STATE OF WASHINGTON
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DIVISION OF GEOLOGY AND EARTH RESOURCES
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INFORMATION CIRCULAR 66

COMPILATION OF EARTHQUAKE HYPOCENTERS IN WESTERN WASHINGTON - 1977

By

ROBERT S. CROSSON

and

LINDA J. NOSON

1979

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COMPILATION OF EARTHQUAKE HYPOCENTERS

IN

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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 and analyzing 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 earth science investigation. Accordingly, this is the sixth in a series of reports, to be updated on a yearly basis, that were designed to make these data available to the public.

The present report covers the year 1977 during which 278 earthquakes were reliably located. A machine-plotted epicenter map is included to provide a large-scale impression of the distribution of these earthquakes. Background and descriptive information presented in previous reports (see Information Circular 53, Crosson, 1974; and Information Circular 55, Crosson, 1975) 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 and the areal distribution of seismograph stations, the seismic "quality" of each station site, and of course the actual earthquake activity of the region. The central Puget Sound basin, 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. Due to network geometry and other reasons, the coverage for earthquake locations is not of uniform quality over the whole of western Washington. Furthermore, some stations that inevitably fail to operate for various periods of time produce additional variations 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 locations deteriorates for earthquakes lying outside the network perimeter.

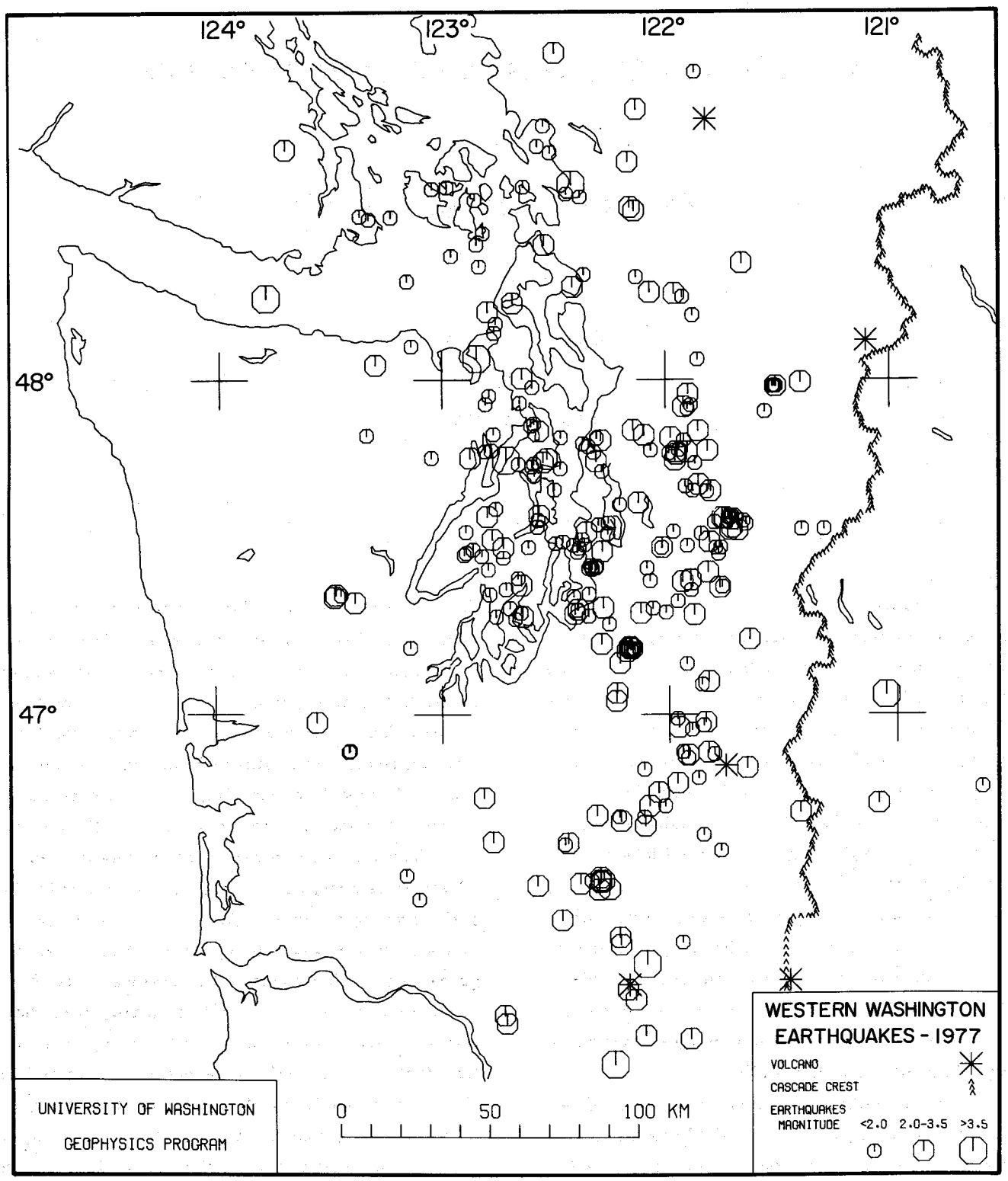

FIGURE 1.—Map showing epicenters for 1977.

