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THE APRIL 25, 1992 CAPE MENDOCINO, CALIFORNIA, EARTHQUAKE AFTERSHOCK EXPERIMENT

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PASSCAL Data Report 93-001

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Data Report
for
The April 25, 1992 Cape Mendocino, California, Earthquake Aftershock Experiment

submitted by

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for the
PROJECT SCIENCE TEAM

PASSCAL DATA REPORT #93-001

ABSTRACT

This report describes data collected during the April 25, 1992 Cape Mendocino Aftershock deployment. This deployment consisted of up to eleven 3-component stations with a variety of sensors including broadband Guralp CMG3-ESP, Striekheisen STS-2, mid-period Kinemetric SH, SV-1, as well as higher frequency 2 Hz sensors and force balance accelerometers. At least 5 stations were in operation between April 28 and May 17, 1992. The data will be made available to the community in 2 data releases. The first release consists of data for fifty-one of the largest and most landward located events that occurred between April 28 and May 6; the second release consists of data for most events of magnitude > 2.0 that occurred between April 27 and May 19,1992. Introductory information about the Cape Mendocino mainshock, the field deployment, data format, and instrument responses are discussed.

1. Introduction

On Saturday April 25, at 11:06 AM (PDT) a magnitude 7.0 earthquake occurred near the small town of Petrolia, about 25 miles south-southwest of Eureka, California. This event was associated with subduction of the Gorda Plate beneath the North American Plate along the Cascadia Subduction Zone (Figure 1) and represents the largest earthquake with this sense of motion to ever be instrumentally recorded in this region. This is significant in light of recent evidence that great subduction zone earthquakes have ruptured the plate boundary in this vicinity in the recent past. Two associated events of magnitudes 6.5 and 6.6 having strike-slip mechanisms, followed within 24 hours of the first earthquake. The epicenters of these events are within the Gorda Plate.

2. Field Deployment and Instrument Parameters

By late Monday, April 27, seven stations were deployed within 20 km of the Petrolia epicenter at Everet Ridge (EVRL), Cape Mendocino (CAML), North Fork Road (NFRL), Lighthouse Road (LHRL), Capetown (CPTI), Bunker Hill (BKHI), and Grizzly Bear Ridge (GBRI). Instrumentation at these sites consisted of RefTek 72A-02 16-bit digitizers and 1 or more of the following 3-component sensors: Kinemetrics FBA-13 accelerometers, Sprengnether S-6000 (2 Hz), Kinemetrics SV-1 SH-1 (5 sec), or Guralp CMG3-ESP broadband seismometers. On Tuesday, April 28, installation of the last 4 stations began at Blue Lake (BLLI), Horse Mountain (HMTI), Pratt Mountain (PMTI), and Fortuna (BYRI). These stations consisted of RefTek digitizers with STS-2 broadband sensors. Figure 1 shows the location of the seismic stations relative to the mainshock and larger aftershock activity. Siting of the STS-2 sensors outboard of the epicentral seismic array was intentional to assure that the larger earthquakes in the aftershock sequence were recorded on scale. Events included in the first data release have their parameters, as determined by the U.S Geological Survey, listed in Table 1; many of these events are plotted on Figure 1. A table listing the parameters for events contained in the second data release will be appended to this report as that data become available.

Table 2 contains station parameter information. Station locations were determined using a portable GPS system and refined using 71/2 ' topographic maps. Errors in latitude, longitude, and elevation are estimated to be no larger than 100 m. Stations hmti and prmi are more precisely located due to the presence of benchmarks at these sites. Most sensors were oriented using a brunton compass and have errors of up to 5° in azimuth. The orientation of the STS-2's at blli, byri, hmti, and prmi were measured more precisely using a gyroscope. Sampling rates, gains, record lengths and other instrument parameters varied between data streams at particular stations and between stations. Most of this information is contained in the sac headers, however all information is contained in the station logs included in this data release. Each DAS was equipped

with either an OMEGA or GOES clock to ensure precise timing. Station logs provide information on timing for each station.

