FINAL TECHNICAL REPORT: 2003

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FINAL TECHNICAL REPORT
USGS Joint Operating Agreement 01HQAG0011
PACIFIC NORTHWEST SEISMOGRAPH NETWORK (PNSN) OPERATIONS

ABSTRACT AND NON-TECHNICAL SUMMARY

This is the final technical report for USGS Joint Operating Agreement 01HQAG0011 *"Pacific Northwest Seismograph Network (PNSN) Operations"*. The PNSN operates seismograph stations in Washington and Oregon, and collects and analyzes earthquake data. Between Jan. 1, 2003 and Dec. 31, 2003 the PNSN analyzed 4,863 events. Of these, 1,978 were earthquakes located within the network. An additional 1,510 earthquakes within the network were too small to locate; including 478 low frequency events near the summit of Mt. Rainier (probably icequakes) and 625 surficial events near the summit of Mt. St. Helens, (probably rockfalls). West of 120.5 degrees west longitude, 1,746 earthquakes were located in Washington and Oregon (including 444 tectonic events in the general vicinity of Mount St. Helens). East of 120.5 degrees W longitude, 232 earthquakes were located. The remaining 1,375 events were located or unlocated blasts (488), regional earthquakes (290) or teleseisms (597).

Between Jan. 1, 2003 and Dec. 31, 2003, 39 earthquakes were reported felt in Washington or Oregon west of the Cascades, ranging in magnitude from 1.6 to 4.8. Eight earthquakes (magnitudes 0.9 to 3.4) were reported felt east of the Cascades.

SUMMARY

USGS Joint Operating Agreement 01HQAG0011 "*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 01HQAG0012, 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 2003, an overview of our public information program, and a summary of 2003 seismicity. Annual reports for 2001 and 2002 cover operations and seismicity for those years. 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 51 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 2003 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 an instrumental record of the shaking that produces liquefaction is of interest for 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. Although there is no shortage of cooperative organizations and building owners, finding internet telemetry connections and obtaining long-term permits for these sites has proven to be challenging. We are making slow progress.

This year one new CREST (Consolidated Reporting of EarthquakeS and Tsunamis) station was installed, near Liberty WA, bringing the total number of PNSN CREST stations to 16. The PNSN also receives 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 select recipients including 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

Data acquisition is divided among three computers; *scossa*, *verme*, and *milli*; which subsequently exchange and share the acquired data. *Pigia* is the digitizer for analog data. Prior to this year, a SUN-based SUNWORM system *waggles* was used to digitize data. However, *waggles* crashed hard in mid 2003. *Pigia* took over , but soon began crashing periodically with no diagnostics and had to be rebuilt. A remote digitizing "miniworm" computer scheduled for installation in Bend, OR was pressed into service at the University of Washington as a replacement.

"Miniworm"systems (local nodes that digitize data and send it to the UW via Internet, eliminating expensive long-distance leased phone-lines) are running in Klamath Falls, OR (installed 4th quarter, 2002) and Forks, WA (installed 2nd quarter 2003),

OPERATIONS

Seismometer Locations and Network Maintenance

Figure 1 shows seismograph stations operated by the PNSN at the end of 2003, 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, 37 broad-band, and 96 strong-motion stations. The Pacific Northwest Seismograph Network (PNSN) operates 171 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 7 components. PNSN stations in southern and central Oregon are maintained by the University of Oregon under Cooperative Agreement 01HQAG0012.

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, 2003 through December, 2003 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 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.