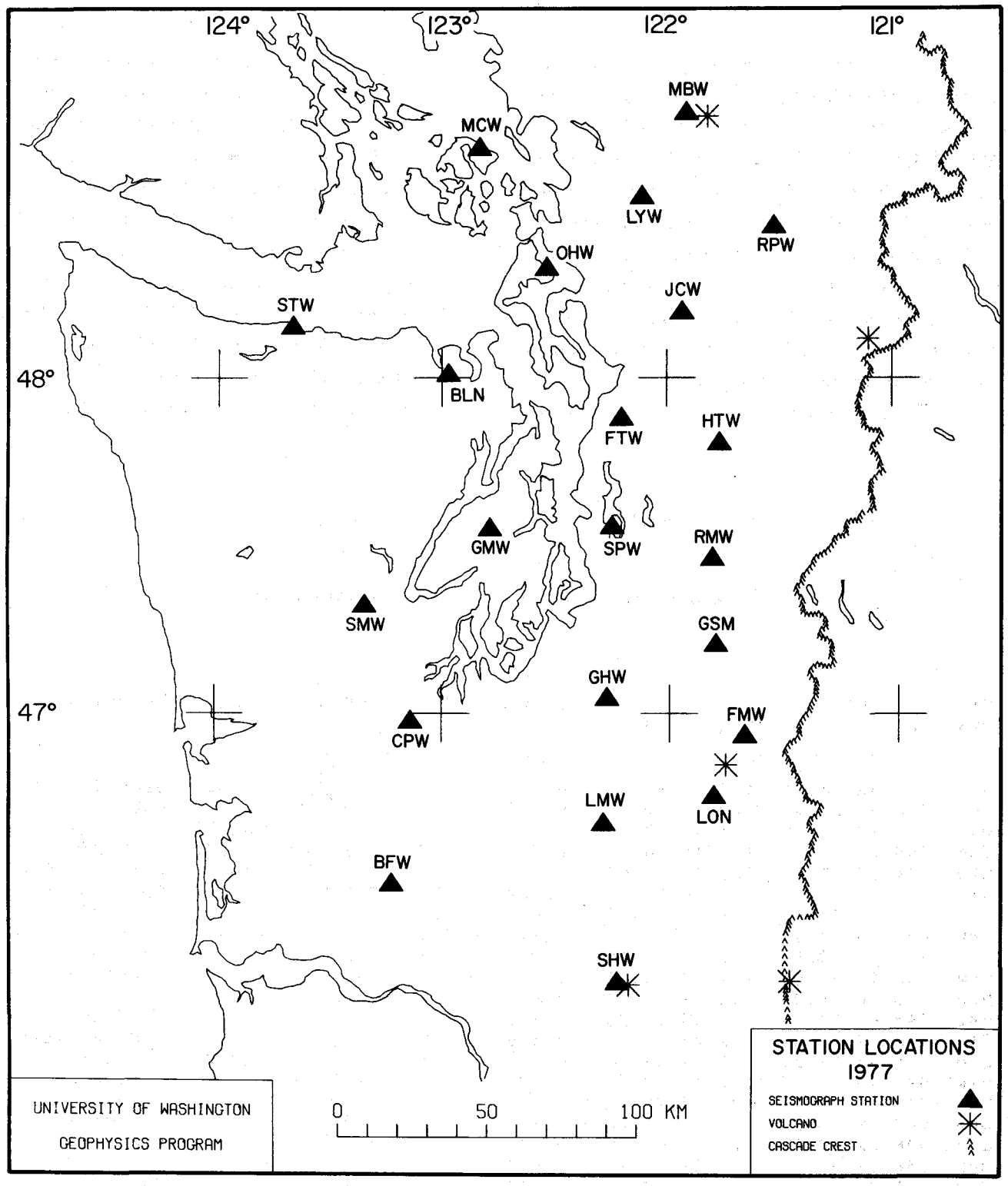

FIGURE 2.—Location map for stations in operation during 1977.

INTRODUCTION

During 1977 the University of Washington operated a 22-station telemetered seismograph network (see table 1), plus one World-Wide Standard (WWSN) station (LON) which is on-site recording in western Washington. This operation is part of a long-range program, initiated with a five-station network in 1970, to obtain high quality data on western Washington earthquakes for seismicity, crustal structure, tectonics, and earthquake hazard studies. A substantial body of data on earthquake locations, magnitudes, and depths has emerged from this work.

This is the sixth 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 technical specifications of the network. Thus, the reader is referred to that report for a description of the network instrumentation, procedure of analysis, glossary of terms, and other information. The second report (Crosson, 1975) covers earthquake data for 1973 in addition to including description of a revised velocity model and revised station delays used to calculate the hypocenter data. These model

TABLE 1.—Summary of network station data

List of NEIS abbreviated stations in western Washington

Sta. Name	LAT Deg	Mn	Sec	LON Deg	Mn	Sec	ELEV Km	P DEL Sec	INSTALL Date	MAG* 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 MT
GSM	047	12	11.40	121	47	40.20	1.305	0.399	6/11/70	165000	GRASS MT
BLN	048	00	26.50	122	58	18.64	0.585	-.137	7/2/70	115000	BLYN MT
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 MT
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	MT FREMONT
BFW	046	29	12.00	123	12	53.40	0.902	0.113	10/25/72	150000	BAW FAW MT
SHW	046	11	33.00	122	14	12.00	1.423	0.319	10/25/72	45000	MT ST. HELENS
MCW	048	40	46.80	122	49	56.40	0.693	0.125	11/8/72	70000	MT CONSTIT
MBW	048	47	02.40	121	53	58.80	1.676	0.433	11/8/72		MT 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
HTW	047	48	12.50	121	46	08.65	0.829	0.000#	6/11/75		HAYSTACK
LMW	046	40	04.80	122	17	28.80	1.195		6/30/75		LADD MT
SMW	047	19	10.20	123	20	30.00	0.840	0.200#	3/24/75		SOUTH MT
LYW	048	32	07.20	122	06	06.00	0.107		4/18/75		LYMAN
OHW	048	19	24.00	122	31	54.60	0.054	-.100#	5/27/75		OAK HARBOR
FTW	047	52	36.00	122	12	05.00	0.147		9/24/75		FAIRMONT
GHW	047	02	30.00	122	16	21.00	0.268		9/24/75		GARRISON HILL
RPW	048	26	54.00	121	30	49.00	0.850		12/1/77		ROCKPORT

Provisional station P delay
* Magnification at 1 Hz; not determined where blank

revisions also apply to the present report except that station delays for those stations added since the second report have either not been established or are provisional. In addition, the simple magnification at 1 Hz (table 1) has not been determined for ten of the stations listed in this report.