3. Data Distribution Format

The data collected during this experiment were provided to the IRIS data management center in sac format with relevant header information such as station and earthquake location, station name, component name etc. included in the sac header. The earthquake locations are those listed in Table 1. from the U.S. Geological Survey. Preliminary earthquake locations were also determined using only data from the stations of this aftershock deployment to check for obvious timing problems. These locations are presently be refined, however most relocations did not differ substantially from those listed in Table 1. The file structure consists of directories labeled with RJulian day for data recorded on Julian days, 118 (April 27, 1992) through 140 (May 19, 1992). Within each Julian day directory are directories containing data for events that occurred on those days labeled by the hour and minute of the first data point in that record. This will almost always correspond to the hour and minute of the origin time of the earthquake recorded, except when the origin time occurred very close to the next later minute. Within the individual event directories, the data files have the following convention: hourmin.station name.component. An example of the directory structure giving the location of a file containing data for the north component of ground motion at station cpti from the event on April 28, 1992 at 4 hours 22 minutes and 3.44 seconds is:

R119/0422/0422.cpti.n

All data recorded for each event are contained in the event directories. Stations missing from these directories were either not triggered by this event or were not recorded due to instrument hardware or software problems. Unfortunately, many such problems were encountered and several data losses were experienced.

The location and name of the original log and error files containing input instrument parameters, the state of health and clock information for all stations are contained in the following directory-file structure:

logs/station name/jd1-jd2.log

logs/station name/jd1-jd2.err

where jd1 and jd2 represent the first and last julian day for which information is contained in the log. This log file is in the original format that results from extraction of the data using the program

ref2segy or ref2sac. The data collected in this experiment have not been corrected for sensor characteristics or timing problems. Nominal instrument responses for the STS-2s and Guralps are given in the next section . Calibration of the Kinemetrics SH-1 and SV-1's was performed and the resulting free period, damping, and magnification (in units of volts/m/s) of these seismometers is provided in the next section.

No adjustments to timing have been made on this data primarily due to the difficulty of interpreting the necessary information from the logs. While the log files indicate that the OMEGA clocks at many of the stations locked and remained locked for much of this experiment, they also indicate that the DSP clock added and subtracted seconds at frequent intervals. We have not attempted to correct the data for this incomprehensible action, but all original timing information is included in this data release for interested users to attempt to interpret and apply. Additional notes on this data, much of which has been extracted from the data logs are as follows:

1. For station cpti, after day 120 at 0539, the log reports that the omega clock is locked but does not report the station name. This is a false lock and to obtain exact time for events after this date a clock drift correction must be calculated and applied.

2. For station bkhi, data was lost for days 122 and 123. On day 124, when data was recorded again, the east component is bad.

3. For station evrl, data was not recovered for days 122 through 135. The log provides no obvious reason for this data loss.

4. For station nfrl, caml and lhrl, many DSP time shifts occurred.

5. For station byri, the clock remained locked throughout the experiment but preliminary earthquake location indicates that the clock was 10.0 seconds ahead.

6. For station prmi the clock never locked and on day 134 a GPS unit was installed in the DAS to temporarily obtain exact time. The clock was off by -739 msec, which was corrected at 135:20:07:05. When the station was removed on day 140, the OMEGA antennae was reconnected at a slightly different spot and the OMEGA clock locked at 140:19:30:09 with a clock phase error of 214 msec. From knowing the exact time at 2 points in time, a drift rate for this DAS can be computed and applied to the data.

4. Instrument Response

Guralp CMG3-ESP

The velocity output scaling is the nominal responses given by the Guralp test sheets. The poles describe the long-period transfer function to input **acceleration**. The instrument transfer functions have two poles (listed in radians) and two zeros. Sensitivities may by off by a factor of 2.

	1. station bkhi:		2. station cpti:		3. station gbri	
poles:	-0.1481	0.1481	-0.4443	0.4443	-0.4443	0.4443
	-0.1481	-0.1481	-0.4443	-0.4443	-0.4443	-0.4443
zeros:	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00

Velocity output (v/m/s)

Z: 1500	Z: 1408	Z: 1407
N 1500	N: 1486	N: 1491
E 1500	E 1479	E:1468

Striekheisen STS-2

Normalized response relative to velocity,

2 zeroes:	0.00 0.00	
	0.00 0.00	
2 poles:	-0.3554E-01	0.3554E-01
	-0.3554E-01	-0.3554E-01

