QUARTERLY NETWORK REPORT 2003-B

on

Seismicity of Washington and Oregon

April 1 through June 30, 2003

Pacific Northwest Seismograph Network

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INTRODUCTION

This is the second quarterly report of 2003 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 CNSS 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.

NETWORK OPERATIONS

Figure 1A shows a map view of stations operating during the quarter. Figure 1B is a more detailed view of stations in the Puget Sound area. 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 and Recording Update

Telemetry has been established for station BULL. The station is located near the Bull Run Dam, close to Sandy, Oregon. The seismograph is owned and maintained by Portland's Bureau of Waterworks. The seismograph was purchased a number of years ago and the PNSN technical and engineering staff have been working with an engineering consultant in establishing the telemetry connection. With this new station the PNSN can move forward in developing ShakeMap capabilities for the Portland area.

Most effort for the ANSS project this quarter went into station maintenance and site improvement. A short period sensor was installed at station ATES and data from this sensor are digitized by the Kinemetrics K2. Small UPS systems, engineered and fabricated by PNSN technical staff, were installed at UWFH and KNJH.

Permitting and siting for new ANSS stations continued this quarter. The emphasis for FY2003 will be in the Duwamish Valley south of downtown Seattle. The priorities are to establish permanent seismographs at locations that recorded the 1965 Olympia earthquake and the 2001 Nisqually earthquake, and to install a 12-channel down-hole array of accelerometers and an accompanying array of piezometers. UW Civil Engineering is cooperating with other local engineers to seek funding for the piezometric array .

Data Recording and EARTHWORM 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 many of the digital stations. We are currently running EARTHWORM-V6.1.

Pigia, our Intel-based EARTHWORM digitizer running under Windows NT, was the primary digitizer for verme while waggles, a SUNWORM digitizer, was the primary digitizer for most of the quarter for scossa and milli. We had serious analog channel digitizing problems during this quarter which continue into the next. Related to a major upgrade of our uninterruptible power system (see below) our primary SUNWORM digitizing system, waggles, crashed. A major disk failure has prevented us from using this system since early June. Pigia became the primary digitizer; however, after operating successfully for a couple of weeks it started crashing periodically with no diagnostics. We have concluded that it is a hardware problem requiring it to be rebuilt. Meanwhile, we are using the digitzer scheduled to be installed as a new mini-worm in Bend, OR. At the end of the quarter we are still trying to resurrect a SUNWORM digitizer and also an additional Windows digitizer. In both cases there are continuing problems getting them to work. The installation, configuration, testing, finding configuration errors, and fixing has taken considerable staff time during June and caused serious data loss.

The University has just completed a major ($55K+) upgrade of our uninterruptible power system. This includes a large UPS (with two hours worth of battery backup) and an auto-start generator. Major rewiring of the power lines, control panels and switches were included. The rewire required considerable effort to bring down and switch over to operating computers

to temporary power and then again onto the new system. These down times and the failures of the earthworm digitizer has resulted in several hours of missed analog data during June. This is more down-time than all of the previous 7 years of SUNWORM operation put together.

Asecond mini-worm (Wintel machine that acts as a separate earthworm node) was installed on April 10, 2003 in Forks, WA. An additional mini-worm was available for installation in Bend, OR to assist in monitoring the Three Sisters area. It was scheduled to be installed in the summer of 2003; however it is now being used as our primary digitizer. The mini-worms digitize signals from the analog stations in their respective regions in order to remove the need for leased telephone lines. The mini-worms send the data back to us via public Internet and also keep a version in case of the internet telemetry going down.

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 estimation tools that would serve the emergency earthquake information needs of WSDOT. To make early notification much more useful for post-earthquake recovery and emergency earthquake response, we are working on the following:

- Implement automated ShakeMap and an associated information transmission system, so that WSDOT will have maps of estimated peak ground acceleration with spectral breakdowns minutes after the earthquake. During the Nisqually earthquake, such maps were not available until it was too late to help WSDOT.
- Build the systems needed to provide estimated bridge damage based on ShakeMap ordinates, the Washington State Bridge Inventory, and WSDOT provided bridge fragility information. A ranked list of bridges will be produced to help prioritize bridge inspections based on probability of damage.

CREST Instrumentation Update

A replacement site for CREST station RWW has been found at Wishkah Valley School where we can use IP connectivity. Noise tests and siting visits have firmed up the location. Installation of CREST equipment at this site will take place later in the summer.

A Kinemetrics Episensor accelerometer was installed at station LTY, qualifying it as a CREST station. This is the last PNSN broadband site to be upgraded with a co-located accelerometer. Currently, all PNSN broadband stations have co-located accelerometers. LTY's telemetry was upgraded by using a short leased-line from LTY to Central Washington University (CWU) where the Geology Department is hosting the receiving equipment and an earthworm node. Data from LTY are acquired by the earthworm system at CWU and exported to the UW via the public Internet. Equipment and software were installed in June, but telephone connections are still being debugged.

Other Station News

At station RRHS, a contractor backed into the instrument hut/vault and damaged it seriously. The instrumentation was not affected but the hut will need a complete replacement.

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
BBO	02/04/03-04/24/03	Down, repaired receiver
BRO	02/04/03-End	Dead
BULL	03/07/03-05/07/03	No communications
CDF	12/20/02-End	Dead
CMW	02/27/03-End	Temporarily turned off
COLT	06/13/03-06/18/03	No communications, changed IP address, no firewall access
DBO	05/19/03-06/03/03	Down because vault caved in
FMW	03/23/03-05/07/03	Down, replaced receiver
GHW	03/23/03-05/07/03	Down, replaced receiver
GSM	03/23/03-End	Dead
HBO	05/08/03-End	Dead
HDW	03/27/03-End	Very noisy
HICC	02/24/03-05/30/03	No communications, building construction
LAB	10/12/02-End	Dead
LTY	6/19/2003	Installed episensor, new data logger, changed telemetry path
LTY	06/19/03-End	Bad timing (no GPS)
MEGW	04/01/03-End	Bad timing

TABLE 1 - Station outages and installations

Station	Outage Dates	Comment
NAC	05/23/03-05/27/03	Down, replaced solar regulator & battery
OBH	01/31/02-End	Temp. removed for logging
PCEP	04/04/03-05/15/03	Removed K2 for repair
PCMD	03/18/03-04/15/03	Removed for repair due to flooding
PCMD	04/15/03-06/17/03	Short period dead, replaced L4
RMW	03/23/03-05/30/03	Down, rebuilt station
RVW	03/27/03-End	Very noisy
RWW	10/24/02-End	Temporarily removed
SAW	5/23/2003	Repaired cabling due to animal damage
SHIP	02/08/03-End	Bad timing, seismograph removed
SOPS	08/27/02-End	No communications, K2 memory problem
TBPA	08/14/02-04/17/03	Removed for repair
TRW	07/14/02-End	Destroyed by fire, to be moved
WIB	12/04/02-End	Intermittent