The basic information of this report is contained in the Appendix. The Appendix listing is a direct copy of a machine listing and should be free of typographical errors. In addition, a machine-plotted map of the epicenter distribution is included. Suggestions as to how to make 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.

HYPOCENTER LISTING

A total of 278 earthquakes, which were successfully located for the year 1977, are listed in the Appendix of this report. We have used symbols (star) in the earthquake table to indicate those events for which we have been able to verify felt reports. This does not of course rule out the possibility that other earthquakes on the list were felt at least on a local basis. Figure 1 shows the locations of epicenters of these earthquakes on a base map of western Washington, with a general breakdown into different magnitude ranges. Station locations are shown on a separate map (fig. 2) to avoid confusion of symbols. These figures are machine plotted 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. In addition, the changes in format and corrections noted in the second report of this series (Crosson, 1975) are incorporated

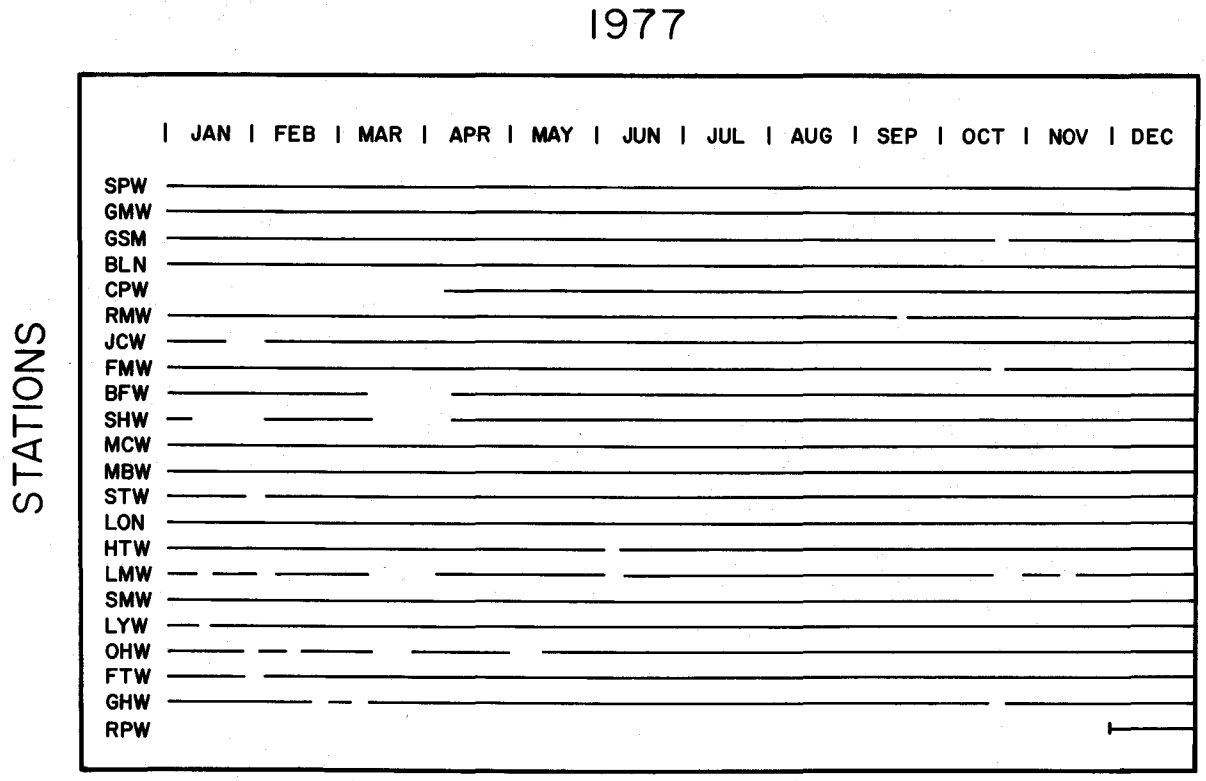

FIGURE 3.—Station activity graph. Solid lines indicate periods when stations are active. Newly installed stations are indicated (ı). Only telemetered stations are included.

here. The velocity model described in Crosson (1975) is also used for this report and its description is not repeated here.

During 1977 only one station (RPW) was added to the network. Thus, station coverage was essentially uniform during the period covered by this report. Table 1 lists pertinent data for each station active during 1977, including station coordinates, elevations, P time corrections (P delays), and installation dates. Only the stations listed in table 1 apply to the data presented in this report. In addition to the variability of station coverage, inevitable failure did occur throughout the year in the operation of some stations, which affects the uniformity of coverage. In an attempt to indicate where such failure may affect the data in this report, we have included a station activity graph (fig. 3) in which major gaps in station operation are indicated.

ACKNOWLEDGMENTS

Many individuals and organizations have contributed to make this work possible and it is difficult to achieve full acknowledgment. Richard Millard and Sue Ferguson provided assistance in reading seismograms and basic data handling. Laurens Engel provided major technical support for the network operation, fulfilling the demanding task of keeping the network operating, often in adverse conditions. Access to lands and facilities for the purpose of station installation has been generously provided by the State Department of Natural Resources, U.S. Forest Service, State Parks Commission, Weyerhauser Company, U.S. Navy, U.S. National Park Service, and the City of Seattle Parks Department. The U.S. Department of the Interior, Geological Survey provided support for radio telemetering operations. Research support has been provided by the U.S. Geological Survey under contracts 14-08-0001-15896 and 14-08-0001-16723.

