SFER	09/01/04-End	Short period dead; needs removal
SFER	10/18/04-11/03/04	No communications
SHIP	11/05/04-End	Removed due to building demolition
SMW	06/20/03-End	Intermittent
SOPS	08/27/02-End	K2 flash problem
SP2	04/23/04-10/13/04	No telemetry
SSS1	9/23/04-End	INSTALLED, communication intermittent
SSS2	10/25/04-End	INSTALLED, communication intermittent
SSO	08/28/04-End	Intermittent
STD	10/21/04	INSTALLED (additional components)
SVOH	12/30/04-End	No communications
TBPA	09/01/04-12/06/04	Bad N component; removed for repair
TDL	11/28/04-End	Dead
TOLO	10/15/04-End	No communications
VGB	09/23/04-End	Intermittent; usually very noisy
WPW	05/02/04-End	Intermittent
YEL	10/22/04	Gain lowered by 12 db

Mt. St. Helens eruption, 2004-2005

Beginning on September 23, 2004 a series of small earthquakes at Mount St. Helens signaled the beginning of the first dome-building eruption at the volcano since 1986. The small earthquakes soon escalated into the most vigorous seismic activity at Mount St. Helens since the catastrophic eruption of 1980. Continuous seismic data from short-period stations near Mt. St. Helens are archived at the PNSN and streamed to the IRIS BUD archive. New procedures were implemented to rapidly handle the large volume of data so the PNSN and Cascade Volcanoes Observatory could assess the significance of the rapidly changing seismicity.

Equipment; gain changes, destruction, replacement, and new installations

Station SEP was destroyed during the ash and steam eruption of Oct. 1. SEP was replaced on Nov. 4 with a six-component station (3 high-gain components and 3 low-gain). New stations BLIS (EHZ and ELZ components installed Oct. 12), NED (EHZ and ELZ components installed Nov. 4),and JRO (3 component broad-band installed Oct. 30) were installed in the crater (BLIS and NED) or in the vicinity of Mt. St. Helens (JRO). Station STD (previously a short period vertical only) had an additional three-component broad-band instrument installed on Oct. 21.

Gain changes were made at stations HSR (turned down 20 dB on Oct. 5), and YEL (turned down 12 db on Oct. 22). The gain changes were made to improve the usefulness of these stations. The volcano signals were nearly continuous and energetic enough to saturate the stations at their initial gains.

24 Hour Volcano Watch and pager alert changes

For most of the quarter, scientists at the PNSN and CVO shared 24-hour volcano watch duties. During the night, scientists would check seismic monitors, webcams and debris flow monitors every 2 hours for unusual activity.

Daytime (7 AM – 11 PM) pager triggering for Mt. St. Helens events had to be desensitized. Normal procedure for daytime pages has been to page for events larger than magnitude 1.8. In late September, daytime pages from Mt. St. Helens began to occur continuously. Therefore, the daytime paging script was modified in early October to page only on Mt. St. Helens events with preliminary magnitudes of 2.0 or greater with 8 or more stations triggering. The daytime paging threshold has been adjusted over the course of the sequence to page on events of higher-than-average magnitude. Alert event pages, normally for earthquakes larger than 2.8, were adjusted to exclude St. Helens events from early Oct. to early November.

Rapid automatic analysis of earthquake data -

Our traditional method of analyzing earthquake data in the Pacific Northwest, i.e. using a triggering algorithm to detect earthquakes and manually processing every earthquake, quickly became unmanageable. To get rapid information on the ongoing sequence, we implemented automatic analysis of selected channels of continuously recorded seismic data. Near-real-time results of these analyses are being updated every 30 minutes at http://www.pnsn.org/WEBICORDER/RMS/

One of the most useful parameters we compute is a Real Time Seismic Amplitude Monitor (RSAM). RSAM is the root mean square (RMS) amplitude of ground motion at a station averaged over a time period. We have found averaging times of 10 minutes and 1 minute to be useful. It is necessary to monitor the RSAM at several stations because the data at close stations may be clipped. The RSAM provides an important parameter to consider in determining the hazard alert level at the volcano. See the "Earthquake Data" section for additional details.

In addition to the RSAM we implemented an event detection algorithm to automatically determine earthquake times from the continuous seismic data. For each earthquake detected we determine the (trigger) time, duration of the signal, maximum amplitude, maximum RMS amplitude, and the frequency of the maximum spectral amplitude. Using this automated procedure, we detected about 500,000 earthquakes during first 110 days of the seismic activity (September 23, 2004- January 11, 2005).

Standard analysis of earthquake data

Beginning in late September, Mount St. Helens began producing thousands of earthquake triggers per day, with each trigger containing numerous earthquakes. Although triggering was mostly due to activity at Mount St. Helens, small earthquakes from elsewhere in the network were also embedded in the same files.

Each triggered event file contained many minutes of data for 500 channels, sampled at 100 samples/sec, and our disk storage quickly began filling, as we had no automated way to sort out the events that were not-at Mount. St. Helens, and thus could not automatically identify unwanted seismic traces. Although the rate of energy release peaked in early October, activity continued at a fairly brisk pace. During the early part of the sequence we focused on providing rapid information on ongoing changes in seismic activity. Currently, seismicity continues at a higher-than-normal level (100-200 events/hour).

Data analysts are now systematically going through the backlog of unprocessed or partially processed data, "slashing out" and processing "non-Mt. St. Helens" earthquakes, locating selected Mount St. Helens events, and flagging pickfiles of unlocated Mt. St. Helens events "g". Because of the large volume of data, pickfiles flagged "g" and their associated data files will be archived as a separate data set for research.

On November 20 we desensitized the triggering at Mount St. Helens so that only the largest events recorded automatically. All non-Mount St. Helens events still produce triggers. To capture significant events at Mount St. Helens, we review continuous data from stations near the mountain, and retrieve data in selected time windows containing especially interesting events and a sample of the seismicity (usually only a few events/hr.), particularly events with large amplitude, impulsive arrivals, or unusual depth, frequency, location , or signal characteristics. These events are processed in the traditional way, i.e. determine a hypocenter, magnitude, and fault plane solution if possible. Less than 1 percent of the detected events were processed in this way and we tended to favor the larger events. Since desensitizing, unlocated Mt. St. Helens events continue to occasionally be flagged "g", but the number of such events is far fewer, due to the change in procedures.

Disk Space

This sequence required emergency acquisition of additional disk space. See last quarter's report for details.

Archiving and Tape-Drive Issues

The PNSN normally archives all triggered events on exabyte tapes. Normally an exabyte tape will last between 2 weeks and a month. However, the eruption caused almost continuous triggering, and the exabyte tapes began filling up at a much faster rate, requiring replacement of the exabyte around every 2 days. The exabyte tape drive broke down, and another exabyte drive and a DLT drive also proved inoperable. Eventually, replacement drives were scavenged from elsewhere in the department. In the interim, data were backed up either to IRIS or a backup hard drive. See last quarter's report for details.

Strong Motion Instrumentation Update

The Duwamish Valley borehole array installation (stations SSS1 and SSS2) was completed at Seattle School District's John Stanford Center at 4th and Lander. A total of 4 tri-axial Kinematics Episensors are deployed at various depths. Deployment depths are 0. 11.5, 43.9 and 50.6 m. Depths were chosen by the ANSS Regional Advisory Committee after review of bore logs collected by Washington State DNR. The two lower sensors are located just above and below the interface of a gravel layer.

At the Duwamish Valley borehole array, a Kinemetrics K2 with an internal Episensor is located on grade. Data streams from the three subsurface Kinemetrics SB Episensors are digitized by a second K2. The sensor at grade has station code SSS2 and channels ENZ, ENE, ENN. The subsurface channels have station code SSS1. Because the EARTHWORM data acquisition system has no protocol for identifying sensors at different depths, we distinguish the sensor streams by modifying station and channel codes. Channels names are EN[ZNE] for the sensor at 50.6m, GN[ZNE] for 43.9m, and FN[ZNE] for 11.5m. The K2 firmware limits the real-time data collection to 2 of the 3 subsurface sensors, so channels GN[ZNE] are not collected in real time..

Station ALKI, initially installed last summer, was finalized with the installation of a GPS antenna for data timing, as well as the installation of an L-4 short period sensor. An additional Kinemetrics K2, from the USGS Seattle Urban Array, will continue to co-occupy the site.

Computer Hardware Update

In early October, *scossa,* our main data collection and processing computer, experienced a major problem which took several hours to resolve. The reasons for the failure are not well understood, but *scossa* was clearly severely overloaded. Fortunately, backup data acquisition system *milli* continued to trigger and no significant data were lost. Because of the critical and volatile situation at Mount St. Helens, the USGS provided funds to purchase a new computer, *tremito*, which was brought on-line about the third week in October. *Scossa* continues to be our main data collection computer, and *tremito* provides additional computational power for manual processing of earthquake data and acts as a fileserver for all the other networked computers in the group.

Automatically generated Web-pages: Webicorder Update

The processes that generate Webicorders (on-line real-time trace data displays), were moved to *grasso*. This allowed us to provide webicorders for more stations and reduced the load on our main real-time system, *scossa*. Currently 92 PNSN stations are available on webicorders through six index pages. Webicorders indexes are grouped by type (short-period, broad-band, and strong motion), plus a special index for stations located on volcanoes. Webicorder pages were redesigned to improve navigation between the six webicorder index pages.

Use of PNSN Data

The IRIS Data Management Center reports 1,028 requests for PNSN trace-data this quarter. Nearly 982,000 traces were requested. This represents an order of magnitude increase over a typical quarter.

EARTHQUAKE DATA - 2004-D

About 22,000 events were digitally recorded and processed at the University of Washington between October 1 and December 31, 2004. This is about 10 times the number of events the PNSN typically processes in a quarter, due to the eruption of Mount St. Helens. Locations in Washington, Oregon, or southernmost British Columbia were determined for 2,602 of these events; 2,524 were classified as earthquakes and 78 as known or suspected blasts. The remaining processed events include teleseisms (162 events), regional events outside the PNSN (65), and unlocated events within the PNSN, mostly at Mt. St.

Helens. Due to the extremely large number of events (automatic counting routines indicate about 500,000 Mount St. Helens events this quarter), only a representative sample of Mount St. Helens seismicity was located. Other unlocated events within the PNSN normally include surficial events on Mt. St. Helens and Mt. Rainier, very small earthquakes, and blasts. Frequent mining blasts occur near Centralia, Washington and we routinely locate them.

Table 2 lists earthquakes reported to have been felt during this quarter. Events with ShakeMaps or Community Internet Intensity Maps (CIIM) are indicated. This quarter, no events generated ShakeMaps. Two events produced "CIIM" maps (**http://pasadena.wr.usgs.gov/shake/pnw/**), which convert "felt" reports sent by the general public (via Internet) into numeric intensity values. CIIM maps show the average intensity by zip code.

Table 3 is this quarter's catalog of earthquakes M 2.0 or greater, located within the network - between 42-49.5 degrees north latitude and 117-125.3 degrees west longitude.

Figure 1. Earthquakes with magnitude greater than or equal to 0.0 (M_c >=0).

Figure 2. Blasts and probable blasts (M_c >=0).

Figure 3a. Mt. St. Helens, station JUN, signal RMS amplitude minima and maxima over the course of the quarter.

Figure 3b. Mt. St. Helens, magnitudes as a function of time over the course of the quarter.

Figure 3c. Earthquakes located near Mt. St. Helens (M_c >=0).

Figure 4. Earthquakes located near Mt. Rainier (M_c >=0).

TABLE 2 - Felt Earthquakes during the 4thQuarter of 2004

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	CIIM	Shake Map
yy/mm/dd hh:mm:ss	deg.	deg.	km				
04/10/30 06:47:03	42.06	120.29	12.2	3.1	15.0 km SSE of Lakeview, OR	✔	
04/11/16 18:21:28	42.06	120.27	12.0	3.5	15.5 km SSE of Lakeview, OR	✔	

OREGON

During the fourth quarter of 2004, 95 earthquakes were located in Oregon between 42.0 degrees and 45.5 degrees north latitude, and between 117 degrees and 125 degrees west longitude. The most notable earthquakes in Oregon were two felt earthquakes, M 3.1 and 3.5 near Lakeview Oregon, near the California border, where swarm activity began in June. The swarm continued this quarter, with 39 earthquakes located in the area including 3 earthquakes of magnitude 3.0 or larger.

The Lakeview area is between the Pacific Northwest and California networks, and few seismometer stations are nearby. The PNSN and California Integrated Seismic Network **(http://www.cisn.org/**) are exchanging data for these events. Each organization analyzes the earthquakes independently. The USGS assigned magnitudes of 3.3 and 3.6 to the two felt events this quarter, Oct. 30 and Nov. 16th (UTC), while the UW computed 3.1 and 3.5 respectively. Another earthquake in the area, on Oct. 7, had a UW-determined magnitude of 3.5, but was not reported felt.

WESTERN WASHINGTON SEISMICITY

During the second quarter of 2004, 2,365 earthquakes were located between 45.5 degrees and 49.5 degrees north latitude and between 121.0 degrees and 125.3 degrees west longitude. Most western Washington seismicity this quarter was in the Mount St. Helens area, see discussion below. No earthquakes were felt this quarter in western Washington.