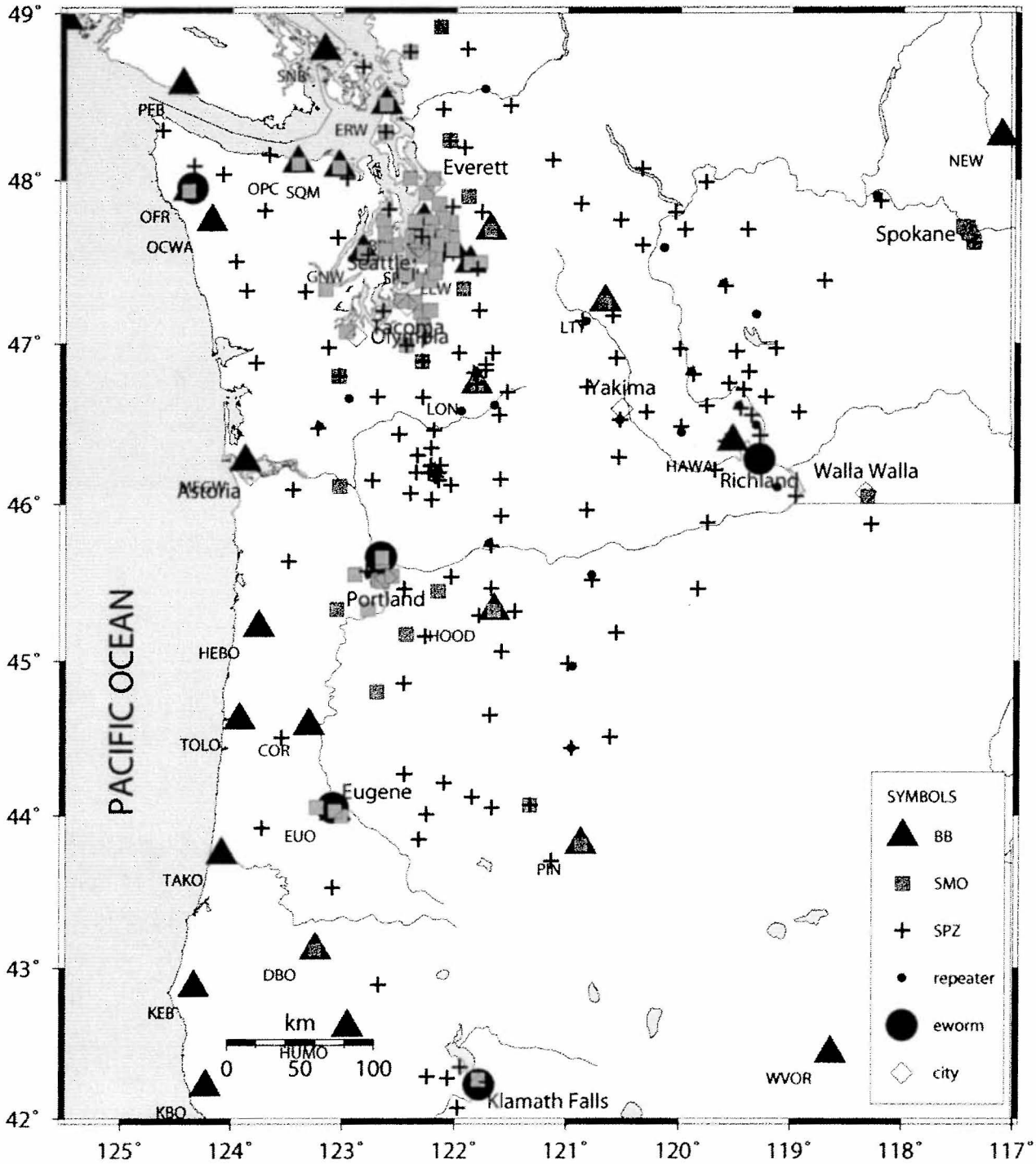

Figure 1. Seismograph Stations.

"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.

TABLE 1A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
		(deg. min. sec.)	(deg. min. sec.)	(km)	
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	-	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, 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
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 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

TABLE 1A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
		(deg. min. sec.)	(deg. min. sec.)	(km)	
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
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
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.
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
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, 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
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)
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 Mt. 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

TABLE 1A - Short-period Stations

STA	F	LAT	LONG	EL	NAME
		(deg. min. sec.)	(deg. min. sec.)	(km)	
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 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
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
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
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
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., 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
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
		(deg. min. sec.)	(deg. min. sec.)	(km)	
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, OR USNSN
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
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 Mdws., OR CREST BB SMO
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 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
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	OlympiRsrc. 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
PFB	C	48 34 30.0	124 26 39.8	0.465	P.Renfrew, Canada
PNLK	%	47 34 54.5	122 02 01.0	0.128	Pine Lake JH ANSS-SMO
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
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, OR USNSN BB
YBH		41 43 55.3	122 42 37.4	1.06	Yreka, CA from UCB

