PACIFIC NORTHWEST SEISMOGRAPH NETWORK OPERATIONS

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Non-technical Summary

The Pacific Northwest Seismograph Network (**PNSN**) operates seismograph stations in Washington and Oregon, and collects, analyzes, and distributes earthquake data and information. Between Oct. 1, 2003 and Sept. 30, 2004 the PNSN analyzed 5,453 events. Of these, 4,589 were earthquakes or blasts within the network (1,471 of which were too small to locate). Within the network area, 2,267 earthquakes were located west of 120.5 degrees west longitude (including 1182 in the general vicinity of Mount St. Helens, which began a magmatic eruption earthquake sequence on Sept. 23, 2004, just a few days before the end of this reporting period), and 375 east of 120.5 degrees west longitude. The remaining events were blasts within the network (509), regional earthquakes (291), teleseisms (573), low-frequency events (300 events, 46 locatable, including ice-quakes near the summit of Mt. Rainier, and events associated with the eruption of Mount St. Helens), and surficial events (558 events, 4 locatable, mostly rockfalls near the summits of Mt. St. Helens and Mt Rainier).

West of the Cascades, 30 earthquakes were reported felt in Washington or Oregon, ranging in magnitude from 1.6 to 4.9. The largest event was a magnitude 4.9 at a depth of about 26 km, located off the Oregon coast about 48 km southwest of Newport, on July 7 (UTC).

East of the Cascades, twenty earthquakes (magnitudes 2.5 to 4.4) were reported felt. Twelve of these, including a magnitude 4.4 quake on June 30 (UTC), were associated with swarm activity near Lakeview Oregon.

This year, several episodes of low-amplitude deep seismic tremor were observed concurrently with "silent slip" events detected with GPS. "Silent slip" events consist of very slow movement on the Cascadia Subduction Zone fault at depths of 25-45 km, and occur periodically at 13 to 16 month intervals. The "deep tremor" signals originate at similar depths. Silent slip and tremor appear to be two manifestations of the same process, which is now being called "Episodic Tremor and Slip (ETS)".

Network Operations

The Pacific Northwest Seismograph Network (**PNSN**) operates 187 short-period, broad-band, or strong-motion seismic stations west of 120 degrees west longitude under this agreement, and 40 additional stations under other support. Some stations include up to 7 components. PNSN stations in southern and central Oregon are maintained by the University of Oregon under Cooperative Agreement 04HQAG006. The PNSN exchanges real-time data with adjacent networks to improve our ability to locate earthquakes on the edge of our network. The PNSN records and assists with the maintenance of several short-period stations operated by the USGS, and receives real-time data from six US National Network (USNSN) stations in Washington and Oregon.

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 the national ANSS catalog. 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 Web-site is created for the event (see **http://www.pnsn.org/SEIS/EQ_Special/lasteq.html**).

Final details are provided as soon as the duty seismologist analyzes the earthquake information. Final locations and magnitudes for earthquakes of M>=2.9 are also disseminated through the NOAA emergency weather notification system.

For all earthquakes, updates of information are posted to Web-pages each time the analyst finalizes a group of locations and magnitudes. In addition to ordinary phone lines, the PNSN has a radio link to the King County and City of Seattle Emergency Operations Centers and an independent direct phone link to the Washington State Dept. of Emergency Services.

The PNSN provides "Recent Earthquakes" web pages using the national "Quake Data Delivery System", "ShakeMap" pages (showing instrumental intensity, PGA, and PGV), and links to the USGS CIIM (Community Internet Intensity Maps) site, which collects, compiles, and interprets web-based felt reports from the public.