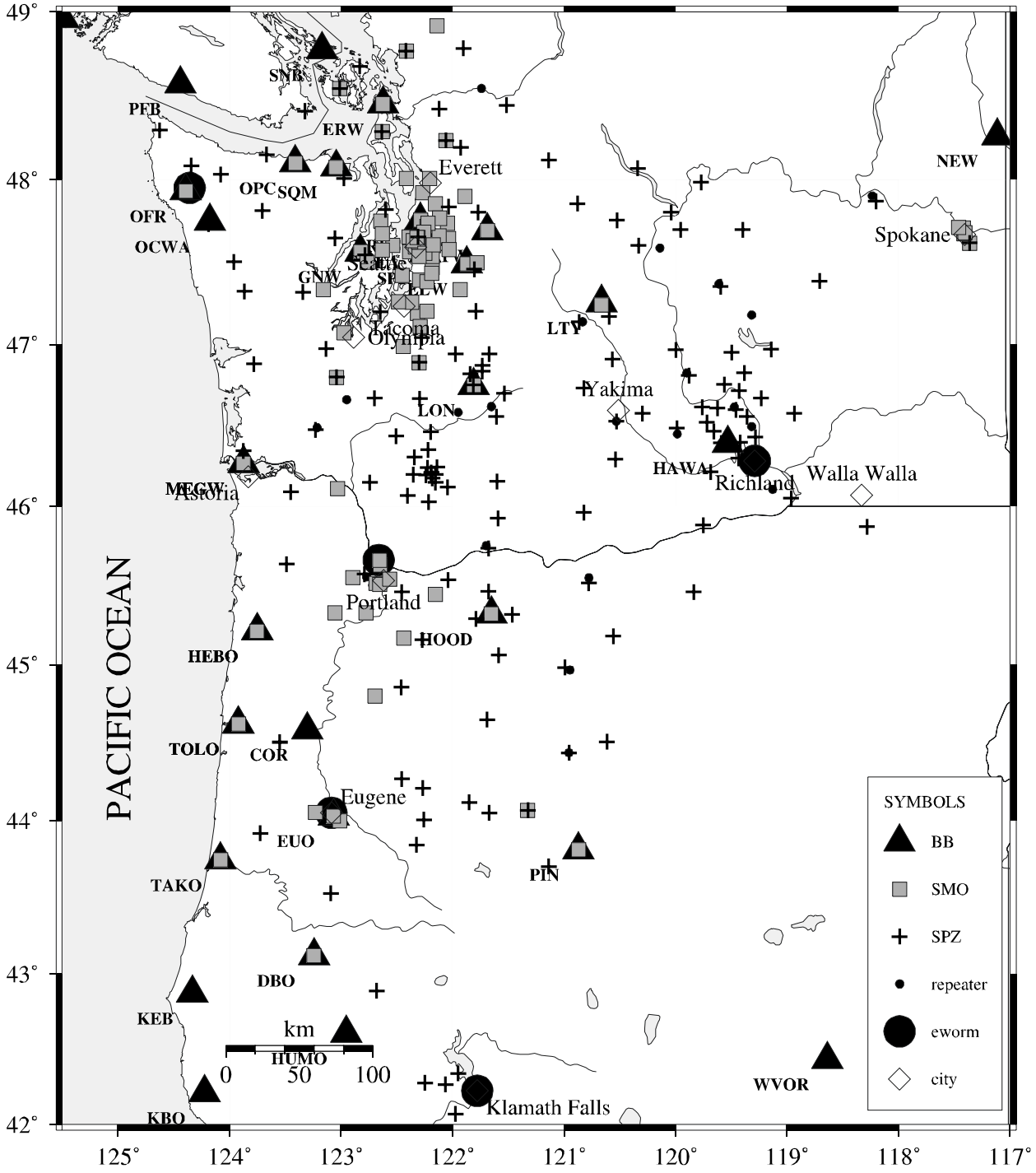


Figure 1 A. Seismograph Stations.

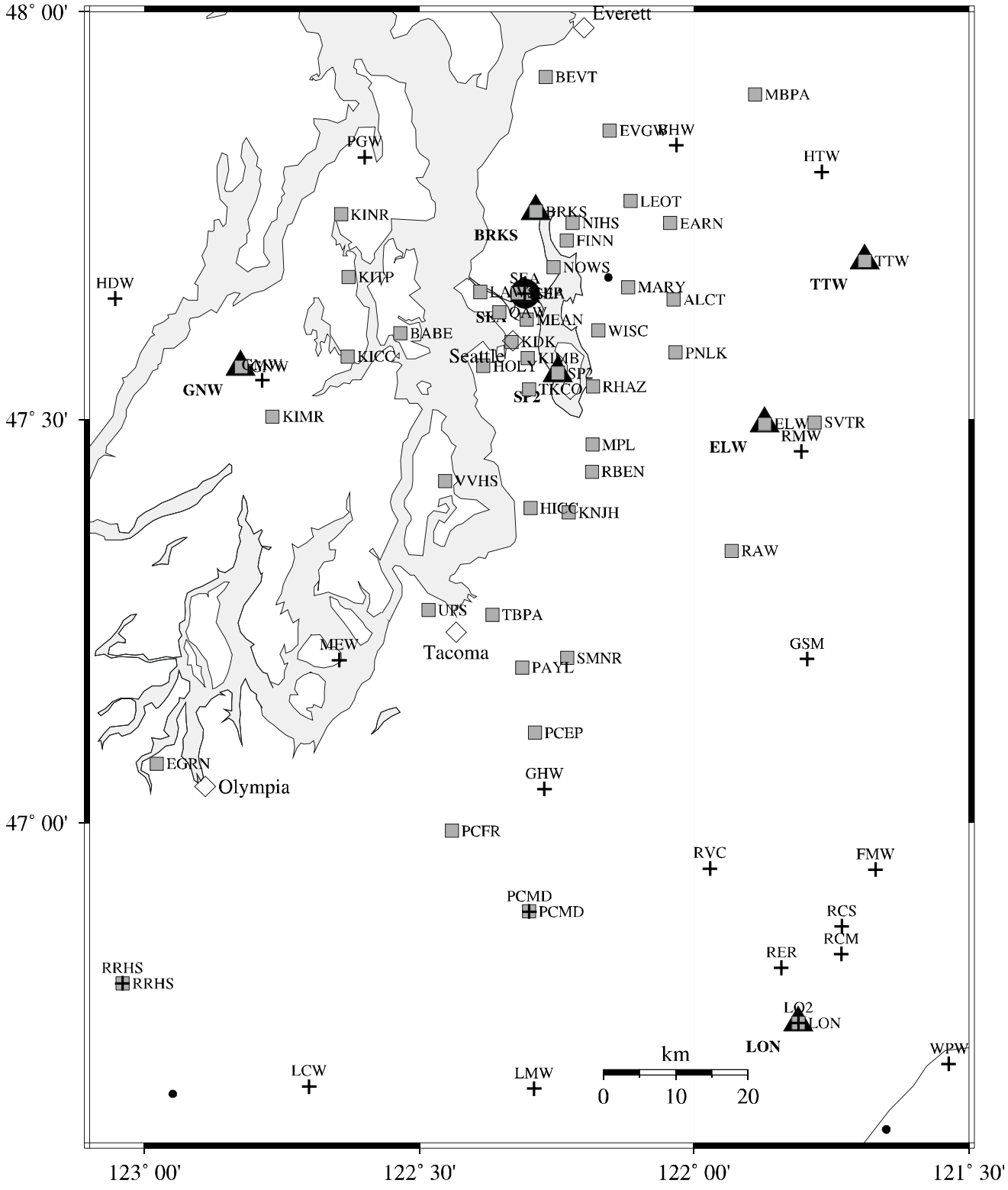
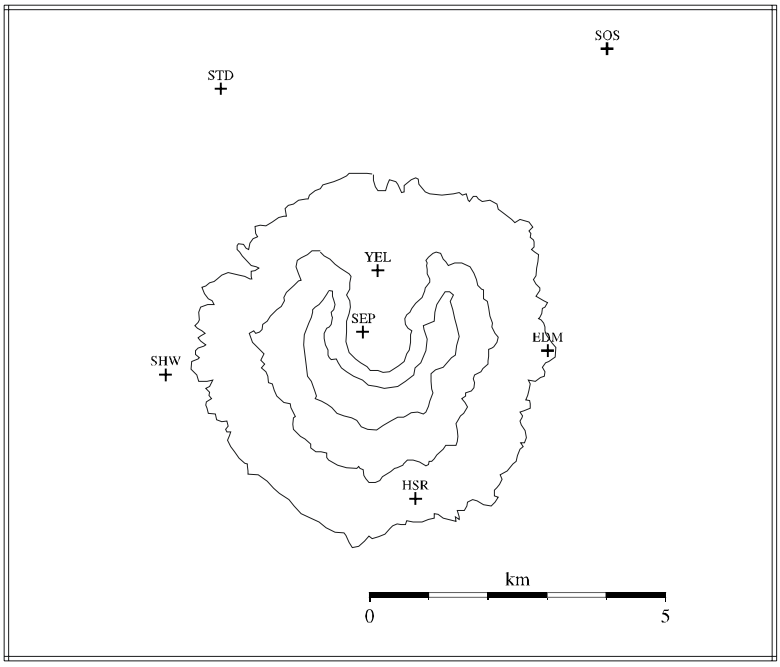


Figure 1 B. Puget Sound seismograph stations, detail of Fig. 1 A



Coordinates as in Fig. 4.