Table1C 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.
		(deg. min. sec.)	(deg. min. sec.)	(km)			
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
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 Comm.	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	Mod. Risk Waste Coll. 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
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

TABLE 1C - Strong-motion three-component stations

STA	F	LAT	LONG	EL	NAME	SENSOR	TEL.
		(deg. min. sec.)	(deg. min. sec.)	(km)			
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 Nat. Rsrcs. Ctr. (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 Elem. 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
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 Prop. (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

TABLE 1C - Strong-motion three-component stations

STA	F	LAT	LONG	EL	NAME	SENSOR	TEL.
		(deg. min. sec.)	(deg. min. sec.)	(km)			
WISC	%	47 36 32.0	122 10 27.8	0.056	Wilburton Instr. Services Cntr.	K2	I
WWHS	%	46 2 43.5	118 19 2.0	0.01	Walla Walla High School	CMG5T	I

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. Continuous seismic data are 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. 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.

Starting in the fall of 2001, we started shipping a large portion of our waveform data to the IRIS DMC in near real time. This was done by running the ew2seed program at IRIS, which connects to our EARTHWORM waveservers and extracts ½ hour of data at a time. Several months of testing proved successful. In the spring of 2003, we started sending all PNSN traces from all wave servers so that IRIS has a complete copy of all our continuous data in 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 2003 which were reported felt. Table 3 gives information on seismic activity recorded at the PNSN annually since 1980. During this reporting period there were 39 earthquakes reported felt west of the Cascades in Washington or Oregon, ranging in magnitude from 1.6 to 4.8.

East of the Cascades in Washington or Oregon, 8 earthquakes were felt during 2003. These ranged from magnitude 0.9 to 3.4.