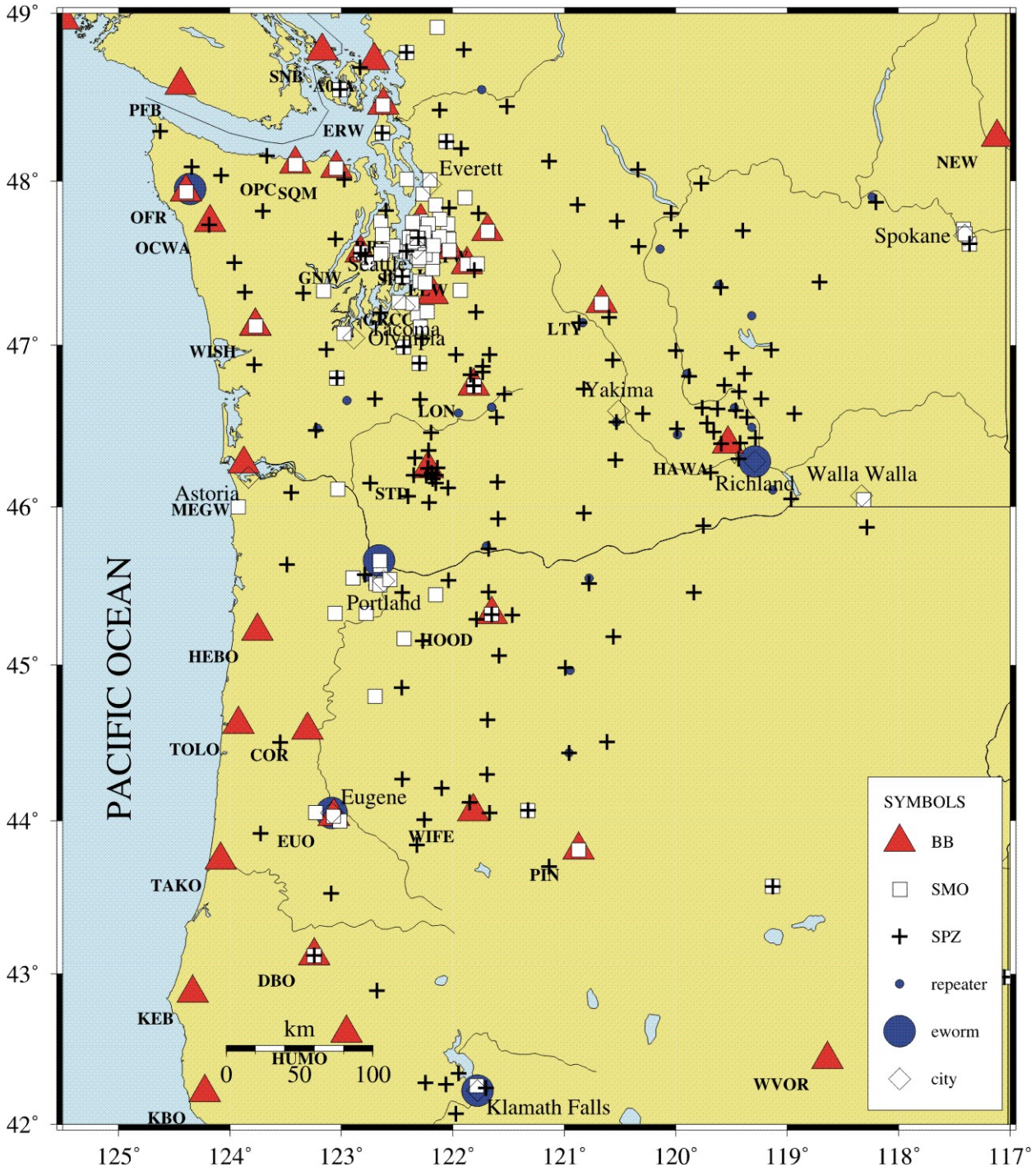


Figure 1a. Seismograph stations operated by or recorded at the PNSN at the end of September 2004. Black crosses indicate the locations of short-period seismometers, Red triangles represent the locations of three-component broad-band seismometer installations, and white squares show the locations of strong-motion stations.