Amplification in differential mode: 1500 v/m/s

Kinemetrics SH-1 and SV-1

Station	Component	Free Period	Damping	Sensitivity (v/m/s)
caml	vertical	5.01	0.6985	190
caml	north	4.91	0.7566	148
caml	east	4.91	0.645	159
nfrl	vertical	5.37	0.8423	242
nfrl	north	5.59	0.8133	157
nfrl	east	4.828	0.8555	137

5. Acknowledgments

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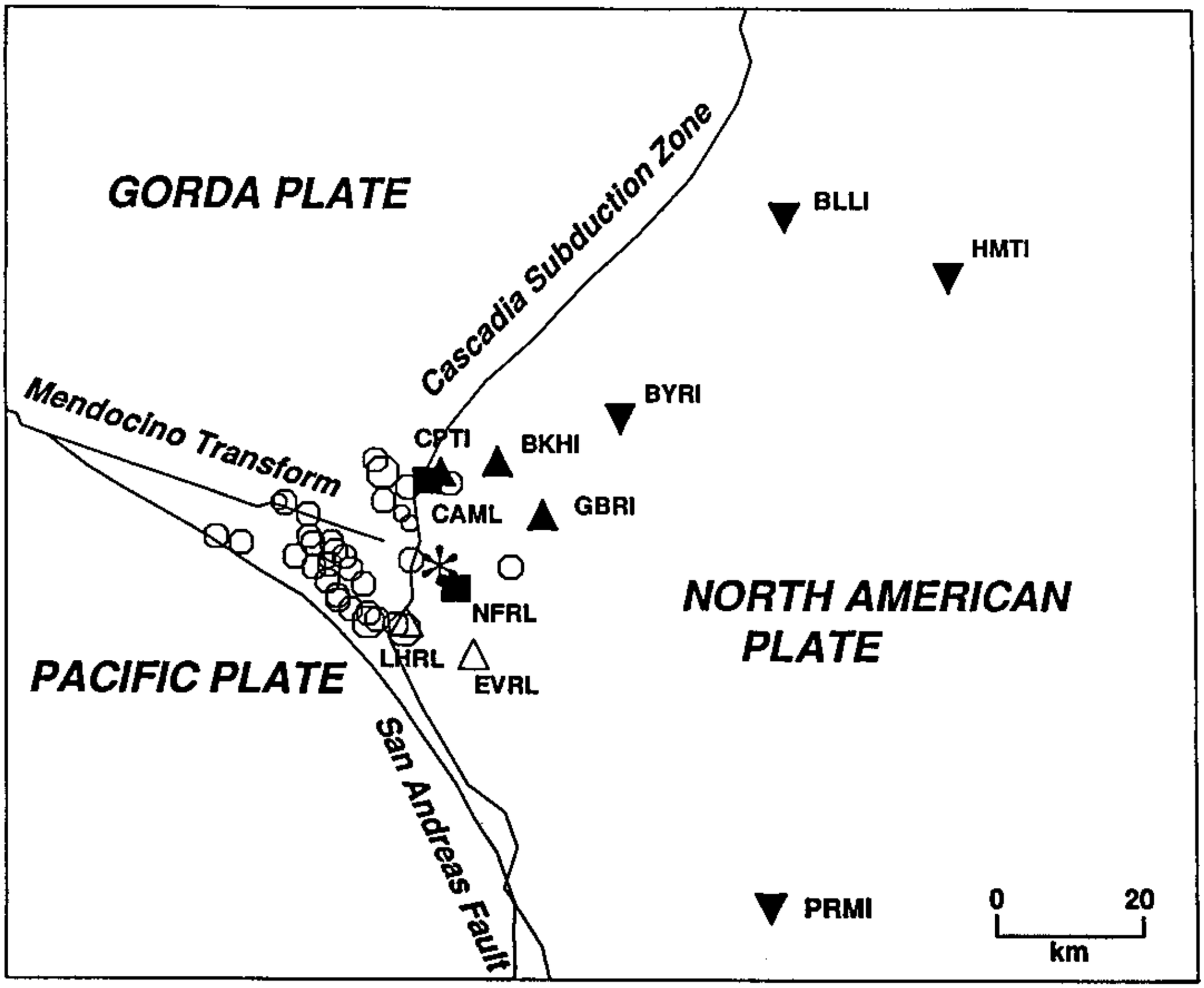

Figure 1 Location of all M>3.0 aftershocks (open circles) in Cape Mendocino aftershock data release 1. Solid symbols show the locations of stations with broadband sensors where the upright triangles, upside down triangles and boxes indicate Guralp CMG-3, STS-2, and Kinemetrics SH-1 and SV-1 sensors respectively. The star marks the mainshock location.

