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DEPARTMENT OF NATURAL RESOURCES

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INFORMATION CIRCULAR 55

COMPILATION OF EARTHQUAKE HYPOCENTERS IN WESTERN WASHINGTON - 1973

By

ROBERT S. CROSSON

1975

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COMPILATION OF EARTHQUAKE HYPOCENTERS

IN

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Robert S. Crosson

SUMMARY

A multistation telemetered seismograph network has been operated in western Washington on a continuous basis since 1970 by the Geophysics Program at the University of Washington. The network provides basic data for accurately locating both large and small earthquakes in a region centered on the Puget Sound basin. This area is bounded on the east and west by the Cascade and Olympic Mountains, respectively, and extends north to the latitude of Mount Baker and south to the latitude of Mount St. Helens. During a 1-year period, a large number of earthquakes are located that may have significance for many areas of investigation; accordingly, this is the second of a series of reports designed to make these data available to the public.

This report covers the year 1973 in which a total of 342 earthquakes were successfully located. It includes the description of a revised crustal velocity structure model, which was used to calculate the earthquake hypocenters, along with a revised station data table. In addition, a machine-plotted map listing all earthquakes in this report is included. However, background and descriptive information, which are contained in the first report of this series (Crosson, 1974), are not repeated here. It is worth re-emphasizing however, that the number of earthquakes successfully located, as apart from recorded, by the network depends critically on the number of and the areal distribution of seismograph stations, the seismic "quality" of each site, and, of course, the actual earthquake activity of the region. The central Puget Sound basin region, between approximately latitudes 47 and 48 degrees, appears to be the most seismically active area of Washington State and is well covered by the present network configuration. Although the number of stations was relatively constant during 1973, with only one station being added during this period, the coverage is not of uniform quality over the whole of western Washington. Furthermore, some stations inevitably fail to operate for various periods of time, producing additional variation in the quality of coverage. Thus, caution must be exercised in interpreting the hypocenter data since the magnitude threshold of detection is not uniform throughout the network, and moreover the accuracy of location deteriorates for earthquakes lying outside

the network perimeter.

INTRODUCTION

During 1973 the University of Washington operated a 13-station telemetered seismograph network, plus one World-Wide Standard (WWSN) station (LON) which is on-site recording. This operation is part of a long-range program starting with a five station network in 1970. A substantial body of data on earthquake locations, magnitudes, and depths has emerged. This is the second in a series of reports designed to present accurate earthquake location data in a standard format for western Washington. The first report (Crosson, 1974) includes earthquake data for 1970, 1971, and 1972 in addition to background information and specifications for the network operation. Thus the reader is referred to that report for a description of the network instrumentation, procedure of analysis, glossary of terms, and other information.

Due to the fact that an improved earth model and improved station delays have been derived for western Washington, a description of this model, which differs from the model used for the previous report, is included here. The basic data of this report, however, are the earthquake hypocenters listed in time sequence in the Appendix. This listing is a direct copy of a machine listing and should be free of typographical errors. Suggestions as to making this series of reports more efficient, useful, or informative are welcome and can be directed to the Washington State Department of Natural Resources, Division of Geology and Earth Resources.

CRUSTAL VELOCITY MODEL

The locations of earthquakes listed in this report depend upon the crustal model used to predict the arrival times of seismic waves. A new crustal velocity model has been calculated using well-

TABLE 1.—Crustal velocity structure used in calculating earthquake hypocenters

Depth to layer top	Compressional wave velocity in layer (KM/SEC)	Velocity error (KM/SEC)
0.0	5.36	0.07
10.0	6.61	.03
16.0	6.70	.03
22.0	6.91	.02
32.0	7.11	.11
35.0	7.16	.13
38.0	6.87	.11
41.0	7.75	.04

recorded earthquakes in the central Puget Sound basin area. This new model is characterized by P-wave (compressional wave) velocities of plane horizontal layers at specified depths in the earth, and is used in the calculation of all hypocenters for this report. Table 1 lists the velocity model used for all calculations. Details of the method used to calculate this model are in preparation for publication. The revised velocity model produces significantly lower residuals and consequently improves the quality of locations obtained with the network.

Station time corrections are applied to each observed arrival in order to correct for the effects of varying station elevation and velocity anomalies local to the station. In the procedure for calculating a velocity model, a revised set of station corrections or delays was obtained. Table 2 lists the station locations including the revised delays. These station delays include both the effects of elevation and velocity anomalies and are used to correct the station readings to a sea-level reference surface. Thus the depths indicated for the velocity model are below sea level. Station delays are subtracted from the arrival times in making this correction.

TABLE 2.—Summary of network station data

List of NEIS abbreviated stations in western Washington

Station name	LAT DEG	MN	SEC	LON DEG	MN	SEC	ELEV KM	P DELAY SEC	Install date	Mag at 1 HZ	Location
SPW	047	33	13.30	122	14	45.10	0.008	1.029	9/17/69	65000	Seward Park
GMW	047	32	52.50	122	47	10.80	0.506	0.100	2/27/70	145000	Gold Mountain
GSM	047	12	11.40	121	47	40.20	1.305	0.399	6/11/70	165000	Grass Mountain
BLN	048	00	26.50	122	58	18.64	0.585	-.137	7/ 2/70	115000	Blyn Mountain
CPW	046	58	25.80	123	08	10.80	0.792	0.241	7/29/70	135000	Capitol Peak
RMW	047	27	34.95	121	48	19.20	1.024	0.385	7/27/71	190000	Rattlesnake Mountain
JCW	048	11	36.60	121	55	46.20	0.616	-.033	2/18/71	120000	Jim Creek
FMW	046	55	54.00	121	40	19.20	1.890	0.246	9/ 4/72	100000	Mount Fremont
BFW	046	29	12.00	123	12	53.40	0.902	0.113	10/25/72	150000	Baw Faw Mountain
SHW	046	11	33.00	122	14	12.00	1.423	0.319	10/25/72	45000	Mount St. Helens
MCW	048	40	46.80	122	49	56.40	0.693	0.125	11/ 8/72	70000	Mount Constitution
MBW	048	47	02.40	121	53	58.80	1.676	0.433	11/ 8/72		Mount Baker
STW	048	09	0.75	123	40	12.00	0.308	0.009	6/27/73		Striped Peak
LON	046	45	00.00	121	48	36.00	0.853	0.011		60000	Longmire