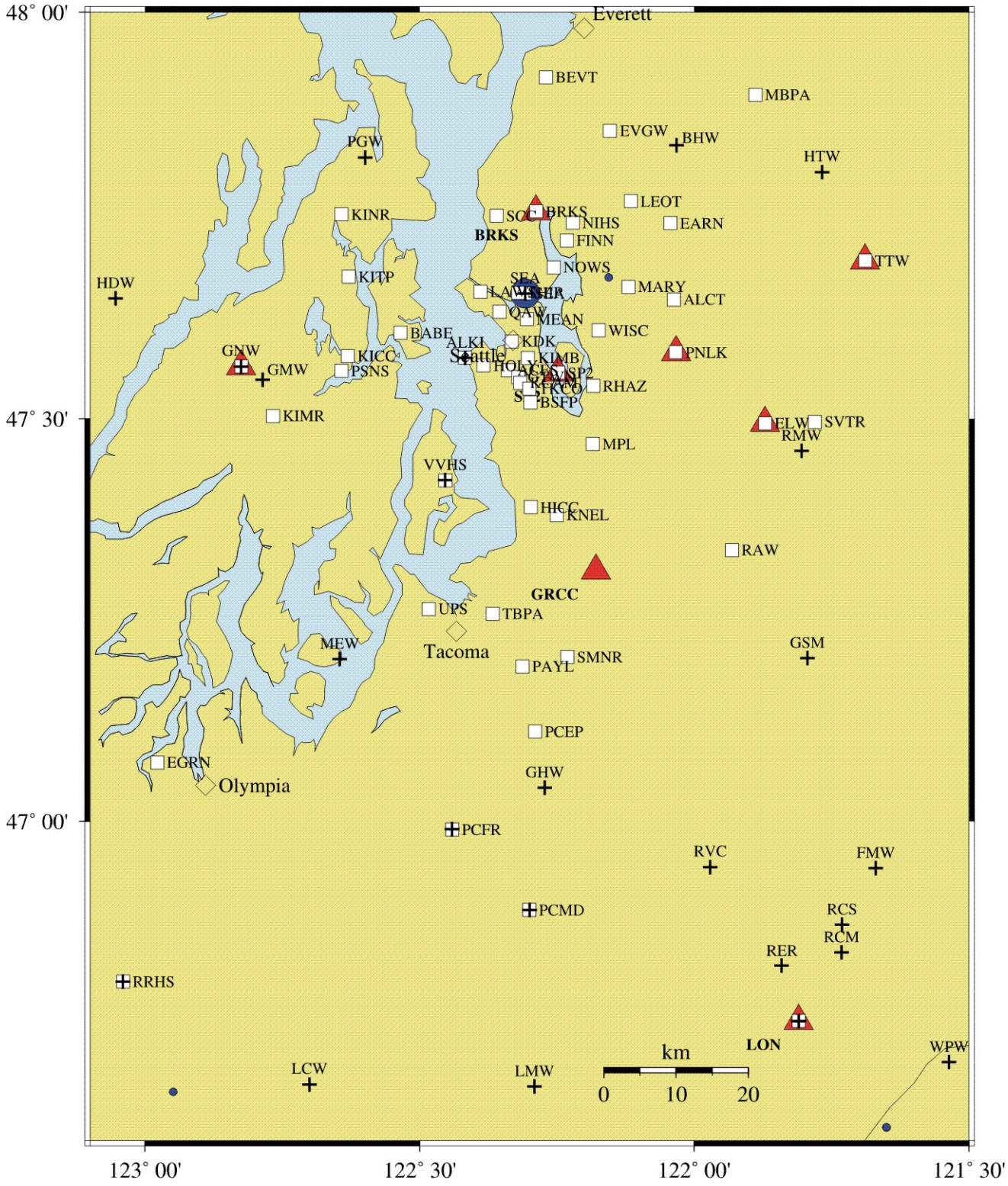


Figure 1b. Detail of Fig. 1a. Puget Sound Seismograph stations operated by or recorded at the PNSN at the end of September 2004. Symbols as in Fig. 1a.

