Final TECHNICAL REPORT: 2004-2006
Pacific Northwest Seismographic Network (PNSN) Operations – Southern Oregon Analog and Broadband Stations

Name of Contractor: **University of Oregon**

Principal Investigators: **Douglas Toomey**
Dept. of Geological Sciences
Cascade Hall
University of Oregon
Eugene, OR 97403

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The views and conclusions contained in this document are those of the authors, and should not be interpreted as necessarily representing the official policies, either express or implied, of the U.S. Government.

FINAL TECHNICAL REPORT 2004-2006
USGS Joint Operating Agreement 04HQAG006
Pacific Northwest Seismographic Network (PNSN) Operations – Southern Oregon Analog and Broadband Stations

ABSTRACT AND NON-TECHNICAL SUMMARY

This is the final technical report for USGS Joint Operating Agreement 04HQAG006 "Pacific Northwest Seismograph Network (PNSN) Operations Southern Oregon Analog and Broadband Stations ". This agreement covered network operations in central and southern Oregon, and contribution of seismic data to the Pacific Northwest Seismograph Network (PNSN). The PNSN receives funding under another USGS Joint Operating Agreement (04HQAG005) for covered network operations in western Washington and northern Oregon, routine data processing, and preparation of bulletins and reports.

Reporting requirements for 04HQAG006 are covered by the report for the main PNSN agreement (04HQAG005) which is attached as **Appendix A**

APPENDIX A of Final TECHNICAL REPORT: 2004-2006 - Pacific Northwest **Seismographic Network (PNSN) Operations – Southern Oregon**

FINAL TECHNICAL REPORT: 2004-2006
USGS Joint Operating Agreement 04HQAG005
PACIFIC NORTHWEST SEISMOGRAPH NETWORK (PNSN) OPERATIONS

Name of Contractor: **University of Washington**

Principal Investigators: **S.D. Malone and A.I. Qamar**
Dept. of Earth and Space Sciences
Box 351310
University of Washington
Seattle, WA 98195-1310

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FINAL TECHNICAL REPORT
USGS Joint Operating Agreement 04HQAG005,
PACIFIC NORTHWEST SEISMOGRAPH NETWORK (PNSN) OPERATIONS,
and 04HQAG006, PNSN Operations – Southern Oregon Analog and Broadband Stations

ABSTRACT AND NON-TECHNICAL SUMMARY

This is the final technical report for USGS Joint Operating Agreement 04HQAG005 *"Pacific Northwest Seismograph Network (PNSN) Operations"*. The PNSN operates seismograph stations in Washington and Oregon, and collects and analyzes earthquake data. Between Jan. 1, 2004 and Sept. 30, 2006 the PNSN analyzed 19,304 events. Of these, 13,068 were earthquakes located within the network. The eruptive episode of Mount St. Helens that started on September 23, 2004 continued through 2005 and 2006. The eruption included hundreds of thousands of earthquakes, of which only a sample were located. The counts given here include only a small percentage of the earthquakes at Mount St. Helens. West of 120.5 degrees west longitude, 12,056 earthquakes were located in Washington and Oregon (including 8,639 volcanic or tectonic events in the general vicinity of Mount St. Helens). East of 120.5 degrees W longitude in Washington and Oregon, 1,012 earthquakes were located. The remaining 6,236 events include located or unlocated blasts (1,073), regional earthquakes (935) or teleseisms (1,722), and small unlocated earthquakes within the network; including 934 unlocated low frequency events near the summit of Mt. Rainier (probably icequakes), and 467 unlocated surficial events near the summit of Mt. St. Helens (probably rockfalls). .

Between Jan. 1, 2004 and Sept. 31, 2006, 49 earthquakes were reported felt west of the Cascades in Washington or Oregon, ranging in magnitude from 1.7 to 4.9. In addition, two earthquakes larger than magnitude 7.0 that occurred outside the PNSN network area, offshore of California, were felt in southwestern Oregon. Twenty-one earthquakes (magnitudes 1.8 to 3.5) were reported felt east of the Cascades in Washington.

SUMMARY

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

CURRENT INITIATIVES

Introduction

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

PNSN Instrumentation

Since 1996, the PNSN has installed digital strong-motion instruments, mostly in the Puget Sound urban area. There are now 53 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,

most data will still be available via dial-up retrieval or site visit. These are in addition to approximately 30 other strong-motion instruments operated independently by the National Strong Motion Project.

The PNSN operates 15 CREST (Consolidated Reporting of EarthquakeS and Tsunamis) stations, and receives data from four additional northern California CREST stations. The PNSN is also currently recording data from 70 Transportable Array "Bigfoot" stations deployed as part of the Earthscope project.

Emergency Notifications

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

EARTHWORM Report

The *Pigia* Intel –Windows computer digitizes analog data. Digital data acquisition is divided among three Sparc-Solaris computers: *verme*, *milli*; and *verli*, which subsequently exchange and share the acquired data. *Scossa* continues to be our main data collection computer. *Tremito*, is used as a backup for scossa, for routine manual data analysis, and as a fileserver for all the other networked computers in the group. *Grasso*, a 2 CPU Intel-Linux box with RAID disc storage, creates near-real-time webicorder images for the PNSN web site and is used for online archival of waveform data. *Gordo* (Intel-Linux) provides additional online archival space to back-up all active file systems.

"Miniworm"systems (Remotely located Intel-Windows computers that run EARTHWORM, digitize data and send it to the UW via Internet, eliminating expensive long-distance leased phone-lines) are running in Oregon at Klamath Falls, Bend, Eugene, and Portland, and in Washington at Forks and Richland.

OPERATIONS

Seismometer Locations and Network Maintenance

The PNSN EARTHWORM SYSTEM now digitally records over 800 channels of real-time or near-real-time seismic data. The Pacific Northwest Seismograph Network (PNSN) operates short-period, broad-band, or strong-motion components at 205 sites west of 120 degrees west longitude under this agreement. Some stations include up to 9 channels of seismic data. 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 and the networks operating various types of stations. Figure 1 shows seismograph stations sending data to the PNSN at the end of September 2006. Stations recorded by the PNSN include a total of 167 short-period stations (14 stations have both vertical short-period and 3-component strong-motion instrumentation), 116 broad-band stations (70 are temporary NSF EarthScope USArray Stations), and 96 strong-motion stations. Figure 2 shows stations in operation at the beginning of this contract period.

Stations supported under this contract, **04HQAG005,** and under **04HQAG006** include 147 short-period, 21 broad-band, and 96 strong-motion stations that cover much of western Washington and Oregon, including the volcanoes of the central Cascades. PNSN stations in western Washington are covered under this contract, and stations in southern and central Oregon are maintained by the University of Oregon under Cooperative Agreement 04HQAG006. Forty permanent stations are operated by the PNSN under other support. 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, short-period seismometers must be replaced every 4-6 years. More than 30 radio telemetry relay sites are also maintained independently of the seismograph stations.