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APPENDIX

CATALOG OF EARTHQUAKES (1977)

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 west longitude (LONG W) 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. Three observations at minimum 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. Normally the only earthquakes with undetermined magnitudes are those with very small magnitudes.

(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.

(h) Felt earthquakes as determined by the University of Washington, various news and other agencies, are designated by a star (*) following the listing.

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG W	DEPTH	SD	NO	MAG	SDMAG
JAN	1	9	2	53.3	47-47-18	122- 4-13	22.9	.1	4	1.9	.1
	4	12	23	32.5	47-45-46	122-31-52	23.4	.1	9	2.1	.5
	6	0	9	49.6	48-24- 5	122-50-38	38.8	.1	5	1.9	.2
	7	3	36	17.4	47-31-18	122-46-36	21.6	.1	7	2.2	.2
	8	2	21	53.1	47-29- 0	122-24- 2	32.5	.2	7	1.9	.2
	9	22	55	58.0	47-41-13	121-51-33	27.3	.1	7	2.2	.1
	11	7	54	29.8	47-13-29	121-38-33	14.4	.3	8	2.3	.3
	12	0	36	37.8	46-28-34	122-16-15	1.0F	.3	7	2.6	.3
	14	4	4	19.4	46-40-46	122-13- 5	1.0F	.3	8	2.1	.1
	14	4	12	22.5	46-50- 5	122- 6-48	3.7	0.0	4	1.9	.2
	14	6	50	18.8	46-41-34	122-13-31	5.0	.3	6	1.7	.1
	15	6	29	46.2	47-34- 5	121-38-58	17.7	.3	6	2.0	.3
	15	6	32	52.1	47-35-21	121-43-48	13.0	.1	8	2.0	.0
	15	6	33	30.9	47-34-40	121-39-45	16.8	.1	5	1.3	.4
	21	17	53	23.7	46-46-56	120-38-18	10.0F	.3	5	1.8	.4
	24	15	31	55.0	47-33-55	122-18-23	24.0	.0	7	1.9	.3
	26	23	37	16.8	48-17-33	123- 9-31	48.4	.1	3	1.4	.5
	27	1	26	57.8	47-22-17	121-53-48	8.1	.3	6	1.9	.2
	28	23	25	48.1	48- 3-36	121-51-18	5.4	.1	8	1.8	.4
	29	17	39	32.3	47-35-13	121-42-47	11.7	.0	5		
	29	17	39	35.5	47-35- 8	121-44-41	8.5	.1	8	2.2	.3
	30	15	0	30.6	47-35-12	121-45-20	8.4	.2	13	2.8	.4
	31	4	19	52.2	47-29-45	122-23-33	22.0	.1	6	1.5	.6
	31	21	59	39.0	46-43-32	122- 5-31	5.7	.0	5	2.1	.4
FEB	1	22	42	46.7	47-49-37	121-58-48	12.0	.1	5	2.2	.2
	2	0	11	47.1	47-33- 0	121-41-14	1.1	.2	5	2.0	.5
	2	8	39	50.9	47-33- 7	121-43-15	8.9	.1	8	2.2	.4
	3	6	23	31.9	48-41-13	123-42-53	19.3	.6	10	2.6	.5
	6	19	38	22.8	47-47-57	122-20-53	27.2	.1	10	1.8	.2
	7	5	42	15.6	48-34- 5	123- 2-42	3.7	.2	6	1.9	.0
	8	22	19	32.6	47-29-51	122- 1-30	8.0	.1	6	2.0	.2
	9	10	1	28.1	47-47-17	121-48-58	18.2	.2	11	2.6	.2
	10	1	58	32.2	47-45-33	121-57-41	28.2	.2	11	2.2	.4
	11	14	23	55.6	46- 5-44	122-43-53	2.2	.2	9	2.5	1.1
	11	16	42	56.1	46- 4-14	122-43-23	12.1	.4	4	2.1	.5
	12	3	46	11.2	47-43-31	122-17-21	23.4	.1	6	2.0	.2
	14	20	40	37.8	46-41-49	122-19-23	17.6	.3	13	2.4	.7
	18	9	26	11.4	47-26-29	122-18-54	25.5	.1	8	1.9	0.0
	19	8	27	56.9	46-47-39	121-58- 5	7.9	.2	5	2.4	
	20	21	39	2.1	47-45-19	122-18-51	26.5	.2	10	2.3	.2
	21	12	58	51.4	47-35-21	121-43-12	12.6	.0	4	1.7	.1
	25	19	9	40.2	46-30-39	122-18-39	24.7	.2	11	2.9	.1
	25	22	58	27.0	46-30- 7	122-17-49	23.4	.2	6	3.0	.1
	27	12	31	30.0	47-35-27	121-42-45	12.9	.1	6	1.8	.2
MAR	5	19	7	11.0	47- 5-54	121-49-29	10.2	.2	7	2.3	.1
	6	11	1	35.2	46-36-59	122-46-44	10.9	.1	6	2.5	.5
	7	9	16	26.5	47-17-30	122-38-34	21.8	.2	8	2.6	.0
	12	16	11	46.5	47-23-47	121-56- 4	10.6	.2	12	2.4	.1
	12	16	22	55.4	47-55-31	122-48-21	1.0F	.3	4	1.5	.2
	13	12	51	19.3	47-17-37	122-21- 7	19.5	.3	6	1.7	.1
	14	1	16	3.8	47-30-54	121-48-49	13.0	.2	11	2.1	.3
	14	7	14	46.2	47-24- 5	121-53-55	13.7	.4	8	2.2	.3
	14	11	28	19.5	47-22-52	121-45-35	27.8	.2	6	1.7	.1
	15	3	27	49.5	47-55- 8	121-55-17	10.0	.1	8	2.2	.0
	15	15	0	55.6	47-18-14	122- 7-13	56.6	.2	8	2.2	.3
	17	0	44	12.0	47-29-53	122- 1-25	6.5	.2	6	2.1	.1
	17	18	32	3.6	47-30-51	122-27-53	16.4	.2	5	1.6	.2
	19	3	38	53.9	46-57-43	121-57-29	7.9	.4	8	2.3	.2