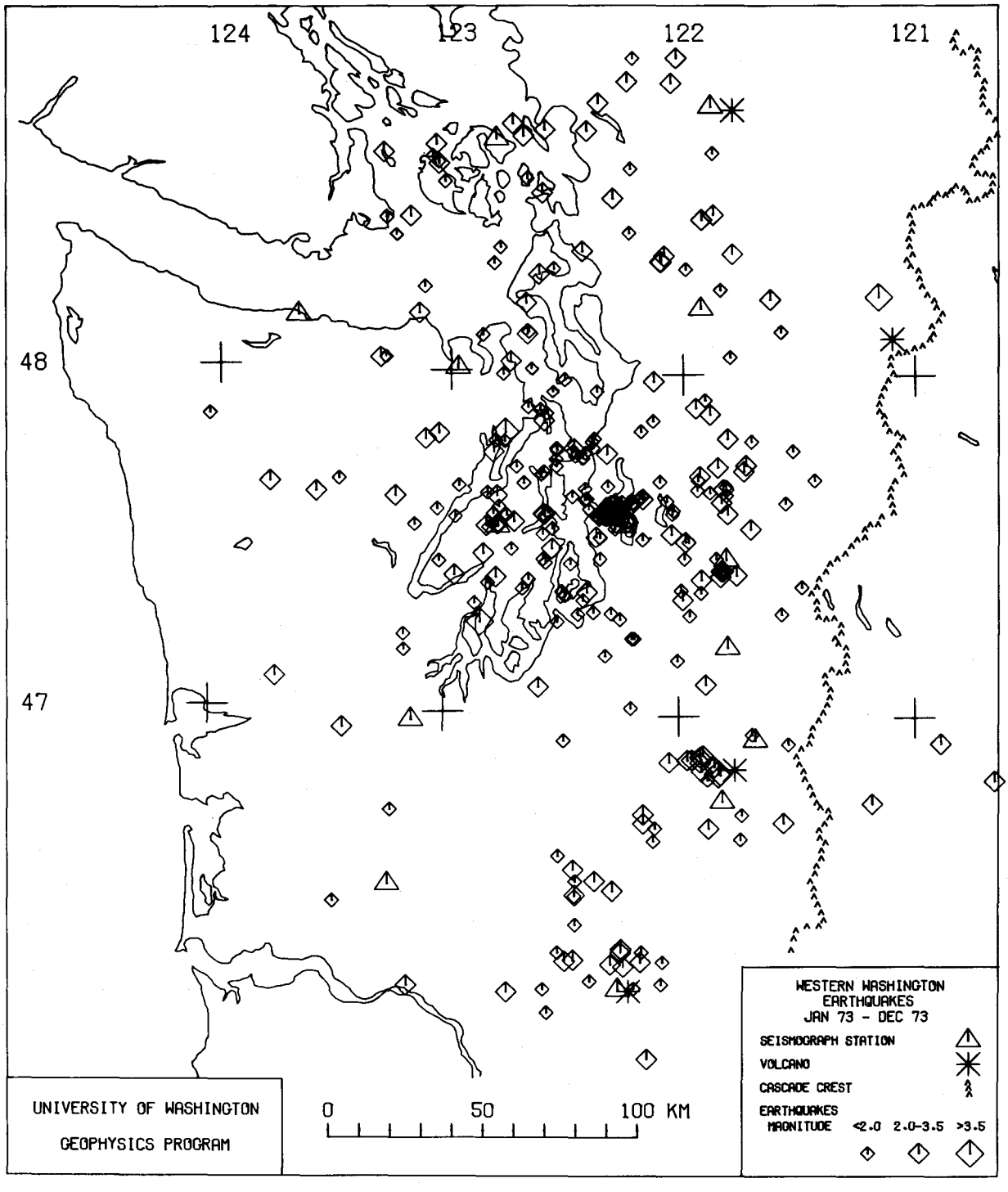

FIGURE 1.—Map showing epicenters for 1973.

HYPOCENTER LISTING

A total of 342 earthquakes, which were located for the year 1973, are listed in the Appendix of this report. Figure 1 shows the epicenter distribution, including the station locations, of all earthquakes listed in the appendix. This figure is machine drawn for accuracy and completeness. Comments contained in the first report of this series (Crosson, 1974) are appropriate and may be helpful in interpreting these data. However, the following changes have been made in this report: (a) an error in the listing program that suppressed listing of the first earthquake of each month has been corrected, and (b) blanks in the magnitude or standard deviation columns indicate that these quantities were not calculated. Magnitudes are not calculated when reliable coda lengths cannot be read from the seismic records. Standard deviations of magnitude are not calculated if less than two coda length observations are made. Note from table 2 that only one station (STW) was added to the network during 1973. Thus station coverage was relatively constant, except for station failures, for the duration covered by this report.

ACKNOWLEDGMENTS

Many individuals and organizations have contributed to make this work possible and it is difficult to achieve full acknowledgment. Jocelyn Nakashima, Betty Yeh, and Jia-Wen Lin provided assistance in reading seismograms and basic data handling. Richard Millard assisted in data editing and processing. Leland Bond provided major technical support for the network operation. The State Department of Natural Resources, U.S. Forest Service, Washington State Parks Commission, Weyerhauser Company, U.S. Navy, U.S. National Park Service, and the City of Seattle Parks Department have all generously provided access to lands for the purpose of seismograph station installation. The U.S. Department of Commerce, National Oceanographic and Atmospheric Administration and the U.S. Department of the Interior, Geological Survey, have provided support of radio telemetering operations. Research support has been provided by the Earth Science Section, National Science Foundation, NSF Grant DES-69-00059-A03 (formerly GA-12826), and the U.S. Geological Survey under Grant 14-08-0001-G-120 and Contract 14-08-0001-14127.