Excluding Mt. St. Helens, the largest earthquake in western Washington this quarter was a magnitude 3.2 event on Nov. 7 (UTC), located beneath the summit of Mt. Rainier at shallow depth (less than 2 km). The deepest earthquake in western Washington this quarter was a magnitude -0.2 event at about 70 km depth located beneath Hyak, WA on Dec. 24 (UTC).

WASHINGTON CASCADE VOLCANOES

Mount St. Helens

Mount St. Helens began an eruptive episode with a vigorous sequence of seismic activity starting on September 23. Activity accelerated into early October. The most energetic seismicity occurred on Oct. 1-5 when several phreatic explosions and half-hour to hour-long periods of harmonic tremor interrupted and temporarily calmed extremely high rates of magnitude 3+ seismicity. Seismicity fell following after Oct. 5, with a second, but less intense peak occurring Oct 7-9. Frequent, but smaller, earthquakes continued to occur throughout the quarter. Figures 3a and 3b summarize Mount St. Helens activity over the fourth quarter, based on automatic analysis procedures developed to manage the extremely high rate of seismicity (see operations section for details).

Because of the high rates of seismicity, only a representative sample (less than 1%) of Mount St. Helens events was located using conventional manual processing. Figure 3c shows located volcano-tectonic earthquakes near Mount St. Helens. Low frequency (L) and avalanche or rockfall events (S) are not shown. Seismograph stations operating during the fourth quarter are shown in the Appendix. See the operations section for details on destruction, replacement and new instrument installation during the fourth quarter.

Estimates of Mount St. Helens seismicity using automated counting procedures suggest that about 500,000 earthquakes occurred during the 4th quarter of 2004. Only a small subset was manually processed. At the time this report was written, 2,184 earthquakes (113 with magnitudes between 3.0 and 3.6) had been were located in the area shown in Fig. 3c using conventional manual processing procedures. An additional 15,000 events have been saved as a research data set, and 5,000 events still await processing. All locatable earthquakes in the 2004/2005 sequence are relatively shallow. No events occurred at depths exceeding 2 km. Most of the epicenters did not occur under what eventually became a new lava dome located just south of the 1980-86 (old) dome. Instead, the epicenters tended to be located on the boundary between the old and new domes near the vent that first appeared in early October, 2004. This conclusion may change when a more refined model of seismic velocity is developed for Mt. St. Helens.

One of the most remarkable aspects of the earthquake signals in 2004/2005 is the regularity of the frequency of occurrence for many months. Typically the earthquakes occurred every 30 seconds, although the inter-event time changed slowly with time. In addition, the sizes of the earthquakes over hours or days are usually very uniform with occasional, larger events. This observation seems to correlate well with observed deformation rates of the dome that were linear for days at a time. Event frequencies varied slightly, with higher-frequency tectonic-type events in the early part of the sequence giving way to events with somewhat lower frequency following the ash emissions and tremor episodes in early October.

Chronology of eruptive seismicity

See also CVO eruption chronology
http://vulcan.wr.usgs.gov/Volcanoes/MSH/Eruption04/Chronology/msh_eruption_chronology_20040923-20041014.html
and PNSN Webicorder archives:
http://www.ess.washington.edu/SEIS/PNSN/WEBICORDER/HELENS/september2004.html

September 23-25: unrest began with a swarm of small earthquakes starting on Sept. 23. The swarm accelerated on Sept. 24, and declined on Sept. 25.

September 26: Seismicity increased, including 10 events of magnitude 2.0-2.8. An official Notice of Volcanic Unrest was issued by the Cascades Volcano Observatory (CVO) at 3:00 p.m., the first since October 1986. Alert Level was 1, "Code Yellow."

September 29: Seismicity increased substantially overnight. Earthquakes occurred at the rate of four per minute. The largest events approached M 2.5 and became more frequent. All earthquakes originated at shallow levels in and below the 1980-86 lava dome. Based on the increased seismicity, at 10:40 a.m. CVO issued a Volcano Advisory--Alert Level 2, "Code Orange." Overflights found deformation on the crater floor south of the 1980-86 dome.

October 1: Beginning at 11:57 a.m. and lasting about 25 minutes, a small steam eruption, with minor ash, issued from a vent just south of the 1980-86 lava dome in the part of the crater-floor glacier that had become increasingly crevassed and uplifted over the past few days. The eruption was not accompanied by any noticeable seismic signal, but immediately following the eruption, seismicity dropped markedly and remained at a low level for about five hours, then gradually increased. A seismic station (SEP) and GPS receiver on the 1980-86 dome were destroyed by ballistics propelled by this eruption.

October 2. At 12:15 p.m., a small steam emission, not accompanied by any significant seismic signal, lasted for 1-2 minutes. Immediately following it, seismic activity changed from principally volcano-tectonic events to continuous low-frequency tremor that lasted 50 minutes. This tremor episode was very energetic and seen on seismometers as far away as JCW in northwestern Washington. During and for about an hour following the tremor episode, few volcano-tectonic events occurred. Activity then began to increase again. At 2:00 p.m., CVO issued a Volcano Alert (Alert Level 3, "Code Red"), and the U.S. Forest Service evacuated its visitor center at Johnston Ridge, which lies 8 km north-northwest of the volcano. (The Johnston Ridge Observatory has remained closed since October 2). Thermal measurements made with forward-looking infrared (FLIR) camera showed only low-temperature rock surfaces.

October 3 At 2:57 a.m., an episode of low-frequency tremor persisted for 25 minutes. No eruptive plume was detected, nor was there a significant change in seismicity. At 10:40 p.m., a small steam (and possibly ash) eruption occurred without a noticeable seismic signal, eventually reaching about 4,600 m altitude (15,000 ft, officially) .

Oct. 4 At 9:43 AM a steam and ash emissions reached elevations of 12,000 feet.. Large-scale uplift of the crater floor was again observed by a CVO overflight.

Oct. 5 At 9:03 a.m. (local time) a vigorous ash eruption (to 12,000 feet) occurred, lasting a full hour, and was followed by an abrupt change to lower frequency, lower amplitude seismicity

Oct. 6 Lower rates of seismicity and weak steam plume. Alert level was lowered to “Volcano Advisory” (Alert level 2, "Code Orange").

Oct. 7 - 13 Lower rates of seismicity, venting of steam, and minor ash emissions continued. On Oct. 11, new extruded material was seen in the crater.
Oct 14 - Oct. 16 Seismicity increased slightly, then fell off again without venting. Extrusion continued.
Oct 16 - Dec. 31 Seismicity continued at rates similar to Oct 7-13 and extrusion of material also continued.

St. Helens event magnitudes

Magnitudes computed for earthquakes at Mount St. Helens often over estimate the true earthquake size. Routine processing of PNSN data uses a coda duration magnitude scale, magnitudes shown in Figure 3b were determined this way. However, shallow earthquakes at Mount St. Helens usually have extended coda durations. This can be due to a complex, multiple-event source as well as very inhomogeneous local velocity structure which causes rapid dispersion of the strongly generated surface waves from shallow events. We have run tests on 60 St. Helens earthquakes with coda duration magnitudes ranging from 0.8 to 3.2, comparing these magnitudes to those computed using a synthetic Wood-Anderson peak amplitude from calibrated broad-band stations. These equivalent "local" magnitudes are always the same or smaller than the coda duration ones. The discrepancy varies from 0.0 to 1.2 magnitude units. For the larger earthquakes (Md >2.7) the discrepancy was no more than 0.4 magnitude units. Thus one must interpret with care any of the magnitudes reported in the PNSN catalog during the current Mount St. Helens sequence.

Mount Rainier

The number of events in close proximity to the cone of Mt. Rainier varies over the course of the year, since the source of much of the shallow activity is presumably ice movement or avalanching at the surface, which is seasonal in nature. Events with very low frequency signals (1-3 Hz) believed to be icequakes are assigned type "L" in the catalog. Emergent, very long duration signals, probably due to rockfalls or avalanches, are assigned type "S" (see Key to Earthquake Catalog). Two events flagged "L" or "S" were located at Mount Rainier this quarter and 106 "L" or "S" events were recorded, but were too small or too emergent to locate reliably. Type L and S events are not shown in Fig. 4.

A total of 99 tectonic events (43 of these were smaller than magnitude 0.0, and thus are not shown in Fig. 4) were located within the region shown in Fig. 4. The largest tectonic earthquake located near Mt. Rainier this quarter was a magnitude 3.2 event on Nov. 7 (UTC), located beneath the summit at shallow depth (less than 2 km).This quarter, 32 tectonic earthquakes were located in the "Western Rainier Seismic Zone" (WRSZ), a north-south trending lineation of seismicity approximately 15 km west of the summit of Mt. Rainier (for counting purposes, the western zone is defined as 46.6-47.0 degrees north latitude and 121.83-122 west longitude). Within 5 km of the summit, there were 59 (23 of them smaller than magnitude 0.0 and thus not shown in Fig. 4) higher-frequency tectonic-style earthquakes, and the remaining events were scattered around the cone of Rainier as shown in Fig. 4.

EASTERN WASHINGTON SEISMICITY

During the fourth quarter of 2004, 60 earthquakes were located in eastern Washington in the area between 45.5 - 49.5 degrees north latitude and 117 - 121 degrees west longitude. The largest earthquake recorded in eastern Washington this quarter was a magnitude 2.9 event on Nov. 2. It occurred at about 3 km depth and was located about 10 km south- southwest- of Chelan.

OTHER SOURCES OF EARTHQUAKE INFORMATION

We provide automatic computer-generated alert messages about significant Washington and Oregon earthquakes by e-mail, FAX or via the pager-based RACE system to institutions needing such information, and we regularly exchange phase data via e-mail with other regional seismograph network operators.

Other regional agencies provide earthquake information. These include the Geological Survey of Canada (Pacific Geoscience Centre), Sidney, B.C. **http://www.pgc.nrcan.gc.ca/seismo/table.htm** ; and other regional networks in the United States **http://earthquake.usgs.gov/regional/** The US Geological Survey coordinates earthquake information nationally; **http://earthquake.usgs.gov**.

Complete catalog listings are available on-line through **http://www.pnsn.org/CATDAT/catalog.html** Key to earthquake catalog can be found in the last quarterly report of each year, or at:
http://www.pnsn.org/INFO_GENERAL/PNSN_QUARTERLY_EQ_CATALOG_KEY.htm

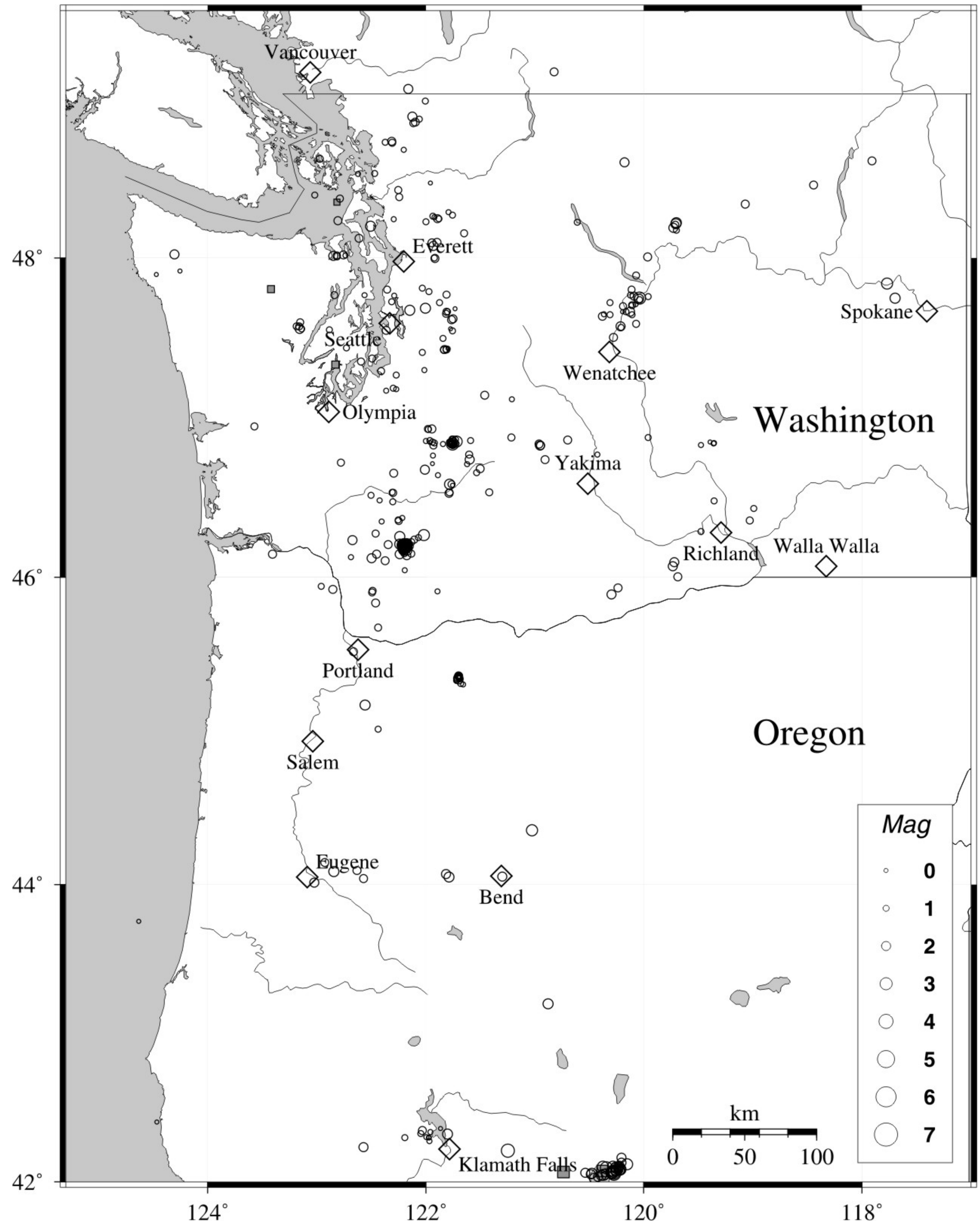


Figure 1 Earthquakes with magnitude greater than or equal to 0.0 (Mc>=0.0). Unfilled diamonds represent cities. Quakes shallower than 30 km are indicated by circles, and deeper quakes by filled squares.