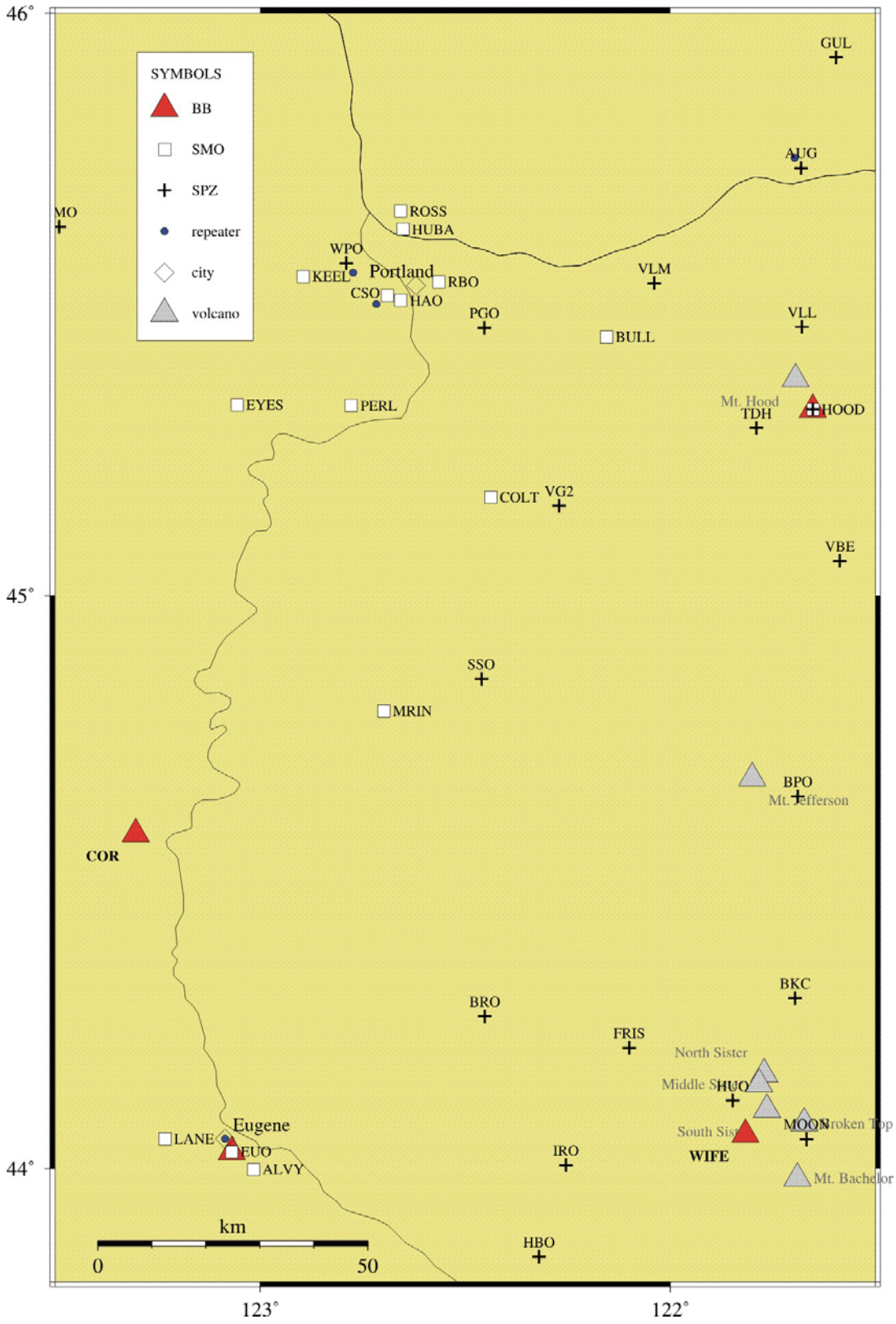


Figure 1c. Detail of Fig. 1a. Willamette Valley Seismograph stations operated by or recorded at the PNSN at the end of September 2004. Symbols as in Fig. 1a.