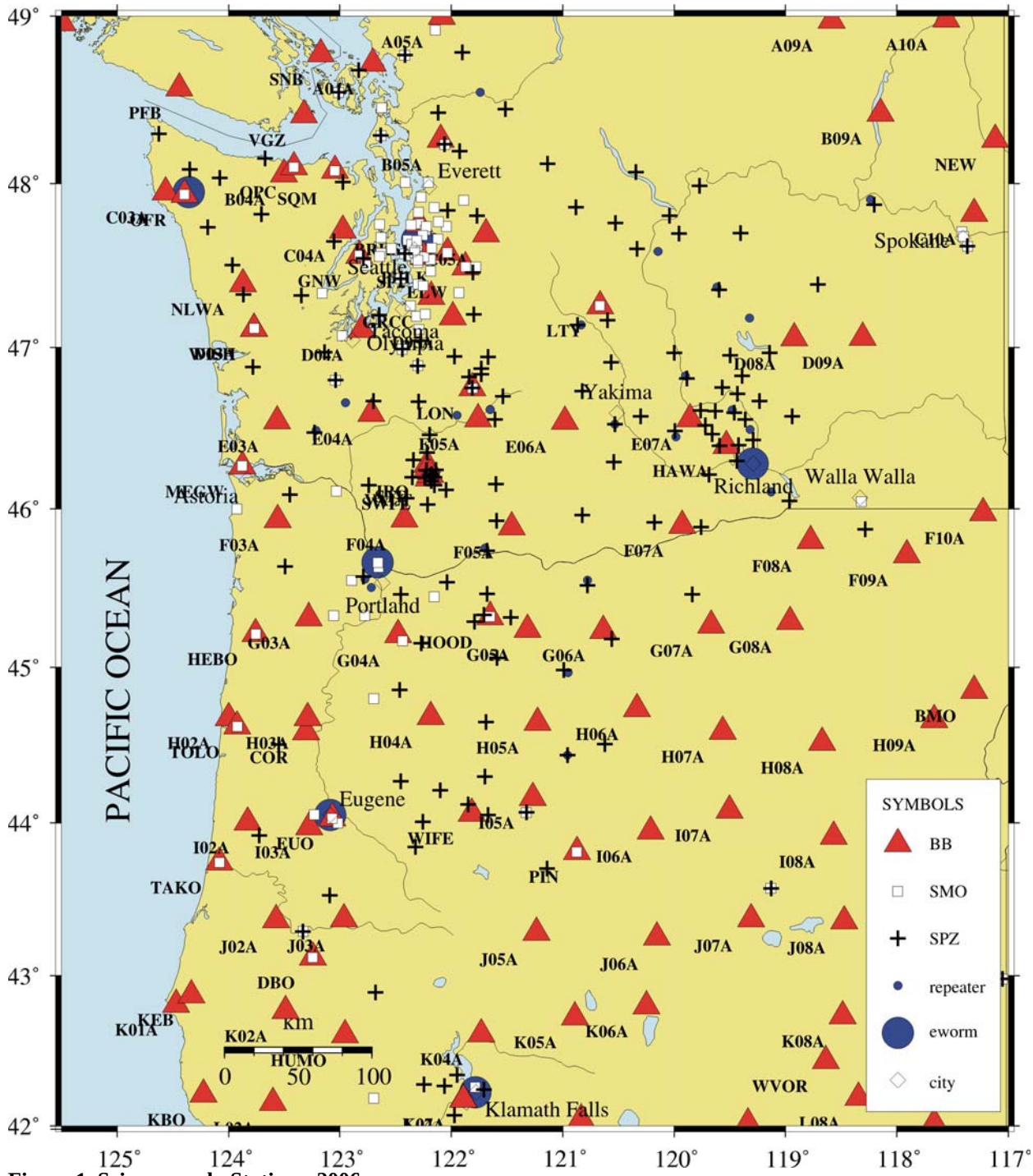

Figure 1. Seismograph Stations, 2006.
"BB" indicates broadband stations (Table 1B), "SMO" indicates strong motion stations (Table 1C), and "SPZ" indicates short-period stations (usually vertical component only) (Table 1A). Repeaters are sites with radio receivers and transmitters used in the transmission 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. The PNSN is currently recording data from 70 Transportable Array "Bigfoot" stations deployed as part of the Earthscope project.

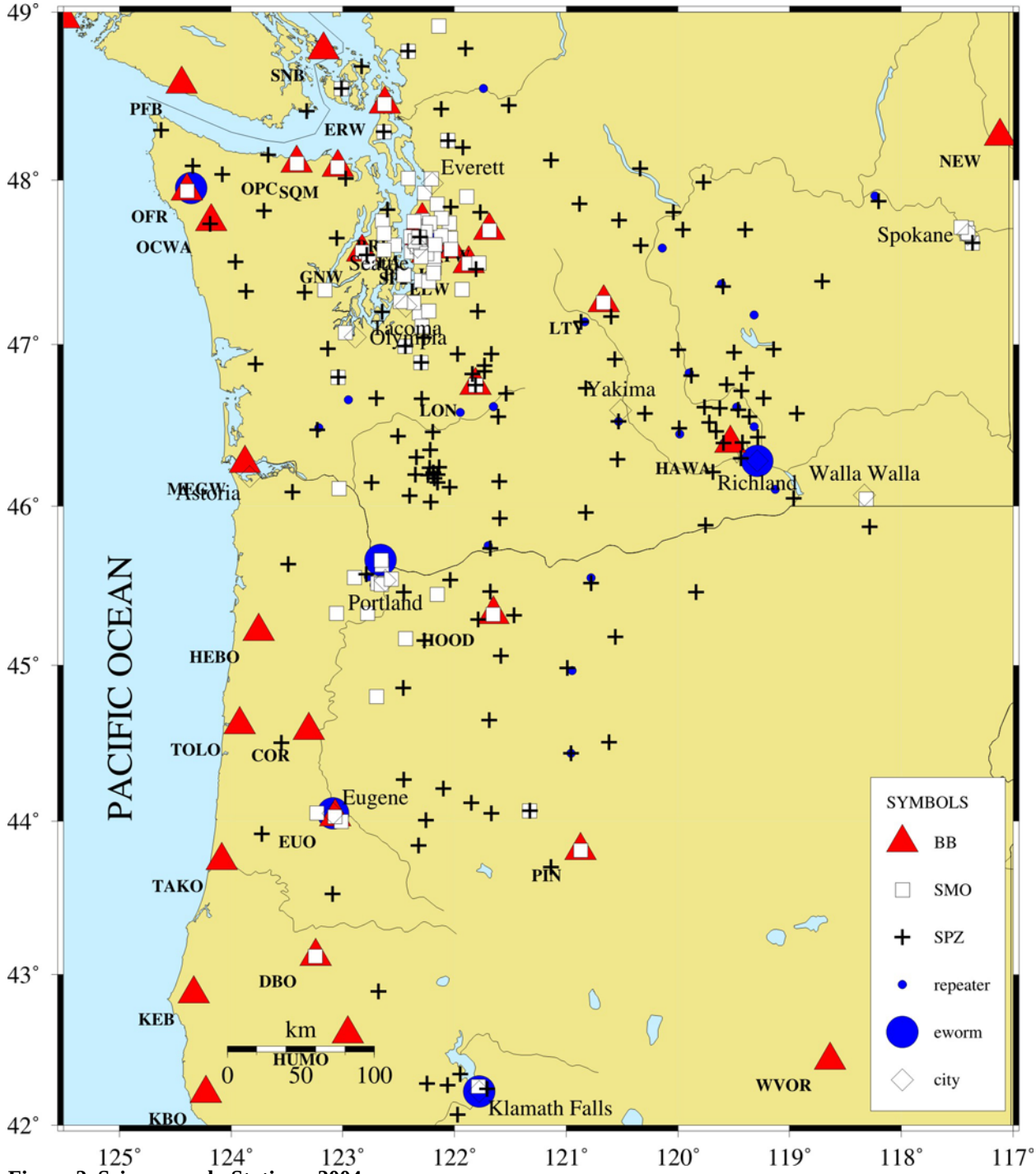

Figure 2. Seismograph Stations, 2004.
Symbols as in Fig. 1

Stations providing data for use in WA & OR earthquake analysis; Tables 1A, 1B, and 1C

Table 1 lists locations of stations that the PNSN uses to locate seismic events in Washington and Oregon as of Sept. 30, 2006. In addition to data from PNSN-operated stations, the PNSN receives data from stations in neighboring networks, from USGS National Network and NSF EarthScope stations in Washington and Oregon. **Table 1A** lists short-period, mostly vertical-component stations the PNSN receives and records. **Table 1B** lists broad-band, mostly 3-component stations, and **Table 1C** lists strong motion, mostly 3-component stations. The first column gives the station code, columns 2-8 give latitude (decimal degrees, north positive), longitude (decimal degrees, east positive), elevation in kilometers, the network that operates the station, the funding agency, the state where the station is located, and the full station name.

Column 5, "NET", gives the Network Code (as per FDSN, **http://www.iris.washington.edu/data/reg_nets.htm**). Stations operated by PNSN are designated "UW" and "UO", CC is the USGS Cascades Volcano Observatory, TA and PB are EarthScope Transportable Array (TA) and Plate Boundary Obesrvatory (PB), MB is Montana Bureau of Mines, CN is the Canadian Pacific Geoscience Centre, HW is the network operated by Battelle on the Hanford Reservation, NC is the Northern California network jointly operated by UC Berkeley and the USGS.

Column 6, "F", gives the funding source for the station:

%- USGS ANSS
- Operated by the USGS Cascades Volcano Observatory
C – Canadian stations operated by the Pacific Geoscience Centre
E – EarthScope project funded by NSF
H - Supported under Pacific Northwest National Laboratory, Battelle contract 259116-A-B3
M – Montana stations operated by Montana Bureau of Mines
N – Stations operated by the Northern California Network (USGS and UC Berkeley)
U – US National Network Statio

TABLE 1 Stations providing data for use in WA & OR earthquake analysis

TABLE 1A - Short-Period Stations

STA	LAT	LONG	EL	NET	F	State	NAME
ALKI	47.575	-122.418	0.001	UW	%	WA	Alki Wastewater Plant, ANSS-SMO
ASR	46.153	-121.602	1.357	UW	%	WA	Mt. Adams - Stagman Ridge
ATES	48.236	-122.060	0.062	UW	%	WA	Arlington Trafton ES ANSS-SMO
AUG	45.736	-121.682	0.865	UW	%	WA	Augspurger Mtn
BBO	42.887	-122.681	1.671	UW	%	OR	Butler Butte
BEN	46.520	-119.722	0.335	HW	H	WA	PNNL station
BEND	44.067	-121.328	1.141	UW	%	WA	UO Bend Office, DOGAMI SMO
BHW	47.837	-122.033	0.198	UW	%	WA	Bald Hill
BKC	44.299	-121.697	1.208	UW	%	OR	Black Crater
BLN	48.007	-122.973	0.585	UW	%	WA	Blyn Mt.
BLT	45.915	-120.177	0.659	UW	H	WA	Bickleton
BOW	46.475	-123.229	0.87	UW	%	WA	Boistfort Mt.
BPO	44.652	-121.690	1.957	UW	%	OR	Bald Peter
BRO	44.267	-122.453	1.341	UW	%	OR	Big Rock Lookout
BRV	46.485	-119.992	0.92	UW	+	WA	Black Rock Valley
BSMT	47.851	-114.788	1.95	MB	M	MT	Bassoo Peak
BUO	42.278	-122.246	1.797	UW	%	OR	Burton Butte
BURN	43.573	-119.131	1.615	UW	G	OR	Burns SMO
BVW	46.811	-119.883	0.67	UW	+	WA	Beverly
CBS	47.805	-120.043	1.067	UW	+	WA	Chelan Butte, South
CDF	46.117	-122.046	0.756	UW	%	WA	Cedar Flats
CHMT	46.914	-113.253	0	MB	M	MT	Chamberlain Mtn.
CMW	48.424	-122.120	1.19	UW	%	WA	Cultus Mtns.