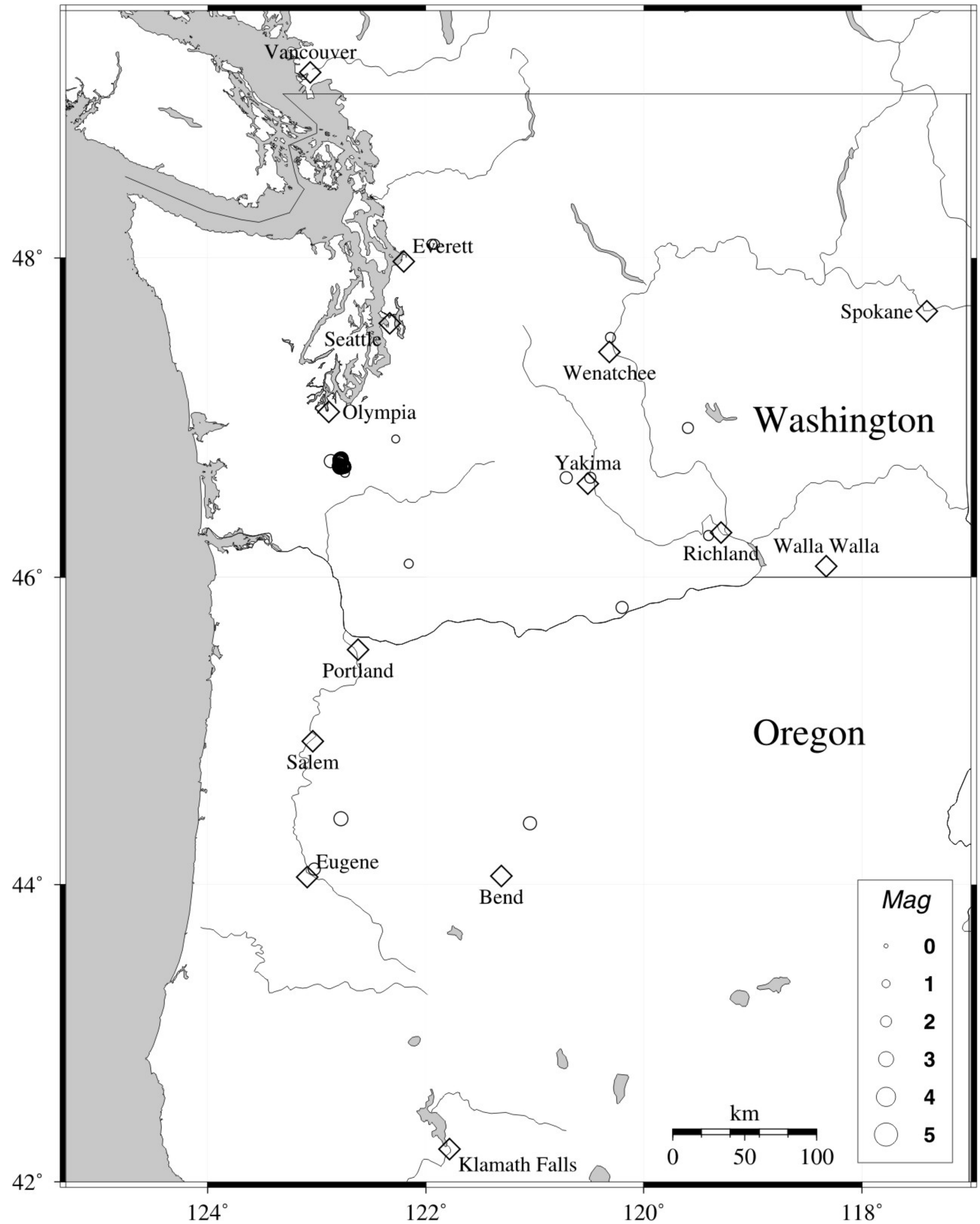


Figure 2. Blasts and probable blasts. Unfilled diamonds represent cities.

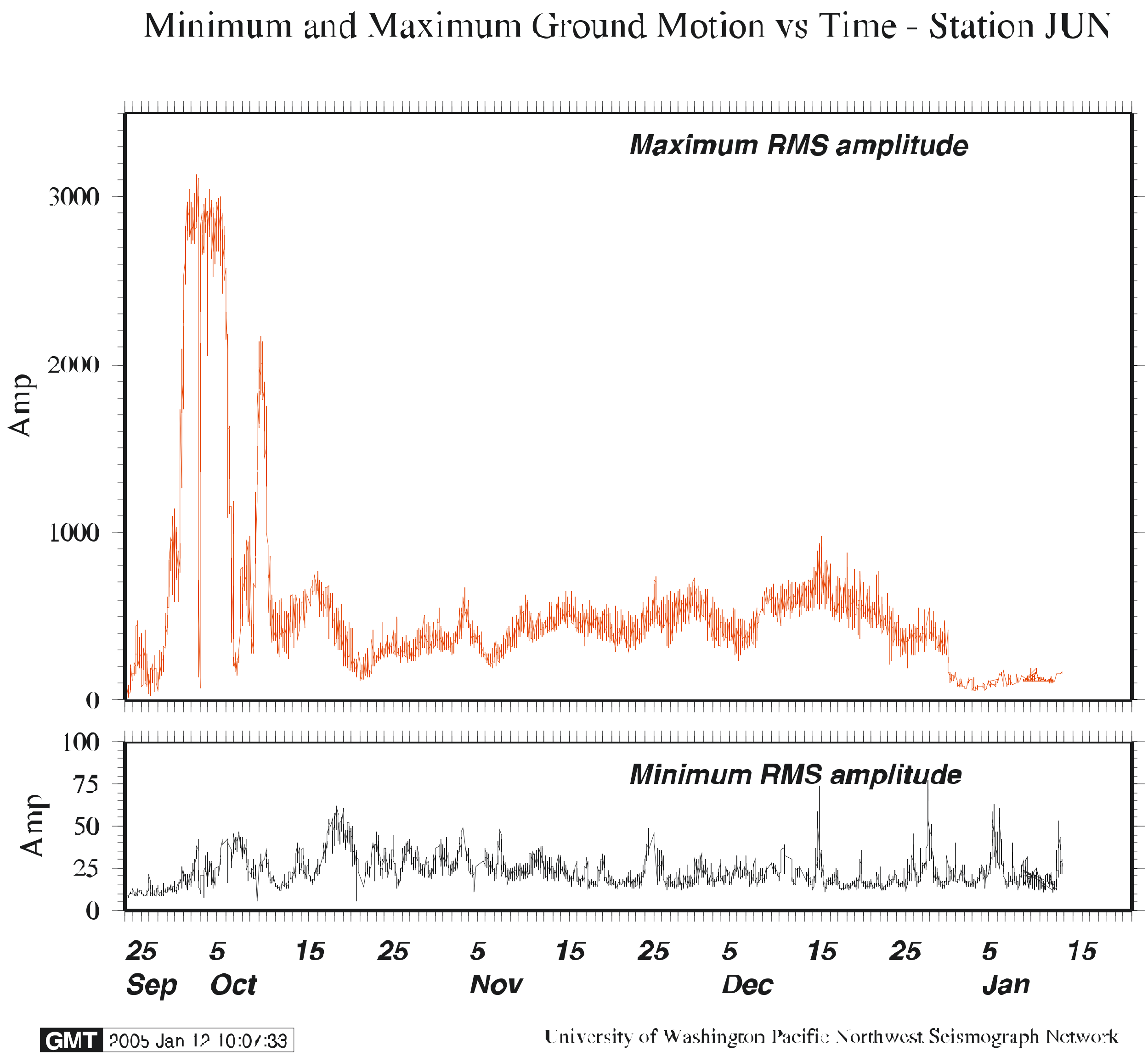


Figure 3 a   History of average signal amplitudes at Mt. St. Helens
The upper panel shows maximum recorded RMS amplitude and the lower panel shows the minimum RMS amplitude. Each half-hour period produces one point on the RMS amplitude graphs. The amplitude of the point is the maximum (or minimum) RMS amplitude in the half hour period of values computed for successive 5-second windows during the half-hour period. In effect, the upper panel tracks the average size of the large earthquakes and the lower panel tracks the amount of ambient noise (background vibrations) between earthquakes. Dates on the horizontal axes are given in Universal Time (UT). Most of the "bad" data points have been removed by an automatic algorithm. Such points are caused by data telemetry problems and calibration signals unrelated to earthquakes. Station JUN is south of the crater.

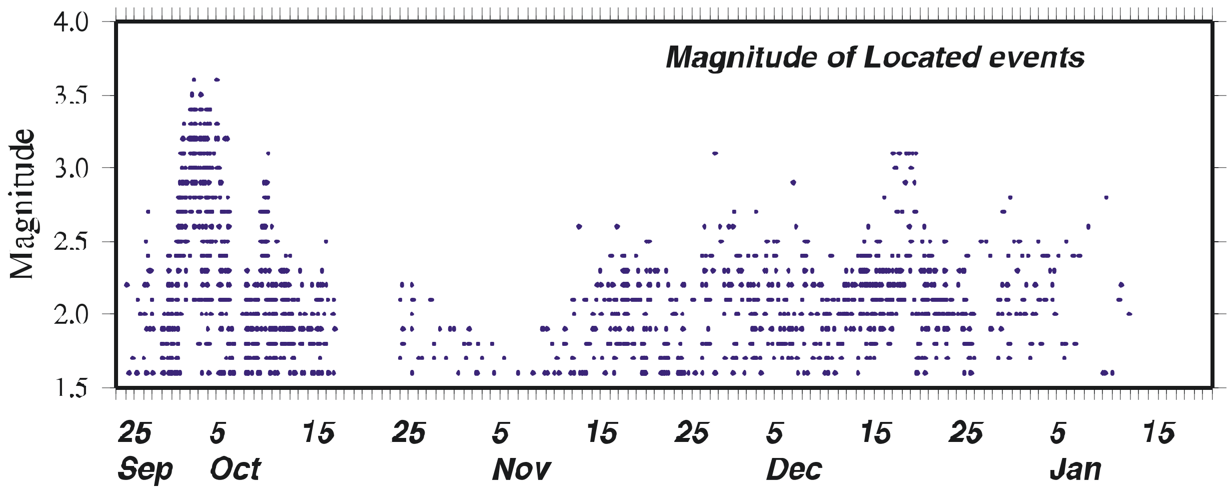


Figure 3 b Magnitudes of manually located events.
The gap in mid-October reflects a time period where manual processing of data is still backlogged. One day can have many earthquakes of the same magnitude, so each dot may represent multiple events. The plot shows maximum magnitudes of 3.5 or greater at the end of September and in early October. Magnitudes since then have varied, but not exceeded 3.0.