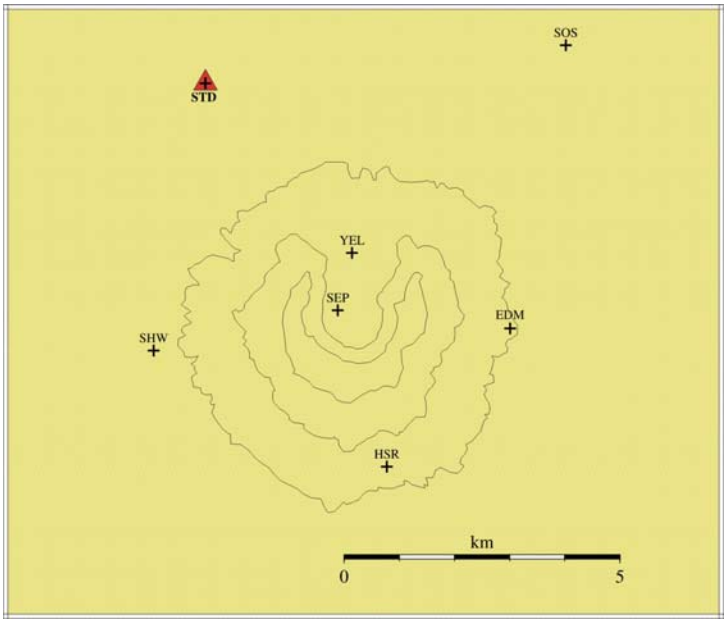


Figure 1d. Detail of Fig. 1a. Mount St. Helens Seismograph stations operated by or recorded at the PNSN at the end of September 2004. Symbols as in Fig. 1a. Contours shown are at 5,000, 6,400, and 7,500 feet.

- ***The PNSN Strong Motion and CREST Programs*:** Since 1996, the PNSN has installed digital strong-motion instruments, mostly in the Puget Sound urban area. There are now 53 ANSS instruments, and a total of 41 other strong-motion real-time stations operated under this agreement. Six additional strong motion stations are operated by other organizations, bringing the total of strong motion stations from which we receive or retrieve data to 100. Continuous data from 95% of these stations are sent to the PNSN via Internet or lease-line modem, 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.

The PNSN also operates 19 CREST (Consolidated Reporting of EarthquakeS and Tsunamis) stations, and records four additional stations operated by the northern California network.

- ***Data Availability*:** Continuous telemetry data streams from all PNSN broadband stations and the higher-quality short-period stations are recorded at the UW, and all broad-band and short-period data are provided to IRIS in near real-time via the IRIS BUD system. Complete unedited trace-data are saved for all network triggers. Edited, quality-controlled event trace-data are archived at the UW on large disks, 5 GByte exabyte tape, and on high-speed, high-capacity (15 GByte) digital linear tape (DLT) cartridges. Edited event trace-data are also archived at the IRIS Data Management Center (DMC) in SEED format, where they can be retrieved by any investigator via the standard IRIS data request mechanisms.

- ***Education and Outreach:*** Staff from the PNSN provide an educational outreach program to better inform the public, policy makers, and emergency managers about seismicity and natural