REFERENCE CITED

Crosson, R. S., 1974, Compilation of earthquake hypocenters in western Washington: Washington Division of Geology and Earth Resources Information Circular 53, 25 p.

APPENDIX

CATALOG OF EARTHQUAKES (1973)

Earthquakes located with the western Washington seismograph network are listed chronologically in this Appendix. The columns are generally self-explanatory except the following features should be noted:

a) The origin time listed is that calculated for the earthquake on the basis of multistation arrival times. It is given in Coordinated Universal Time (UTC), which is identical to Greenwich Civil Time, in hours (HR), minutes (MN), and seconds (SEC). To convert to Pacific Standard Time (PST), subtract eight hours.

b) The epicenter location is given in north latitude (LAT N) and east longitude (LONG E) in degrees, minutes and seconds.

c) In most cases the depths, which are given in kilometers, are freely calculated by computer from the arrival-time data. In some instances depths must be fixed arbitrarily to obtain epicenter solutions. Such depths are noted by an F (fixed) in the column immediately following the depth.

d) The residual standard deviation (SD) is taken about the mean of the station first-arrival residuals. It is only meaningful as a general statistical measure of the goodness of the solution when 5 or more stations are used in the solution. Good solutions are normally characterized by SD values less than about 0.4.

e) NO is the number of station observations used in calculating the earthquake location. A minimum of three station observations are required and generally the greater the number of observations used, the better the solution quality.

f) MAG is the local Richter magnitude as calculated using the coda length-magnitude relationship determined for western Washington. Where blank, data were insufficient or impossible to obtain for a reliable magnitude determination.

g) SDMAG is the magnitude standard deviation. Where blank, either no magnitude was calculated or only one station observation was used to determine the magnitude.

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
JAN	1	4	20	59.0	48-19-44	122- 6-17	19.5	.2	7	2.3	.3
	1	11	13	5.5	47-35-40	123- 2-50	40.0	.1	7	1.8	.0
	1	11	43	29.7	48-20-46	122- 5-33	20.0	.2	7	2.4	.3
	2	4	34	59.0	48-42-28	122-37-21	20.9	.2	7	2.3	.3
	3	0	17	5.3	47-59-35	122-46-33	49.1	.0	3	1.0	.7
	4	18	51	46.5	47-39-19	121-52-47	25.0	.0	5	1.6	.2
	13	23	2	41.1	47-47-50	122-45-50	21.4	.0	5	1.6	.5
	14	10	12	54.3	47-24-35	121-49-47	19.8	.2	7	2.2	.3
	14	21	46	34.3	46-30-30	122-25-25	30.4	.1	4	1.5	.1
	16	3	27	29.9	47-54- 6	121-56-42	17.9	.2	10	3.4	.3
	16	4	7	23.3	47-55-30	121-54-18	23.6	.1	5	1.9	.4
	16	4	27	10.9	46-18-14	122- 8-19	1.0F	.0	3	1.7	.2
	18	10	26	32.5	46-44-49	121-10-38	1.0F	.4	6	2.6	.6
	19	5	1	8.6	45-48-44	122-48-49	2.2	.2	3	2.0	.2
	23	13	17	16.5	47-46-15	122-28- 8	25.9	.0	5	1.6	.3
	24	4	18	5.4	46-16-23	122-27-38	2.7	.1	7	2.2	.1
	24	13	32	7.1	46-32-33	122-25-59	8.4	.3	10	2.8	.2
	25	15	30	31.2	48-26-50	123-11-44	24.1	.5	9	2.8	.3
	25	17	20	53.5	47-17-44	121-57-33	14.1	.3	5	2.0	.3
	28	9	24	21.5	47-36-19	122-46-57	22.7	.0	4	1.2	.5
	28	11	53	17.5	45-59-21	122- 6-32	6.9	.4	10	3.3	.3
	29	2	15	36.0	47-33-57	122-13-36	22.9	.4	7	1.9	.2
	29	10	10	23.7	47-36- 4	122- 2- 5	17.5	.3	8	1.8	.3
	30	5	39	41.7	47-39-42	123-46- 2	52.0	.1	8	3.0	.2
FEB	1	21	0	10.4	47-43-45	121-50-49	17.0	.3	7	2.2	.1
	2	12	37	5.5	48- 1-57	123-18-30	45.8	.2	8	2.1	.6
	6	7	17	6.9	46-55-27	120-53-17	8.8	.4	9	3.0	.5
	6	7	22	49.2	47-37-43	122- 3-45	10.8	.1	4	1.7	.2
	6	22	55	59.7	47-29- 6	122-33- 3	47.1	.1	8	3.0	.2
	9	1	7	35.7	46-40-13	121-51-54	9.2	.1	8	2.8	.3
	9	2	33	54.7	47-28-57	122-43-26	24.3	.1	7	1.9	.2
	10	5	54	51.2	47-16-16	122-31-22	73.4	.2	4	1.3	.1
	12	10	54	57.1	46-56-49	123-25-33	31.0	.2	6	2.5	.2
	13	0	29	33.8	48- 3- 6	121-48- 4	6.5	.1	5	1.7	.0
	13	8	28	22.6	47-32-41	122-17- 4	23.5	.1	7	1.6	.3
	13	10	59	40.8	47-43- 6	121-44- 4	22.1	.2	6	2.2	.1
	15	14	35	8.9	47-43-23	122-42-35	23.5	.1	6	2.0	.3
	18	1	6	34.2	47-46-40	122-32-27	23.1	.2	6	1.5	.3
	19	2	47	59.1	48-33- 2	123- 3- 3	.1	.1	3	1.6	.1
	21	8	7	41.6	47-32-56	122-50- 7	9.4	.0	4	2.1	.1
	22	4	47	17.2	47-16- 3	122-51-10	23.5	.3	11	3.8	.1
	22	16	51	54.9	47-32-49	123- 8-34	6.9	.1	4	1.5	.2
	24	8	45	5.7	47-27-43	121-50-54	23.6	.1	5	1.6	.5
	24	17	32	30.3	47- 1-13	122-12-15	69.9	.1	4	1.6	
	24	23	10	49.2	47-31-13	122-21-49	25.5	.1	8	2.1	.2
	25	2	3	21.7	48-43-31	122-45-44	53.9	.3	8	2.5	.1
	26	20	41	7.2	48-47-21	122-23-32	9.0	.2	8	2.5	.0
	27	6	3	6.5	46-30-36	122-20-34	21.0	.2	10	2.7	.3
	27	14	5	1.8	46-16-36	122-25-31	1.0F	.1	8	2.5	.9
MAR	2	14	1	52.1	48- 9-56	123- 8-44	27.9	.1	7	2.7	.2