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG W	DEPTH	SD	NO	MAG	SDMAG	
MAR	22	0	4	38.7	47-18- 1	122-24-45	12.5	.1	7	2.2	.1	
	22	10	1	23.1	47-45- 2	121-52-22	12.2	.3	6	1.7	.1	
	23	13	16	27.2	47-18-20	122- 0-33	23.7	.3	7	1.9	.1	
	25	2	8	55.6	46-29-15	122-35- 7	1.0F	.3	8	2.3	.1	
	26	13	13	36.1	47-57-24	121-53-59	20.7	.2	7	2.2	.1	
	26	17	39	56.5	47-11-19	122-10-59	9.1	.1	8	2.3		
	26	20	41	17.2	47-12- 4	122-10-22	14.0	.1	11	2.8	.0	
	26	20	42	43.8	47- 9-12	122-12-57	25.0	.1	6	2.0	.1	
APR	1	3	8	32.1	47-42-47	122-35-20	17.5	.2	5	2.0	.1	
	2	11	27	9.2	47-35-14	121-43-25	12.0	.0	6	1.7	.1	
	2	19	41	51.5	47-11-49	122- 9-42	18.5	.2	7	2.2	.1	
	3	9	28	27.9	47-45-56	123- 2-56	40.5	.0	6	1.5	.1	
	4	12	54	37.9	47-11-58	122-10-26	14.7	.2	11	2.4	.1	
	6	8	9	53.8	47-17-56	121-53- 3	18.9	.2	9	2.2	.1	
	7	11	4	21.3	47-22-47	121-46-12	18.5	.3	12	2.1	.1	
	7	18	55	42.3	47-54-13	121-33-33	21.9	.1	3	1.6	.1	
	8	1	10	57.0	48-38-58	122- 9-28	8.8	.3	7	2.1	.1	
	11	9	31	2.9	47-11-43	122-10-40	16.3	.2	8	1.9	.1	
	12	17	19	26.2	47-32-36	122-21-34	8.0	.2	5	2.0	.1	
	14	12	32	54.9	47-50- 8	122-46-14	1.0F	.3	7	1.8	.2	
	18	22	17	36.4	47-18-47	122-23-55	9.1	.2	7	2.1	.1	
	19	15	49	14.4	47-30-17	122-25- 1	22.5	.3	7	1.7	.1	
	19	16	5	22.7	47-18-43	122-24- 3	9.6	.2	8	1.9	.1	
	26	7	3	16.4	48-58-32	122-29- 7	9.4	.0	4	2.0	.2	
	28	7	19	55.6	47- 9- 6	121-55-12	22.2	.2	5	1.8	.1	
	28	19	39	48.8	47-55-45	122-39-14	1.0F	.2	5	1.6	.7	
MAY	1	23	10	35.4	47-32-36	122-53-40	17.5	.0	5	1.9	.1	
	2	9	33	2.7	47-12-40	122-17-46	19.3	.3	9	2.0	.1	
	5	4	35	5.3	46-18-34	122-13-27	6.4	.3	12	3.2	.2	
	7	1	10	2.8	47-35-36	122-34- 6	18.7	.2	13	2.3	.1	
	8	12	14	8.5	47-45-53	122-52-30	48.0	.2	17	3.0	.7	
	17	8	12	20.5	46-53- 8	121-49-51	32.6	.2	7	2.2	.1	
	17	21	22	22.8	47-49-59	122- 5-56	1.0F	.2	6	2.2	.1	
	18	11	6	35.3	46-58-32	123-33-15	38.6	.2	11	2.5	.1	
	18	20	9	45.1	47- 2-23	122-14- 0	7.1	0.0	3	2.1	.6	
	21	18	18	23.5	46-30- 9	122-18-39	23.7	.3	13	2.6	.1	
	22	8	35	17.4	46- 8-37	122- 9-43	3.8	.2	7	2.9	.1	
	22	17	13	30.5	48-20-44	121-39- 6	3.4	.2	10	2.3	.1	
	25	3	53	18.2	47-25-30	121-49-17	19.8	.2	12	2.3	.1	
	29	18	53	11.5	47-50-42	122-34-16	47.0	.1	12	2.2	.1	
	30	4	35	55.2	46-29-51	122-18-34	25.4	.4	15	3.0	.1	
JUN	2	3	41	33.1	47-29-48	122-43-42	20.6	.1	6	2.1	.0	
	2	9	32	10.0	47-30-21	122-22- 8	23.6	.1	8	1.9	.1	
	3	7	17	42.1	47-28-45	121-46-28	28.2	.1	5	1.9	.1	
	7	6	52	9.2	46-28-30	122-19- 1	8.8	.2	10	2.6	.1	
	7	8	9	57.7	47-59-28	121-23-52	2.0	.2	12	2.5	.1	
	12	9	15	55.8	47-11-51	122-10-14	13.4	.2	16	2.1	.1	
	12	17	5	55.1	47-12- 5	122-10- 7	16.4	.2	17	2.2	.1	
	12	22	3	34.0	47-19- 8	122-17-12	7.4	.2	12	2.1	.1	
	12	22	59	24.9	47-11-11	122- 9-28	16.1	.1	5	1.0	.5	
	14	1	59	29.8	47-25-58	122-20-10	13.4	.3	13	1.8	.2	
	14	5	38	6.0	47-26-13	122-20-17	22.9	.2	9	1.4	.1	
	14	7	7	57.6	47-26-39	122-20-34	23.5	.1	6	1.3	.2	
	17	6	16	2.1	47-45-31	122-42-53	19.8	.2	19	4.0	.1	*
	17	22	37	21.9	48-34-23	122-58-40	6.7	.1	7	1.7	.2	
	17	22	43	7.1	48-16-34	122-24-45	24.3	.2	10	2.0	.1	
	19	4	23	15.6	47-23- 7	122-38-53	46.1	.2	19	2.8	.1	
	19	4	48	33.1	46-39-56	122- 6-42	22.6	.3	13	2.4	.2	