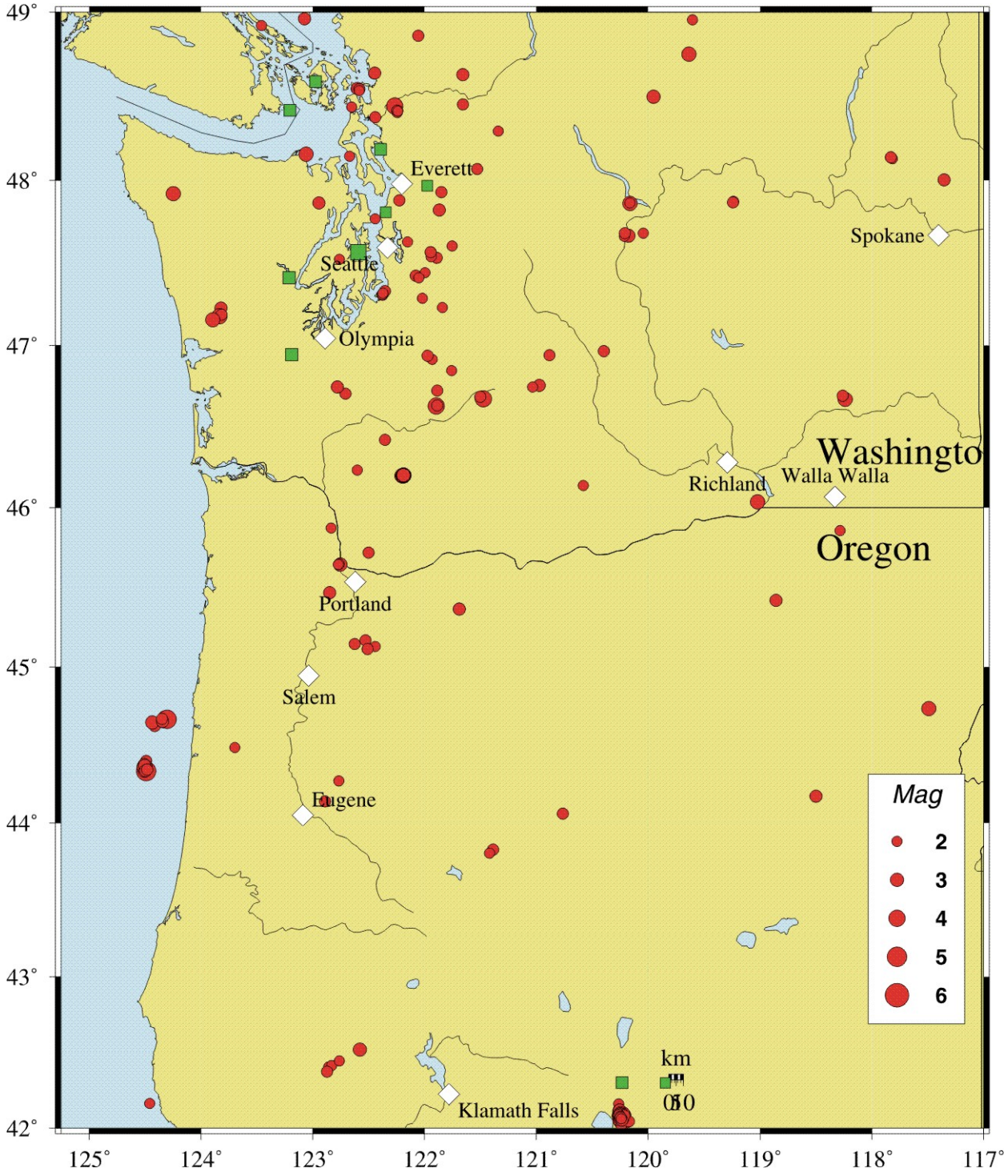
hazards. Most of the PNSN strong-motion instruments are located at public schools and monthly e-mail information and news updates are sent to teachers. We also provide information sheets, lab tours, workshops, and media interviews, and have an audio library with several tapes. Current seismic activity and other information are available via Internet on the World-Wide-Web (WWW): **http://www.pnsn.org**

- ***Special Events:*** PNSN staff participated in meetings with numerous groups, including hosting meetings of the **ANSS PNW Region Advisory Committee** (see **www.pnsn.org/SEIS/ANSS/welcome.html**), Cascadia Regional Earthquake Workgroup (CREW), and Contingency Planners and Reovery Manager (CPARM). and making presentations in other meetings, such as **ANSS, IRIS and Earthscope committees**, as well as numerous presentations for the general public. PNSN faculty, staff, and students authored or co-authored at least a dozen abstracts presented at the 2003 **Geological Society of America** meeting in Seattle.

Seismicity

Between Oct. 1, 2003 and Sept. 30, 2004, 30 earthquakes were reported felt in Washington or northern Oregon west of the Cascades, ranging in magnitude from 1.6 to 4.9. Twenty earthquakes (magnitudes 2.1 to 3.4) were reported felt east of the Cascades, twelve of them (ranging in magnitude from 2.5 to 4.4) as part of an earthquake swarm near Lakeview Oregon.