TABLE 1A - Short-Period Stations

STA	LAT	LONG	EL	NET	F	State	NAME
CPW	46.973	-123.138	0.792	UW	%	WA	Capitol Peak
CRF	46.825	-119.388	0.189	UW	+	WA	Corfu
DPW	47.871	-118.204	0.892	UW	+	WA	Davenport
DY2	47.985	-119.773	0.89	UW	+	WA	Dyer Hill 2
EDM	46.197	-122.151	1.609	UW	%	WA	East Dome, Mt. St. Helens
ELK	46.305	-122.342	1.27	UW	%	WA	Elk Rock
ELL	46.910	-120.568	0.789	UW	+	WA	Ellensburg
EPH	47.356	-119.597	0.661	UW	+	WA	Ephrata
ET3	46.577	-118.939	0.286	UW	+	WA	Eltopia (replaces ET2)
ETW	47.604	-120.334	1.477	UW	+	WA	Entiat
FHE	46.952	-119.498	0.455	UW	+	WA	Frenchman Hills East
FL2	46.196	-122.351	1.378	UW	%	WA	Flat Top 2
FMW	46.941	-121.671	1.859	UW	%	WA	Mt. Fremont
FRIS	44.212	-122.102	1.642	UO	%	OR	Frissel Point
GBB	46.609	-119.629	0.185	HW	H	WA	PNNL Station
GBL	46.598	-119.461	0.33	UW	+	WA	Gable Mountain
GHW	47.041	-122.274	0.268	UW	%	WA	Garrison Hill
GL2	45.960	-120.824	1	UW	+	WA	New Goldendale
GLK	46.558	-121.611	1.305	UW	%	WA	Glacier Lake
GMO	44.439	-120.957	1.689	UW	%	OR	Grizzly Mountain
GMW	47.548	-122.788	0.506	UW	%	WA	Gold Mt.
GPW	48.118	-121.138	2.354	UW	%	WA	Glacier Peak
GSM	47.203	-121.796	1.305	UW	%	WA	Grass Mt.
GUL	45.924	-121.597	1.189	UW	%	WA	Guler Mt.
H2O	46.396	-119.424	0.175	HW	H	WA	Water PNNL Station
HAM	42.069	-121.971	1.999	UW	%	OR	Hamaker Mt.
HBO	43.844	-122.321	1.615	UW	%	OR	Huckleberry Mt.
HDW	47.648	-123.056	1.006	UW	%	WA	Hoodsport
HOG	42.242	-121.706	1.887	UW	%	OR	Hogback Mtn.
HSO	43.526	-123.091	1.02	UW	%	OR	Harness Mountain
HSR	46.174	-122.181	1.72	UW	%	WA	South Ridge, Mt. St. Helens
HTW	47.804	-121.769	0.833	UW	%	WA	Haystack Lookout
HUO	44.120	-121.849	2.037	UO	%	OR	Husband OR (UO)
IRO	44.005	-122.255	1.642	UO	%	OR	Indian Ridge
JBO	45.461	-119.838	0.645	UW	+	OR	Jordan Butte
JCW	48.195	-121.927	0.792	UW	%	WA	Jim Creek
JORV	42.978	-117.054	1.338	UW	G	OR	Jorden Valley SMO
JUN	46.147	-122.152	1.049	UW	%	WA	June Lake
KMO	45.635	-123.491	0.975	UW	%	OR	Kings Mt.
KOS	46.463	-122.196	0.61	UW	%	WA	Kosmos
KTR	41.908	-123.378	1.347	NC	N	CA	NCSN
LAB	42.268	-122.064	1.774	UW	%	OR	Little Aspen Butte
LAM	41.610	-122.626	1.769	NC	N	CA	NCSN
LAS	41.599	-121.578	2.047	NC	N	CA	NCSN
LBC	40.837	-121.350	1.525	NC	N	CA	NCSN
LCCM	45.838	-111.879	1.669	MB	M	MT	Lewis and Clark Caverns
LCW	46.670	-122.702	0.396	UW	%	WA	Lucas Creek
LHE	41.629	-122.232	2.117	NC	N	CA	NCSN
LMW	46.668	-122.293	1.195	UW	%	WA	Ladd Mt.

TABLE 1A - Short-Period Stations

STA	LAT	LONG	EL	NET	F	State	NAME
LNO	45.872	-118.286	0.771	UW	+	OR	Lincton Mt.
LO2	46.750	-121.811	0.853	UW	%	WA	Longmire
LOC	46.717	-119.432	0.21	UW	+	WA	Locke Island
LTI	41.176	-121.489	1.156	NC	N	CA	NCSN
LVP	46.066	-122.402	1.13	UW	%	WA	Lakeview Peak
MBW	48.784	-121.901	1.676	UW	%	WA	Mt. Baker
MCMT	44.828	-112.850	2.323	MB	M	MT	McKenzie Canyon
MCW	48.679	-122.833	0.693	UW	%	WA	Mt. Constitution
MDW	46.613	-119.762	0.33	UW	+	WA	Midway
MEW	47.202	-122.647	0.097	UW	%	WA	McNeil Island
MIBL	46.197	-122.187	2.132	CC	#	WA	St. Helens between BLIS and MIDE
MJ2	46.557	-119.360	0.146	UW	+	WA	May Junction 2
MOON	44.052	-121.669	2.24	UW	%	OR	Moon Mt
MOX	46.577	-120.299	0.501	UW	+	WA	Moxie City
MPO	44.505	-123.551	1.249	UW	%	OR	Mary's Peak
MTM	46.025	-122.213	1.121	UW	%	WA	Mt. Mitchell
NAC	46.733	-120.825	0.728	UW	+	WA	Naches
NCO	43.704	-121.139	1.908	UW	%	OR	Newberry Crater
NED	46.200	-122.185	2.06	CC	#	WA	NE part of old Dome, St. Helens
NEL	48.070	-120.341	1.5	UW	+	WA	Nelson Butte
NLO	46.089	-123.452	0.826	UW	%	OR	Nicolai Mt.
OBC	48.035	-124.079	0.938	UW	%	WA	Olympics - Bonidu Creek
OBH	47.326	-123.867	0.383	UW	%	WA	Olympics - Burnt Hill
OCP	48.298	-124.625	0.487	UW	%	WA	Olympics - Cheeka Peak
OD2	47.388	-118.711	0.553	UW	+	WA	Odessa site 2
ON2	46.881	-123.782	0.257	UW	%	WA	Olympics - North River
OOW	47.734	-124.187	0.561	UW	%	WA	Octopus West
OSD	47.816	-123.705	2.008	UW	%	WA	Olympics - Snow Dome
OSR	47.505	-123.963	0.815	UW	%	WA	Olympics Salmon Ridge
OT3	46.669	-119.234	0.322	UW	+	WA	New Othello (replaces OT2 8/26/94)
OTR	48.085	-124.345	0.712	UW	%	WA	Olympics - Tyee Ridge
PAT2	45.884	-119.758	0.259	UW	+	WA	Paterson 2
PCFR	46.990	-122.442	0.137	UW	%	WA	PC Firing Range ANSS-SMO
PCMD	46.889	-122.301	0.239	UW	%	WA	PC Mountain Detachment ANSS-SMO
PGO	45.462	-122.454	0.253	UW	%	OR	Gresham
PRO	46.213	-119.687	0.553	UW	+	WA	Prosser
RAFT	46.196	-122.186	2.132	CC	#	WA	RAFT, St Helens Crater
RCM	46.836	-121.733	3.085	UW	%	WA	Mt. Rainier, Camp Muir
RCS	46.871	-121.732	2.877	UW	%	WA	Mt. Rainier, Camp Schurman
RED	46.297	-119.439	0.33	HW	H	WA	Red Mountain PNNL Station
RER	46.819	-121.842	1.756	UW	%	WA	Mt. Rainier, Emerald Ridge
RMW	47.460	-121.807	1.024	UW	%	WA	Rattlesnake Mt. (West)
RNO	43.916	-123.725	0.85	UW	%	OR	Roman Nose
RPW	48.448	-121.515	0.85	UW	%	WA	Rockport
RRHS	46.799	-123.042	0.047	UW	%	WA	Rochester HS ANSS-SMO
RSW	46.394	-119.592	1.045	UW	+	WA	Rattlesnake Mt. (East)
RVC	46.944	-121.974	1	UW	%	WA	Mt. Rainier - Voight Creek
RVW	46.148	-122.743	0.46	UW	%	WA	Rose Valley
SAW	47.702	-119.402	0.701	UW	+	WA	St. Andrews