Figure 1 C. Mt. St. Helens area seismographic stations, detail of Fig. 1 A

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 01-HQ-AG-0011. 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 2A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
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, Oregon
BEN	H	46 31 12.0	119 43 18.0	0.335	PNNL station
BEND	%	44 04 00.8	121 19 36.0	-	UO Bend Office, DOGAMI SMO
BHW	%	47 50 12.6	122 01 55.8	0.198	Bald Hill
BLN	%	48 00 26.5	122 58 18.6	0.585	Blyn Mt.
BOW	%	46 28 30.0	123 13 41.0	0.87	Boistfort Mt.
BPO	%	44 39 06.9	121 41 19.2	1.957	Bald Peter, Oregon
BRO	%	44 16 02.5	122 27 07.1	0.135	Big Rock Lookout, Oregon
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, Oregon

TABLE 2A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
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
CMM	%	46 26 07.0	122 30 21.0	0.62	Crazy Man 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 16 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, Oregon
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., Oregon
HBO	%	43 50 39.5	122 19 11.9	1.615	Huckleberry Mt., Oregon
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., Oregon
HSO	%	43 31 33.0	123 05 24.0	1.02	Harness Mountain, Oregon
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, Oregon
JCW	%	48 11 42.7	121 55 31.1	0.792	Jim Creek
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., Oregon
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, Oregon
LAM	N	41 36 35.2	122 37 32.1	1.769	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
LMW	%	46 40 04.8	122 17 28.8	1.195	Ladd Mt.

TABLE 2A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
LNO	+	45 52 18.6	118 17 06.6	0.771	Lincton Mt., Oregon
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
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 46.8	122 49 56.4	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 05.5	121 40 05.5	2.27	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, Oregon
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, Oregon
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., Oregon
OBC	%	48 02 07.1	124 04 39.0	0.938	Olympics - Bonidu Creek
OBH	%	47 19 34.5	123 51 57.0	0.383	Olympics - Burnt Hill
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
PCMD	%	46 53 20.9	122 18 00.9	0.239	PC Mountain Detachment ANSS-SM
PGO	%	45 27 42.6	122 27 11.5	0.253	Gresham, Oregon
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, Oregon
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 SMO
SEA	%	47 39 15.8	122 18 29.3	0.03	UW, Seattle (Wood Anderson BB
SEP	#	46 12 00.7	122 11 28.1	2.116	September lobe, Mt. St. Helens
SFER	%	47 37 10.4	117 21 55.7	0.715	Spokane Schools, Ferris High S
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

TABLE 2A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
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, Oregon
STD	%	46 14 16.0	122 13 21.9	1.268	Studebaker Ridge
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., Oregon
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, Oregon
VCR	%	44 58 58.2	120 59 17.4	1.015	Criterion Ridge, Oregon
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, Oregon
VG2	%	45 09 20.0	122 16 15.0	0.823	Goat Mt., Oregon
VGB	+	45 30 56.4	120 46 39.0	0.729	Gordon Butte, Oregon
VGZ	C	48 24 50.0	123 19 27.8	0.067	Canada
VIP	%	44 30 29.4	120 37 07.8	1.731	Ingram Pt., Oregon
VLL	%	45 27 48.0	121 40 45.0	1.195	Laurance Lk., Oregon
VLM	%	45 32 18.6	122 02 21.0	1.15	Little Larch, Oregon
VSP	%	42 20 30.0	121 57 00.0	1.539	Spence Mtn, Oregon
VT2	+	46 58 02.4	119 59 57.0	1.27	Vantage2
VTH	%	45 10 52.2	120 33 40.8	0.773	The Trough, Oregon
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
WIB	%	46 20 34.8	123 52 30.6	0.503	Willapa Bay
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, Oregon
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 - Broad-band stations

STA	F	LAT	LONG	EL	NAME
BRKS	%	47 45 19.1	122 17 17.9	0.02	Brookside ANSS-SMO
COR	U	44 35 08.5	123 18 11.5	0.121	Corvallis, Oregon (OSU BB)
DBO	%	43 07 09.0	123 14 34.0	0.984	Dodson Butte, Oregon (UO CREST
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

TABLE 2B - Broad-band stations

STA	F	LAT	LONG	EL	NAME
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 S
HUMO		42 36 25.6	122 57 24.1	0.555	Hull Mountain,OR BB from UCB
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 23.0	123 54 29.0	1.265	Red Mtn, OR CREST BB
KSXB	N	41 49 51.0	123 52 33.0	-	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)
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 Cen
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
PFB	C	48 34 30.0	124 26 39.8	0.465	P.Renfrew, Canada
PIN	%	43 48 40.0	120 52 19.0	1.865	Pine Mt., Oregon (U0 CREST, B
PNT	C	49 18 57.6	119 36 57.6	0.55	Canada, BB
SEA	%	47 39 15.8	122 18 29.3	0.03	UW, Seattle (Wood Anderson 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)
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
WVOR	U	42 26 02.0	118 38 13.0	1.344	Wildhorse Valley, Oregon (USNS
YBH		41 43 55.3	122 42 37.4	1.06	Yreka, CA from UCB

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.
ALCT	%	47 38 48.8	122 2 15.7	0.055	Alcott Elementary	K2	I
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	0	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
BULL		45 26 45.8	122 9 16.9	0.222	Bull Run Dam	A	I
COLT	%	45 10 13.1	122 26 12.8	0.213	Colton High School	CMG5T	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
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
KDK	%	47 35 42.7	122 19 56.0	0.004	King Dome	K2	I
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 Communications	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 Facility	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
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)	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

TABLE 2C - Strong-motion three-component stations

STA	F	LAT	LONG	EL	NAME	SENSOR	TEL.
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
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
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
SEA	%	47 39 15.8	122 18 29.3	0.03	University of Washington	A20,PMD2023	L
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,R
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
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 Instructional Services Center	K2	I

EARTHQUAKE DATA - 2003-B

There were 1,049 events digitally recorded and processed at the University of Washington between April 1 and June 30, 2003. Locations in Washington, Oregon, or southernmost British Columbia were determined for 591 of these events; 483 were classified as earthquakes and 108 as known or suspected blasts. The remaining 458 processed events include teleseisms

(132 events), regional events outside the PNSN (76), 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 3A is a listing of all earthquakes reported to have been felt during this quarter. Events with ShakeMaps or Community Internet Intensity Maps (CIIM) are indicated. ShakeMap **http://www.ess.washington.edu/shake/index.html** shows instrumentally measured shaking using data from accelerometers in the network. Peak ground acceleration (PGA) values are modeled using information from accelerometers, local geology, and distance to the epicenter. CIIM maps **http://pasadena.wr.usgs.gov/shake/pnw/** are made using "felt" reports relayed via Internet. The "felt" reports are converted into numeric intensity values, and the CIIM map shows the average intensity by zip code.

Table 3B is a listing of earthquakes magnitude 2.5 or greater and in some cases include parameters for focal mechanisms from P-wave first motions. Table 4 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 2. Earthquakes with magnitude greater than or equal to 0.0 (M_c >=0).

Figure 3. Blasts and probable blasts (M_c >=0).

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

Figure 5. Earthquakes located near Mt. Rainier (M_c >=0).

Figure 6. Focal mechanisms computed for earthquakes M 2.5 or larger.