Between Oct. 1, 2003 and Sept. 30, 2004 the PNSN analyzed 5,453 events. Of these, 4,589 were earthquakes or blasts within the network (1,471 of which were too small to locate). Within the network area, 2,267 earthquakes were located west of 120.5 degrees west longitude (including 1182 in the general vicinity of Mount St. Helens, which began a magmatic eruption at on Sept. 23, 2004, just a few days before the end of this reporting period), and 375 east of 120.5 degrees west longitude. The remaining events were blasts within the network (509), regional earthquakes (291), teleseisms (573), low-frequency events (300 events, 46 locatable, including ice-quakes near the summit of Mt. Rainier, and events associated with the eruption of Mount St. Helens), and surficial events (558 events, 4 locatable, mostly rockfalls near the summits of Mt. St. Helens and Mt Rainier).



- **Figure 2.** Earthquakes magnitude 2.0 or larger between Oct. 1, 2003 and Sept. 30, 2004. Locations of a few cities are shown as white-filled diamonds. Earthquakes are indicated by red circles or green squares; red circles represent earthquakes at depths shallower than 30 km, and green squares represent earthquakes at 30 km or deeper.

TABLE 2-- FELT EARTHQUAKES Oct. 1, 2003 - Sept. 30, 2004

DATE-TIME is in Universal Time (UTC) which is PST + 8 hours.
Magnitudes are reported as local magnitude (Ml).
QUAL is location quality A-good, D-poor