Table 1. USGS Aftershock Locations

DATE			LAT (N)		LONG (W)		DEPTH	MAG	NO	GAP	Dm	RMS	ERRORS	
YRMODY	HRMN	SEC	DEG	MIN	DEG	MIN	KM			DEG	KM		HOR	VER
920428	0422	03.44	40	18.58	124	24.93	20.54	3.2	14	241	12.	0.05	1.0	0.2
920428	0542	16.67	40	23.77	124	36.57	22.93	2.9	23	245	25.	0.20	2.2	1.3
920428	0556	47.34	40	18.50	124	27.71	8.38	3.2	16	244	15.	0.08	1.0	0.4
920428	0944	50.01	40	22.67	124	24.18	6.19	3.1	10	237	12.	0.14	1.4	0.7
920428	1356	02.68	40	18.03	124	29.74	22.73	3.4	21	245	17.	0.11	1.6	0.5
920428	1453	50.57	40	17.25	124	23.11	6.99	3.0	20	233	8.	0.15	0.9	0.4
920428	1838	24.48	40	18.64	124	28.03	7.98	3.3	17	254	15.	0.14	1.3	0.4
920428	2123	17.41	40	26.19	124	16.47	8.58	2.9	6	256	13.	0.06	3.8	1.5
920428	2259	03.85	40	25.98	124	37.32	15.28	2.9	12	265	25.	0.15	3.2	0.6
920429	0532	13.75	40	24.58	124	34.08	13.82	2.5	10	284	21.	0.11	2.7	0.6
920429	0552	31.09	40	22.36	124	35.43	22.99	3.0	22	241	24.	0.14	1.7	0.9
920429	1042	15.17	40	26.40	124	25.54	6.10	2.8	16	226	24.	0.18	1.6	0.8
920429	1435	05.78	40	22.68	124	40.53	17.57	2.9	12	265	31.	0.17	3.5	0.8
920430	0219	08.98	40	19.59	124	27.22	7.66	3.1	13	261	15.	0.11	1.5	0.5
920430	0443	23.50	40	16.69	124	21.92	22.71	2.6	11	235	6.	0.10	1.6	0.6
920430	0607	01.35	40	25.19	124	25.02	8.83	2.5	10	253	9.	0.08	1.2	0.5
920430	0840	20.58	40	22.51	124	34.91	26.09	3.5	26	240	24.	0.12	1.2	1.0
920430	0849	41.37	40	18.91	124	30.47	21.92	3.1	15	244	19.	0.09	2.0	0.5
920430	0856	52.23	40	16.72	124	21.77	23.14	2.7	9	231	19.	0.09	1.6	0.6
920430	0953	26.34	40	16.50	124	24.16	24.12	4.1	23	232	9.	0.15	1.4	0.6
920430	1029	49.80	40	19.43	124	29.25	27.29	3.2	15	250	17.	0.08	1.4	0.6
920501	0403	45.21	40	18.87	124	25.70	20.49	3.1	14	249	13.	0.07	1.4	0.2
920501	0409	40.58	40	18.51	124	15.87	8.54	2.9	13	133	8.	0.19	0.8	0.5
920501	0415	38.88	40	16.96	124	26.02	22.13	3.4	21	228	11.	0.11	1.2	0.4
920501	0822	49.99	40	18.92	124	37.53	11.10	3.3	15	284	28.	0.14	2.5	0.9
920501	1542	56.73	40	20.80	124	31.79	27.63	3.6	20	249	22.	0.08	1.5	0.8
920501	1657	41.99	40	23.18	124	37.30	33.18	2.7	7	264	68.	0.34	9.6	19.6
920501	2241	52.97	40	19.20	124	32.48	9.63	3.6	19	245	21.	0.16	1.5	0.4
920501	2259	43.49	40	22.25	124	32.50	24.60	3.1	32	227	21.	0.15	1.1	1.5
920502	0941	45.50	40	23.28	124	13.49	10.30	3.5	23	112	9.	0.09	0.2	0.2
920502	1130	31.37	40	17.60	124	27.59	22.51	3.9	23	228	14.	0.11	1.1	0.4
920502	1208	15.78	40	21.53	124	22.25	15.43	3.1	22	216	13.	0.19	0.9	0.3
920502	1518	34.34	40	18.00	124	16.67	9.88	2.9	17	143	6.	0.22	0.7	0.4
920502	1520	41.85	40	18.74	124	39.99	9.76	3.1	10	287	31.	0.23	5.6	2.4
920503	0934	55.94	40	19.38	124	17.18	33.88	2.5	17	154	9.	0.13	0.8	1.0
920503	0955	37.88	40	19.70	124	29.49	19.28	3.0	16	251	18.	0.41	4.6	1.1
920503	1447	48.32	40	22.33	124	32.87	14.73	2.9	10	287	21.	0.12	1.8	0.3
920503	1728	17.49	40	22.28	124	32.23	14.74	2.7	14	253	21.	0.11	1.8	0.4
920503	2003	12.53	40	20.47	124	31.25	24.27	3.1	18	248	21.	0.16	2.1	0.9
920504	0013	27.91	40	20.30	124	28.11	20.40	3.6	16	249	17.	0.07	1.3	0.2
920504	0033	54.25	40	23.92	124	22.86	10.10	2.8	13	224	9.	0.12	0.9	0.4
920504	0035	50.91	40	24.44	124	24.43	9.10	3.0	16	224	20.	0.17	0.9	0.5
920504	0159	19.40	40	23.94	124	23.45	10.63	3.0	18	223	10.	0.10	0.7	0.3
920504	0506	20.02	40	27.35	124	28.28	11.19	3.3	19	234	12.	0.08	0.7	0.2
920504	0708	19.00	40	17.11	124	24.45	23.81	3.7	20	237	9.	0.09	1.1	0.4
920504	0744	42.61	40	16.87	124	23.45	22.24	3.6	14	229	8.	0.17	1.6	0.7
920504	0932	19.08	40	20.94	124	29.65	20.63	3.5	17	250	19.	0.10	1.5	0.2
920505	1046	17.10	40	16.80	124	20.81	8.40	4.4	19	209	5.	0.16	0.8	0.3
920505	2306	48.02	40	17.93	124	16.79	10.49	2.7	18	145	6.	0.18	0.6	0.3
920506	0025	57.50	40	24.84	124	26.36	10.62	3.3	22	232	11.	0.11	0.7	0.3
920506	0733	12.26	40	22.76	124	12.13	8.43	2.6	20	102	8.	0.12	0.3	0.3