TABLE 3A - Felt Earthquakes during the 2ndQuarter of 2003

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	CIIM	ShakeMap
yy/mm/dd hh:mm:ss	deg.	deg.	km				
03/04/15 09:42:43	47.70	122.60	23.8	2.1	4.0 km SE of Poulsbo, WA		
03/04/17 01:38:02	47.69	122.10	13.7	2.7	8.3 km E of Kirkland, WA	x	
03/04/24 19:26:30	45.63	122.74	17.2	3.9	14.3 km NW of Portland, OR	x	
03/04/25 10:02:12	47.67	123.25	51.3	4.8	37.3 km ESE of Mt Olympus, WA	x	x
03/04/25 21:55:31	45.63	122.74	16.8	2.2	14.9 km NW of Portland, OR		
03/04/28 22:25:48	45.12	122.43	15.1	2.8	26.3 km SE of Canby, OR		
03/05/30 03:50:07	47.48	122.72	25.0	3.7	11.4 km SW of Bremerton, WA	x	x
03/06/20 02:01:23	47.65	121.98	19.6	3.5	5.4 km W of Carnation, WA	x	x
03/06/20 15:29:56	47.62	122.16	32.1	2.5	2.6 km ENE of Bellevue, WA		
03/06/26 12:44:57	45.75	122.32	7.6	2.2	33.6 km NE of Portland, OR		
03/06/28 06:15:50	47.93	121.83	15.7	2.4	12.9 km NE of Monroe, WA		

TABLE 3B – Earthquakes M 2.5 or larger, 2ndQuarter of 2003

Focal mechanisms noted where computed. Some earthquakes have more than one possible mechanism.

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	STRIKE	DIP	RAKE
yy/mm/dd hh:mm:ss	deg.	deg.	km			deg.	deg.	deg.
03/04/17 01:38:02	47.69	122.10	13.7	2.7	8.3 km E of Kirkland, WA	95	70	-140
03/04/24 19:26:30	45.63	122.74	17.2	3.9	14.3 km NW of Portland, OR	120	35	139
03/04/25 10:02:12	47.67	123.25	51.3	4.8	37.3 km ESE of Mt Olympus, WA	75	60	-70
03/04/25 11:56:35	47.68	123.24	49.7	2.9	37.8 km ESE of Mt Olympus, WA	40	15	50
03/04/28 22:25:48	45.12	122.43	15.1	2.8	26.3 km SE of Canby, OR	65	80	40
03/05/18 18:06:32	45.19	120.12	3.7	2.7	7.0 km SE of Condon, OR	-	-	-
03/05/27 18:59:33	48.93	123.04	16.4	2.6	22.3 km S of Vancouver, BC	120	60	140
03/05/30 03:49:67	47.49	122.73	25.0	3.7	11.4 km SW of Bremerton, WA	320	90	-10
03/06/01 17:06:03	45.19	120.11	0.0	2.8	7.4 km SE of Condon, OR	-	-	-
03/06/20 02:01:23	47.65	121.99	19.6	3.5	5.4 km W of Carnation, WA	115	45	180
03/06/20 15:29:56	47.62	122.17	32.1	2.5	2.6 km ENE of Bellevue, WA	120	75	120

OREGON

During the second quarter of 2003, a total of 35 earthquakes were located in Oregon between 42.0 degrees and 45.5 degrees north latitude, and between 117 degrees and 125 degrees west longitude. An earthquake sequence in Oregon this quarter occurred near the Washington border, just north of 45.5 degrees N latitude (and thus counted with western Washington, rather than Oregon). The sequence began with a magnitude 3.9 event on April 24 located at about 17 km depth 14 km northwest of Portland. Twenty-two aftershocks were recorded in the vicinity during the remainder of the quarter, including a felt event of magnitude 2.2 on April 25.

OREGON CASCADE VOLCANOES

This quarter 11 earthquakes were located in the area around Mount Hood from 45.25 to 45.45 N latitude and 121.6 to 121.8 W longitude. The largest earthquake near Mt. Hood this quarter was a magnitude 1.1 event on April 3.

WESTERN WASHINGTON SEISMICITY

During the second quarter of 2003, 370 earthquakes were located between 45.5 degrees and 49.5 degrees north latitude and between 121 degrees and 125.3 degrees west longitude. Seven earthquakes were felt this quarter in western Washington. Details are in Table 3A.

The largest felt earthquake in western Washington was a magnitude 4.8 earthquake on April 25, located at about 51 km depth approximately 37 km east-southeast of Mt. Olympus. About 700 felt reports from 160 zip codes were received by CIIM. A smaller, midcrustal (~20 km depth) earthquake, M 3.7 on May 30 UTC, located in a more populous area near Bremerton prompted about 1700 reports to CIIM from 183 zip codes. ShakeMaps were created for both events. The deepest quake in western Washington this quarter was a magnitude 0.8 earthquake at about 73 km depth, located about 14 km northeast of Carnation WA on June 23.

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 was one located event flagged "L" or "S" at Mount Rainier this quarter although 43 "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 33 tectonic events (10 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 1.6 event at a depth of about 7 km located about 19 km west-northwest of the summit. This quarter, 19 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 8 (2 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, 109 earthquakes were located at Mount St. Helens in the area shown in Fig. 5. Of these earthquakes, 19 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 0.9 event at about 2 km depth on June 10 UTC. It was located about .5 km southeast of the summit.

One type "S" or "L" events was located at Mount St. Helens, and 102 "L" or "S" events too small to locate were recorded.

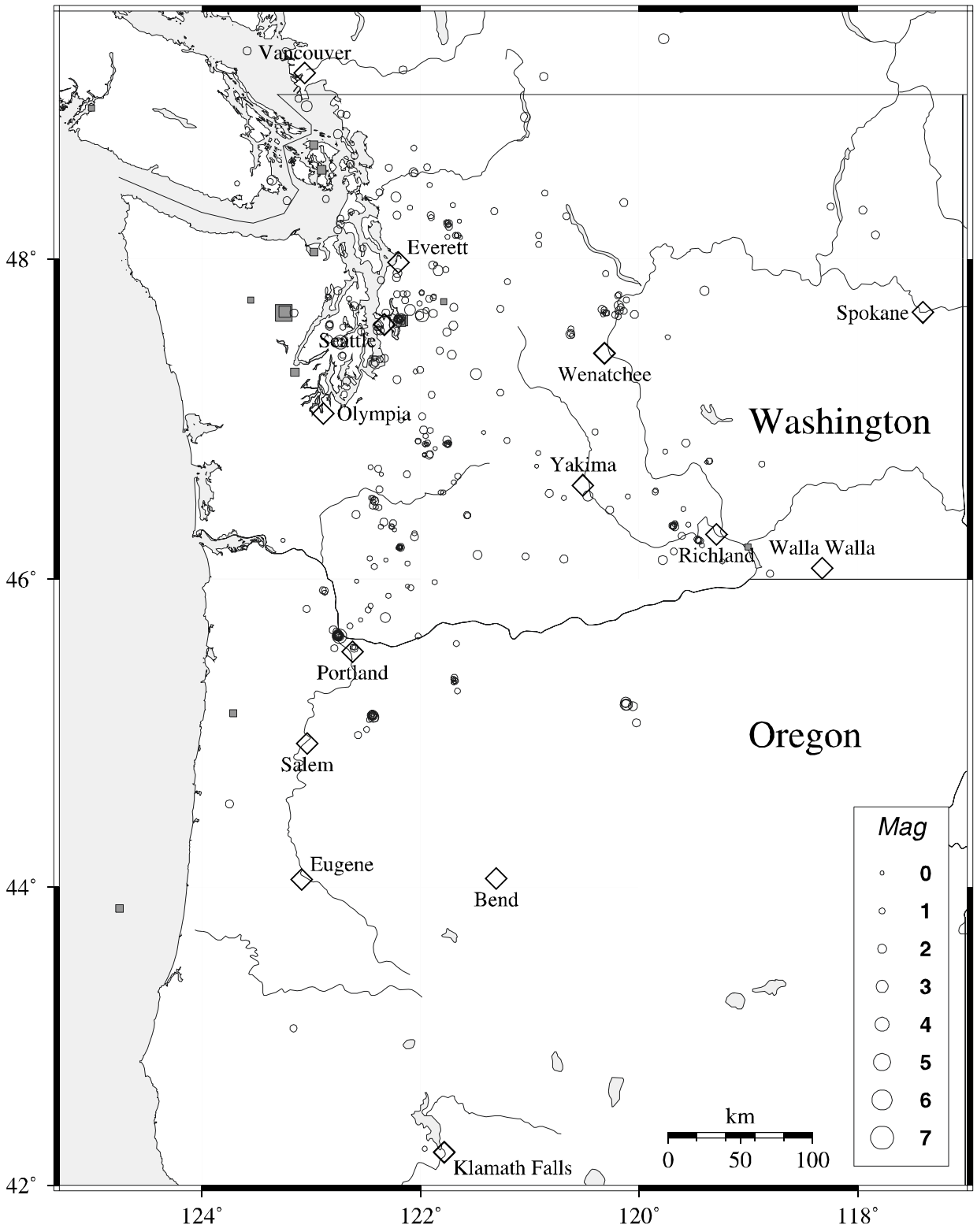


Figure 2. Earthquakes with magnitude greater than or equal to 0.0 (Mc >=0.)
Unfilled diamonds represent cities.