DATE-(UTC)-TIME yy/mm/dd hh:mm:ss	LAT(N) deg.	LON(W) deg.	DEP km	MAG Ml	QUAL	COMMENTS
03/10/01 13:27:36	44.73N	117.48W	22.1	3.1	DD	27.7 km E of Baker, OR
03/10/13 01:11:58	47.58N	121.86W	7.7	1.6	BB	2.2 km NE of Fall City, WA
03/10/25 23:35:21	47.53N	121.89W	18.6	2.3	BA	3.7 km S of Fall City, WA
03/11/13 00:57:54	42.52N	122.57W	16.8	2.9	BB	23.2 km WNW of Mt McLoughlin, OR
03/12/14 04:59:47	46.58N	121.69W	4.9	1.8	AC	20.5 km WNW of Goat Rocks, WA
03/12/26 10:07:45	48.75N	119.63W	0.4	3.4	DD	43.1 km N of Okanogan, WA
04/01/06 22:45:51	48.63N	122.45W	0.0	2.1	BC	14.3 km S of Bellingham, WA
04/01/07 00:11:51	48.64N	122.44W	0.1	2.7	CC	14.0 km SSE of Bellingham, WA
04/01/09 09:08:17	45.63N	122.76W	17.4	2.1	AA	15.8 km NW of Portland, OR
04/01/14 12:13:38	47.86N	120.16W	2.5	3.3	CC	11.5 km WNW of Chelan, WA
04/01/14 12:39:53	47.86N	120.16W	0.7	2.1	CC	11.5 km WNW of Chelan, WA
04/01/16 03:20:11	47.33N	122.35W	24.5	2.4	BA	12.1 km NNE of Tacoma, WA
04/01/16 08:18:18	47.56N	122.59W	55.6	3.6	BA	3.0 km E of Bremerton, WA
04/01/26 16:43:10	47.10N	122.20W	10.7	1.8	AA	20.2 km SW of Enumclaw, WA
04/02/09 14:33:11	47.66N	120.17W	0.7	2.9	CC	3.7 km E of Entiat, WA
04/02/09 20:04:27	48.37N	122.43W	0.0	2.4	CC	8.9 km WSW of Mount Vernon, WA
04/02/26 01:51:54	45.64N	122.75W	18.9	3.0	BA	16.2 km NW of Portland, OR
04/02/28 02:01:47	46.03N	119.02W	1.0	3.3	CB	20.2 km SSE of Kenewick, WA
04/03/17 11:34:27	48.44N	122.26W	0.1	3.8	CC	6.0 km ENE of Mount Vernon, WA
04/03/19 05:41:34	45.14N	122.62W	26.1	2.4	CA	14.0 km SSE of Canby, OR
04/04/15 06:32:14	46.93N	121.97W	12.6	2.3	BA	18.8 km WNW of Mt Rainier, WA
04/04/25 14:42:33	47.82N	121.86W	17.7	2.5	BA	8.7 km ESE of Monroe, WA
04/05/10 13:22:59	47.67N	120.27W	0.0	1.8	CB	4.2 km WNW of Entiat, WA
04/05/13 19:43:14	47.91N	124.24W	0.0	3.1	CC	10.9 km ESE of Forks, WA
04/05/17 13:03:37	46.94N	123.18W	41.6	2.7	AA	23.3 km ESE of Satsop, WA
04/06/10 18:09:06	47.18N	123.83W	0.1	2.3	CC	23.6 km N of Aberdeen, WA
04/06/12 15:12:09	47.22N	123.81W	0.0	2.6	DC	28.1 km N of Aberdeen, WA
04/06/17 09:16:42	46.67N	118.23W	17.6	3.4	BD	67.2 km N of Walla Walla, Wa
04/06/20 19:32:12	46.62N	121.88W	4.0	2.6	BC	26.8 km SSW of Mt Rainier, WA
04/06/24 07:57:52	48.54N	122.60W	19.9	2.8	BB	24.1 km NW of Mount Vernon, WA
04/06/25 01:41:32	42.04N	120.25W	13.4	3.0	DB	17.8 km SSE of Lakeview, OR
04/06/25 21:48:31	46.62N	121.89W	0.2	3.9	CC	27.0 km SSW of Mt Rainier, WA
04/06/27 03:24:42	42.07N	120.24W	11.4	3.2	BB	15.6 km SSE of Lakeview, OR
04/06/27 07:00:14	42.09N	120.24W	11.6	3.9	BB	13.9 km SE of Lakeview, OR
04/06/27 07:03:16	42.07N	120.24W	10.4	3.2	DB	15.7 km SSE of Lakeview, OR
04/06/27 11:32:37	42.07N	120.24W	6.9	3.0	BC	15.2 km SE of Lakeview, OR
04/06/27 11:40:37	48.41N	122.24W	0.0	2.2	CB	6.9 km E of Mount Vernon, WA
04/06/28 03:58:48	48.41N	122.23W	1.5	2.0	AB	7.4 km E of Mount Vernon, WA
04/06/29 01:38:49	42.05N	120.23W	14.3	2.7	DB	17.3 km SSE of Lakeview, OR
04/06/30 12:21:45	42.07N	120.23W	10.9	4.4	BB	15.4 km SE of Lakeview, OR
04/06/30 18:59:45	42.07N	120.25W	3.6	2.5	CD	15.4 km SSE of Lakeview, OR
04/07/01 03:12:19	41.99N	120.22W	1.8	2.9	DD	23.9 km SSE of Lakeview, OR
04/07/01 05:44:59	41.80N	120.18W	2.5	2.9	DD	44.8 km SSE of Lakeview, OR
04/07/05 05:42:09	42.06N	120.23W	8.7	3.2	DC	16.7 km SSE of Lakeview, OR
04/07/12 16:45:00	44.33N	124.48W	29.2	4.9	BD	48.4 km SW of Newport, OR
04/07/22 20:26:26	42.09N	120.24W	1.1	4.3	AC	14.3 km SE of Lakeview, OR
04/07/26 06:40:46	47.17N	123.83W	12.4	3.5	CC	22.7 km N of Aberdeen, WA
04/08/16 21:05:53	46.67N	121.47W	0.3	4.0	CB	17.5 km N of Goat Rocks, WA
04/08/19 06:06:03	44.66N	124.30W	27.9	4.7	BD	19.9 km W of Newport, OR
04/08/31 16:58:00	46.72N	121.88W	7.4	2.2	AA	17.2 km SW of Mt Rainier, WA

Publications

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

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