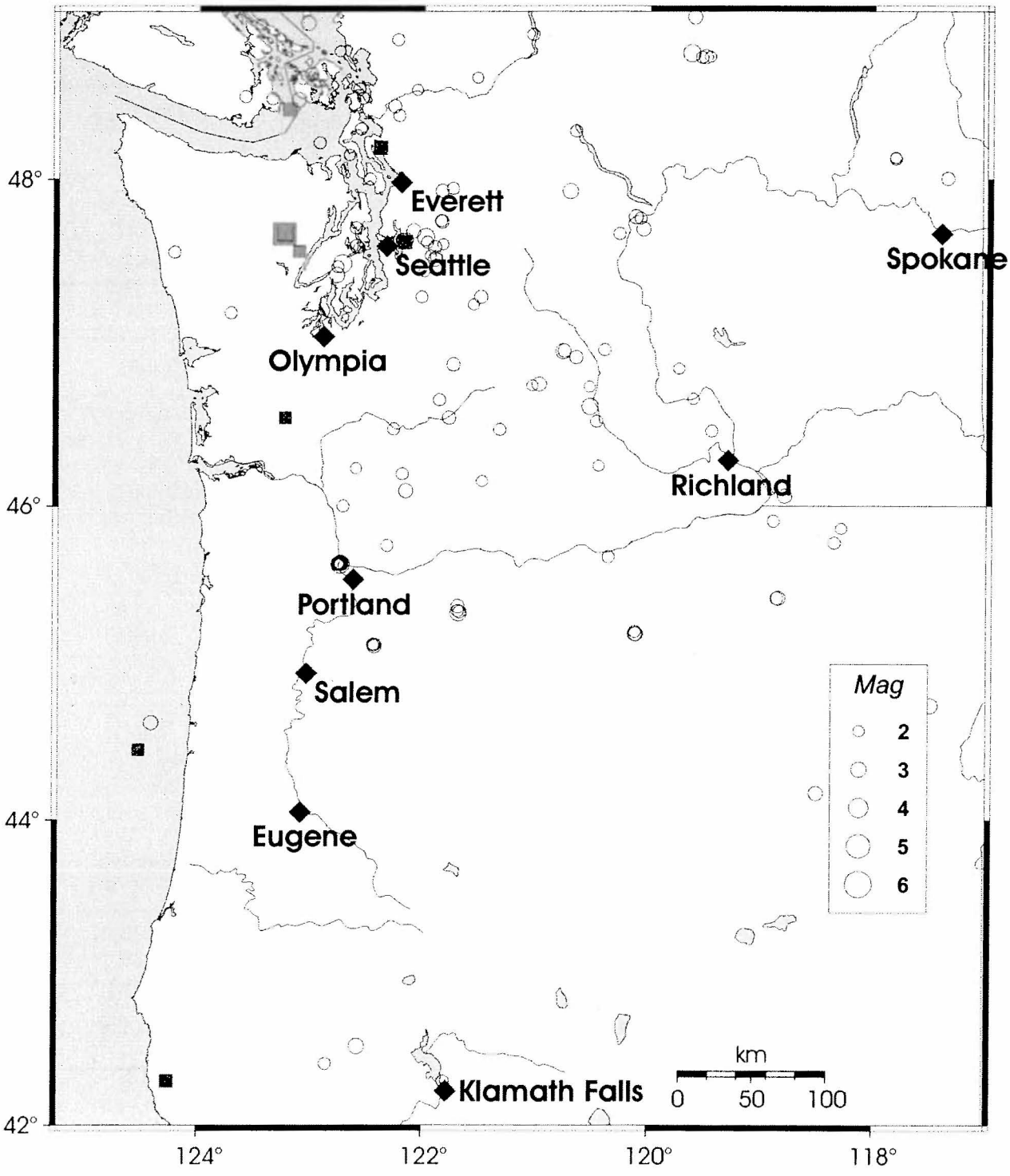

Figure 2. Seismicity 2003

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

TABLE 2 - Felt Earthquakes during 2003

DATE-(UTC)-TIME	LAT (N)	LON (W)	DEP	M	COMMENTS	CIIM	Shake Map
mm/dd/yyyy hh:mm	deg.	deg.	km				
1/09/2003 17:55:12	47.62	121.97	8.8	2.1	5.3 km SW of Carnation, WA	-	-
1/13/2003 09:58:01	47.78	120.13	4.6	2.6	11.1 km SW of Chelan, WA	-	-
1/14/2003 00:06:06	48.48	123.12	20.9	2.7	10.9 km SW of Friday Harbor, WA	-	-
1/14/2003 20:52:51	47.59	121.91	2.3	2.5	3.0 km NNW of Fall City, WA	✔	✔
1/15/2003 03:41:58	46.62	120.53	11.0	3.2	2.7 km NNW of Yakima, WA	-	-
1/17/2003 01:18:27	48.63	123.01	13.5	2.4	10.2 km N of Friday Harbor, WA	-	-
1/17/2003 01:42:38	48.61	123.09	8.2	2.4	10.2 km NW of Friday Harbor, WA	-	-
1/31/2003 22:47:28	47.74	121.84	0.0	2.5	11.0 km E of Duvall, WA	-	-
2/07/2003 09:16:51	48.49	123.60	23.0	2.2	19.9 km WNW of Victoria, BC	-	-
2/08/2003 18:39:10	47.52	121.90	5.8	2.8	5.3 km S of Fall City, WA	✔	-
2/19/2003 13:54:13	46.55	121.77	1.4	2.4	24.9 km W of Goat Rocks, WA	-	-
3/09/2003 03:29:53	47.64	122.16	22.0	2.4	4.3 km NE of Bellevue, WA	-	-
3/18/2003 11:42:28	47.60	122.60	27.2	2.5	3.8 km NNE of Bremerton, WA	-	-
3/20/2003 16:07:47	48.73	119.51	0.0	2.7	41.0 km N of Okanogan, WA	-	-
3/21/2003 11:23:12	49.23	123.59	6.9	2.2	40.2 km WNW of Vancouver, BC	-	-
3/24/2003 13:16:49	49.23	123.58	23.6	2.7	39.9 km WNW of Vancouver, BC	-	-
3/24/2003 13:43:37	49.25	123.62	15.3	2.9	43.5 km WNW of Vancouver, BC	-	-
3/31/2003 21:20:22	45.64	122.76	16.9	2.6	15.5 km NW of Portland, OR	-	-
4/15/2003 09:42:44	47.71	122.61	23.8	2.1	4.0 km SE of Poulsbo, WA	-	-
4/17/2003 01:38:03	47.69	122.10	13.7	2.7	8.3 km E of Kirkland, Wa	✔	-
4/24/2003 19:26:30	45.63	122.74	17.2	3.9	14.3 km NW of Portland, OR	✔	✔
4/25/2003 10:02:13	47.67	123.25	51.3	4.8	37.3 km ESE of Mt Olympus, WA	✔	✔
4/25/2003 21:55:31	45.64	122.75	16.8	2.2	14.9 km NW of Portland, OR	-	-
4/28/2003 22:25:48	45.12	122.43	15.1	2.8	26.3 km SE of Canby, OR	-	-
5/30/2003 03:49:68	47.49	122.73	25.0	3.7	11.4 km SW of Bremerton, WA	✔	✔
6/20/2003 02:01:23	47.65	121.99	19.6	3.5	5.4 km W of Carnation, WA	✔	✔
6/20/2003 15:29:57	47.62	122.17	32.1	2.5	2.6 km ENE of Bellevue, WA	-	-
6/26/2003 12:44:57	45.75	122.32	7.6	2.2	33.6 km NE of Portland, OR	-	-
6/28/2003 06:15:50	47.93	121.84	15.7	2.4	12.9 km NE of Monroe, WA	-	-