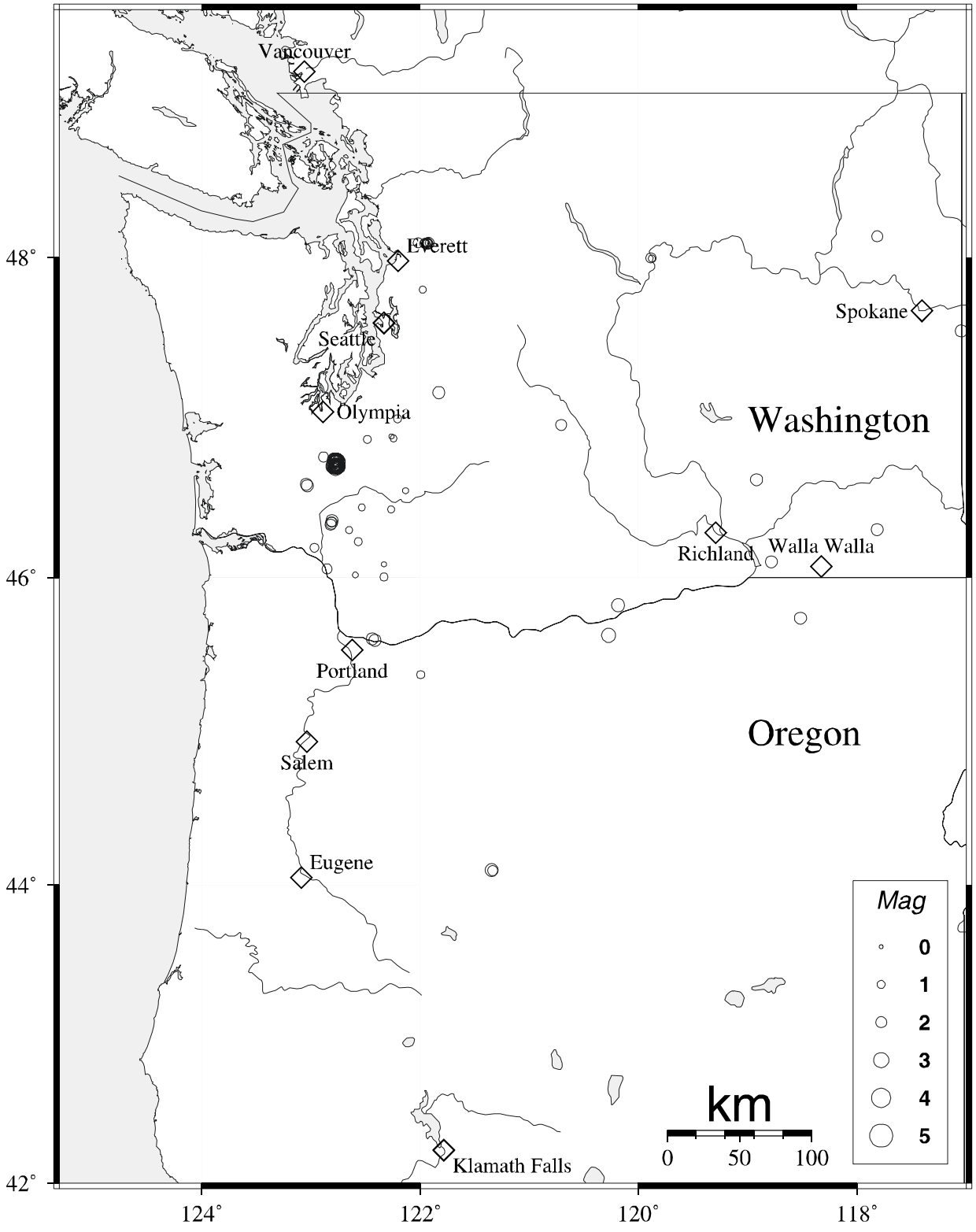
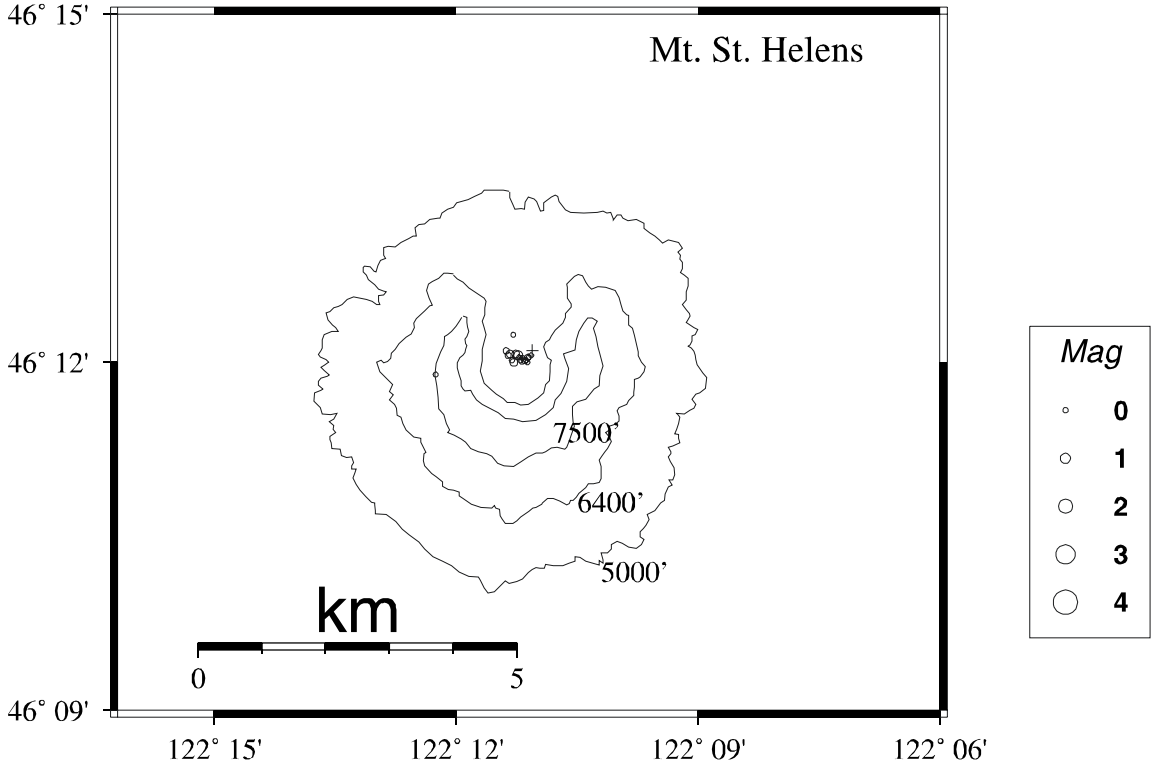