TABLE 1A - Short-Period Stations

STA	LAT	LONG	EL	NET	F	State	NAME
SBES	48.768	-122.416	0.119	UW	%	WA	Silver Beach ES ANSS-SMO
SEP	46.200	-122.191	2.116	UW	#	WA	September lobe, Mt. St. Helens (Dome
SFER	47.619	-117.367	0.715	UW	%	WA	Spokane Schools, Ferris High ANSS-SMO
SHW	46.193	-122.236	1.425	UW	%	WA	Mt. St. Helens
SHWZ	46.193	-122.236	1.425	UW	%	WA	Mt. St. Helens (CVO version)
SLF	47.761	-120.529	1.75	UW	%	WA	Sugar Loaf
SMW	47.319	-123.344	0.877	UW	%	WA	South Mtn.
SNI	46.464	-119.661	0.323	HW	H	WA	Snively PNNL station
SOS	46.244	-122.138	1.27	UW	%	WA	Source of Smith Creek
SSO	44.856	-122.462	1.242	UW	%	OR	Sweet Springs
STD	46.238	-122.224	1.268	UW	%	WA	Studebaker Ridge
STDM	46.238	-122.224	1.268	UW	%	WA	Studebaker Ridge Microphone
STW	48.151	-123.671	0.308	UW	%	WA	Striped Peak
SUG	46.216	-122.176	1.859	UW	%	WA	Sugar Bowl, MSH
SVOH	48.289	-122.633	0.022	UW	%	WA	Skagit Valley CC ANSS-SMO
TBM	47.170	-120.599	1.006	UW	+	WA	Table Mt.
TDH	45.290	-121.792	1.541	UW	%	OR	Tom,Dick,Harry Mt.
TDL	46.351	-122.217	1.4	UW	%	WA	Tradedollar Lake
TIMB	45.336	-121.710	1.901	CC	#	OR	Timberline, 0regon
TRW	46.292	-120.543	0.723	UW	+	WA	Toppenish Ridge
TWW	47.138	-120.870	1.027	UW	+	WA	Teanaway
UMPQ	43.291	-123.332	0.162	UW	%	WA	Umpqua Community College, DOGAMI SMO
UWFH	48.546	-123.013	0.01	UW	%	WA	UW Friday Harbor ANSS-SMO
VBE	45.060	-121.588	1.544	UW	%	OR	Beaver Butte
VCR	44.983	-120.989	1.015	UW	%	OR	Criterion Ridge
VDB	49.026	-122.103	0.404	CN	C	BC	Canada
VFP	45.318	-121.466	1.716	UW	%	OR	Flag Point
VG2	45.155	-122.272	0.823	UW	%	OR	Goat Mt.
VGB	45.516	-120.779	0.729	UW	+	OR	Gordon Butte
VIP	44.508	-120.620	1.731	UW	%	OR	Ingram Pt.
VLL	45.463	-121.680	1.195	UW	%	OR	Laurance Lk.
VLM	45.538	-122.040	1.15	UW	%	OR	Little Larch
VSP	42.342	-121.950	1.545	UW	%	OR	Spence Mtn
VT2	46.967	-120.000	0.385	UW	+	WA	Vantage2
VTH	45.181	-120.562	0.773	UW	%	OR	The Trough
VVHS	47.423	-122.455	0.095	UW	%	WA	Vashon HS ANSS-SMO
WA2	46.755	-119.567	0.244	UW	+	WA	Wahluke Slope
WAT	47.699	-119.955	0.821	UW	+	WA	Waterville
WIW	46.429	-119.289	0.128	UW	+	WA	Wooded Island
WPO	45.573	-122.791	0.334	UW	%	OR	West Portland
WPW	46.699	-121.537	1.28	UW	%	WA	White Pass
WRD	46.970	-119.146	0.375	UW	+	WA	Warden
WRW	47.856	-120.883	1.189	UW	%	WA	Wenatchee Ridge
YA2	46.527	-120.531	0.652	UW	+	WA	Yakima
YEL	46.210	-122.189	1.75	UW	#	WA	Yellow Rock, Mt. St. Helens
YPT	46.049	-118.963	0.325	UW	+	WA	Yellepit

TABLE 1B – BROAD-BAND STATIONS							
STA	**LAT**	**LONG**	**EL**	**NET**	**F**	**State**	**NAME**
A04A	48.720	-122.706	0.024	TA	E	WA	Lummi Island
A05A	48.998	-122.085	0.174	TA	E	WA	Maple Falls
A09A	48.975	-118.585	0.931	TA	E	WA	Danville
A10A	48.981	-117.559	0.688	TA	E	WA	Northport
B04A	48.058	-123.504	0.029	TA	E	WA	Port Angeles
B05A	48.264	-122.096	0.154	TA	E	WA	Bryant
B09A	48.423	-118.149	0.63	TA	E	WA	Rice
BMO	44.853	-117.306	1.154	US	U	WA	Blue Mountain Ob (USNSN) BB
C03A	47.948	-124.566	0.048	TA	E	WA	Quillayute Airport Forks
C04A	47.717	-122.972	0.053	TA	E	WA	Brinnin
C05A	47.695	-121.690	0.541	TA	E	WA	Tolt Res
C10A	47.819	-117.308	0.684	TA	E	WA	Spilker Farm, Colbert.
COR	44.586	-123.303	0.121	US	U	OR	Corvallis (USNSN) BB
D03A	47.116	-123.770	0.049	TA	E	WA	Wishkah
D04A	47.111	-122.804	0.03	TA	E	WA	Lacey
D05A	47.188	-121.989	0.266	TA	E	WA	Enumclaw
D08A	47.057	-118.921	0.385	TA	E	WA	Wollman Farm, Schrag.
D09A	47.062	-118.309	0.54	TA	E	WA	Jones Farm, Ritzville.
DBO	43.119	-123.244	0.984	UO	%	OR	Dodson Butte (UO CREST BB SMO)
E03A	46.546	-123.563	0.072	TA	E	WA	Lebam
E04A	46.593	-122.720	0.215	TA	E	WA	Onalaska
E05A	46.561	-121.760	0.451	TA	E	WA	Randle
E06A	46.543	-120.979	0.911	TA	E	WA	Yakima
E07A	46.559	-119.855	0.561	TA	E	WA	Sunnyside
EUO	44.029	-123.070	0.16	UO	%	OR	Eugene,OR U0 CREST BB SMO
F03A	45.931	-123.559	0.325	TA	E	OR	Seaside
F04A	45.933	-122.419	0.211	TA	E	WA	Amboy
F05A	45.884	-121.459	0.454	TA	E	WA	White Salmon
F07A	45.895	-119.928	0.227	TA	E	WA	Phinny Hill Vineyards, Prosser.
F08A	45.797	-118.777	0.487	TA	E	OR	Pendleton.
F09A	45.709	-117.909	0.894	TA	E	OR	S2 Ranch, Elgin.
F10A	45.973	-117.228	1.136	TA	E	OR	Beach Ranch, Enterprise.
G03A	45.315	-123.281	0.208	TA	E	OR	Yamhill
G04A	45.206	-122.478	0.273	TA	E	OR	Mulino
G05A	45.242	-121.317	0.594	TA	E	OR	Wamic
G06A	45.236	-120.635	0.78	TA	E	OR	Carlson Farm, Grass Valley
G07A	45.266	-119.669	0.801	TA	E	OR	Ruggs Ranch, Heppner
G08A	45.290	-118.960	1.318	TA	E	OR	Pilot Rock
GNW	47.564	-122.827	0.165	UW	%	WA	Green Mt CREST BB SMO
GRCC	47.312	-122.181	0.13	UW	%	WA	Green River CC BB
H02A	44.676	-124.000	0.209	TA	E	OR	Toledo
H03A	44.677	-123.292	0.214	TA	E	OR	Soap Creek Ranch, Albany
H04A	44.684	-122.186	0.652	TA	E	OR	Detroit Lake
H05A	44.647	-121.227	0.721	TA	E	OR	Madrase
H06A	44.734	-120.335	0.516	TA	E	OR	Lindquist Farm, Mitchell
H07A	44.591	-119.565	1.204	TA	E	OR	Lands Inn, Kimberly
H08A	44.519	-118.670	1.373	TA	E	OR	Prairie City
H09A	44.665	-117.664	1.263	TA	E	OR	Durkee