Dm: minimum distance to nearest Calnet station used in earthquake location

Table 2. Station Parameters

Station	Lat (°N)	Long (°W)	El (m)	DAS #	Sensor	Channel	AZ (from geogr. N)
blli	40.884	123.99	247	269	STS-2	v, n, e	0° N*
bkhi	40.458	124.204	610	365	Guralp ESP	v, n, e	0° N
+byri	40.597	124.136	90	284	STS-2	v, n, e	7.5° W*
caml	40.456	124.386	250	230	S-6000 days119-120	v, n, e	0° N
					Kinemetric SH,	v, n, e	0° N
					SV-1 days 121 on		
					FBA-13	fbv, fbn, fbe	0° N
cpti	40.454	124.382	230	364	Guralp ESP	v, n, e	0° N
evrl	40.279	124.238	150	233, 40	S-6000	v, n, e	18° E
					FBA-13	fbv, fbn, fbe	0° N
gbri	40.458	124.204	700	368	Guralp ESP	v, n, e	0° N
hmti	40.875	123.732	1509	439	STS-2	v, n, e	6° W*
lhrl	40.290	124.350	40	177	S-6000	v, n, e	0° N
					FBA-13	fbv, fbn, fbe	0° N
nfrl	40.351	124.293	85	176	S-6000 day 119	v, n, e	36° E
					Kinemetric SH,	v, n, e	0° N
					SV-1 days 120 on		
					FBA-13	fbv, fbn, fbe	0° N
prmi	40.121	123.692	1185	298	STS-2	v, n, e	8.5° E*

*azimuths measured with gyroscope
+recorded both high gain (hg) and low gain (lg) channels