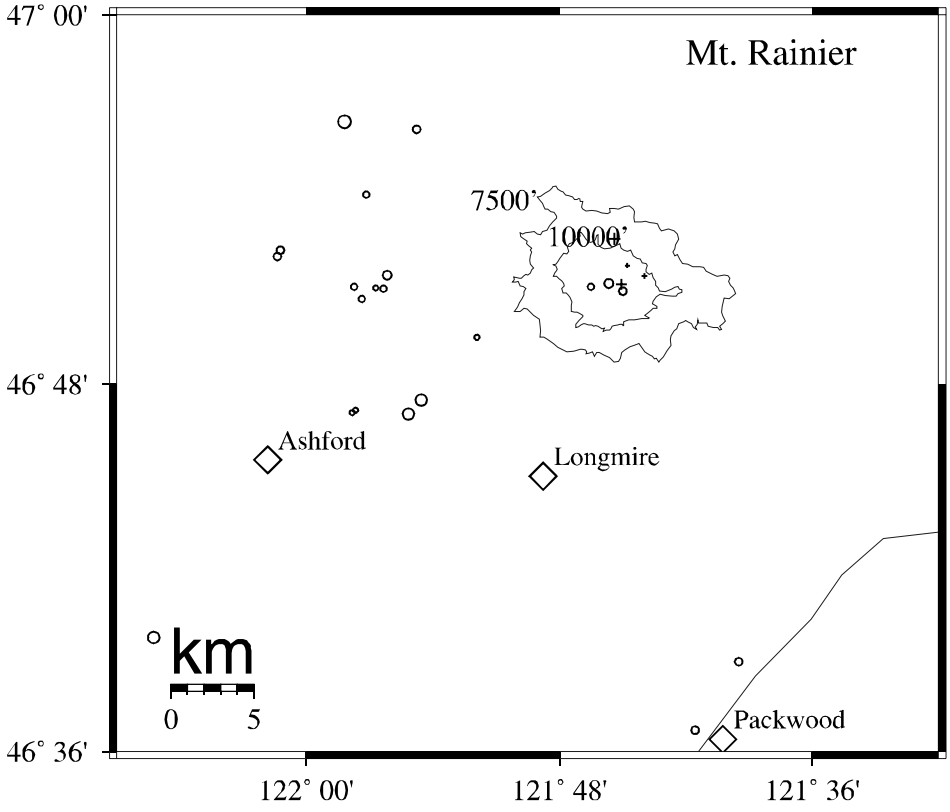
Figure 3. Blasts and probable blasts. Unfilled diamonds represent cities

Figure 4. Earthquakes at Mt. St. Helens, M>0.



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

Figure 5. Earthquakes at Mt. Rainier, M>0.



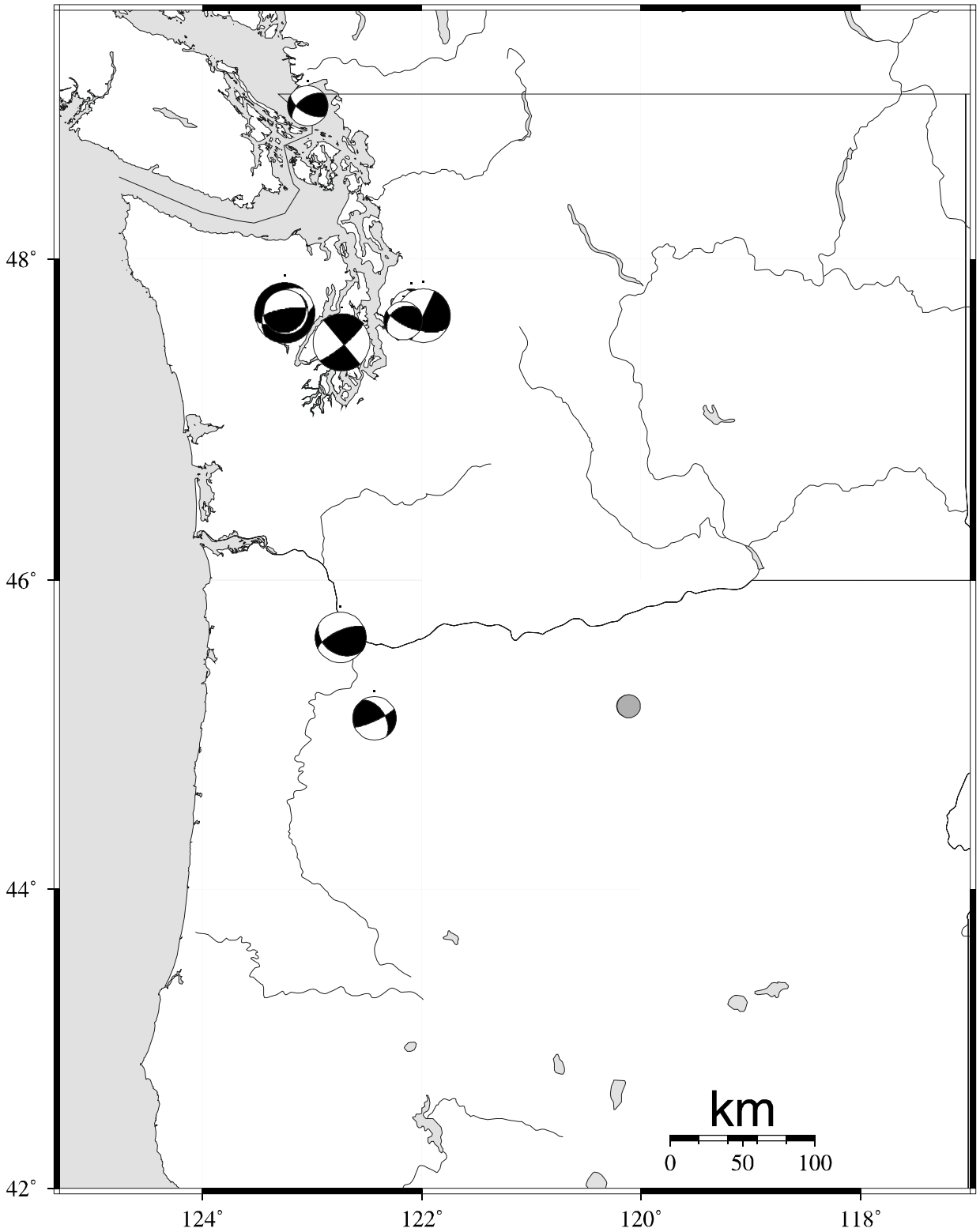


Figure 6. Focal mechanisms for earthquakes magnitude 2.5 or greater.
See Table 3B for details

EASTERN WASHINGTON SEISMICITY

During the second quarter of 2003, 78 earthquakes were located in eastern Washington in the area between 45.5-49.5 degrees north latitude and 117-121 degrees west longitude. No earthquakes were recorded near Spokane this quarter. The largest earthquake in Washington this quarter was magnitude 2.3, on May 1. It located at a near-surface depth (<2 km) approximately 8 km south-southeast of Yakima. Other activity in eastern Washington included a spatial cluster of 20 crustal events near Entiat.

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. The "Outreach Activities" section describes how to access PNSN data via e-mail, Internet, and World-Wide-Web. To request additional information by e-mail, contact seis_info@ess.washington.edu.

Earthquake information in the quarterlies has been published in final form by the Washington State Department of Natural Resources as information circulars entitled "Earthquake Hypocenters in Washington and Northern Oregon" covering the period 1970-1989 (see circulars Nos. 53, 56, 64-66, 72, 79, 82-84, and 89). These circulars, plus circular No. 85, "Washington State Earthquake Hazards", are available from Washington Dept. of Natural Resources, Division of Geology and Earth Resources, Post Office Box 47007, Olympia, WA 98504-7007, or by telephone at (360) 902-1450.

Several excellent maps of Pacific Northwest seismicity are available. A very colorful perspective-view map (18" x 27") entitled "Major Earthquakes of the Pacific Northwest" depicts selected epicenters of strong earthquakes (magnitudes > 5.1) that have occurred in the Pacific Northwest. A more detailed full-color map is called "Earthquakes in Washington and Oregon 1872-1993", by Susan Goter (USGS Open-File Report 94-226A). It is accompanied by a companion pamphlet "Washington and Oregon Earthquake History and Hazards", by Yelin, Tarr, Michael, and Weaver (USGS Open-File Report 94-226B). The pamphlet is also available separately. Maps can be ordered from: "Earthquake Maps", U.S. Geological Survey, Box 25046, Federal Center, MS 967, Denver, CO 80225, phone (303) 273-8477. The price of each map is $12. (including US shipping and handling).