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
MAR	5	9	44	42.3	48-19-45	122- 6-35	18.7	.2	7	2.5	.2
	5	16	58	38.4	46-40-53	122- 8-26	11.4	.2	11	2.7	.2
	9	8	9	2.8	46-37-47	122- 5-49	28.6	.0	4	1.7	.5
	14	0	9	13.9	46-51-54	121-54-17	11.2	.3	6	2.2	.4
	14	10	10	8.2	48-18-10	122-34-10	38.3	.2	5	1.8	.1
	15	14	15	31.8	46-15-57	122-16- 7	10.0	.3	6	2.1	.3
	24	12	9	10.7	47-53-49	122-39-57	18.1	.1	5	2.0	.2
	25	5	58	50.1	47-21-33	122-23-52	23.2	.6	7	2.4	.2
	26	10	18	10.4	47-21-44	121-54-43	76.0	.1	4	1.4	.0
	26	13	51	18.4	46-55-17	122-29- 4	27.9	.2	7	1.9	.2
	27	16	1	13.3	46-48-50	120-39-39	2.0	.3	8	2.8	.1
	28	8	5	17.8	48-41-21	122-42-51	10.9	.1	4	2.1	.3
	30	10	48	50.7	47-10-51	123-10-26	39.2	.0	4	1.7	.1
	31	7	51	11.9	48-31-25	122-37-33	1.0F	.6	4	2.0	.2
APR	2	0	8	31.0	47-21-34	122-30-21	22.4	.2	7	1.8	.3
	6	14	35	8.7	46-11-22	122-33- 2	.8	.1	5	1.7	.4
	7	7	51	56.8	47-33-45	122-42-57	25.2	.1	7	2.2	.2
	7	21	6	43.8	46-18- 9	122-13-35	.2	.3	11	3.0	.1
	8	11	46	29.8	47-24- 1	121-54-39	8.5	.2	8	2.3	.3
	8	22	44	45.7	46-42-30	122- 8-27	8.0	.3	7	2.1	.1
	13	4	10	20.7	47-37- 8	122-12-48	26.0	.1	9	2.0	.1
	13	7	3	8.9	47-49-22	122-45-42	51.6	.1	11	3.7	.2
	14	23	54	36.9	46-52-16	121-57-35	9.1	.3	6	2.4	.4
	15	20	3	42.5	47-25-31	121-49-10	20.7	.2	6	1.9	.2
	18	13	0	16.6	47-25-35	121-49- 9	20.8	.0	4	2.0	.1
	19	19	33	46.0	46-18-44	122-13-29	.3	.1	9	3.4	.1
	20	3	52	41.0	47-31-54	122- 2-22	22.1	.1	6	2.2	.3
	23	1	11	26.6	47-43-31	122-32-19	34.9	.0	4	1.7	.3
	23	5	22	29.4	47-38-16	122-47-28	25.7	.0	5	2.1	.4
	24	7	48	5.1	47- 4-42	122-35-49	23.8	.1	9	2.6	.0
	29	22	5	2.1	47-46-41	122-27-56	23.1	.3	7	2.1	.2
	30	6	18	12.6	46-52-49	121-54-20	11.6	.1	6	2.6	.2
	30	17	57	39.2	47-32-59	122-47- 5	29.6	.0	4	1.6	.3
MAY	1	5	37	31.4	47-34-11	122-13-37	22.4	.0	5	1.8	.2
	1	18	36	53.6	47-23-57	122-47-19	10.2	.2	7	2.6	.2
	3	14	19	39.7	48-21-46	122-48-10	6.4	.3	4	1.8	
	7	21	58	49.8	47-47-55	122-48-15	19.6	.1	6	1.9	.1
	10	6	19	18.1	47-51-28	122-35-46	25.0	.1	8	2.6	.1
	13	7	26	59.1	47-31- 8	122-20-49	27.6	.1	6	1.8	
	13	7	57	42.2	46-38-20	121-43-49	2.2	.1	5		
	14	12	31	23.3	47-44- 9	121-43-31	10.2	.2	5	2.2	
	15	12	59	44.0	47-41- 8	122- 5-38	15.2	.2	5	1.8	.1
	19	5	13	29.8	47-30-36	121-58-45	10.4	.1	5	2.0	.1
	19	19	9	15.1	47-37-36	121-49-45	7.7	.1	5	2.0	.1
	21	12	5	50.5	46-10-48	122-42- 0	.0	.1	6	2.1	.1
	23	12	56	3.9	47-23-39	122-38-56	23.4	.0	4	1.1	.1
	26	12	36	47.0	47-38-10	122-10-46	6.1	.0	4	1.4	.2
	26	12	52	49.2	46-11-45	122-10-11	8.3	.1	4	1.8	.3
	26	17	6	50.2	47-37-59	122- 9-57	7.3	.1	10	2.4	.1
	26	18	36	23.3	47-38-24	122-10- 8	6.5	.4	5	1.8	.1