TABLE 1B – BROAD-BAND STATIONS							
STA	**LAT**	**LONG**	**EL**	**NET**	**F**	**State**	**NAME**
HAWA	46.392	-119.533	0.367	US	U	WA	Hanford Nike USNSN BB
HEBO	45.214	-123.755	0.875	UW	%	OR	Mt. Hebo CREST BB SMO
HLID	43.563	-114.414	1.772	US	U	ID	Hailey USNSN BB
HOOD	45.321	-121.653	1.52	UW	%	OR	Mt Hood Meadows CREST BB SMO
HUMO	42.607	-122.957	0.555	BK	N	OR	Hull Mountain,OR BB from UCB
I02A	44.004	-123.830	0.17	TA	E	OR	Mapleton
I03A	43.973	-123.278	0.206	TA	E	OR	Eugene
I05A	44.163	-121.268	1.011	TA	E	OR	Bend
I06A	43.944	-120.211	1.297	TA	E	OR	Prineville
I07A	44.082	-119.504	1.293	TA	E	OR	Izee
I08A	43.910	-118.569	1.189	TA	E	OR	Drewsey
I09A	43.973	-117.741	0.95	TA	E	OR	Lost Marbles Ranch, Westfall
J02A	43.365	-123.575	0.136	TA	E	OR	Umpqua
J03A	43.372	-122.965	0.292	TA	E	OR	Ideyld Park
J05A	43.284	-121.236	1.54	TA	E	OR	Fort Rock
J06A	43.252	-120.153	1.407	TA	E	OR	Christmas Valley
J07A	43.374	-119.311	1.273	TA	E	OR	Hines
J08A	43.358	-118.474	1.229	TA	E	OR	Circle Bar Ranch, Crane
J09A	43.347	-117.754	1.303	TA	E	OR	Fry Pan Ranch, Harper
JRO	46.275	-122.218	1.28	CC	#	WA	Johnston Ridge Observatory
K01A	42.809	-124.469	0.175	TA	E	OR	Sixes
K02A	42.767	-123.490	0.963	TA	E	OR	Glendale
K04A	42.613	-121.731	1.305	TA	E	OR	Chilquin
K05A	42.726	-120.893	1.887	TA	E	OR	Summer Lake
K06A	42.799	-120.251	1.34	TA	E	OR	Valley Falls
K07A	42.180	-121.890	1.41	TA	E	OR	Frenchgler
K08A	42.731	-118.486	1.391	TA	E	OR	Mann Creek Ranch, Princeton
K09A	42.700	-117.725	1.176	TA	E	OR	Rome
L02A	42.156	-123.602	0.485	TA	E	OR	Cave Junction
L04A	42.175	-121.891	1.336	TA	E	OR	Klamath Falls
L05A	42.047	-120.834	1.751	TA	E	OR	Lakeview
L07A	42.019	-119.340	1.816	TA	E	OR	Adel
L08A	42.190	-118.345	1.49	TA	E	OR	Fields
L09A	42.019	-117.667	1.431	TA	E	NV	Wilkinson Ranch, McDermitt
LON	46.750	-121.811	0.853	UW	%	WA	Longmire CREST BB LONLZ SMO
LTY	47.256	-120.666	0.97	UW	%	WA	Liberty BB CREST SMO
MEGW	46.266	-123.877	0.351	UW	%	WA	Megler CREST BB SMO
MOD	41.902	-120.303	1.554	BK	N	WA	Modoc Plateau, CA from UCB
NEW	48.264	-117.120	0.76	US	U	WA	Newport Observatory USNSN BB
NLWA	47.390	-123.870	0.61	US	U	WA	Neilton Lookout USNSN BB
OFR	47.933	-124.396	0.152	UW	%	WA	Olympics - Forest Resource Center CRE
OPC	48.100	-123.413	0.09	UW	%	WA	Olympic Penn College CREST BB SMO
OZB	48.960	-125.493	0.671	CN	C	BC	Canada BB
PIN	43.811	-120.873	1.865	UO	%	OR	Pine Mt. (U0 CREST, BB, SMO)
PNT	49.317	-119.617	0.55	CN	C	BC	Canada, BB
SNB	48.775	-123.171	0.408	CN	C	BC	Canada BB
SQM	48.077	-123.047	0.03	UW	%	WA	Sequim (CREST BB SMO)
STD	46.238	-122.224	1.268	UW	%	WA	Studebaker Ridge
SWFL	46.189	-122.202	2.268	CC	#	WA	Southwest Flank, St. Helens

TABLE 1B – BROAD-BAND STATIONS							
STA	**LAT**	**LONG**	**EL**	**NET**	**F**	**State**	**NAME**
TAKO	43.743	-124.082	0.046	UW	%	OR	Tahkenitch CREST BB SMO
TOLO	44.622	-123.923	0.021	UW	%	OR	Toledo BPA CREST BB SMO
VALT	46.214	-122.189	1.681	CC	#	WA	St. Helens Crater
VGZ	48.414	-123.324	0.067	CN	C	BC	Canada
WIFE	44.060	-121.817	1.955	CC	#	WA	Wife at 3-Sisters from CVO
WISH	47.117	-123.771	0.045	UW	%	WA	Wishkah CREST BB SMO
WVOR	42.434	-118.637	1.344	US	U	OR	Wildhorse Valley (USNSN BB)
BRKS	47.755	-122.290	0.02	UW	%	WA	Brookside ANSS-SMO BB
ELW	47.494	-121.873	0.267	UW	%	WA	EchoLakeBPA BB-SMO-IDS20
HUMO	42.607	-122.957	0.555	BK	N	OR	Hull Mountain,OR BB from UCB
KBO	42.213	-124.226	1.008	NC	N	OR	Bosley Butte CREST BB
KEB	42.872	-124.334	0.818	NC	N	OR	Edson Butte CREST BB
KRMB	41.523	-123.908	1.265	NC	N	OR	NCSN Red Mtn CREST BB
KSXB	41.830	-123.877	0	NC	N	OR	NCSN Camp Six CREST BB
MOD	41.902	-120.303	1.554	BK	N	WA	Modoc Plateau, CA from UCB
PFB	48.572	-124.440	0.465	CN	C	BC	P.Renfrew, Canada BB
PNLK	47.582	-122.035	0.128	UW	%	WA	Pine Lake JH ANSS-SMO BB
SP2	47.556	-122.249	0.03	UW	%	WA	Seward Park, Seattle SMO-IDS24 BB(7/
YBH	41.732	-122.710	1.06	BK	N	WA	Yreka, CA from UCB BB

TABLE 1-C – STRONG MOTION STATIONS							
STA	**LAT**	**LONG**	**EL**	**NET**	**F**	**State**	**NAME**
ACES	47.560	-122.341	0	UW	%	WA	Army Corps of Engineers Seattle ANSS-
ALKI	47.575	-122.418	0.001	UW	%	WA	Alki Wastewater Plant, ANSS-SMO
ALST	46.109	-123.034	0.198	UW	%	OR	Alston BPA site - SMO
ALVY	43.998	-123.017	0.155	UW	%	OR	Alvey BPA site - SMO
ATES	48.236	-122.060	0.062	UW	%	WA	Arlington Trafton ES ANSS-SMO
BABE	47.606	-122.537	0.083	UW	%	WA	Bainbridge School ANSS-SMO
BEND	44.067	-121.328	1.141	UW	%	WA	UO Bend Office, DOGAMI SMO
BEVT	47.920	-122.271	0.17	UW	%	WA	Boeing Everett ANSS-SMO
BRKS	47.755	-122.290	0.02	UW	%	WA	Brookside ANSS-SMO BB
BSFP	47.520	-122.298	0.005	UW	%	WA	Boeing Fire Protection
BULL	45.446	-122.156	0.222	UW	%	OR	Bull Run Dam SMO
BURN	43.573	-119.131	1.615	UW	G	OR	Burns SMO
COLT	45.170	-122.438	0.213	UW	%	OR	Colton HS ANSS SMO
EARN	47.741	-122.045	0.159	UW	%	WA	East Ridge ES ANSS-SMO
EGRN	47.073	-122.979	0.057	UW	%	WA	Evergreen College ANSS-SMO
ELW	47.494	-121.873	0.267	UW	%	WA	EchoLakeBPA BB-SMO-IDS20
ERW	48.454	-122.626	0.389	UW	%	WA	Mt. Erie SMO-IDS24 BB
EVCC	48.007	-122.206	0.03	UW	%	WA	Everett College ANSS-SMO
EVGW	47.854	-122.155	0.122	UW	%	WA	Everett Gateway Middle School ANSS-SM
EYES	45.329	-123.058	0.061	UW	%	OR	Ewing Young ES, Newberg ANSS SMO
FINN	47.719	-122.233	0.121	UW	%	WA	Finn Hill Jr High ANSS-SMO
GTWN	47.551	-122.322	0.025	UW	%	WA	Georgetown Playfield ANSS-SMO
HART	47.584	-122.350	0.002	UW	%	WA	Harbor Island, ANSS-SMO
HICC	47.390	-122.299	0.115	UW	%	WA	Highline CC ANSS-SMO
HOLY	47.565	-122.385	0.106	UW	%	WA	Holy Rosary ANSS-SMO
HUBA	45.631	-122.653	0.023	UW	%	WA	Hudson Bay HS, ANSS SMO
JORV	42.978	-117.054	1.338	UW	G	OR	Jorden Valley SMO