USGS Cascades Volcano Observatory has a video, "Perilous Beauty: The Hidden Dangers of Mount Rainier", about the risk of lahars from Mount Rainier. Copies are available through: Northwest Interpretive Association (NWIA), 909 First Avenue Suite 630, Seattle WA 98104, Telephone e: (206) 220-4141, Fax: (206) 220-4143.

Other regional agencies provide earthquake information. These include the Geological Survey of Canada (Pacific Geoscience Centre, Sidney, B.C.; (250) 363-6500, FAX (250) 363-6565), which produces monthly summaries of Canadian earthquakes; the US Geological Survey which produces weekly reports called "Seismicity Reports for Northern California" (USGS, attn: Steve Walter, 345 Middlefield Rd, MS-977, Menlo Park, CA, 94025) and "Weekly Earthquake Report for Southern California" (USGS, attn: Dr. Kate Hutton or Dr. Lucy Jones, CalTech, Pasadena, CA.).

KEY TO EARTHQUAKE CATALOG IN TABLE 4

Origin time: is calculated for each earthquake on the basis of multi-station arrival times. Time is given in Coordinated Universal Time (UTC), in hours:minutes:seconds. To convert to Pacific Standard Time (PST) subtract eight hours, or to Pacific Daylight Time subtract seven hours.

North latitude: of the epicenter, in degrees and minutes.

West longitude: of the epicenter, in degrees and minutes.

Depth: given in kilometers, is usually freely calculated from the arrival-time data. In some instances, the depth must be fixed arbitrarily to obtain a convergent solution. Such depths are noted by an asterisk (*) in the column immediately following the depth. A $ or a # following the depth mean that the maximum number of iterations has been exceeded without meeting convergence tests and both the location and depth have been fixed.

Coda-length magnitude, Mc: an estimate of local magnitude ML (Richter, C.F., 1958, Elementary Seismology: W.H. Freeman and Co., 768p), calculated using the coda-length/magnitude relationship determined for Washington (Crosson, R.S., 1972, Bull. Seism. Soc. Am., v. 62, p. 1133-1171). Magnitudes may be revised as we improve our analysis procedure.

NS: the number of station observations, and NP: the number of P and S phases used to calculate the earthquake location. A minimum of three stations and four phases are required. Generally, more observations improve the quality of the solution.

Azimuthal gap: The largest angle (relative to the epicenter) containing no stations.

Root-mean-square residual: (observed arrival time minus predicted arrival time) at all stations used to locate the earthquake. It is only useful as a measure of the quality of the solution when 5 or more well-distributed stations are used in the solution. Good solutions are normally characterized by RMS values less than about 0.3 sec.

Quality factors: Two factors indicate the general reliability of the solution (A is best quality, D is worst). Similar quality factors are used by the USGS for events located with the computer program HYPO71.

First Quality factor is a measure of the hypocenter quality based on travel-time residuals. For example:
A quality requires an RMS less than 0.15 sec.
D quality has an RMS of 0.5 sec.

Second Quality factor depends on the spatial distribution of stations around the epicenter, i.e. number of stations, their azimuthal distribution, and the minimum distance DMIN from the epicenter to a station. A quality requires a solution with 8 or more phases, GAP <= 90 degrees and DMIN <= 5 km or depth, whichever is greater. If the number of phases, NP, is 5 or fewer or GAP > 180 degrees or DMIN > 50 km the solution is assigned quality D.

Crustal velocity model: Layered velocity models appropriate to different geographic areas are used in location calculations (Ludwin, R.S., et al., 1994, Earthquake hypocenters in Washington and northern Oregon, 1987-1989, and Operation of the Washington Regional Seismograph Network, Information Circular 89, Washington State Dept. of Natural Resources).

P3 - Puget Sound model
C3 - Cascade model
S3 - Mt. St. Helens model including Elk Lake
N3 - northeastern model
E3 - southeastern model
O0 - Oregon model
K3 - Southern Oregon, Klamath Falls area model
R0 and J1 - Regional and Offshore models

Flagging: Events flagged in Table 4 use the following code:

F- earthquake reported to have been felt
P - probable explosion
L - low frequency earthquake (e.g. glacier movement, volcanic activity)
H - handpicked from helicorder records
S - Special event (e.g. rockslide, avalanche, volcanic steam emission, harmonic tremor, sonic boom), not a man-made explosion or tectonic earthquake
X - known explosion

EARTHQUAKE CATALOG, 2003-B

Complete catalog listings are available on-line through http://www.ess.washington.edu/SEIS/PNSN/CATDAT/catalog.html

TABLE 4. Tectonic earthquakes, 2nd quarter, 2003, magnitude 2.0 and larger

Within the area 42-49.5 degrees north latitude and 117-125.3 degrees west longitude

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
April 2003											
1	00:16:59	45 38.29	122 45.67	17.17	2.3	46/049	42	0.19	BA	C3	
15	09:42:44	47 42.55	122 36.51	23.82	2.1	48/048	95	0.16	BB	P3	F
17	01:38:03	47 41.29	122 05.84	13.70	2.7	77/077	37	0.45	CA	P3	F
24	19:26:30	45 37.97	122 44.32	17.19	3.9	67/069	41	0.22	BA	C3	F
25	10:02:13	47 40.23	123 15.00	51.26	4.8	93/093	53	0.18	BA	P3	F
25	11:56:36	47 40.58	123 14.38	49.66	2.9	46/046	95	0.15	BB	P3	
25	21:55:31	45 38.13	122 44.78	16.75	2.2	47/055	41	0.19	BA	C3	F
28	22:25:48	45 06.93	122 25.82	15.15	2.8	52/060	43	0.39	CA	O0	F
May 2003											
DAY	**TIME**	**LAT**	**LON**	**DEPTH**	**M**	**NS/NP**	**GAP**	**RMS**	**Q**	**MOD**	**TYP**
1	01:34:04	45 07.51	122 26.61	14.96	2.1	32/035	43	0.22	BA	O0	
1	20:16:56	46 31.50	120 28.02	0.03*	2.3	8/008	170	0.29	BC	E3	
1	21:33:01	45 07.41	122 26.08	15.37	2.4	33/034	43	0.24	BA	O0	
13	08:00:36	45 38.28	122 44.82	15.77	2.0	40/045	42	0.20	BA	C3	
17	21:14:47	45 12.48	120 07.33	0.02*	2.3	8/008	211	0.11	AD	O0	

18	18:06:32	45 11.62	120 07.21	3.66	2.7	10/010	170	0.13	BC	O0	
27	01:18:07	48 22.93	122 13.49	15.35	2.2	25/027	53	0.35	CB	P3	
27	18:59:34	48 55.78	123 02.36	16.37	2.6	20/021	223	0.24	BD	P3	
29	04:53:15	47 17.40	121 29.51	16.45	2.5	42/043	42	0.18	BB	C3	
30	03:50:08	47 29.37	122 43.78	25.00	3.7	71/088	55	0.19	BA	P3	F

June 2003

DAY	TIME	LAT	LON	DEPTH	M	NS/NP	GAP	RMS	Q	MOD	TYP
1	17:06:03	45 11.64	120 06.79	0.02*	2.8	20/020	145	0.20	BC	O0	
6	21:54:54	48 51.90	121 02.23	2.24*	2.2	9/010	225	0.34	CD	C3	
17	10:13:40	46 09.16	121 28.56	0.03*	2.0	27/027	76	0.31	CB	C3	
19	15:13:50	48 45.88	122 45.37	0.69$	2.0	18/018	146	0.31	CC	P3	
20	02:01:23	47 39.19	121 59.18	19.63	3.5	102/103	24	0.29	BA	P3	F
20	15:29:57	47 37.35	122 10.13	32.13	2.5	92/094	23	0.42	CA	P3	F
22	14:11:44	49 20.14	119 46.57	0.05*	2.3	11/011	222	0.62	DD	N3	
24	23:05:57	48 28.85	123 21.47	23.05	2.3	27/029	105	0.21	BB	P3	
25	13:01:12	48 31.92	122 03.83	0.04*	2.0	9/009	149	0.11	AC	P3	
26	12:44:57	45 45.14	122 19.29	7.59	2.2	36/038	82	0.17	BC	C3	F
26	19:44:06	47 38.06	122 11.65	26.91	2.4	57/059	32	0.19	BA	P3	
28	06:15:50	47 55.83	121 50.28	15.68	2.4	48/050	45	0.26	BA	P3	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.ess.washington.edu/SEIS/PNSN.