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
MAY	26	21	49	29.0	47-42-32	122-35-29	18.0	.0	5	1.1	.0
	26	22	8	11.4	47-20-30	121-59-21	15.9	.2	8	2.2	.2
	27	6	54	19.8	48-18-59	122-49-40	26.2	.1	3	1.7	.3
	28	19	51	47.5	47- 5-37	121-53-13	17.7	.2	10	2.8	.4
	31	0	42	54.0	47-20-53	122-29-23	16.3	.3	9	2.0	.2
	31	8	45	29.1	48-21-21	122-26-51	3.8	.2	6	2.3	.3
JUN	1	19	5	55.0	48-14-55	121-50-43	7.0	.2	4	1.9	.4
	2	3	34	13.2	47-58-44	122-30-33	47.9	.3	7	1.8	.4
	3	8	8	21.5	46-16-29	122- 8-34	6.1	.1	5	2.0	.3
	3	11	16	3.2	48-24-41	122-14-44	17.9	.2	7	1.9	.3
	4	0	40	55.5	47-40-34	123-28-13	48.0	.3	9	1.8	.2
	6	0	12	7.0	48-39-33	123- 5-39	18.9	.4	10	3.0	.3
	9	11	11	39.1	47-35-36	121-48-12	10.3	.2	11	3.3	.2
	11	1	32	19.2	47-25-34	121-48-37	20.0	.2	7	1.9	.2
	11	4	21	27.5	47-53-26	122-36-47	10.3	.1	4	1.5	.4
	11	6	38	46.7	47-22- 0	122-40-30	25.7	.1	10	1.9	.3
	11	12	19	23.0	47-30-53	122- 9-55	3.5	.2	10	1.9	.2
	12	15	44	25.6	48-55-32	122- 3-13	3.7	.4	8	2.3	.2
	14	12	54	35.7	47-37-48	123-13-37	48.5	.2	11	3.0	.2
	15	3	36	26.7	47-20-55	122-29-39	22.1	.2	9	2.0	.1
	16	9	51	16.4	48- 6-25	122-52- 7	26.5	.0	3	1.0	.4
	17	7	28	32.1	47-39-52	122-57-19	41.5	.1	6	1.6	.3
	19	22	26	40.5	46-11-30	123- 7-20	7.9	.3	9	2.3	.2
	21	11	39	55.6	47-32-35	122-33- 7	10.8	.2	5	1.3	.2
	25	6	54	28.4	46- 7-15	122-31-47	9.2	.1	4	1.7	.1
	26	2	43	.8	47-48-27	122-22-47	16.6	.1	4	1.3	.3
	26	13	58	25.8	46-40- 4	122- 5-27	3.3	.3	8	1.9	.2
JUL	2	12	35	.6	47-51-12	124- 2-14	.1	.0	4	1.5	.4
	4	12	14	18.4	47-33-12	122-47-20	23.6	.2	9	2.1	.3
	5	18	43	24.0	47-18- 2	122-22-10	35.9	.0	4	1.7	.1
	9	21	58	27.0	46-42-28	123-12-48	2.3	.1	5	1.9	.2
	12	6	42	43.8	47-46-21	122-32-22	9.2	.2	5	1.4	.1
	13	6	27	57.8	47-36- 2	122-15- 7	7.1	.1	6	1.7	.1
	15	12	44	58.0	47-37-12	122-12-27	23.7	.0	4	1.1	.2
	15	13	54	2.5	47-34-55	122-44-52	25.2	.0	4	.5	.2
	17	17	41	8.7	47-40-32	122-40-36	23.1	.0	5	1.4	.2
	18	21	58	5.4	46-49-55	121-49-40	8.2	.2	12	3.9	.1
	18	22	0	28.0	46-51- 7	121-50-41	11.5	.3	8	2.4	.4
	18	22	2	36.4	46-49-41	121-49- 6	7.8	.3	12	2.9	.4
	19	9	43	25.6	47-16-55	122-15-21	23.2	.5	7	1.5	.3
	20	14	18	17.9	47-22-54	121-28-54	1.0F	.2	9	1.9	.2
	21	4	13	49.8	47-48-49	121-48-25	21.8	.1	9	2.6	.4
	21	5	30	20.1	47-52-46	122-35- 7	13.9	.2	9	1.5	.1
	22	12	56	48.0	47-28- 4	122-50-38	23.8	.1	11	2.9	.3
	23	10	6	25.2	48-13-20	121-37-40	5.1	.3	11	2.5	.2
	24	21	50	59.4	47-58-40	122- 7-35	15.0	.3	5	2.8	
	25	3	54	23.4	48-26-32	123-18- 0	46.5	.3	6	1.5	.1
	26	8	46	25.3	47- 9-48	122- 0-27	1.0F	.3	7	1.9	.4
	27	20	16	11.9	48-30-42	122-19-10	20.1	.4	12	2.1	.4
	30	0	31	8.9	47-24-52	121-45-39	17.1	.2	11	2.7	.2