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG W	DEPTH	SD	NO	MAG	SDMAG	
JUN	19	14	17	32.4	46-58-35	121-50-25	7.3	.3	9	2.2	.3	
	19	19	45	56.7	47-12- 4	122-10-20	13.3	.2	15	2.1	.1	
	20	5	27	6.9	47-28-49	122-53-35	22.3	.1	5	1.5	.3	
	20	22	44	.4	46-19-55	122-13-40	7.7	.2	8	2.4	.3	
	22	12	15	35.8	47-32-20	122-15-57	2.0	.3	8	1.5	.2	
	22	13	19	7.1	47-11-41	122- 9-24	17.7	.2	13	1.8	.2	
	22	21	39	25.8	47-28-29	122-54- 9	20.4	.2	7	1.5	.3	
	23	1	32	37.1	46-42-21	121-25-59	3.9	.4	10	2.2	.1	
	23	4	12	16.7	46-53-22	123-24-28	5.9	.0	5	2.0	.4	
	24	14	4	49.5	47-11-46	122-10- 4	16.2	.1	9	1.6	.1	
	26	5	47	26.7	46- 2- 8	122- 7-12	6.0	.1	6	2.5	.3	
	27	21	58	38.3	48-32- 6	122-51- 4	4.9	.5	5	1.7	.1	
JUL	1	11	13	14.6	48-15-37	122- 3-55	17.3	.2	10	2.1	.1	
	2	4	26	54.1	46-53-12	123-24-45	4.5	0.0	4	1.9	.1	
	3	20	36	8.6	48-20-10	122-49-58	15.6	.0	5	1.0	.3	
	4	3	52	52.0	47-20-20	121-57-23	19.3	.3	7	1.3	.2	
	4	14	19	47.0	48-48-20	122- 6-60	5.2	.2	16	2.6	.2	
	5	13	40	3.6	47-47- 4	122-48-25	19.6	.1	7	1.4	.3	
	10	7	19	29.9	48-34-53	122-24-50	15.2	.3	12	3.5	.3	*
	11	19	17	27.6	47-47-22	121-56-40	29.1	.1	8	1.5	.2	
	13	7	15	5.7	47- 3-28	121- 2-45	.1	.3	16	3.9	.3	*
	13	8	0	25.3	47-34-56	121-42-42	9.9	.2	19	2.7	.2	
	13	18	45	36.3	47-35-22	122-47-60	14.9	.2	12	2.3	.2	
	13	20	10	9.5	46-59-14	121-57-52	7.1	.3	9	1.8	.1	
	14	2	22	6.6	46-23- 2	122-28-42	6.8	.2	11	2.7	.2	
	15	9	36	15.9	48-32-38	122-22-29	11.2	.1	7	1.9	.1	
	15	15	43	52.8	47-47- 3	121-57-19	27.4	.2	17	3.3	.1	
	18	21	28	31.5	47- 3-48	122-13-46	6.2	.2	9	2.3	.2	
	19	8	36	17.5	47-25-54	122-47-45	5.9	.3	12	1.9	.1	
	20	15	48	40.2	47-34-23	121-47-27	27.9	.5	6	1.5	.2	
	20	18	56	22.2	47-50-54	122- 8-53	63.7	.2	18	2.5	.1	
	21	9	16	40.2	47-18-60	122-42- 2	23.1	.2	7	1.7	.1	
	23	7	10	3.2	47-18-13	122-39- 2	23.4	.2	13	1.9	.2	
	25	6	59	9.2	47-26- 6	122-21- 4	18.8	.1	15	1.8	.4	
	25	21	4	3.9	48- 3-45	122-50-41	53.8	.2	20	3.7	.0	
	31	8	12	33.3	46-48-35	121-52-32	10.2	.3	7	2.0	.2	
AUG	1	1	8	8.7	46-38-17	121-51-29	7.0	.4	8	1.9	.2	
	1	3	22	44.5	47-46-36	121-57-14	24.0	.2	10	2.0	.1	
	2	10	51	37.2	47-27-60	122-43-44	23.6	.1	10	1.6	.2	
	3	4	59	41.9	47-33-30	122-34-37	24.8	0.0	4	1.0	.1	
	4	9	46	12.1	47-37-53	122- 7-37	8.7	.1	9	2.1	.1	
	4	14	18	41.8	47-44-47	122-39-36	14.2	.1	7	1.3	.2	
	5	11	39	57.1	47-49- 4	122-17-32	17.9	.3	19	2.7	.2	*
	5	14	37	11.8	47-52- 3	122-35-26	10.4	.0	4	.8	.3	
	5	18	42	17.2	47-49-26	122-18-40	9.8	.2	6	1.5	.1	
	6	9	13	28.2	46-10-25	122-11-48	6.6	.3	9	2.1	1.0	
	7	13	28	59.4	46-41-31	122- 6-58	22.5	.3	7	1.5	.1	
	8	6	25	5.1	47-49-33	122-28-18	24.4	.1	9	1.7	.2	
	10	7	18	7.7	48- 8-21	122-45-57	21.0	.2	8	1.5	.2	
	11	6	10	2.7	47-11-46	122- 9- 7	14.6	.1	7	1.6	.2	
	13	23	6	59.8	47-46-57	122-19-25	20.3	.1	9	1.7	.1	
	14	8	18	48.3	47-28-18	122-49-28	22.1	.1	6	1.7	.1	
	18	3	55	13.0	47-17-30	122-45-41	7.3	.3	6	1.3	.2	
	18	8	37	20.1	47-22-21	122-43- 3	21.7	.1	8	1.4	.3	
	18	9	45	18.8	47-50-47	121-51-24	10.4	.2	14	2.5	.2	
	19	1	1	10.0	47-21-27	122-47-24	28.6	.1	4	1.3	.3	
	19	14	57	5.1	48-15-23	121-57-23	4.6	.1	7	2.1	.3	
	20	5	20	26.9	48-45-26	122-32-18	18.3	.4	8	1.9	.6	