Telephone, Mail, and On-line outreach

The PNSN audio library system received 575 calls this quarter. Our audio library provides several recordings; we have resumed regular updating of messages concerning current seismic activity. This service was suspended for a quarter to reassess need and was resumed due to demand from a few loyal callers without Internet access. Additionally, there is currently a recording describing seismic hazards in Washington and Oregon, and another on earthquake prediction.

Callers often request our one-page information and resource sheet on seismic hazards in Washington and Oregon. Thousands of these have been issued and we encourage others to reproduce and further distribute this flyer. Our information sheet discussing earthquake prediction is also frequently requested. Callers to the audio library have the option of being transferred to the Seismology Lab for additional available information. This quarter the Seismology Lab responded in person to:

- 20 calls from emergency managers and government,
- 55 calls from the media,
- 15 calls from k-12 educators,
- 25 calls from the business community,
- 65 calls from the general public.

Internet outreach:

PNSN staff replied to 115 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 PNSN web site offers many pages, including maps and lists of the most recent PNW earthquakes, general information on earthquakes and PNW earthquake hazards, information on past notable PNW earthquakes, and searchable

catalogs of earthquake summary cards. Automatically updated Web pages on seismicity of Cascade Volcanos, and Quarterly Reports are also available. Additionally:

- **Recent Earthquake List:** http://www.ess.washington.edu/recenteqs/ provides lists of all recent significant earthquakes.
- **"Webicorders":** http://www.ess.washington.edu/SEIS/PNSN/WEBICORDER/ provides pages displaying continuous data from PNSN seismographic stations.
- **"ShakeMap":** http://www.ess.washington.edu/shake/index.html shows maps of instrumentally measured shaking. Table 3A indicates which events this quarter generated ShakeMaps.

Table 3A also indicates the felt events this quarter that generated Community Internet Intensity Maps (CIIM). CIIM maps are made using Internet reports. For a well-felt event hundreds (or thousands) of people fill out an on-line form describing their experiences during the earthquake. These "felt" reports are converted into numeric intensity values, and the CIIM map shows the average intensity by zip code.

- **CIIM Maps:** http://pasadena.wr.usgs.gov/shake/pnw/

In addition to the PNSN web site, the UW Dept. of Earth and Space Sciences and the PNSN host several other earthquake-related web sites:

- **Volcano Systems Center:** http://www.vsc.washington.edu/ is a cooperative effort of the UW and the USGS that links volcano-related activities of the UW Dept. of Earth and Space Sciences and Oceanography departments with related USGS activities.
- **Seismosurfing:** http://www.ess.washington.edu/seismosurfing.html is a comprehensive listing of sites worldwide that offer substantive seismology data and information. This page is mirrored at two sites in Europe.
- **"Tsunami!":** http://www.ess.washington.edu/tsunami offers many pages, including an excellent discussion on the physics of tsunamis, and short movie clips. Benjamin Cook developed it under the direction of Dr. Catherine Petroff (UW Civil Engineering).
- **The UW Dept. of Earth and Space Sciences Global Positioning System (GPS):** The http://www.ess.washington.edu/GPS/gps.html site provides information on geodetic studies of crustal deformation in Washington and Oregon.

K-20 Education Outreach:

PNSN and USGS staff provided 20 Seismology Lab tours and presentations for K-20 students and teachers serving about 400 people this quarter. Tours were also provided to visiting scientists, undergraduates, and groups of potential graduate students visiting the PNSN.

- **Educational Resources Page:** http://www.ess.washington.edu/SEIS/PNSN/EDHOME/index.html.

Amy Lindemuth maintains an email list-service with over 50 local K-20 educators, subscribers interested in earth sciences education. PNSN analyst Amy Wright has produced and distributed monthly newsletters to this list since January 2003. Topics include interesting records available on the webicorders, classes and workshops for teachers, and other current events in seismology and science 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. The PNSN also welcomes media representatives to participate in regional earthquake monitoring planning efforts including the PNWANSS Advisory Committee.

Five felt earthquakes attracted significant media interest this quarter, including quakes felt in Portland and Seattle. The April 24th Magnitude 3.9 earthquake located just northwest of the City of Portland OR generated over 1000 CIIM felt reports. The PNSN provided briefings for the Oregon Department of Geology and Mineral Industries (DOGAMI) public relations staff, and DOGAMI staff provided local interviews for the Portland media.

On May 29 at 8:49 PM local time an earthquake occurred in central Puget Sound near Bremerton. This quake was located in the lower crust (20 km deep). The urban location of the earthquake, and its early evening timing, caused it to be

felt by large numbers of people. About 1,700 on-line reports were sent to CIIM and the event was well covered by Seattle media. PNSN staff provided local interviews.

This quarter PNSN and USGS staff also provided interviews on the uses of LIDAR to detect surface rupture, slow interplate slip events, and the associated deep tremor being studied by Steve Malone and graduate student Wendy McCausland. USGS Paleoseismologist Brian Sherrod also provided interviews about the USGS trenching across the Tacoma Fault.

Ruth Ludwin developed a Press Release on 1872 EQ Relocation, "Washington's Largest Historic Crustal Earthquake, in 1872, was Probably near Entiat," posting it on the PNSN webpage with links to related information including the article, "The December 1872 Washington State Earthquake," by William H. Bakun, Ralph A. Haugerud, Margaret G. Hopper, and Ruth S. Ludwin, recently published in the Bulletin of the Seismological Society of America.

The Cascadia Regional Earthquake Workgroup video "Business Survival Kit for Earthquakes and Other Disasters" was released this quarter. Bill Steele and Craig Weaver participated in the planning and production of this product and are interviewed in the 30-minute video (produced by Global Net Productions for CREW) that is included in this planning kit. For more information visit http://www.crew.org/.

Meetings and Presentations:

Steve Malone:

- Presented a talk on volcanic earthquake-like seismic events caused by the movement of glaciers at the **AGU/EGS/EUG meeting** in France.
- Gave a talk reviewing seismic network recording and processing systems at the **SSA meeting** in Puerto Rico.

Aggeliki Barberopoulou:

- Presentation at the **SSA meeting** in Puerto Rico, about the local (Puget Lowland) amplification of seismic waves from the Mw 7.9 Alaska earthquake and the resulting seiche that damaged house boats in Lake Union, Seattle.

Ruth Ludwin:

- Made two trips to Olympic Peninsula in support of **WA State DEM Tsunami Educational Video** for K-6.
- Presented two general talks on Pacific Northwest seismic hazards at the Juan de Fuca Festival.

Bill Steele:

- Staffed a PNSN booth at the Annual "Partners in Preparedness" Conference; attended by over 500 public and private sector emergency managers and other interested parties.
- Co-presented a workshop on Puget Sound Crustal Earthquake Hazards and Information Products for Responders with Brian Sherrod of the USGS Seattle Field Office.
- Organized and spoke at a workshop for the Seattle Floating Homes Association on Seiche Hazards in Seattle.
- Assisted ESS faculty and Bob Yeats, from the University of Oregon, in the development of the new ESS undergraduate course "Earthquakes."

The PNSN remains an active participant in a number of organizations whose goals and objectives are complementary to the PNSN mission to reduce loss of life and property due to earthquakes. Bill Steele serves on the Board of Directors and as Secretary of the Cascade Region Earthquake Workgroup (**CREW**) and represents the PNSN in The Contingency Planners and Recovery Managers (**CPARM**). Bill serves as an advisor to a number of Project Impact Communities and is a member of **The Washington State Emergency Management Association**. Tony Qamar is an active member of the **Washington State Seismic Safety Committee**. Steve Malone is the Regional Coordinator for the **ANSS** and participates in monthly **National Implementation Committee** conference calls and meetings.