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
JUL	31	20	37	1.0	47-26-36	122-34-35	21.2	.1	6	1.3	.4
	31	20	41	22.8	47-27-13	122-35-17	20.0	.1	5	1.1	.3
AUG	7	11	57	41.0	48- 7-39	121-34-51	1.0F	.1	4	1.5	.4
	8	0	50	43.9	47-35- 6	122-48-21	15.3	.2	6	1.2	.3
	10	22	12	14.7	47-13-32	122-11-33	17.5	.1	6	1.7	.2
	11	4	11	47.8	46-17-54	122-29-27	6.8	.1	8	1.9	.3
	11	10	2	24.2	47-13-33	122-12- 7	18.2	.1	6	1.9	.1
	12	11	7	55.4	47-53- 1	121-53- 1	17.0	.2	13	2.7	.1
	12	15	11	20.0	47-38-15	123-34- 5	50.6	.2	13	3.5	.2
	18	23	2	12.4	47-47-56	122-23-24	36.1	.3	7	1.9	.1
	20	2	2	37.0	47-22- 7	121-59-47	8.5	.1	6	1.7	.1
	22	4	33	7.8	46-48-49	121-52-22	9.0	.3	8	1.9	.2
	25	8	25	59.1	47-49-52	122-10-45	20.3	.4	7	1.7	.1
	25	15	27	.9	46-28-55	122-16- 5	3.0	.2	8	2.7	.1
	26	18	57	27.0	47-24- 9	122-57-57	16.4	.5	14	2.4	.2
	26	19	0	7.5	47-22-54	122-49-24	25.9	.0	4	.6	.0
	26	19	0	19.3	47-26-33	123- 1-59	33.9	.1	8	1.6	.2
	26	19	7	40.2	47-51-41	122- 7-40	27.3	.2	11	1.8	.0
	29	6	18	5.4	47-48-56	123- 2-50	47.2	.1	11	2.3	.2
	29	14	53	14.5	46-26- 2	123-26-33	5.2	.1	3	1.5	.3
	30	15	3	.6	47-37-24	122-12-25	25.3	.1	7	1.6	.2
	30	23	14	22.3	47-34-60	122-19-32	7.0	.0	4	1.6	.0
	31	5	29	56.7	47-35-28	122-19-13	7.6	.1	5	1.5	.1
	31	9	6	4.6	47-35-42	122-18-48	7.6	.0	4	1.5	.1
	31	22	58	19.0	46-12-58	122-21-17	7.5	.1	5	1.8	.1
SEP	1	3	13	5.0	47-34-40	122-19-30	7.2	.2	7	1.5	.2
	1	3	16	48.0	47-35-39	122-19-13	7.5	.3	9	1.9	.1
	1	3	20	32.0	47-34-43	122-19-33	7.2	.2	7	1.5	.2
	1	10	56	1.7	47-37-56	122-24-24	7.2	.0	3	1.5	.2
	1	22	29	36.5	48-27-13	121-55-53	3.5	.2	8	2.0	.1
	2	3	42	38.5	47-35-28	122-18-56	7.3	.2	8	1.9	.2
	2	8	50	34.7	46-34-55	122-29-51	6.9	.2	6	1.3	.2
	2	10	57	30.3	47-35-34	122-19-19	7.0	.1	8	2.0	.2
	3	9	46	20.3	47-34-60	122-19-15	6.9	.1	7	1.6	.1
	3	14	3	39.1	47-37-45	122-24-50	6.9	.0	3	1.6	.2
	3	14	10	54.5	47-35-11	122-19-11	7.1	.1	6	1.3	.0
	3	16	0	56.5	47-42- 4	122-36-10	22.4	.1	7	1.4	.1
	4	5	38	44.7	48-28- 5	121-52-52	4.9	.3	8	2.3	.1
	4	17	56	49.2	48-13-54	121- 9-29	.1	.3	14	3.7	.2
	4	19	57	8.5	48-14-38	123- 7-27	20.4	.2	5	1.5	.2
	5	0	18	39.5	48- 6-43	122-40-37	58.1	.3	11	2.1	.1
	5	0	47	17.1	46-15-38	122-12-52	6.0	.3	7	2.4	.2
	5	1	39	33.9	47-35-28	122-19-12	7.3	.0	6	1.9	.1
	5	21	36	6.0	48-21-14	121-47-46	1.2	.3	8	2.4	.1
	6	8	15	16.5	47-39-41	122-24-51	6.3	.0	3	1.0	.2
	8	11	38	55.8	47-35-11	122-35-28	23.1	.1	13	2.8	.2
	8	12	9	16.1	47-35-24	122-34-16	19.6	.1	7	1.8	.1
	8	12	59	46.4	47-35- 6	122-35-12	22.9	.1	13	2.7	.1
	8	15	7	39.4	47-34-56	122-35- 6	22.4	.1	9	1.9	.1
	9	17	59	35.4	46-42-38	121-43-33	6.4	.4	8	1.9	.3