TABLE 1-C – STRONG MOTION STATIONS							
STA	**LAT**	**LONG**	**EL**	**NET**	**F**	**State**	**NAME**
KCAM	47.544	-122.319	0.005	UW	%	WA	King County Airport Maint. Shop, ANSS
KDK	47.595	-122.333	0.004	UW	%	WA	Coastal Environmental, Seattle ANSS-S
KEEL	45.550	-122.896	0.067	UW	%	OR	Keeler BPA site - SMO
KFAL	42.258	-121.786	1.326	UW	%	OR	Klamath Falls ANSS-SMO
KICC	47.577	-122.632	0.017	UW	%	WA	Kitsap 911 center ANSS-SMO
KIMB	47.575	-122.304	0.069	UW	%	WA	Kimball School ANSS-SMO
KIMR	47.503	-122.768	0.123	UW	%	WA	Kitsap Mod Risk ANSS-SMO
KINR	47.751	-122.644	0.008	UW	%	WA	Kitsap Road Shed ANSS-SMO
KITP	47.675	-122.631	0.076	UW	%	WA	Kitsap Road Shed ANSS-SMO
KNEL	47.381	-122.252	0.014	UW	%	WA	Kent Elementary ANSS-SMO
LANE	44.052	-123.233	0.12	UW	%	OR	Lane BPA site - SMO
LAWT	47.656	-122.391	0.05	UW	%	WA	Lawton School ANSS-SMO
LEOT	47.768	-122.117	0.115	UW	%	WA	Leota J. High ANSS-SMO
LYNC	47.826	-122.294	0.019	UW	%	WA	Lynnwood City Hall, ANSS-SMO
MARY	47.663	-122.121	0.011	UW	%	WA	Marymoor Park ANSS-SMO
MBKE	48.917	-122.143	1.01	UW	%	WA	M Baker Kendall ANSS-SMO
MBPA	47.898	-121.890	0.186	UW	%	WA	Monroe BPA SMO-IDS20
MEAN	47.623	-122.306	0.037	UW	%	WA	Meany Middle School, ANSS SMO
MPL	47.468	-122.186	0.122	UW	%	WA	Maple Valley SMO-IDS24
MRIN	44.800	-122.699	0.187	UW	%	WA	Marion BPA site DOGAMI SMO
NIHS	47.741	-122.223	0.137	UW	%	WA	Inglemoor HS ANSS-SMO
NOWS	47.686	-122.257	0.002	UW	%	WA	NOAA, Seattle Bldg 3-SMO-IDS20
OHC	47.334	-123.159	0.006	UW	%	WA	Hood Canal JH ANSS-SMO
PAYL	47.193	-122.314	0.009	UW	%	WA	Puyallup School ANSS-SMO
PCEP	47.111	-122.291	0.16	UW	%	WA	PC East Precinct ANSS-SMO
PCFR	46.990	-122.442	0.137	UW	%	WA	PC Firing Range ANSS-SMO
PCMD	46.889	-122.301	0.239	UW	%	WA	PC Mountain Detachment ANSS-SMO
PERL	45.328	-122.779	0.068	UW	%	WA	Pearl BPA site DOGAMI SMO
PNLK	47.582	-122.035	0.128	UW	%	WA	Pine Lake JH ANSS-SMO BB
PSNS	47.559	-122.644	0.006	UW	%	WA	PSNS Bremerton SMO
QAW	47.632	-122.356	0.14	UW	%	WA	Queen Anne, Seattle SMO-IDS24
RAW	47.337	-121.933	0.208	UW	%	WA	Raver BPA SMO-IDS20
RHAZ	47.540	-122.185	0.108	UW	%	WA	Hazelwood ES ANSS-SMO
ROSS	45.662	-122.658	0.061	UW	%	WA	Ross BPA Vancouver -SMO
RRHS	46.799	-123.042	0.047	UW	%	WA	Rochester HS ANSS-SMO
SBES	48.768	-122.416	0.119	UW	%	WA	Silver Beach ES ANSS-SMO
SCC	47.750	-122.361	0	UW	%	WA	Shoreline CC ANSS-SMO
SEA	47.654	-122.309	0.03	UW	%	WA	UW, Seattle (Wood Anderson BB SMO-IDS
SEAS	45.997	-123.926	0.005	UW	%	OR	Seaside SMO
SFER	47.619	-117.367	0.715	UW	%	WA	Spokane Schools, Ferris High ANSS-SMO
SMNR	47.204	-122.233	0.022	UW	%	WA	Sumner HS ANSS-SMO
SOUA	42.184	-122.695	0.634	UW	%	WA	Southern Oregon Univ., DOGAMI SMO
SP2	47.556	-122.249	0.03	UW	%	WA	Seward Park, Seattle SMO-IDS24 BB(7/
SSS2	47.582	-122.331	0.005	UW	%	WA	John Stanford Center surface ANSS-SMO
SVOH	48.289	-122.633	0.022	UW	%	WA	Skagit Valley CC ANSS-SMO
SVTR	47.496	-121.782	0.146	UW	%	WA	Two Rivers School, Snoqualmie Valley
SWID	48.008	-122.413	0.062	UW	%	WA	South Whidbey SD ANSS-SMO
TBPA	47.258	-122.368	0.002	UW	%	WA	Tacoma WA BPA SMO-IDS20
TKCO	47.537	-122.302	0.005	UW	%	WA	King Co EOC - SMO

TABLE 1-C – STRONG MOTION STATIONS							
STA	**LAT**	**LONG**	**EL**	**NET**	**F**	**State**	**NAME**
UMPQ	43.291	-123.332	0.162	UW	%	WA	Umpqua Community College, DOGAMI SMO
UWFH	48.546	-123.013	0.01	UW	%	WA	UW Friday Harbor ANSS-SMO
VVHS	47.423	-122.455	0.095	UW	%	WA	Vashon HS ANSS-SMO
WISC	47.609	-122.176	0.056	UW	%	WA	Wilburton Center ANSS-SMO
WWHS	46.045	-118.318	0.01	UW	%	WA	Walla Walla HS ANSS SMO
SHLY	47.708	-117.416	0.626	_	_	WA	Spokane temp K2 (Swanson)
SNIO	47.679	-117.405	0.584	_	_	WA	Spokane SMO. Nat. Inst. Occ. Safety H
DBO	43.119	-123.244	0.984	UO	%	OR	Dodson Butte (UO CREST BB SMO)
EUO	44.029	-123.070	0.16	UO	%	OR	Eugene,OR U0 CREST BB SMO
GNW	47.564	-122.827	0.165	UW	%	WA	Green Mt CREST BB SMO
HEBO	45.214	-123.755	0.875	UW	%	OR	Mt. Hebo CREST BB SMO
HOOD	45.321	-121.653	1.52	UW	%	OR	Mt Hood Meadows CREST BB SMO
LON	46.750	-121.811	0.853	UW	%	WA	Longmire CREST BB LONLZ SMO
LTY	47.256	-120.666	0.97	UW	%	WA	Liberty BB CREST SMO
MEGW	46.266	-123.877	0.351	UW	%	WA	Megler CREST BB SMO
OFR	47.933	-124.396	0.152	UW	%	WA	Olympics - Forest Resource Center CRE
OPC	48.100	-123.413	0.09	UW	%	WA	Olympic Penn College CREST BB SMO
PIN	43.811	-120.873	1.865	UO	%	OR	Pine Mt. (U0 CREST, BB, SMO)
SQM	48.077	-123.047	0.03	UW	%	WA	Sequim (CREST BB SMO)
TAKO	43.743	-124.082	0.046	UW	%	OR	Tahkenitch CREST BB SMO
TOLO	44.622	-123.923	0.021	UW	%	OR	Toledo BPA CREST BB SMO
WISH	47.117	-123.771	0.045	UW	%	WA	Wishkah CREST BB SMO

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 manual 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. All stations we routinely use are continuously telemetered in real time. All of the real-time data are continuously recorded into temporary disk storage areas called “wave tanks” that can accommodate about 24 hours of continuous data for the entire network. Triggering algorithms create individual event files lasting for several minutes depending on the size of the earthquake. In addition, continuous seismic data are permanently archived for about 60 stations, many on volcanoes. We continue to use the UW2 pickfile and data formats, and analysis tools that have been in place for more than a decade.

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

Since 2003, all PNSN broad-band and short-period traces are sent to the IRIS DMC in near-real-time, which makes complete copies of all our continuous data available through the BUD (Buffer of Uniform Data) system.