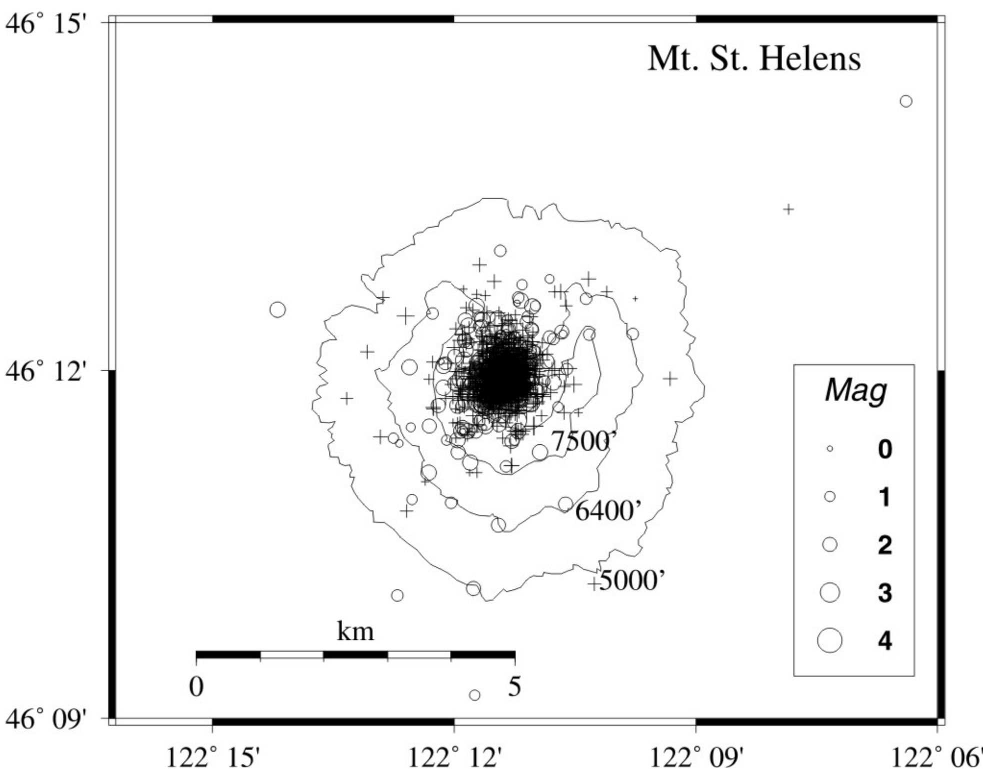


Figure 3 c Earthquakes at Mt. St. Helens, M>0.0.

Plus' symbols indicate depth less than 1 km. Circles indicate depth greater than 1 km. Elevation contours shown in feet

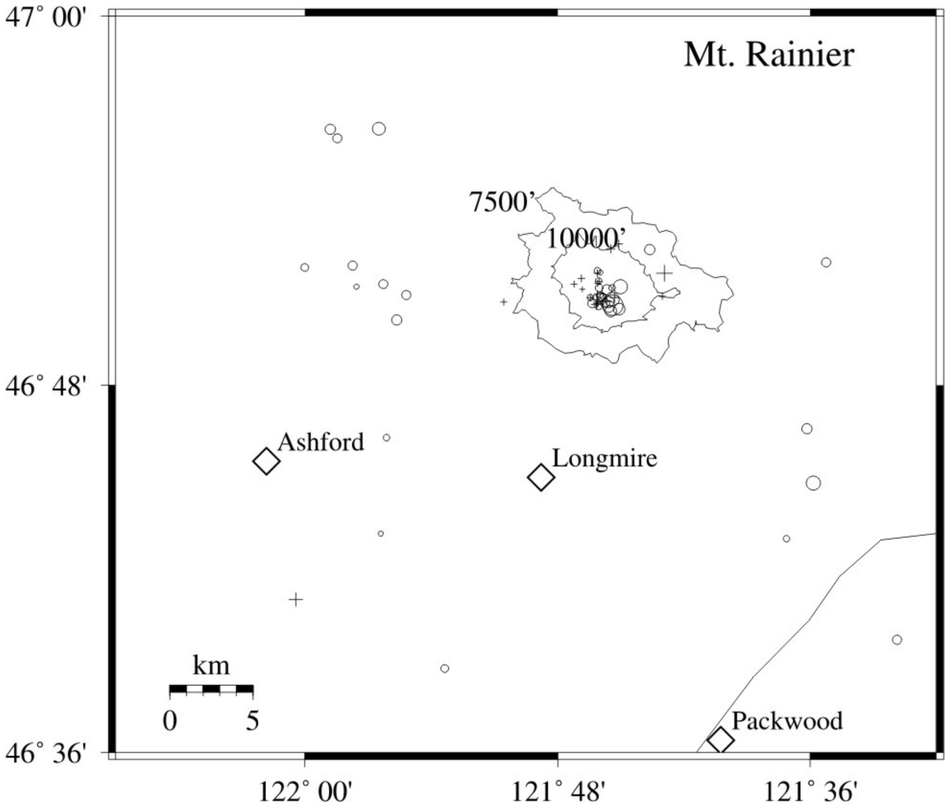


Figure 4. Earthquakes at Mt. Rainier, M>0.0.

EARTHQUAKE CATALOG, 2004-D

This quarter's catalog lists earthquakes of magnitude 2.0 or larger, but **DOES NOT INCLUDE *any*** events at Mount St. Helens. Complete catalog listings are available on-line through **http://www.pnsn.org/CATDAT/catalog.html** Key to earthquake catalog can be found in the last quarterly report of each year, or at: **http://www.pnsn.org/INFO_GENERAL/PNSN_QUARTERLY_EQ_CATALOG_KEY.htm**

Oct. 2004

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
2	03:36:32.01	47 41.46	122 00.11	8.99*	2.3	62/065	31	0.41	CA	P3	
2	12:05:33.72	46 15.99	122 01.00	0.03*	2.7	8/008	226	0.27	BD	S3	
4	13:59:39.98	45 20.53	121 42.03	4.94	2.1	9/014	102	0.17	BB	O0	
4	14:01:17.11	46 14.14	122 40.35	1.13	2.1	6/006	189	0.14	CD	C3	
7	08:23:32.28	42 03.35	120 16.45	3.35	3.5	8/009	264	0.15	CD	O0	
7	09:13:10.54	42 02.05	120 25.30	0.03*	2.0	7/007	273	0.30	BD	K3	
7	09:17:13.38	42 03.63	120 17.03	11.37$	2.7	13/014	155	0.27	BC	K3	
8	08:54:55.84	42 05.18	120 12.82	6.13	2.6	11/012	266	0.31	CD	K3	
9	03:46:56.22	42 12.85	121 14.83	0.02*	3.6	10/010	203	0.54	DD	K3	
15	22:44:20.76	46 35.43	121 46.96	8.69	2.4	45/048	30	0.24	BB	C3	
20	00:21:42.34	44 03.18	121 17.87	3.04	2.1	10/010	219	0.14	BD	O0	
22	04:16:59.89	42 03.99	120 16.91	12.08*	2.2	11/011	250	0.28	BD	K3	
23	16:52:46.58	42 02.79	120 22.37	0.04*	2.6	12/014	215	0.34	CD	K3	
23	17:08:47.30	42 04.80	120 13.35	8.32	2.2	8/009	280	0.11	BD	K3	
23	17:30:32.01	42 07.12	120 09.19	9.98*	2.5	8/008	291	0.17	BD	K3	
23	17:37:57.24	42 05.01	120 13.87	8.91	2.1	7/008	278	0.17	CD	K3	
23	20:08:50.13	42 06.06	120 14.25	0.02*	2.4	10/010	260	0.20	BD	K3	
30	06:47:03.28	42 03.83	120 17.48	12.24$	3.1	16/017	153	0.74	DC	K3	
30	06:57:58.96	42 05.05	120 12.71	6.81	2.3	6/007	282	0.11	BD	K3	

Nov 2004

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
1	14:30:50.87	46 50.77	121 45.42	1.46	2.0	31/032	78	0.16	BA	C3	
2	06:21:43.70	47 45.11	120 02.42	2.81	2.9	27/027	46	0.25	BB	N3	
7	15:45:48.62	42 04.04	120 15.54	0.02*	2.1	4/005	271	0.18	BD	K3	
7	19:23:59.73	46 50.58	121 45.37	1.60*	3.2	45/046	27	0.17	BA	C3	
8	17:39:01.73	44 04.18	121 48.85	2.74$	2.1	5/005	146	0.08	CD	O0	
9	18:23:40.62	42 04.31	120 16.90	0.45	2.2	8/009	250	0.14	CD	K3	
11	20:12:13.86	42 19.53	121 48.07	0.02*	2.2	8/008	188	0.11	AD	K3	
15	06:53:55.34	42 04.60	120 15.41	0.05*	2.3	6/006	272	0.30	BD	K3	
16	18:21:28.52	42 03.70	120 16.73	11.98$	3.5	18/019	157	0.48	CC	K3	
16	18:46:53.40	42 05.12	120 15.16	1.57*	2.1	6/007	273	0.21	BD	K3	
20	20:20:12.40	44 21.51	121 01.49	0.04*	2.6	18/018	153	0.20	BC	O0	
20	20:56:51.85	48 11.74	122 30.39	29.45	2.2	40/040	49	0.27	BA	P3	
23	00:50:14.34	49 01.79	122 09.66	0.04*	2.0	4/004	224	0.10	AD	P3	
23	09:43:24.51	48 00.79	122 50.87	20.84	2.1	23/024	65	0.20	BA	P3	
26	19:26:06.79	42 04.60	120 16.91	13.88	2.6	14/014	199	0.57	DD	K3	
26	19:45:02.91	42 04.31	120 22.71	32.3	2.8	14/014	173	0.47	CC	K3	
26	21:49:42.73	42 06.28	120 16.86	0.04*	2.6	7/007	233	0.14	AD	K3	
26	23:24:38.94	42 04.79	120 15.82	0.06*	2.1	6/007	270	0.33	CD	K3	
26	23:59:09.83	42 06.57	120 13.41	0.02*	2.0	9/009	262	0.26	BD	K3	
27	00:07:02.35	42 07.80	120 12.27	23.5	2.0	6/006	297	0.33	DD	K3	
27	01:33:22.96	42 05.86	120 20.52	20.24*	2.9	9/009	231	0.22	BD	K3	
27	03:25:59.80	42 03.41	120 28.67	14.47	2.3	8/008	271	0.17	DD	K3	
27	10:09:09.87	42 04.11	120 44.34	42.81	2.9	13/013	246	0.71	DD	K3	
27	13:35:38.63	42 06.15	120 22.58	0.03*	2.6	9/009	241	0.44	CD	K3	
27	22:28:17.51	42 03.64	120 32.17	16.16	2.0	7/007	269	0.46	DD	K3	
28	11:22:01.67	42 05.89	120 15.43	1.80$	2.3	9/010	256	0.18	DD	K3	
29	23:49:53.16	45 10.67	122 33.32	22.04	2.2	28/029	109	0.38	CB	O0	

Dec 2004

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
7	00:45:25.34	46 12.10	122 11.21	0.05#	2.0	9/009	104	0.15	AB	R0	
12	01:08:24.22	47 45.24	117 41.90	0.04*	2.3	7/007	178	0.25	BC	N3	
12	13:56:16.15	47 50.51	117 46.33	19.07$	2.7	6/006	180	0.57	DC	N3	
15	00:43:21.69	48 12.97	119 42.03	0.04*	2.2	14/014	217	0.08	AD	N3	
15	10:09:12.83	42 01.46	120 27.30	14.88#	2.3	8/008	271	0.28	BD	K3	
15	22:38:13.58	48 12.74	119 42.26	0.04*	2.2	16/016	187	0.16	BD	N3	
16	20:07:24.49	44 05.15	122 50.63	0.04*	2.3	9/009	128	0.15	AC	O0	
17	19:20:07.57	44 00.73	123 01.34	2.17	2.0	5/005	136	0.06	BD	O0	
17	22:14:50.82	48 01.40	124 18.34	20.17#	2.1	13/013	108	0.08	AB	P3	
18	02:24:46.30	46 50.14	120 57.14	0.53$	2.1	20/021	80	0.34	CC	C3	
20	18:28:19.20	42 02.73	120 23.48	13.1	2.3	10/010	274	0.31	DD	K3	
22	22:57:07.46	47 34.66	120 12.84	2.73	2.1	19/021	62	0.18	BB	N3	
28	01:01:36.75	47 40.70	122 08.82	25	2.2	44/047	37	0.26	BA	P3	

OUTREACH ACTIVITIES

The PNSN staff and faculty participate in an educational outreach program designed to better inform the public, educators, businesses, policy makers, government agencies, engineers, and the emergency management community about earthquake, volcano and related hazards. Our program offers lectures, classes, lab tours, workshops, consultations, and electronic and printed information products. Special attention is paid to the information needs of the media. We provide information directly to the public through information sheets, an audio library, email, and via the Internet at http://www.pnsn.org.

Audio Library, Phone

Public interest in the continuing eruption of Mt. St. Helens resulted in very high volumes of calls in October, gradually dropping close to "normal" as the quarter progressed. The Seismology Lab responded to over 250 calls from the general public, Emergency Managers and government agencies, and ~150 calls from the Media. In addition, the PNSN audio library system received 350 calls this quarter. The audio library provides several recordings. We have a regularly updated message concerning current seismic activity, and there are also recordings describing seismic hazards in Washington and Oregon and earthquake prediction. Callers to the audio library have the option of being transferred to the Seismology Lab for additional information. The report from last quarter describes a temporary expansion of the PNSN phone system, which extended into early October.

Internet outreach: www.pnsn.org

At the end of September, the PNSN moved the www.pnsn.org URL from the departmental server to a higher-capacity University server. See last quarter's report for details. The University server was able to handle the extremely high volumes of traffic that occurred as seismic activity intensified in late September and early October. Between Sept. 28th and Oct. 21st, the University server absorbed 23 million "hits", and the departmental server had 14 million hits, for a total of 37 million hits, corresponding to about 12 million pages of information.