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
SEP	10	21	20	34.4	48-55-21	122-14-44	13.6	.2	7	1.8	.2
	11	3	2	37.1	46-27-54	122-25-34	6.4	.2	8	1.9	.2
	11	12	31	53.8	47-26-28	122-28-14	10.4	.2	5	1.3	.4
	11	15	33	21.0	48-51-12	122-16- 7	4.7	.4	5	2.4	.2
	11	15	39	37.4	48-37-28	123- 6-28	14.4	.3	8	1.9	.2
	11	22	49	51.7	48-36-30	123- 4-53	9.8	.2	6	1.8	.1
	12	9	4	52.5	47- 5-29	123-43-10	21.3	.2	8	2.5	.1
	12	11	34	14.9	47-27-42	121-59- 2	22.9	.1	5	1.7	.3
	12	12	51	19.9	47-20-10	122-24-51	7.4	.1	7	1.6	.3
	14	5	52	6.0	48- 7- 8	122-40-12	22.9	.1	6	1.5	.1
	14	8	4	38.7	46-28- 4	122-25-30	.3	.3	9	2.2	.1
	14	21	18	41.2	47-34-57	122-20-24	7.0	.0	5	1.6	.1
	15	2	27	44.0	47-47-56	123- 6-16	44.8	.1	12	2.0	.2
	16	1	0	29.5	47-45-52	122-19-24	25.7	.2	14	2.4	.2
	16	19	49	37.8	47-34-24	122-58- 5	13.7	.3	9	2.0	.1
	16	21	54	36.4	48-42-28	122-26-25	20.9	.3	9	2.3	.2
	18	0	25	9.9	47-35-49	122-19-46	7.5	.6	7	1.5	.0
	22	8	31	14.8	47-33- 3	121-42-13	78.2	.2	7	2.2	.1
	24	7	27	32.1	48-37-54	123-19-22	62.5	.1	11	2.8	.4
	24	11	4	36.5	46-52-22	121-56-26	9.0	.2	9	2.2	.5
	25	22	55	16.7	47-35-49	122-18-42	7.2	.2	8	1.9	.4
	26	16	40	8.5	47-35-41	122-19-12	8.1	.1	9	2.4	.3
	26	21	7	9.3	47-35-29	122-19-45	8.3	.2	11	2.8	.2
	27	7	0	13.3	47-35-37	122-17-37	7.3	.3	10	2.3	.3
	27	7	47	21.3	47-35-59	122-19-33	7.6	.1	9	2.0	.3
	27	8	39	2.1	47-36- 9	122-18-42	8.0	.1	7	1.6	.3
	27	8	54	30.4	47-35-31	122-18-47	7.5	.1	7	1.7	.3
	27	13	57	8.5	47-35-39	122-19- 4	7.9	.2	7	1.6	.3
	27	23	9	45.0	47-35-50	122-19-12	7.7	.2	10	2.2	.3
	28	13	25	35.0	47-35-26	122-18-55	7.2	.0	6	1.7	.3
	28	22	50	25.4	47-35- 2	122-19- 7	6.3	.2	8	2.1	.4
	29	0	2	2.2	47-45- 2	122-25-30	25.4	.0	6	1.5	.2
	29	12	13	34.4	48- 0-36	122-39-11	4.1	.1	4	1.6	.3
	29	16	24	23.2	47-36- 4	122-23-53	8.1	.0	4	1.3	.5
	29	17	12	25.4	47-35- 2	122-21-11	6.4	.0	4	1.7	.1
	30	6	48	15.3	48- 2- 1	123-17- 7	44.8	.2	7	1.6	.5
	30	14	26	57.3	47-36- 9	122-19-48	6.7	.1	5	1.3	.5
OCT	1	5	36	17.4	47-56-35	122-33-41	21.3	.1	6	1.6	.2
	1	10	20	19.7	47-35-13	122-20-42	7.6	.0	4	.9	.4
	2	6	0	46.7	47-35-59	122-19-30	7.6	.1	7	1.7	.5
	3	4	23	52.2	48-23-35	123-15-20	35.3	.4	7	1.7	.4
	3	7	31	46.4	46-44-59	121-59-31	1.0F	.2	4	1.6	.5
	5	3	17	2.6	47-57-30	122-33- 5	25.2	.2	13	2.8	.2
	5	4	48	58.5	47-36-29	122-16- 3	8.1	.2	8	1.7	.3
	5	5	14	.5	47-26- 6	121-49-11	22.5	.1	5	1.6	.5
	5	9	31	8.7	47-44-49	122-32-30	19.6	.5	6	1.6	.5
	6	6	51	25.4	47-46-54	122-23- 7	30.6	.1	4	1.4	.4
	7	13	48	9.4	47-35-53	122-19-30	7.8	.1	9	2.0	.4
	7	13	49	34.4	47-36- 8	122-19-33	7.9	.1	6	1.9	.4
	7	13	53	10.3	47-36- 7	122-19-24	8.0	.1	11	3.3	.4

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
OCT	7	13	57	6.3	47-34-58	122-19-27	7.4	.1	6	1.7	.2
	7	14	19	33.8	47-38-20	122-28- 8	6.2	.7	5	1.5	.4
	7	14	31	34.8	47-35-14	122-19-28	8.0	.1	7	1.9	.5
	7	16	36	2.2	47-36-15	122-19-24	7.8	.2	12	2.8	.4
	7	23	30	17.4	47-36-10	122-15-56	8.3	.1	9	2.4	.3
	7	23	34	42.9	47-35-56	122-16-23	8.8	.1	9	2.5	.4
	7	23	37	41.1	47-36- 7	122-15-57	7.9	.0	5	1.7	.1
	8	1	4	19.0	47-36-18	122-16- 1	8.3	.0	5	1.8	.2
	8	4	37	46.5	47-36-17	122-16-10	8.5	.2	9	1.8	.4
	8	5	31	44.3	47-36- 6	122-16-32	8.4	.0	5	1.5	.2
	8	5	34	19.6	47-36-56	122-15-24	7.8	.2	11	2.8	.5
	9	9	31	24.9	47-35-54	122-20- 1	7.7	.1	6	1.7	.2
	9	19	56	39.3	47-35-35	122-18-43	7.1	.1	6	2.3	.4
	10	0	50	36.3	47-45-30	122-27-30	29.1	.2	7	1.6	.3
	10	0	53	42.7	47-35-52	122-19-45	7.6	.2	11	2.5	.3
	10	3	2	11.6	47-13-41	123-10-41	14.4	.1	5	1.5	.6
	10	19	48	56.2	47-35-42	122-18-40	7.9	.1	8	1.7	.4
	12	9	35	25.1	47-36-15	122-18-43	7.8	.1	13	2.8	.3
	12	12	2	9.8	47-35-38	122-18-47	8.1	.1	11	2.6	.3
	13	15	44	46.6	47-35-38	122-19- 8	8.0	.0	4	1.8	.2
	14	13	1	49.2	47-38-50	122-50- 3	46.9	.0	5	1.1	.3
	14	17	5	8.1	48-18-33	121-59-57	16.8	.1	6	1.6	.5
	15	5	28	53.9	47-35-18	122-19-37	7.5	.0	4	1.6	.2
	17	6	35	35.4	47-33-20	122-16-49	7.5	.4	8	1.6	.3
	19	17	17	.3	47-32-47	122-49-35	22.6	.3	6	1.5	.6
	19	19	21	25.7	47-36-35	122-18- 1	5.2	.3	8	1.5	.5
	19	19	23	16.7	47-36- 7	122-18-53	7.1	.2	9	1.9	.3
	21	16	30	17.7	47-27-28	122-20-43	18.0	.3	10	1.9	.4
	22	22	58	48.3	47-36-33	122-19-37	6.5	.3	7	1.5	.5
	23	6	39	41.3	46-16-38	122- 3- 5	9.5	.0	4	1.7	.1
	25	11	32	48.4	47-36- 1	122-19- 9	7.7	.1	9	2.6	.3
	25	13	59	6.7	47-30-41	121-57-59	11.8	.1	9	1.7	.4
	30	17	32	10.1	47-35-51	122-19-12	8.1	.6	10	2.1	.4
NOV	1	12	56	33.1	47-38-57	121-48-37	14.1	.1	5	1.8	.5
	2	20	29	9.4	47-10-30	122-18-57	9.3	.1	5	1.6	.5
	3	16	22	1.0	47-35-39	122-19-24	8.4	.2	12	3.0	.3
	3	16	25	12.0	47-35-55	122-19-28	7.4	.3	11	2.3	.4
	3	17	8	24.0	47-35- 0	122-21-40	7.3	.1	5	1.5	.6
	3	18	42	38.0	47-35-37	122-18-49	7.7	.2	10	1.9	.4
	6	23	11	21.4	47-39-58	121-49-23	20.5	.3	12	2.1	.5
	7	9	34	44.2	48-17-18	122-37-60	17.1	.4	6	2.1	.0
	7	11	45	14.9	48-35-59	122-14-53	13.2	.1	5	1.9	.3
	8	8	39	26.0	47-41-34	121-55-53	7.6	.1	6	1.9	.3
	8	17	4	59.0	47-25-39	121-49-36	20.7	.1	12	2.4	.5
	10	1	35	55.4	48-12-14	122-41- 7	35.6	.3	8	2.0	.3
	11	19	1	58.3	48-38-57	121-53-25	12.0	.2	4	1.8	.3
	14	1	32	53.3	48-36-15	123- 4-51	12.2	.2	12	2.7	.2
	14	7	18	10.6	48-34- 1	122-41-44	12.4	.1	4	1.6	.4
	19	8	48	49.1	47-36-43	122-19-27	6.8	.1	5	1.4	.4
	19	9	9	27.1	47-35-39	122-19-11	7.3	.2	13	2.9	.3