7/06/2003 05:55:11	47.42	122.78	8.1	3.0	19.5 km SW of Bremerton, WA	✔	✔
7/08/2003 13:27:38	47.66	120.28	0.0	1.9	4.1 km W of Entiat, WA	-	-
7/25/2003 20:48:01	45.64	122.74	17.4	3.0	14.8 km NW of Portland, OR	-	-
7/26/2003 05:26:34	45.64	122.74	16.8	2.2	14.8 km NW of Portland, OR	-	-
7/26/2003 11:24:45	45.64	122.73	16.9	2.8	14.5 km NW of Portland, OR	✔	-
7/27/2003 10:31:29	45.63	122.74	18.3	2.4	14.2 km NW of Portland, OR	-	-
7/29/2003 06:21:40	46.00	122.71	19.8	2.1	23.5 km SE of Longview, WA	-	-
8/22/2003 19:08:38	47.66	117.44	0.5	0.9	2.2 km WSW of Spokane, WA	-	-
9/01/2003 08:54:63	47.95	121.75	11.6	2.3	19.6 km ENE of Monroe, WA	-	-
9/01/2003 18:37:53	47.67	120.27	4.9	2.1	3.7 km WNW of Entiat, WA	-	-
9/21/2003 06:12:41	47.61	121.83	17.4	2.0	6.5 km NE of Fall City, WA	-	-
9/22/2003 14:06:20	47.94	116.99	0.7	3.3	43.0 km NE of Spokane, WA	✔	-
10/01/2003 13:28:**	44.73	117.49	22.1	3.1	27.7 km E of Baker, OR	-	-
10/13/2003 01:11:58	47.58	121.87	7.7	1.6	2.2 km NE of Fall City, WA	-	-
10/25/2003 23:35:22	47.53	121.89	18.6	2.3	3.7 km S of Fall City, WA	-	-
11/13/2003 00:57:54	42.52	122.58	16.8	2.9	23.2 km WNW of Mt McLoughlin, OR	-	-

DATE-(UTC)-TIME	LAT (N)	LON (W)	DEP	M	COMMENTS	CIIM	Shake Map
mm/dd/yyyy hh:mm	deg.	deg.	km				
12/14/2003 04:59:48	46.59	121.70	4.9	1.8	20.5 km WNW of Goat Rocks, WA	-	-
12/26/2003 10:07:46	48.75	119.63	0.4	3.4	43.1 km N of Okanogan, WA	✔	-

TABLE 3 Annual counts of events recorded by the PNSN, 1980-2003

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

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 into 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. 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 72 Seismology Lab tours and lectures for visiting class groups, serving ~1,500 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.

ACKNOWLEDGMENTS

Seismic stations, telemetry links, and data acquisition equipment were maintained by Jim Ramey and 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, Amy Lindemuth, Robert Lesley and Lynn Hultgrien 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.ess.washington.edu/SEIS/PNSN/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 2003. Final published catalogs are available from 1970, when the network began operation, though 1989.

• Reports and Articles using data from the PNSN or related to PNSN activities

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