By December the load on our web services had eased, but after the Dec. 26th Sumatra & Andaman Islands earthquake and tsunami, the load again peaked. "**Tsunami!**", a site hosted by the UW Dept. of Earth and Space Sciences since 1995 is the #1 tsunami link on google and other popular search engines. The departmental server was overwhelmed by demand, and many hours of intervention were required to keep the server up and running. **Tsunami!** was originally developled by graduate student Ben Cook under the supervison of Dr. Catherine Petroff of UW's Civil Engineering. Although it has not been kept up to date, many other sites link to it, accounting for it's high search-engine ranking. Professors Catherine Petroff and Jody Borgeois are leading a major overhaul of **Tsunami!** . The PNSN is participating in the overhaul, and the renewed site will contain information about paleotsunami research and Cascadia Subduction Zone Tsuanmis as well as a major reorganization of links to other tsunami resources.

Mike Brown, the chair of the Dept. of Earth and Space Sciences, declared PNSN, Tsunami! and department web sites essential departmental services. A memorandum of understanding with the University's Computer & Communications unit (C&C) was develop and signed. C&C will provide dual separated web servers located in different UW Gigabit backbone locations and will implement a round-robin-type dynamic network service (DNS) to these machines with "fail-over" redundancy to maximize availability and reliability. The total cost of these services and necessary hardware is about $3,000 a year which is being paid by the Dept. of Earth and Space Sciences, a significant new contribution to PNSN operations. The transition to the new system is expected in March, 2005.

E-mail Communications

PNSN staff replied to about 1,000 e-mail messages from the public seeking information on a variety of topics via the ***seis_info@ess.washington.edu*** email address. This level of activity has created a substantial new work load carried primarily by Ruth Ludwin. Routine questions are typically responded to within a day; complex or sensitive questions are routed to the appropriate staff person for a more in-depth response. Requests may include complex scientific inquiries, assistance with hazard assessments and legal issues, consultations with government agencies, and support for engineering issues related to strong motion data.

Information Products

CIIM maps were generated for two events this quarter, and no ShakeMaps were generated. See "Earthquake Data" section for details.

CISN Display servers are receiving PNSN recent earthquake data and now provide links to our ShakeMaps, automatically generated following significant earthquakes. The CISN Display beta version was distributed for testing to select users who provide feedback to PNSN staff. Anticipation of the release of version 1 of the CISN Display is growing in our region and, depending on demand, new servers may be required to augment those in Pasadena and Berkeley to ensure data delivery in 2005. PNSN staff will also face demands for development of additional data layers of interest to clients within Washington and Oregon. This product will first supplement and later replace the CUBE based RACE (Rapid Alert for Cascadia Earthquakes) systems currently deployed.

K-20 Education Outreach: http://www.pnsn.org/EDHOME/index.html

PNSN and USGS staff gave 12 Seismology Lab tours and presentations for K-20 students and teachers, serving about 240 students this quarter. The PNSN also maintains an email list-service and distributed monthly newsletters to over 50 local K-20 educators and subscribers interested in earth-sciences education.

Bill Steele provided lectures and lab tours for about 30 teachers attending workshops in conjunction with the National Science Teachers' Association, Northwestern Region conference. In December, Bill Steele and Chris Newhall held a short workshop "How Mt. St. Helens works" for 30 educators at the Pacific Science Center. The Science Center sends educators into classrooms where they run science workshops.

Media Relations:

PNSN staff frequently provides interviews, research support, and referrals to radio, television, film, and print media. The PNSN organizes press conferences, contributes to TV and radio news programs and talk shows, and provides field opportunities linking reporters with working scientists. Staff members also assist news organizations, authors, television producers, and independent documentary makers to design accurate and informative stories and programs related to earthquake and volcano hazards. PNSN staff work to link reporters and producers developing stories with the appropriate research institutions, agencies, and scientists working in the areas to be covered by the piece. The PNSN coordinates the release of information and media relations with the USGS Western Region, the Cascades Volcano Observatory, and the Oregon Department of Geology and Mineral Industries (DOGAMI).

The eruption of Mount St. Helens (MSH) began at the end of September and increased very rapidly. MSH activity peaked in early October creating unprecedented demand for interviews, background information, and television appearances for PNSN staff and researchers. During the first few weeks in October, PNSN faculty, staff, and students held hundreds of interviews with regional, national and international media providers, sometimes at a rate of 25-50/day. National TV news programs served included ABC News Nightline, CNN, MSNBC, Fox News, and NBC Nightly News. International radio interviews included Swedish, German and Scottish radio. Newspapers covering the eruption included the New York Times, the Christian Science Monitor, National Geographic, and Japanese newspapers.

Throughout the quarter, PNSN scientists participated in early morning science conferences with CVO to share data and interpretations, and develop "talking points" for use in interviews. In early October the Seismology Lab was opened to the media from about 7 AM to 7 PM. Due to staff constraints, we declined most invitations for remote interviews, and also refused, for the most part, to keep the lab open for the 10 and 11 PM newscasts. Even with these restrictions, key PNSN staff and researchers were averaging 12 hour days, 7 days a week. After the first week of October everyone was asked to take at least one day off a week to prevent burn out.

National networks received audio and video feeds from their local affiliate stations via satellite uplinks. Two local television stations (KING 5 and KIRO 4) installed digital video links to the PNSN lab, freeing their transmission trucks to move to Coldwater Visitors Center near MSH and by mid-October, following the dramatic shift to smaller earthquakes that accompanied the start of new dome extrusion at MSH, the main media focus shifted to the Coldwater Visitors Center and the Joint Information Center established by the National Forest Service in Vancouver. With fewer television interviews PNSN staff was able to spend more time assisting writers to develop newspaper and magazine articles by providing background information, interviews, graphics, and referrals to CVO scientists monitoring the eruption and State and Federal agencies managing the hazard assessment.

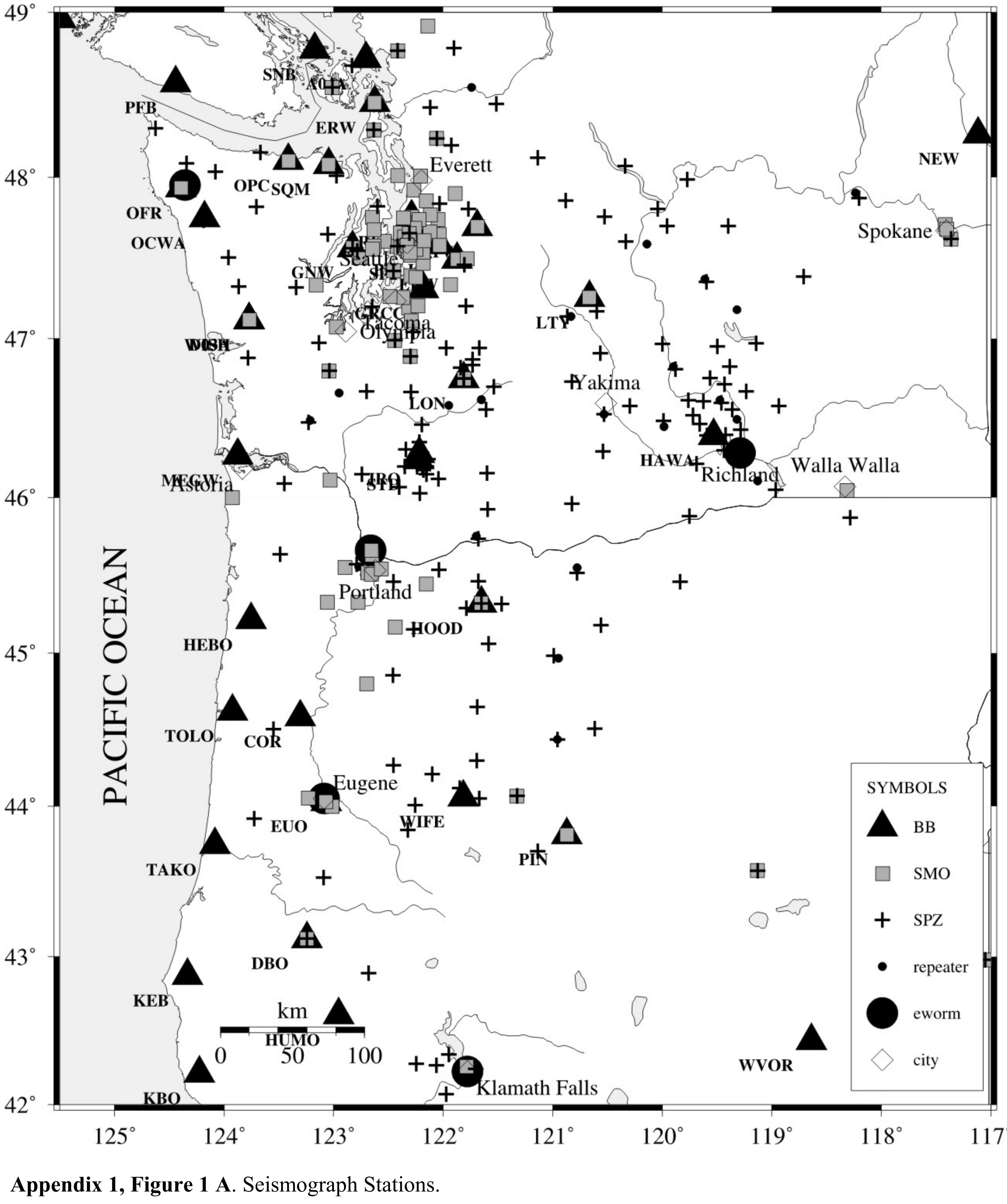
Despite geographical separation, USGS Scientists at CVO, National Forest Service personnel at the Joint Information Center near Vancouver and PNSN staff (with assistance from our colleagues in the USGS Seattle Field Office at UW) provided consistent information to the media. The PNSN and UW supported a telecommunications conference bridge used for daily science meetings with CVO. The 7 AM science meetings were initially conducted daily, but dropped to three days a week in mid-October. Although both seismic activity at Mount St. Helens and media frenzy declined significantly as the quarter went on, both continued at a higher-than-normal level through the end of the quarter.

Meetings, Presentations and Visitors:

A British film production company taped an interview with George Thomas about scientific research on the abilities of animals and pets to predict earthquakes. The show will be broadcast on the Animal Planet cable channel in April or May. Ruth Ludwin was interviewed in connection with an article being written for "Smithsonian" magazine on Cascadia and the Seattle Fault. Steve Malone gave a talk to the Seattle Surgeon's Professional Group. Wendy McCausland attended the US-Japan Conference on Earthquake Science in California and gave a presentation on deep tremor. Wendy McCausland, Guy Medema, George Thomas and Steve Malone made presentations at the fall AGU meeting, where Steve Malone also hosted a press conference on Mount St. Helens.

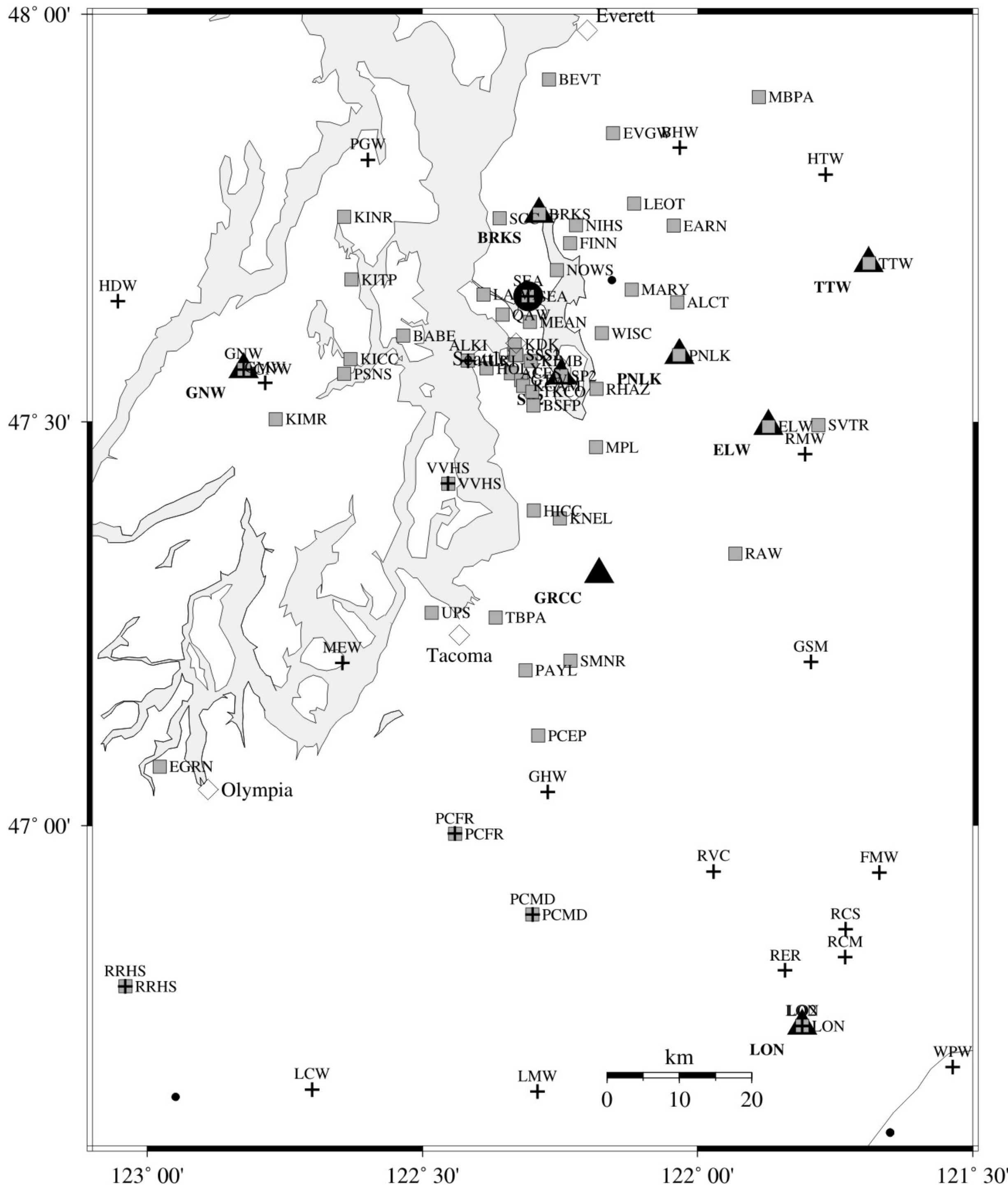
Bill Steele participated in meetings with CREW (Cascadia Regional Earthquake Workgroup), CPARM (Contingency Planners and Recovery Managers), and UW-EMPC (Emergency Management Planning Committee). The Seattle ShakeMap/ShakeCast working group met at the UW in October to finalize input to a proposal to FEMA to develop a high resolution ShakeMap for the greater Seattle Area and to implement ShakeCast for FEMA region X, Washington State Emergency Management Division and the City of Seattle. If funded, this project will result in additional products including automatic generation of HAZUS loss estimation models following potentially damaging earthquakes.