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG W	DEPTH	SD	NO	MAG	SDMAG	
AUG	20	10	35	41.3	47-30-13	121-54-42	23.1	.0	5	1.4	.3	
	21	2	34	24.0	48- 0-12	122-38-33	23.7	.2	11	2.3	.2	
	22	12	56	50.1	47-11-56	123- 8-30	19.1	0.0	4	1.3	.3	
	23	5	14	21.3	48- 9-57	122-45-33	19.4	.1	5	1.2	.7	
	25	11	29	.6	46-57-16	121-54- 4	10.4	.6	4	1.9	.6	
	26	5	2	12.0	47-33- 8	121-24-18	8.0	.2	8	1.7	.3	
	26	5	54	17.4	46-53-16	121-56-31	14.4	.2	7	1.5	.9	
	26	5	59	37.2	47-33- 9	121-18-20	1.3	.2	5	1.5	.1	
	27	14	3	58.3	48-41-47	122-34- 1	17.1	.1	5	1.7	.4	
	27	16	3	12.9	46-18-60	121-57-25	2.5	.2	6	1.9	.9	
	28	5	16	5.5	47-32-23	121-50-59	27.8	.1	9	1.5	.4	
	29	3	35	3.7	46-26-39	123- 6-12	13.0	.1	5	1.9	.4	
	29	5	6	48.7	46-35-28	121-47- 2	5.9	.3	9	1.8	.6	
	30	7	18	40.1	47-21- 7	122-25- 6	20.4	.0	5	1.3	.7	
	31	17	10	5.9	48-26- 7	122-48-53	58.1	.2	5	1.4	.1	
SEP	3	9	30	9.6	47-40-52	121-55- 3	27.8	.4	7	1.7	.3	
	5	21	12	45.9	47-21-32	122-21- 3	11.9	.1	6	1.6	.5	
	8	1	45	20.1	46-44-57	122-49- 7	5.1	.2	15	3.4	.8	
	9	22	25	48.1	46-52-42	121-55-13	7.8	.3	11	2.1	.6	
	12	0	29	9.2	47-40-12	122-29-59	25.3	.1	8	1.4	.5	
	13	20	11	23.6	47-39-55	121-49-20	18.3	.0	5	1.5	.3	
	14	20	5	21.6	47-29-51	121-47- 9	2.5	.3	7	1.4	.6	
	14	22	46	56.5	48-12- 7	122-47-43	22.9	.2	10	2.2	.2	
	16	4	32	36.3	47-49-56	123-20-20	40.3	0.0	3	1.3	.8	
	17	18	24	3.1	46-36-34	122-27-51	10.1	.2	11	2.0	.5	
	18	20	6	54.1	46-36-49	122-26-60	13.7	.2	8	2.1	.3	
	21	22	33	33.9	47-29-53	121-45-52	2.6	.2	6	1.8	.1	
	22	20	17	19.6	47-11-37	122- 9-59	17.1	.1	7	1.7	.5	
	24	19	5	37.8	48-11-30	121-52-30	21.4	.1	5	1.9	.9	
	25	6	24	33.4	48-30- 9	122- 7-54	11.0	.2	14	3.0	.4	
	25	22	32	3.8	46-52- 8	121-55-11	12.0	.2	6	1.9	.3	
	26	6	59	13.3	48-33-11	122-26-13	21.4	.2	11	1.9	.5	
	30	5	18	43.2	48-28-60	123-13-56	9.8	.2	4	1.6	.1	
	30	5	24	54.1	47- 5-24	121-51-17	10.2	.2	6	1.9	.7	
OCT	1	8	2	42.1	47-51-40	122-36-17	20.7	.2	8	1.5	.2	
	2	1	46	4.1	46- 1-32	121-55-35	3.5	.0	4	2.1	.8	
	4	2	27	13.3	47-34-14	122-15-46	37.2	.0	7	1.6	.4	
	4	23	45	27.4	48-40-37	122-30-32	5.6	.3	8	2.0	.3	
	5	8	22	13.6	46-30-55	123- 9-33	21.2	.1	4	1.5		
	6	15	3	3.0	48-34-27	122-37-54	19.6	.2	7	1.8	.2	
	7	6	22	57.9	45-56-56	122-15-17	1.0F	.4	7	4.1	4.0	
	8	15	6	42.7	47-44-53	122-35-24	22.0	.2	8	1.6	.6	
	9	1	49	29.9	47-34-43	122-34-23	21.5	.1	9	1.8	.1	
	10	3	14	20.6	47-46-49	121-59-14	20.9	.2	7	1.5	.4	
	12	5	24	25.1	46-15- 4	122- 6-41	7.0	.1	6	3.9	4.1	
	12	8	51	17.6	47-40- 3	121-53- 0	26.2	.2	11	1.8	.5	
	12	18	18	45.6	47-56-60	122-47-22	8.3	.1	3	1.1		
	13	14	52	2.2	49- 6-38	123-24-12	21.1	.3	13	2.7	.3	
	14	2	53	32.3	48-30-47	122- 8-60	10.4	.3	18	3.3	.5	*
	15	4	24	7.2	48-14-35	123-47-43	49.3	.2	13	5.2	3.2	
	15	18	52	18.8	47-31-18	122-22-45	20.2	.1	7	1.6	.1	
	18	4	12	26.3	46-52-48	121-48-21	1.0F	.3	5	1.6		
	19	0	22	41.3	47-29-11	122-17-26	24.1	.2	11	2.1	.3	
	20	2	0	23.7	47-32-44	121-58-21	9.1	.0	4	1.4	.1	
	21	23	10	33.8	47-17- 3	122-40-36	10.0	.0	4	1.3	.4	
	22	4	39	57.5	47-47-15	122-46-52	10.0	.0	4	1.4	.1	
	22	9	0	37.7	48-13-39	122-41- 4	23.3	.3	13	2.4	.1	
	27	23	59	21.4	48-28-40	123-19-56	43.3	.1	5	1.5	.1	