Publications

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

PNSN PERSONNEL CHANGES

Dr. John Vidale replaced Dr. Stephen Malone as Director of the PNSN in fall of 2006 (Dr. Malone will continue to work with the PNSN part-time, concentrating on volcano seismicity research), and Dr. Paul Bodin joined the PNSN as Operations Manager. Several additional seismologists joined our working group; Dr. Heidi Houston assumed a teaching position at the UW, and Dr. Joan Gomberg joined the USGS/UW group. Dr. Justin Rubenstein is working as a post-doc with Dr. Vidale, and Dr. Renate Hartog joined the PNSN on an interim basis to review and complete station response information. Dr. Tony Qamar, a co-PI of the PNSN, died in a traffic accident on October 4th, 2005 while driving to retrieve GPS instruments on the Olympic Peninsula.

A considerable number of changes also occurred in the PNSN technical staff. Staff members Allen Strelow, George Thomas, Amy Lindemuth and Robert Leslie resigned. Karl Hagel and Mike Archbold were hired as technicians, and programmers Bill Gustafson and Terry Bartlett joined us to implement new code and help improve the robustness of our computer operations. Jon Connolly was hired to assist with outreach and field operations. Dr. Lynn Simmons, a USGS contract employee, assumed additional duties, and Tom Yelin of the USGS is taking a more active role in the PNSN, including assuming occasional responsibility for emergency response duties. Continuing PNSN staff at the UW are Ruth Ludwin, Bill Steele and Amy Wright **.**

SEISMICITY, EMERGENCY NOTIFICATION, AND OUTREACH

Seismicity

Figure 3 shows earthquakes of magnitude 2.0 or larger located in Washington and Oregon during this repnorting period.

Tables 2a, 2b, and 2c list earthquakes reported to have been felt from Jan. 1, 2004 – Nov. 30 2006. Events with ShakeMaps (**http://www.pnsn.org/shake/**) or Community Internet Intensity Maps (CIIM; **http://pasadena.wr.usgs.gov/shake/pnw/**) are indicated. ShakeMaps show ground acceleration, combining measured values obtained from seismometers and modeled values interpolated from measured values and adjusted for soil properties. CIIM converts "felt" reports sent by the general public (via Internet) into numeric intensity values, and produces map showing the average intensity in each zip-code area.

Table 3 gives quarterly estimated counts of earthquakes at Mt. St. Helens since Sept. 2004. These counts are provided by CVO, and are determined by an automated event detector, and manually reviewed for accuracy.

Between Jan. 1, 2004 and Sept. 30, 2006 49 earthquakes were reported felt in Washington or Oregon west of the Cascades, ranging in magnitude from 1.7 to 4.9. . In addition, two earthquakes larger than magnitude 7.0 that occurred outside the PNSN network area, offshore of California, were felt in southwestern Oregon. Twenty-one earthquakes (magnitudes 1.8 to 4.4) were reported felt east of the Cascades in Washington and Oregon.

TABLE 2a - Felt Earthquakes during 2004

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	CIIM	Shake Map
yy/mm/dd hh:mm:ss	deg.	deg.	km				
04/01/06 22:45:52	48.64	122.45	0.0	2.1	14.3 km S of Bellingham, WA		
04/01/07 00:11:51	48.64	122.44	0.1	2.7	14.0 km SSE of Bellingham, WA	✔	
04/01/09 09:08:18	45.63	122.76	17.4	2.1	15.8 km NW of Portland, OR		
04/01/14 12:13:39	47.86	120.16	2.5	3.3	11.5 km WNW of Chelan, WA	✔	✔
04/01/14 12:39:54	47.86	120.16	0.7	2.1	11.5 km WNW of Chelan, WA		
04/01/16 03:19:71	47.33	122.36	24.5	2.4	12.1 km NNE of Tacoma, WA		
04/01/16 08:18:18	47.57	122.59	55.6	3.6	3.0 km E of Bremerton, WA	✔	✔

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

TABLE 2b - Felt Earthquakes during 2005

DATE-(UTC)-TIME	LAT(N)	LON(W)	DEP	MAG	COMMENTS	CIIM	Shake Map
yy/mm/dd hh:mm:ss	deg.	deg.	km				
05/02/03 14:08:04	48.08	122.57	32.2	3.1	30.4 km WNW of Everett, WA	✔	✔
05/03/06 13:20:06	48.02	121.83	13.6	3.5	12.2 km SE of Granite Falls, WA	✔	✔
05/03/13 03:37:47	47.25	122.82	24.1	3.3	23.8 km NNE of Olympia, WA	✔	✔
05/05/18 14:46:23	48.14	122.60	27.2	2.6	35.4 km WNW of Everett, WA	✔	
05/06/15 02:50:57	41.32	126.03	10.0	7.2 (USGS)	160.6 km WSW of Crescent City, CA	✔	

05/06/17 06:21:34	40.18	127.54	10.0	6.4 (USGS)	295.0 km WSW of Eureka, CA	✔	
05/06/25 13:49:11	45.52	122.63	14.9	2.7	2.0 km SW of Portland, OR	✔	✔
05/06/29 14:37:14	46.65	120.61	10.0	3.5	10.1 km NW of Yakima, WA		
05/11/23 20:53:15	48.85	122.13	0.0	4.0	6.6 km ENE of Deming, WA	✔	✔
05/12/15 10:26:02	47.72	117.76	0.1	2.4	27.0 km WNW of Spokane, WA (Mission & N Division)		
05/12/27 05:46:07	47.76	121.82	12.4	2.3	12.4 km ENE of Duvall, WA	✔	

TABLE 2c - Felt Earthquakes during 2006 (to Sept. 30)

DATE-(UTC)-TIME yy/mm/dd hh:mm:ss	LAT(N) deg.	LON(W) deg.	DEP km	MAG Ml	COMMENTS	CIIM	CIIM - # of felt reports	Shake Map
06/01/12 18:15:58	46.57	124.14	36.5	2.4	49.4 km NNW of Astoria, OR	✔	40	
06/01/15 12:29:46	48.55	123.50	40.8	3.3	18.8 km NW of Victoria, BC	✔	31	✔
06/01/26 03:53:18	48.82	122.16	0.4	2.4	4.0 km E of Deming, WA	✔	42	
06/01/26 21:43:31	48.83	122.15	1.9	1.8	4.7 km ENE of Deming, WA			
06/01/26 21:54:57	48.80	122.21	19.6	1.7	2.5 km S of Deming, WA			
06/01/29 02:00:53	45.51	122.63	15.4	2.8	2.1 km SSW of Portland, OR	✔	2261	✔
06/02/03 01:47:46	47.95	122.39	33	3.3	14.9 km WSW of Everett, WA	✔	900	✔
06/02/09 19:26:26	47.47	121.80	8.4	2.9	2.6 km SW of North Bend, WA	✔	105	✔
06/02/11 11:47:56	47.47	121.79	7.6	2.9	2.8 km SSW of North Bend, WA			
06/03/04 17:38:47	44.75	123.72	43.5	3.3	29.0 km ENE of Newport, OR	✔	141	
06/04/26 14:24:06	45.01	122.56	20.0	3.0	27.1 km ESE of Woodburn, OR	✔	65	
06/07/04 20:37:02	48.35	123.19	45.7	3.6	13.7 km SE of Victoria, BC	✔	260	✔
06/07/25 06:13:37	47.63	120.20	6.7	3.1	3.0 km SSE of Entiat, WA	✔	18	
06/08/03 08:39:18	45.80	122.60	14.6	3.8	29.7 km N of Portland, OR	✔	3748	✔
06/08/09 14:32:16	45.80	122.60	12.7	2.3	29.7 km N of Portland, OR	✔	13	
06/09/13 17:56:07	46.19	122.19	0	3.2	0.4 km SSW of Mt St Helens, WA	✔	11	

Significant seismicity in Washington and Oregon during 2004 included:

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

TABLE 3: Mount St. Helens 2004-2006 Quarterly earthquake counts at HSR; provided by CVO.		
Year	**Quarter**	**HSR event count**
2004	4th	292,352
2005	1st	123,502
	2nd	49,811
	3rd	12,085
	4th	30,315
2006	1st	30,617
	2nd	*13,236
	3rd	*1,800
* - Count is an estimate, review is incomplete		

The Indian Ocean tsunami of December 26, 2004 caused considerable public interest well into 2005. The tectonic situation and length of the Cascadia Subduction Zone are virtually identical to the Sumatra rupture area of 2004, and the graphic visuals from the Indian Ocean event were a wake-up call for many Cascadia residents.