APPENDIX 1, PNSN Quarterly Report 2004-D – Station Maps and Locations

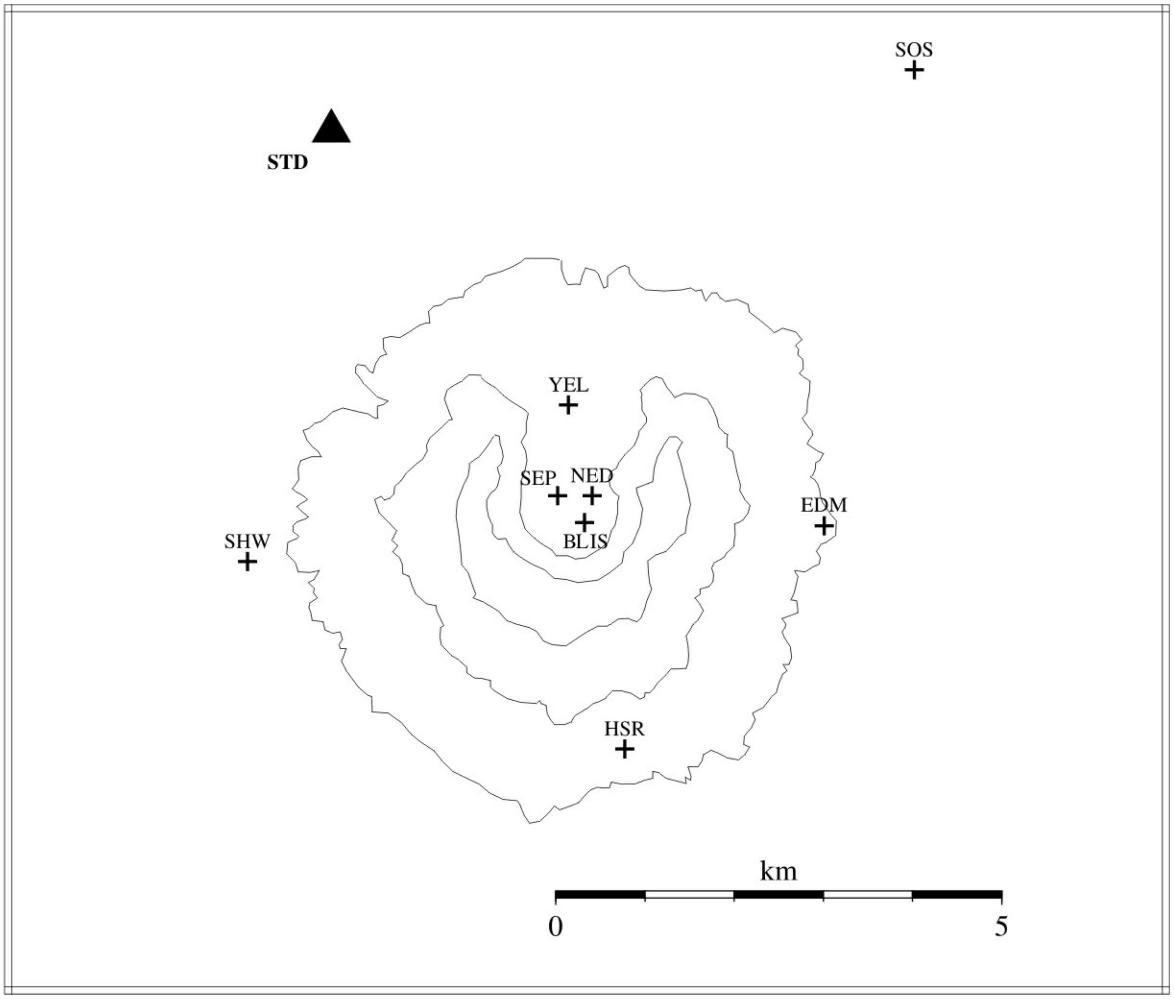


Appendix 1, Figure 1 A. Seismograph Stations.

"BB" indicates broadband stations (Table 2B), "SMO" indicates strong motion stations (Table 2C), and "SPZ" indicates short-period stations (usually vertical component only) (Table 2A). Repeaters are sites with radio receivers and transmitters used in the transmission of seismic data to the UW via FM telemetry. "eworm" represents sites where a "mini-earthworm" system is running on a local computer to collect data for transfer to the UW via the internet.



Appendix 1, Figure 1 B. Puget Sound seismograph stations, detail of Fig. 1 A



Appendix 1, Figure 1 C. Mount St. Helens seismograph stations, detail of Fig. 1 A

Appendix 1, Table 2A lists short-period, mostly vertical-component stations used in locating seismic events in Washington and Oregon. The first column in the table gives the 3-letter station designator, followed by a symbol designating the funding agency; stations marked by a percent sign (%) were supported by USGS joint operating agreement 04-HQ-AG-005. A plus (+) indicates support under Pacific Northwest National Laboratory, Battelle contract 259116-A-B3. Stations designated "#" are USGS-maintained stations recorded at the PNSN. Stations designated by letters are operated by other networks, and telemetered to the PNSN. "M" stations are received from the Montana Bureau of Mines and Geology, "C" stations from the Canadian Pacific Geoscience Center, "U" stations from the US Geological Survey (usually USNSN stations), "N" stations from the USGS Northern California Network, and "H" stations from the Hanford Reservation via the Pacific Northwest National Labs. “G” stations are contributed by other organizations, with some assistance from the PNSN. Other designations indicate support from other sources. Additional columns give 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 2A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
ALKI	%	47 34 30.4	122 25 03.4	0.001	Alki Wastewater Plant, ANSS-SM
ASR	%	46 09 09.9	121 36 01.6	1.357	Mt. Adams - Stagman Ridge
ATES	%	48 14 10.9	122 03 33.0	0.062	Arlington Trafton ES ANSS-SMO
AUG	%	45 44 10.0	121 40 50.0	0.865	Augspurger Mtn

TABLE 2A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
BBO	%	42 53 12.6	122 40 46.6	1.671	Butler Butte, OR
BEN	H	46 31 12.0	119 43 18.0	0.335	PNNL station
BEND	%	44 04 00.8	121 19 36.0	1.141	UO Bend Office, DOGAMI SMO
BHW	%	47 50 12.6	122 01 55.8	0.198	Bald Hill
BKC	%	44 17 57.9	121 41 45.6	1.208	Black Crater, OR
BLIS	#	46 11 51.5	122 11 07.3	2.116	Blister St. Helens Dome
BLN	%	48 00 26.5	122 58 18.6	0.585	Blyn Mt.
BOW	%	46 28 30.0	123 13 41.0	0.87	Boistfort Mt.
BPO	%	44 39 06.9	121 41 19.2	1.957	Bald Peter, OR
BRO	%	44 16 02.5	122 27 07.1	0.135	Big Rock Lookout, OR
BRV	+	46 29 07.2	119 59 28.2	0.92	Black Rock Valley
BSMT	M	47 51 04.8	114 47 13.2	1.95	Bassoo Peak, MT
BUO	%	42 16 42.5	122 14 43.1	1.797	Burton Butte, OR
BURN		43 34 23.0	119 07 49.0	1.615	Burns, OR SMO
BVW	+	46 48 39.5	119 52 56.4	0.67	Beverly
CBS	+	47 48 17.4	120 02 30.0	1.067	Chelan Butte, South
CDF	%	46 07 01.4	122 02 42.1	0.756	Cedar Flats
CHMT	M	46 54 51.0	113 15 07.0	-	Chamberlain Mtn, MT
CMW	%	48 25 25.3	122 07 08.4	1.19	Cultus Mtns.
CPW	%	46 58 25.8	123 08 10.8	0.792	Capitol Peak
CRF	+	46 49 30.0	119 23 13.2	0.189	Corfu
DPW	+	47 52 14.3	118 12 10.2	0.892	Davenport
DY2	+	47 59 06.6	119 46 16.8	0.89	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	1.27	Elk Rock
ELL	+	46 54 34.8	120 33 58.8	0.789	Ellensburg
EPH	+	47 21 22.8	119 35 45.6	0.661	Ephrata
ET3	+	46 34 38.4	118 56 15.0	0.286	Eltopia (replaces ET2)
ETW	+	47 36 15.6	120 19 56.4	1.477	Entiat
FHE	+	46 57 06.9	119 29 49.0	0.455	Frenchman Hills East
FL2	%	46 11 47.0	122 21 01.0	1.378	Flat Top 2
FMW	%	46 56 29.6	121 40 11.3	1.859	Mt. Fremont
FRIS	%	44 12 44.0	122 06 01.8	1.642	Frissel Point, OR
GBB	H	46 36 31.8	119 37 40.2	0.185	PNNL Station
GBL	+	46 35 54.0	119 27 35.4	0.33	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	New Goldendale
GLK	%	46 33 27.6	121 36 34.3	1.305	Glacier Lake
GMO	%	44 26 20.8	120 57 22.3	1.689	Grizzly Mountain, OR
GMW	%	47 32 52.5	122 47 10.8	0.506	Gold Mt.
GPW	%	48 07 05.0	121 08 12.0	2.354	Glacier Peak
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.
H2O	H	46 23 44.5	119 25 22.7	0.175	Water PNNL Station
HAM	%	42 04 08.3	121 58 16.0	1.999	Hamaker Mt., OR
HBO	%	43 50 39.5	122 19 11.9	1.615	Huckleberry Mt., OR
HDW	%	47 38 54.6	123 03 15.2	1.006	Hoodsport
HOG	%	42 14 32.7	121 42 20.5	1.887	Hogback Mtn., OR
HSO	%	43 31 33.0	123 05 24.0	1.02	Harness Mountain, OR
HSR	%	46 10 28.0	122 10 46.0	1.72	South Ridge, Mt. St. Helens
HTW	%	47 48 14.2	121 46 03.5	0.833	Haystack Lookout
HUO	%	44 07 10.9	121 50 53.5	2.037	Husband OR (UO)
IRO	%	44 00 19.0	122 15 15.4	1.642	Indian Ridge, OR
JBO	+	45 27 41.7	119 50 13.3	0.645	Jordan Butte, OR