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG W	DEPTH	SD	NO	MAG	SDMAG
OCT	28	4	25	38.3	47-33-27	121-42-48	10.8	.1	7	2.4	.1
	28	6	14	56.1	47-47- 1	121-54-21	18.7	.2	9	2.0	.2
	28	11	56	46.8	47-20- 1	123-23-17	10.7	.2	5	2.1	.2
	29	1	32	4.2	47-21- 0	123-28-45	11.5	.2	8	2.5	.3
	29	8	40	37.3	47-21-19	123-27- 2	13.2	.3	6	1.9	.2
	29	10	35	48.4	47-21-23	123-28-25	11.4	.2	8	2.7	.2
	31	10	18	52.5	47-58-34	122-35-51	22.8	.1	5	1.0	.4
NOV	6	1	36	59.2	47-24-20	122-39-47	21.4	.1	7	1.6	.2
	6	11	7	2.8	47-48-27	122-22-24	9.8	.1	8	1.6	.2
	12	12	8	29.9	47-55-24	121-53-16	10.3	.1	6	1.9	.5
	13	14	58	39.3	46-45-58	122- 3- 5	2.1	.2	10	2.1	1.0
	13	5	27	51.6	46-43-30	122- 1-24	7.3	.2	9	1.9	.5
	13	18	34	32.4	48-24- 4	122-32-20	25.0	.2	10	2.3	.3
	15	8	4	57.2	47-29-28	122-51-49	22.5	.1	5	1.4	.3
	15	9	41	57.9	47-29-52	122-37- 0	17.7	0.0	4	1.4	.3
	20	15	16	29.5	46-29-36	122-23-53	20.0	.2	10	2.1	.5
	24	14	16	4.1	47-16-12	122-15-41	16.7	.2	7	.9	.3
	25	15	40	2.1	47-26-13	122- 5-29	18.6	.2	9	1.8	.6
	26	11	1	38.8	47-26-11	122-19-11	17.4	.1	5	.8	
	28	22	9	11.7	46-50-21	121-39-44	7.7	.3	5	2.2	
	29	19	58	38.3	46-30- 7	122-20-59	25.2	.0	5	1.2	
	30	5	7	42.4	48- 5-58	123- 8-22	41.0	.0	5	1.1	.1
	30	23	29	44.5	46-43-57	121- 5-24	1.0F	.5	8	2.3	.3
DEC	1	7	2	14.2	46-58- 2	121-50-56	17.8	.4	10	1.8	.1
	7	8	51	52.7	47-37-32	122-12-41	23.8	.1	6	1.7	
	9	8	6	42.5	47-45- 8	122-32-57	23.2	.1	15	2.2	.3
	11	14	30	17.7	48-14-47	121-55-10	23.7	.0	5	1.5	0.0
	12	10	49	51.5	48-18-19	122- 7-32	11.1	.2	8	1.9	.2
	14	15	59	33.9	47-44-20	122-35-57	26.8	.1	5	1.6	.2
	15	13	1	32.1	48-18-44	122-21-40	3.2	.6	7	1.5	.6
	18	7	37	21.9	47-19- 3	122- 4- 2	7.9	.2	6	1.5	.6
	18	13	16	33.3	47-44- 1	122-28-21	22.6	0.0	4	1.5	.3
	19	14	29	47.0	47-36-45	122-45-41	21.6	.1	7	1.6	.2
	22	23	33	58.7	47-54-43	121-54-12	15.8	.2	11	2.0	.7
	23	20	40	14.6	47-30-36	122-29-50	16.6	.2	8	1.6	.2
	24	9	57	22.9	48-29-13	123-22-22	1.0F	0.0	3	1.1	.8
	26	22	40	34.9	48- 2-37	123-18- 2	44.6	.1	7	2.2	.1
	27	3	19	51.8	47-58-45	121-30-33	8.5	.1	8	2.1	.5
	27	3	25	2.9	47-58-46	121-31-21	8.7	.2	8	1.6	
	27	3	25	30.4	47-58-46	121-30-29	9.7	.3	8	1.6	
	27	3	26	8.2	47-58-48	121-30-55	11.5	.3	7	1.8	.3
	27	18	50	35.8	47-40- 2	121-48-19	17.7	.1	14	2.1	.4
	27	19	54	28.4	48-22- 4	122-57-33	3.8	.1	5	1.5	
	28	21	12	54.4	48-55- 3	121-50-55	9.7	.1	4	1.2	.5
	30	3	11	17.7	47-23-56	122- 4-40	18.1	.1	8	1.5	.4
	31	2	22	46.7	47-49- 5	121-55-18	10.4	.1	5	1.9	.1