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
NOV	19	9	15	.9	47-34-32	122-19-49	7.0	.4	7	1.9	.4
	19	9	16	46.5	47-37-47	122-17-11	6.7	.2	5	1.2	.5
	19	14	52	34.1	47-37- 9	122-19-18	7.3	.1	5	1.4	.4
	20	13	35	8.9	48-51-11	122- 4-34	8.9	.3	10	2.4	.6
	21	7	0	35.0	47-19-23	122-52-46	54.8	.0	5	1.8	.2
	22	2	23	34.8	47-17-45	122-26-13	19.6	.0	4	1.8	.4
	26	7	11	33.9	47-17-58	122-17-43	7.2	.3	6	1.6	.1
	29	3	54	20.6	47-39-47	121-56- 0	28.0	.3	6	1.9	.3
	30	18	39	16.1	47-48-29	121-42-17	10.5	.0	4	1.9	.4
DEC	1	11	7	6.8	47-40-15	122-19- 2	10.3	.1	4	1.9	.4
	3	2	39	36.6	46-55-20	121-31-59	9.0	.3	4	1.9	.5
	4	23	44	10.8	46-53-11	121-53-37	7.3	.3	7	2.4	.5
	6	18	46	30.1	46-22-58	122-25-14	49.0	.4	6	1.8	.4
	7	9	59	19.1	47-35-36	122- 2-24	16.9	.0	5	1.9	.4
	8	16	3	14.1	47-46- 6	122-24-58	14.6	.1	6	1.3	.3
	9	12	45	12.1	47-45-59	122-48-44	22.6	.1	12	2.4	.3
	9	13	39	8.8	47-46-50	121-31-35	10.4	.1	4	1.6	.3
	9	22	13	35.7	47-31-41	122-35-34	26.5	.1	7	1.8	.5
	10	13	16	45.0	46-12-42	122- 3-23	11.6	.1	4	1.8	.3
	11	4	46	42.0	46-50-26	121-53-59	11.9	.2	11	2.8	.4
	13	3	59	13.4	47-18-16	121-34- 4	.2	.1	3	1.3	.4
	13	4	6	1.4	46-56-60	121-41-13	20.3	.0	4	1.6	.4
	14	14	10	10.6	47-35-32	122-19- 7	7.6	.2	8	2.0	.5
	14	14	21	49.5	47-35-32	122-21- 7	6.8	.1	5	1.4	.6
	14	14	25	22.3	47-35-56	122-19- 8	7.8	.2	12	2.9	.2
	14	14	27	18.5	47-35-16	122-20-41	7.5	.0	4	2.0	.4
	14	14	30	15.6	47-34-37	122-21-25	7.2	.0	4	1.6	.4
	14	14	33	6.4	47-37-31	122-18-15	6.2	.0	4	1.4	.4
	14	20	25	17.5	47-56-51	122-22-19	28.7	.1	9	1.9	.4
	16	2	56	20.7	47-35- 6	122-22- 9	6.8	.3	7		
	17	7	13	52.2	47-35-15	122-20- 8	7.0	.2	7	1.7	.5
	22	2	16	44.7	47-37-39	121-33-18	1.9	.1	4	1.1	.4
	22	4	11	48.0	46-41-25	121-32-59	6.1	.4	9	2.5	.5
	24	2	51	32.8	47-40-28	121-48-41	22.8	.0	4	1.5	.5
	24	3	33	15.7	47-41-43	121-25-50	3.3	.3	4	1.2	.0
	25	14	39	.8	47-42-15	121-55-24	26.4	.2	10	2.3	.3
	25	14	43	40.6	47-34- 2	122-13-45	22.5	.2	9	2.4	.2
	26	4	37	31.3	47-34-28	122-21-15	7.0	.4	7	1.8	.5
	26	11	40	56.5	47-35-36	122-20-35	7.8	.2	7	1.9	.3
	26	17	0	28.3	47-35-12	122-19-35	7.2	.2	5	1.8	.2
	29	16	47	59.8	48- 1-56	122-44-50	52.4	.2	9	2.8	.3
	31	23	44	40.9	46-51-57	122- 2-13	4.9	.2	5	2.1	.4