TABLE 2A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
JCW	%	48 11 42.7	121 55 31.1	0.792	Jim Creek
JORV	%	42 58 40.0	117 03 10.0	1.338	Jorden Valley, OR SMO
JUN	%	46 08 50.0	122 09 04.4	1.049	June Lake
KMO	%	45 38 07.8	123 29 22.2	0.975	Kings Mt., OR
KOS	%	46 27 46.7	122 11 41.3	0.61	Kosmos
KTR	N	41 54 31.2	123 22 35.4	1.378	CAL-NET
LAB	%	42 16 03.3	122 03 48.7	1.774	Little Aspen Butte, OR
LAM	N	41 36 35.2	122 37 32.1	1.769	CAL-NET
LAS	N	41 35 57.6	121 34 36.0	-	CAL-NET
LBC	N	40 50 12.3	121 20 59.8	-	CAL-NET
LCCM	M	45 50 16.8	111 52 40.8	1.669	Lewis and Clark Caverns, MT
LCW	%	46 40 14.4	122 42 02.8	0.396	Lucas Creek
LHE	N	41 37 42.6	122 13 49.8	-	CAL-NET
LMW	%	46 40 04.8	122 17 28.8	1.195	Ladd Mt.
LNO	+	45 52 18.6	118 17 06.6	0.771	Lincton Mt., OR
LO2	%	46 45 00.0	121 48 36.0	0.853	Longmire
LOC	+	46 43 01.2	119 25 51.0	0.21	Locke Island
LON	%	46 45 00.0	121 48 36.0	0.853	Longmire CREST BB LONLZ SMO
LTI	N	41 10 34.0	121 29 19.6	-	CAL-NET
LVP	%	46 03 58.0	122 24 02.6	1.13	Lakeview Peak
MBW	%	48 47 02.4	121 53 58.8	1.676	Mt. Baker
MCMT	M	44 49 39.6	112 50 55.8	2.323	McKenzie Canyon, MT
MCW	%	48 40 45.1	122 49 52.9	0.693	Mt. Constitution
MDW	+	46 36 47.4	119 45 39.6	0.33	Midway
MEW	%	47 12 07.0	122 38 45.0	0.097	McNeil Island
MJ2	+	46 33 27.0	119 21 32.4	0.146	May Junction 2
MOON	%	44 03 06.2	121 40 06.0	2.24	Moon Mt, OR
MOX	+	46 34 38.4	120 17 53.4	0.501	Moxie City
MPO	%	44 30 17.4	123 33 00.6	1.249	Mary's Peak, OR
MTM	%	46 01 31.8	122 12 42.0	1.121	Mt. Mitchell
NAC	+	46 43 59.4	120 49 25.2	0.728	Naches
NCO	%	43 42 14.4	121 08 18.0	1.908	Newberry Crater, OR
NED	#	46 12 01.5	122 11 03.4	2.06	NE part of old Dome, St. Helen
NEL	+	48 04 12.6	120 20 24.6	1.5	Nelson Butte
NLO	%	46 05 21.9	123 27 01.8	0.826	Nicolai Mt., OR
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
OCP	%	48 17 53.5	124 37 30.0	0.487	Olympics - Cheeka Peak
OD2	+	47 23 15.6	118 42 34.8	0.553	Odessa site 2
ON2	%	46 52 50.8	123 46 51.8	0.257	Olympics - North River
OOW	%	47 44 03.6	124 11 10.2	0.561	Octopus West
OSD	%	47 48 59.2	123 42 13.7	2.008	Olympics - Snow Dome
OSR	%	47 30 20.3	123 57 42.0	0.815	Olympics Salmon Ridge
OT3	+	46 40 08.4	119 13 58.8	0.322	New Othello (replaces OT2 8/26
OTR	%	48 05 00.0	124 20 39.0	0.712	Olympics - Tyee Ridge
PAT	+	45 52 55.2	119 45 08.4	0.262	Paterson
PCFR	%	46 59 23.3	122 26 27.4	0.137	PC Firing Range ANSS-SMO
PCMD	%	46 53 20.9	122 18 00.9	0.239	PC Mountain Detachment ANSS-SMO
PGO	%	45 27 42.6	122 27 11.5	0.253	Gresham, OR
PGW	%	47 49 18.8	122 35 57.7	0.122	Port Gamble
PRO	+	46 12 45.6	119 41 08.4	0.553	Prosser
RCM	%	46 50 08.9	121 43 54.4	3.085	Mt. Rainier, Camp Muir
RCS	%	46 52 15.6	121 43 52.0	2.877	Mt. Rainier, Camp Schurman
RED	H	46 17 51.0	119 26 15.6	0.33	Red Mountain PNNL Station

TABLE 2A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
RER	%	46 49 09.2	121 50 27.3	1.756	Mt. Rainier, Emerald Ridge
RMW	%	47 27 35.0	121 48 19.2	1.024	Rattlesnake Mt. (West)
RNO	%	43 54 58.9	123 43 25.5	0.85	Roman Nose, OR
RPW	%	48 26 54.0	121 30 49.0	0.85	Rockport
RRHS	%	46 47 58.6	123 02 25.4	0.047	Rochester HS ANSS-SMO
RSW	+	46 23 40.2	119 35 28.8	1.045	Rattlesnake Mt. (East)
RVC	%	46 56 34.5	121 58 17.3	1	Mt. Rainier - Voight Creek
RVW	%	46 08 53.2	122 44 32.1	0.46	Rose Valley
SAW	+	47 42 06.0	119 24 01.8	0.701	St. Andrews
SBES	%	48 46 05.9	122 24 54.2	0.119	Silver Beach ES ANSS-SMO
SEA	%	47 39 15.8	122 18 29.3	0.03	UW, Seattle (Wood Anderson BB)
SEP	#	46 12 01.4	122 11 21.8	2.116	September lobe, Mt. St. Helens
SFER	%	47 37 10.4	117 21 55.7	0.715	Spokane Schools, Ferris High A
SHW	%	46 11 37.1	122 14 06.5	1.425	Mt. St. Helens
SLF	%	47 45 32.0	120 31 40.0	1.75	Sugar Loaf
SMW	%	47 19 10.7	123 20 35.4	0.877	South Mtn.
SNI	H	46 27 50.4	119 39 35.1	0.323	Snively PNNL station
SOS	%	46 14 38.5	122 08 12.0	1.27	Source of Smith Creek
SSO	%	44 51 21.6	122 27 37.8	1.242	Sweet Springs, OR
STD	%	46 14 16.0	122 13 21.9	1.268	Studebaker Ridge
STDM	%	46 14 16.0	122 13 21.9	1.268	Studebaker Ridge Microphone
STW	%	48 09 03.1	123 40 11.1	0.308	Striped Peak
SVOH	%	48 17 21.8	122 37 54.8	0.022	Skagit Valley CC ANSS-SMO
TBM	+	47 10 12.0	120 35 52.8	1.006	Table Mt.
TDH	%	45 17 23.4	121 47 25.2	1.541	Tom,Dick,Harry Mt., OR
TDL	%	46 21 03.0	122 12 57.0	1.4	Tradedollar Lake
TRW	+	46 17 32.0	120 32 31.0	0.723	Toppenish Ridge
TWW	+	47 08 17.4	120 52 06.0	1.027	Teanaway
UWFH	%	48 32 46.0	123 00 43.0	0.01	UW Friday Harbor ANSS-SMO
VBE	%	45 03 37.2	121 35 12.6	1.544	Beaver Butte, OR
VCR	%	44 58 58.2	120 59 17.4	1.015	Criterion Ridge, OR
VDB	C	49 01 34.0	122 06 10.1	0.404	Canada
VFP	%	45 19 05.0	121 27 54.3	1.716	Flag Point, OR
VG2	%	45 09 20.0	122 16 15.0	0.823	Goat Mt., OR
VGB	+	45 30 56.4	120 46 39.0	0.729	Gordon Butte, OR
VIP	%	44 30 29.4	120 37 07.8	1.731	Ingram Pt., OR
VLL	%	45 27 48.0	121 40 45.0	1.195	Laurance Lk., OR
VLM	%	45 32 18.6	122 02 21.0	1.15	Little Larch, OR
VSP	%	42 20 30.0	121 57 00.0	1.539	Spence Mtn, OR
VT2	+	46 58 02.4	119 59 57.0	0.385	Vantage2
VTH	%	45 10 52.2	120 33 40.8	0.773	The Trough, OR
VVHS	%	47 25 25.1	122 27 13.1	0.095	Vashon HS ANSS-SMO
WA2	+	46 45 19.2	119 33 56.4	0.244	Wahluke Slope
WAT	+	47 41 55.2	119 57 14.4	0.821	Waterville
WIW	+	46 25 45.6	119 17 15.6	0.128	Wooded Island
WPO	%	45 34 24.0	122 47 22.4	0.334	West Portland, OR
WPW	%	46 41 55.7	121 32 10.1	1.28	White Pass
WRD	+	46 58 12.0	119 08 41.4	0.375	Warden
WRW	%	47 51 26.0	120 52 52.0	1.189	Wenatchee Ridge
YA2	+	46 31 36.0	120 31 48.0	0.652	Yakima
YEL	#	46 12 35.0	122 11 16.0	1.75	Yellow Rock, Mt. St. Helens
YPT	+	46 02 55.8	118 57 44.0	0.325	Yellepit

Table 2B lists broad-band stations used in locating seismic events in Washington and Oregon, and Table 2C lists strong-motion stations. The format for station locations is the same for all station tables, as described above.

TABLE 2B - Broadband Stations

STA	F	LAT	LONG	EL	NAME
A04A	E	48 43 12.6	122 42 20.5	0.024	Lummi Island, WA
BRKS	%	47 45 19.1	122 17 17.9	0.02	Brookside ANSS-SMO BB
COR	U	44 35 08.5	123 18 11.5	0.121	Corvallis, OR (USNSN) BB
D03A	E	47 06 58.3	123 46 11.0	0.049	Wishkah, WA
DBO	%	43 07 09.0	123 14 34.0	0.984	Dodson Butte, OR (UO CREST BB)
ELW	%	47 29 39.4	121 52 17.2	0.267	EchoLakeBPA BB-SMO-IDS20
ERW	%	48 27 14.4	122 37 30.2	0.389	Mt. Erie SMO-IDS24 BB
EUO	%	44 01 45.7	123 04 08.2	0.16	Eugene,OR U0 CREST BB SMO
GNW	%	47 33 51.8	122 49 31.0	0.165	Green Mt CREST BB SMO
GRCC	G	47 18 42.5	122 10 46.0	0.13	Green River CC BB
HAWA	U	46 23 32.3	119 31 57.2	0.367	Hanford Nike USNSN BB
HEBO	%	45 12 49.2	123 45 15.0	0.875	Mt. Hebo, OR CREST BB SMO
HLID	U	43 33 45.0	114 24 49.3	1.772	Hailey, ID USNSN BB
HOOD	%	45 19 17.8	121 39 07.8	1.52	Mt Hood Meadows, OR CREST BB SMO
HUMO		42 36 25.6	122 57 24.1	0.555	Hull Mountain,OR BB from UCB
JRO		46 16 31.0	122 12 59.7	1.28	Johnston Ridge Observatory
KBO	N	42 12 45.0	124 13 33.3	1.008	Bosley Butte, OR CREST BB
KEB	N	42 52 20.0	124 20 03.0	0.818	Edson Butte, OR CREST BB
KRMB	N	41 31 22.6	123 54 28.7	1.265	CAL-NET Red Mtn, OR CREST BB
KSXB	N	41 49 49.4	123 52 36.8	-	CAL-NET Camp Six, OR CREST BB
LON	%	46 45 00.0	121 48 36.0	0.853	Longmire CREST BB LONLZ SMO
LTY	%	47 15 21.2	120 39 53.3	0.97	Liberty BB CREST SMO
MEGW	%	46 15 57.4	123 52 38.2	0.332	Megler, WA CREST BB SMO
MOD		41 54 08.9	120 18 10.6	1.555	Modoc Plateau, CA from UCB
NEW	U	48 15 50.0	117 07 13.0	0.76	Newport Observatory USNSN BB
OCWA	U	47 44 56.0	124 10 41.2	0.671	Octopus Mtn. USNSN BB
OFR	%	47 56 00.0	124 23 41.0	0.152	Olympics - Forest Resource Center
OPC	%	48 06 01.0	123 24 41.8	0.09	Olympic Penn College CREST BB
OZB	C	48 57 37.1	125 29 34.1	0.671	Canada BB
PFB	C	48 34 30.0	124 26 39.8	0.465	P.Renfrew, Canada BB
PIN	%	43 48 40.0	120 52 19.0	1.865	Pine Mt., OR (U0 CREST, BB, SMO)
PNLK	%	47 34 54.5	122 02 01.0	0.128	Pine Lake JH ANSS-SMO BB
PNT	C	49 18 57.6	119 36 57.6	0.55	Canada, BB
SNB	C	48 46 33.6	123 10 16.3	0.408	Canada BB
SP2	%	47 33 23.3	122 14 52.8	0.03	Seward Park, Seattle SMO-IDS24
SQM	%	48 04 39.0	123 02 44.0	0.03	Sequim, WA (CREST BB SMO)
STD	%	46 14 16.0	122 13 21.9	1.268	Studebaker Ridge
TAKO	%	43 44 36.6	124 04 52.5	0.046	Tahkenitch, OR CREST BB SMO
TOLO	%	44 37 19.3	123 55 16.6	0.021	Toledo BPA, OR CREST BB SMO
TTW	%	47 41 40.7	121 41 20.0	0.542	Tolt Res, WA CREST BB SMO
WIFE		44 03 35.4	121 48 58.7	1.955	Wife at 3-Sisters from CVO
WISH	%	47 07 01.8	123 46 11.6	0.045	Wishkah CREST BB SMO
WVOR	U	42 26 02.0	118 38 13.0	1.344	Wildhorse Valley, OR (USNSN BB)
YBH		41 43 55.3	122 42 37.4	1.06	Yreka, CA from UCB BB

Table 2C lists strong-motion, three-component stations operating in Washington and Oregon that provide data in real or near-real time to the PNSN. Several of these stations also have broad-band instruments, as noted.