Significant seismicity in Washington and Oregon in 2005 included:

- Two sizable earthquakes in June 2005 occurred offshore of northern California, outside the area of PNSN authoritative coverage. The larger of these, events (M 7.2), triggered a tsunami warning (although no sizable tsunami actually occurred) in the early evening hours of June 17 (PDT) that revealed several shortcomings in preparedness. The USGS reported: "Crescent City sounded its warning sirens …. and thousands of residents and visitors were evacuated. In many other areas, communication problems prevented the tsunami warning from reaching the public until after the warning had been canceled.…Tuesday's warning…revealed some gaps in communication and planning that local agencies and communities now have an opportunity to fix." **http://soundwaves.usgs.gov/2005/07/research.html**
- Mount St. Helens' eruption: The eruption that began in 2004 continued through 2005. Seismicity remained vigorous, although at a lower level than in the early weeks of the eruption. Dome-building and dome-breakup continued through the year. The general pattern was ongoing seismicity located at the juncture of the new and old domes, with ongoing dome extrusion and intermittent large rockfalls as the extruded material cooled and crumbled. Flashes of light were observed on the Johnston Ridge webcam when nighttime rockfalls exposed glowing magma in the extruded magma.
- "Episodic Tremor and Slip" (ETS) associated with geodetic changes occurred north of Puget Sound from about September 5-30. Additional information is available at: http://www.pnsn.org/WEBICORDER/DEEPTREM/summer2005.html

In 2006, significant seismicity in Washington and Oregon included:

- Mount St. Helens' eruption: The eruption that began in 2004 continued through 2006, the rate of activity continued to decline, though dome-building and dome-breakup continued through the year.
- Two earthquakes, magnitude 2.8 and 3.8, were widely felt in the Portland metropolitan area on June 1 and August 3, respectively.

Public Information and Outreach

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

The PNSN has an educational outreach program to better inform the public, policy makers, and emergency managers. Outreach includes information sheets, lab tours, lectures, workshops, and media interviews, and an audio library with several tapes. Services for the press and other media include interviews, consultations, referrals and research to provide accurate information to reporters. PNSN staff hosted or organized several meetings and made numerous presentations on topics related to earthquake or volcanic hazards, preparedness, and related information. Outreach talks were presented to a wide variety of groups, including state and county officials, representatives of utility and private companies, and engineering and emergency management groups and many general public groups. Seismology Lab tours and lectures were provided for visiting class groups, serving 3,600 students; primarily from grades 3-12.

The eruption of Mt. St. Helens, beginning in September of 2004, created an enormous demand for information, as did the devastating Indian Ocean tsunami of Dec. 26 2004. The Indian Ocean tsunami created a demand for information about Cascadia megathrust hazards. A tsunami advisory was issued in June of 2005 for an M 7.2 earthquake offshore California. Some communities were evacuated, though no significant tsunami occurred. An M 8.1 Kuril Islands earthquake in November of 2006 caused a tsunami watch/warning. Although the watch was cancelled, the tsunami was energetic enough to damage floating docks in Crescent City California. Each of these events created reactions and opportunities for our staff to improve earthquake and tsunami hazard outreach efforts.

In 2005, other groups released scenarios for a M 9.0. Cascadia megathrust earthquake and for a M 6.7 shallow crustal earthquake on the Seattle fault. Both scenarios received significant public interest. Links to both are available: http://www.pnsn.org/NEWS/PRESS_RELEASES/SCENARIOS.html

Several cycles of Episodic Tremor and Slip (ETS) were recorded by the PNSN during the contract period, and attracted significant meda attention.

ACKNOWLEDGMENTS

Seismic stations, telemetry links, and data acquisition equipment are maintained by Karl Hagel at the UW, Patrick McChesney (UW engineer stationed at CVO in Vancouver, Washington), and Don Hartshorn (of Pacific Northwest National Labs in Richland, WA). . Pat Ryan of 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. Allen Strelow, George Thomas, Robert Leslie, and Eric Flood also assisted with technical station maintenance over the course of the contract period, but are no longer with the PNSN. Bill Steele is involved in governmental relations, and provides information to the public with assistance from Jon Connolly and student helper Karl Popejoy. Amy Wright handles routine data analysis and archiving of digital trace data in UW2 format. Dr. Lynn Simmons (USGS contract employee) and Mike Archbold work on strong motion instrumentation and software. Ruth Ludwin writes reports, maintains the PNSN web-pages, and works on issues related to data archiving. Bill Gustafson managed the PNSN computer network, and Dr. Renate Hartog manages the station response information. Graduate Student Assistants are involved on an ongoing basis with record changing, data review and interpretation, and field work, especially at difficult-to-reach stations. At different times and particularly during the eruption of Mt. St. Helens, extensive processing assistance was provided by graduate students Wes Thelan and Guy Medema, and by Dr. Peggy Johnson. Dr. Anthony Qamar played a significant role in monitoring and interpreting the Mt. St. Helens data, and provided web pages helpful for tracking activity. Dr. Daniel Johnson of PSU provided web pages detailing the GPS monitoring of ETS episodes. Tom Yelin of the USGS also assists with some aspects of PNSN operations.

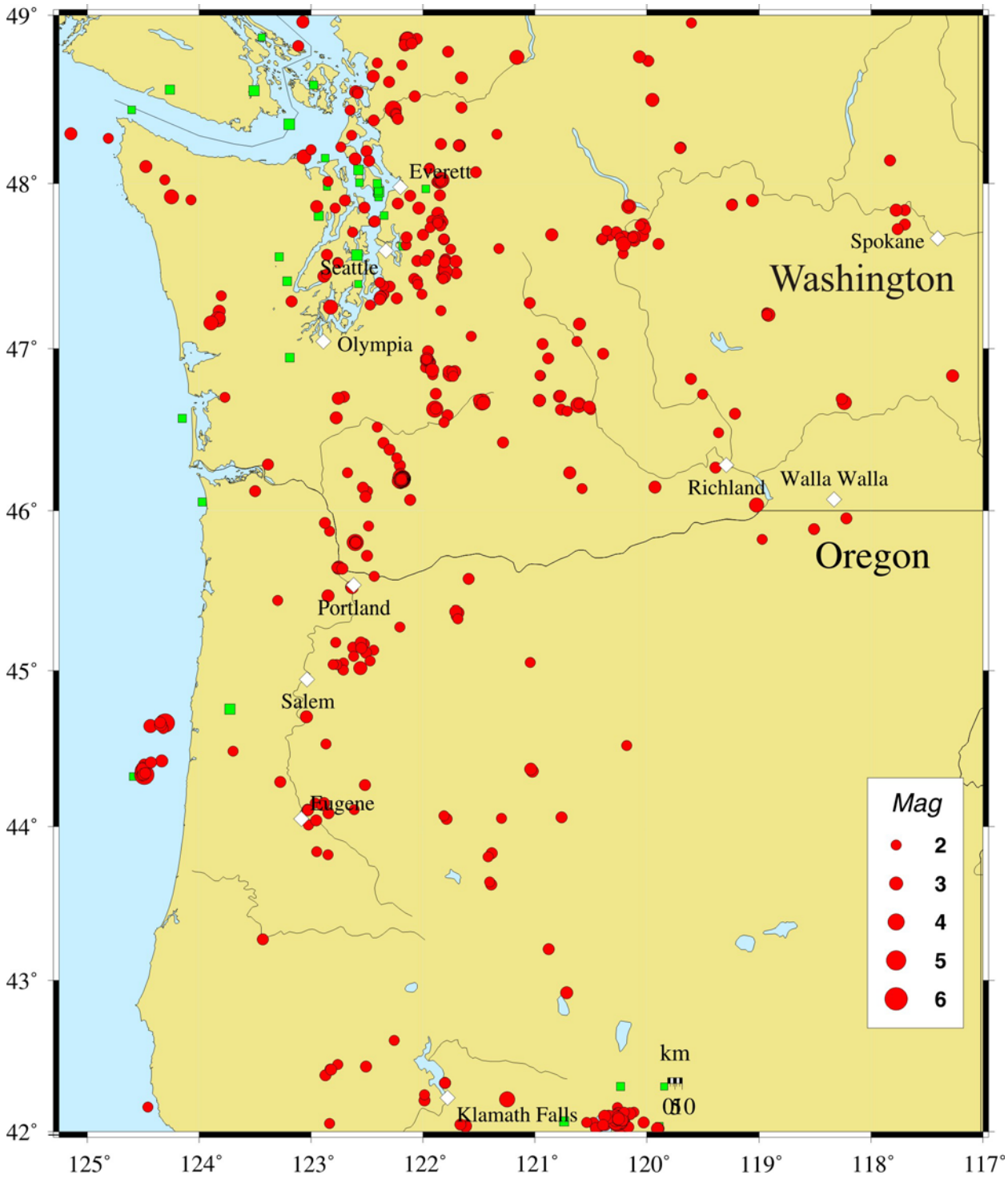

Figure 3. Seismicity, Jan. 2004 - Sept. 2006

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

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

Publications

Quarterly bulletins from the PNSN (http://www.pnsn.org/REPTS/quarterly.html) provide operational details and descriptions of seismic activity in Washington and Oregon. These are available from 1984 through the first quarter of 2006. Final published catalogs are available from 1970, when the network began operation, though 1989.

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