The "SENSOR" field designates what type of seismic sensor is used:

A = Terra-Tech SSA-320 SLN triaxial accelerometer/Terra-Tech IDS24
A20 = Terra-Tech SSA-320 triaxial accelerometer/Terra-Tech IDS20 recording system
FBA23 = Kinemetrics FBA23 accelerometers and Reftek recording system
EPI = Kinemetrics Episensor accelerometers and Reftek recording system
BB = Guralp CMG-40T 3-D broadband velocity sensor
BB3 = Guralp CMG3T 3-D broadband velocity sensor
BBZ = Broad Band sensor, PMD 2024, vertical component only
K2 = Kinemetrics Episensor accelerometers and K2 recording system

The "TELEMETRY" field indicates the type of telemetry used to recover the data:
D = dial-up,
E = continuously telemetered via Internet from a remote EARTHWORM system
I = continuously telemetered via Internet
L = continuously telemetered via dedicated lease-line telephone lines
P = continuously telemetered via dedicated lease-line telephone lines using PPP protocol
M = continuously telemetered via BPA microwave
R = continuously telemetered via spread-spectrum radio

TABLE 2C - Strong-motion three-component stations

STA	F	LAT	LONG	EL	NAME	SENSOR	TEL.
ACES	%	47 33 35.0	122 20 23.6	0	Army Corps of Engineers Seattle	CMG5T	I
ALCT	%	47 38 48.8	122 2 15.7	0.055	Alcott Elementary	K2	I
ALKI	%	47 34 30.4	122 25 3.4	0.001	Alki	K2	L
ALST	%	46 6 32.3	123 1 58.5	0.198	Alston	A20	E,M
ALVY	%	43 59 53.2	123 0 57.0	0.155	Alvey	K2	E,M
ATES	%	48 14 10.9	122 3 33.0	0.062	Trafton Elementary	K2	I
BABE	%	47 36 21.0	122 32 7.0	0.083	Blakely Elementary	K2	I
BEND	%	44 4 0.8	121 19 36.0	1.141	U of O Bend Field Office	K2	I
BEVT	%	47 55 12.0	122 16 12.0	0.17	Boeing Plant Everett	K2	I
BRKS	%	47 45 19.1	122 17 17.9	0.02	Brookside Elementary	K2,BBZ	I
BSFP	%	47 31 12.0	122 17 54.0	0.005	Boeing Fire Protection	CMG5T	I
BULL	*	45 26 45.8	122 9 16.9	0.222	Bull Run Dam	A	I
BURN	#	43 34 23.0	119 7 49.0	1.615	Burns Butte Radio Building	K2	M,I
COLT	%	45 10 13.1	122 26 12.8	0.213	Colton High School	CMG5T	I
CSEN	%	47 48 4.5	122 13 6.5	0.055	Crystal Springs Elementary	K2	I
CSO	#	45 31 1.0	122 41 22.5	0.036	Canyon	FBA23	D
DBO	%	43 7 9.0	123 14 34.0	0.984	Dodson Butte (CREST)	EPI,BB3	E,L-PPP
EARN	%	47 44 27.2	122 2 37.7	0.159	East Ridge Elementary	K2	I
EGRN	%	47 4 24.0	122 58 41.0	0.057	Evergreen State College	K2	I
ELW	%	47 29 39.4	121 52 17.2	0.267	Echo Lake	A,BB	D,M,L
ERW	%	48 27 14.4	122 37 30.2	0.389	Mount Erie	A,BB	D,L,M
EUO	%	44 1 45.7	123 4 8.2	0.16	Eugene Golf Course (CREST)	EPI,BB	E,L-PPP
EVCC	%	48 0 27.0	122 12 15.3	0.03	Everett Community College	K2	I
EVGW	%	47 51 15.8	122 9 12.2	0.122	Gateway Middle School	K2	I
EYES	%	45 19 46.5	123 3 23.5	0.061	Ewing Young Elementary	CMG5T	I
FINN	%	47 43 10.2	122 13 55.9	0.121	Finn Hill Junior High	K2	I
GNW	%	47 33 51.8	122 49 31.0	0.165	Green Mountain (CREST)	EPI,BB3	L-PPP
GTWN	%	47 33 4.8	122 19 14.8	0.025	Georgetown Playfield	CMG5T	I,Wireless
HAO	#	45 30 33.1	122 39 24.0	0.018	Harrison	FBA23	D
HEBO	%	45 12 49.2	123 45 15.0	0.875	Mt. Hebo (CREST)	EPI,BB	M,E
HICC	%	47 23 24.4	122 17 52.4	0.115	Highline Community College	K2	I
HOLY	%	47 33 55.4	122 23 1.0	0.106	Holy Rosary School	K2	I
HOOD	%	45 19 17.8	121 39 7.8	1.52	Hood Meadows (CREST)	EPI,BB	L-PPP,I
HUBA	%	45 37 51.0	122 39 4.9	0.023	Hudson's Bay High School	CMG5T	I
JORV	%	42 58 40.0	117 3 10.0	1.338	Jordan Valley High School	K2	I
KCAM	%	47 32 39.0	122 19 2.1	0.005	King County Airport Maintenance	CMG5T	I
KDK	%	47 35 42.7	122 19 56.0	0.004	King Dome	K2	I

TABLE 2C - Strong-motion three-component stations

STA	F	LAT	LONG	EL	NAME	SENSOR	TEL.
KFAL	%	42 15 27.7	121 47 6.5	1.326	Klamath Falls	CMG5T	Serial
KEEL	%	45 33 0.8	122 53 42.4	0.067	Keeler	A20	D,E,M
KICC	%	47 34 37.9	122 37 52.4	0.017	Kitsap County Central Commun.	K2	I
KIMB	%	47 34 29.3	122 18 10.1	0.069	Kimball Elementary	K2	I
KIMR	%	47 30 11.0	122 46 2.0	0.123	Moderate Risk Waste Collection Fac.	K2	I
KINR	%	47 45 6.0	122 38 35.0	0.008	North Road Shed	K2	I
KITP	%	47 40 30.0	122 37 47.0	0.076	Wastewater Treatment Plant	K2	I
KNEL	%	47 22 50.5	122 15 2.5	0.014	Kent Elementary School	K2	I
KNJH	%	47 23 5.0	122 13 42.0	0.014	Kent Junior High	K2	I
LANE	%	44 3 6.5	123 13 54.8	0.12	Lane	K2	E,M
LAWT	%	47 39 23.4	122 23 21.9	0.05	Lawton Elementary	SLN-320	I
LEOT	%	47 46 4.4	122 6 56.2	0.115	Leota Junior High	K2	I
LON	%	46 45 0.0	121 48 36.0	0.853	Longmire Springs (CREST)	EPI,BB3	L-PPP
LTY	%	47 15 21.2	120 39 53.4	0.97	Liberty Heights Mine (CREST)	EPI,BB3	I
MARY	%	47 39 45.7	122 7 11.6	0.011	Marymoor Park	K2	I
MBKE	%	48 55 2.0	122 8 29.0	1.01	Kendall Elementary	K2	I
MBPA	%	47 53 54.7	121 53 20.2	0.186	Monroe	A20	D,M,L
MEAN	%	47 37 21.7	122 18 18.7	0.037	Meany Middle School	K2	I
MEGW	%	46 15 57.4	123 52 38.2	0.332	Megler (CREST)	EPI,BB	M,E
MPL	%	47 28 7.0	122 11 4.5	0.122	Maple Valley	A	D,M,L
MRIN	%	44 48 1.4	122 41 53.8	0.187	Marion	K2	M,E
MURR	%	47 7 12.0	122 33 36.0	0.082	Camp Murray	K2	None
NIHS	%	47 44 29.2	122 13 17.1	0.137	Inglemoore High School	K2	I
NOWS	%	47 41 12.0	122 15 21.2	0.002	NOAA Sand Point	A20	I
OFR	%	47 56 0.0	124 23 41.0	0.152	Olympic Natural Resources Center (CREST)	EPI,BB	I,E
OHC	%	47 20 2.0	123 9 29.0	0.006	Hood Canal Junior High	K2	I
OPC	%	48 6 1.0	123 24 41.8	0.09	Peninsula College (CREST)	EPI,BB	I
PAYL	%	47 11 34.0	122 18 46.0	0.009	Aylen Junior High	K2	I
PCEP	%	47 6 41.8	122 17 24.0	0.16	Puyallup East Sheriff Precinct	K2	I
PCFR	%	46 59 23.3	122 26 27.4	0.137	Roy Training Center	K2	I
PCMD	%	46 53 20.9	122 18 0.9	0.239	Mountain Detachment	K2	I
PERL	%	45 19 42.0	122 46 40.2	0.068	Pearl	K2	M,E
PIN	%	43 48 40.0	120 52 19.0	1.865	Pine Mtn. (CREST)	EPI,BB3	E,L-PPP
PNLK	%	47 34 54.5	122 2 1.0	0.128	Pine Lake Middle School	K2	I
PSNS	%	47 33 32.0	122 38 35.0	0.006	Puget Sound Naval Shipyard	A20	I
QAW	%	47 37 54.3	122 21 15.5	0.14	Queen Anne	A20	L
RAW	%	47 20 14.0	121 55 53.2	0.208	Raver	A20	M,L
RBEN	%	47 26 6.7	122 11 10.0	0.152	Benson Hill Elementary	K2	I
RBO	#	45 32 27.0	122 33 51.5	0.158	Rocky Butte	FBA23	D
RHAZ	%	47 32 24.7	122 11 1.3	0.108	Hazelwood Elementary	A20	I
ROSS	%	45 39 43.0	122 39 25.0	0.061	Ross	A20	E
RRHS	%	46 47 58.6	123 2 25.4	0.047	Rochester High School	K2	I
RWW	%	46 57 53.7	123 32 31.7	0.015	Ranney Well (CREST)	EPI,BB3	L-PPP
SBES	%	48 46 5.9	122 24 54.2	0.119	Silver Beach Elementary School	K2	I
SCC	%	47 44 59.4	122 21 35.3	0	Shoreline Community College	CMG5T	I
SEA	%	47 39 15.8	122 18 29.3	0.03	University of Washington	A20,PMD2023	L
SEAS	%	45 59 51.3	123 55 28.2	0.005	Seaside	K2	I
SFER	%	47 37 10.4	117 21 55.7	0.715	Ferris High School	K2	I
SGAR	%	47 40 37.8	117 24 50.3	0.579	Garfield Elementary	K2	I
SHIP	%	47 39 19.0	122 19 14.4	0.005	WashDOT Lake Union Shop	CMG5T	I,Wireless
SHLY	$	47 42 30.4	117 24 57.7	0.626	Spokane Temp	K2	None
SMNR	%	47 12 16.6	122 13 53.4	0.022	Sumner High School	K2	I
SNIO	$	47 40 46.0	117 24 18.0	0.584	Spokane NIOSH	K2	None

TABLE 2C - Strong-motion three-component stations

STA	F	LAT	LONG	EL	NAME	SENSOR	TEL.
SOPS	$	47 43 40.8	117 18 46.5	0.707	Orchard Prairie Elementary	K2	I
SP2	%	47 33 23.3	122 14 52.8	0.03	Seward Park	A,BB	L
SQM	%	48 4 39.0	123 2 44.0	0.03	Sequim Battelle Properties (CREST)	EPI,BB	I,R
SSS1	%	47 34 55.1	122 19 47.5	0.005	John Stanford Center 1	K2	I
SSS2	%	47 34 55.1	122 19 47.5	0.005	John Stanford Center 2	K2	I
SVOH	%	48 17 21.8	122 37 54.8	0.022	Skagit Valley College Oak Harbor	K2	I
SVTR	%	47 29 45.4	121 46 49.3	0.146	Two Rivers School	CMG5T	I
SWES	%	47 42 51.0	117 27 53.2	0.623	Westview Elementary	K2	I
SWID	%	48 0 31.0	122 24 42.0	0.062	South Whidbey Primary School	K2	I
TAKO	%	43 44 36.6	124 4 52.5	0.046	Tahkenitch (CREST)	EPI,BB	M,E
TBPA	%	47 15 29.0	122 22 1.0	0.002	Tacoma	A20	M,L,D
TKCO	%	47 32 12.7	122 18 1.5	0.005	King County Airport	A20	I
TOLO	%	44 37 19.3	123 55 16.6	0.021	Toledo (CREST)	EPI,BB	M,E
TTW	%	47 41 40.7	121 41 20.0	0.542	Tolt Reservoir (CREST)	EPI,BB3	I
UPS	%	47 15 50.2	122 29 1.1	0.113	University of Puget Sound	K2	I
UWFH	%	48 32 46.0	123 0 43.0	0.01	Friday Harbor Laboratories	K2	I
VVHS	%	47 25 25.1	122 27 13.1	0.095	Vashon High School	K2	I
WISC	%	47 36 32.0	122 10 27.8	0.056	Wilburton Inst. Services Center	K2	I
WWHS	%	46 2 43.5	118 19 2.0	0.01	Walla Walla High School	CMG5T	I