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INFORMATION CIRCULAR 53

COMPILATION OF EARTHQUAKE HYPOCENTERS IN WESTERN WASHINGTON

By

ROBERT S. CROSSON

1974

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FOREWORD

The need for subsurface information in plate tectonic studies, mineral exploration, oil and gas exploration, and geologic hazard studies has increased greatly over the past few years. With the careful evaluations that are being required on various projects, such as thermal nuclear power-plant sites, it has become increasingly important to gather seismic data.

Relatively little has been published on seismic data in Washington, and the Division of Geology and Earth Resources is fortunate to be able to publish this report on earthquake hypocenters in the western part of the state. It is the division's intent to publish hypocenter data on a yearly basis in the future.

The author, Dr. Robert S. Crosson, who is currently on the staff of the University of Washington, has spent several years in this work and is primarily responsible for the establishment of the seismograph telemetry network. Dr. Crosson received his Ph.D. degree from Stanford University in geophysics and has been on the University of Washington Geophysics Program since 1966.

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COMPILATION OF EARTHQUAKE HYPOCENTERS

IN

WESTERN WASHINGTON

By

Robert S. Crosson

SUMMARY

Since mid-1970, a multistation seismograph telemetry network has been operated by the University of Washington Geophysics Program for the purpose of studying the distribution of small earthquakes in western Washington. The operation of this network of instruments has opened up a vast new body of data on the locations, sizes, and properties of earthquakes ranging to magnitude one and smaller. Because of the great number of small earthquakes that occur in a year's time, data on these events may be valuable for many purposes involving public safety and welfare, as well as scientific research. Accordingly, this is the first of a series of reports on the locations and times of earthquakes recorded on the western Washington network. This report covers all data obtained from the first installation of the multistation network in July of 1970 until the end of the year 1972. Future reports will update this one on an annual basis. This report includes description of instruments and data-reduction procedures that will not be repeated in subsequent reports.

Data are presented in a table listing the calculated location of each earthquake that was adequately detected on the network stations. In addition, machine-plotted yearly summary maps showing the epicenter locations and magnitude ranges of earthquakes are included. It should be understood that the number of earthquakes recorded by the network of seismograph stations depends critically on the number of and areal extent of stations as well as the seismic "quality" of each site. Therefore, since the number of stations has increased each year, the number of earthquakes listed each year has increased correspondingly and should not be interpreted as an actual increase in the rate of earthquake occurrence. Data on the dates of installation of stations are included to assist in interpreting this characteristic.

Generally, the central Puget Sound basin region exhibits the highest rate of occurrence of small earthquakes in the area covered by the network. Earthquakes in this central region are also generally deeper than earthquakes occurring in the north and south portions of the basin. A very few earthquakes with depths greater than 30 kilometers occur along the west margin of Puget Sound and beneath the Olympic Mountains. Caution must be exercised in

interpreting the epicenter maps since the magnitude threshold of detection is not uniform throughout the area covered by the network, and moreover the accuracy of location deteriorates for earthquakes lying outside the network perimeter.

INTRODUCTION

In mid-1970 a five-station seismograph telemetry network was installed in the central Puget Sound basin. The data from each station is telemetered by radio back to a central recording facility at the Geophysics Program, University of Washington, in Seattle. Although western Washington has long been known to be a seismically active region, no adequate network existed prior to this time for the location and study of small earthquakes. Previous studies of earthquakes and crustal structure in western Washington were carried out using only larger (usually felt) earthquakes by Neumann (1957). Rasmussen (1967) has provided an extensive compilation of larger historic earthquakes in the region. Subsequent studies, using data from the new network, demonstrate that the quantity and quality of data obtainable from this system of modern instruments opens up an entirely new spectrum of earthquake investigations in this region. For example, for every earthquake felt in western Washington there may be over 100 well-recorded earthquakes greater than magnitude 1.

The original network has grown in number of stations and in areal extent. Although the primary motivation for this project is research into the seismicity and tectonics of the Pacific Northwest, the results of the investigations may be useful for public safety, land use planning and coordination, mineral exploration, siting of dams, bridges, and nuclear reactors, as well as other geological and geophysical applications. Accordingly, it is sought in this and subsequent reports of this series to present basic earthquake hypocenter data, as obtained from the seismograph array, in a detailed form that can be readily used and interpreted by a variety of potentially interested persons. This first report covers all earthquakes recorded through the end of 1972 and includes additional explanatory material. Subsequent annual reports will be devoted mainly to the basic data to minimize costs and to promote efficient and timely publication. Every attempt will be made to keep these reports as current as possible in full view of the importance of the "time axis" in reporting earthquakes. The basic data of this report are the earthquake hypocenters listed in their time sequence in the Appendix. The data format adopted here will be retained insofar as possible in subsequent reports. However, suggestions as to how to make this series more efficient or useful are welcome and can be directed to the Washington State Department of Natural Resources, Division of Geology and Earth Resources.

INSTRUMENTATION

The telemetered seismograph network, from which data for the present report were obtained, is described by Crosson (1970 and 1972). Each station consists of a single component vertical short-period seismometer, an amplifier, and a voltage-controlled oscillator (VCO), which converts the output voltage from each amplifier to a frequency modulated audio tone. The tone is telemetered back to the central recording laboratory at the University of Washington by radio (in one case telephone line) where it is reconverted to the seismic signal and recorded on a multichannel oscillographic recorder (Develocorder) and a 14-channel magnetic tape recorder. Figure 1 is a block diagram of the network components. All seismographs have identical frequency response; that

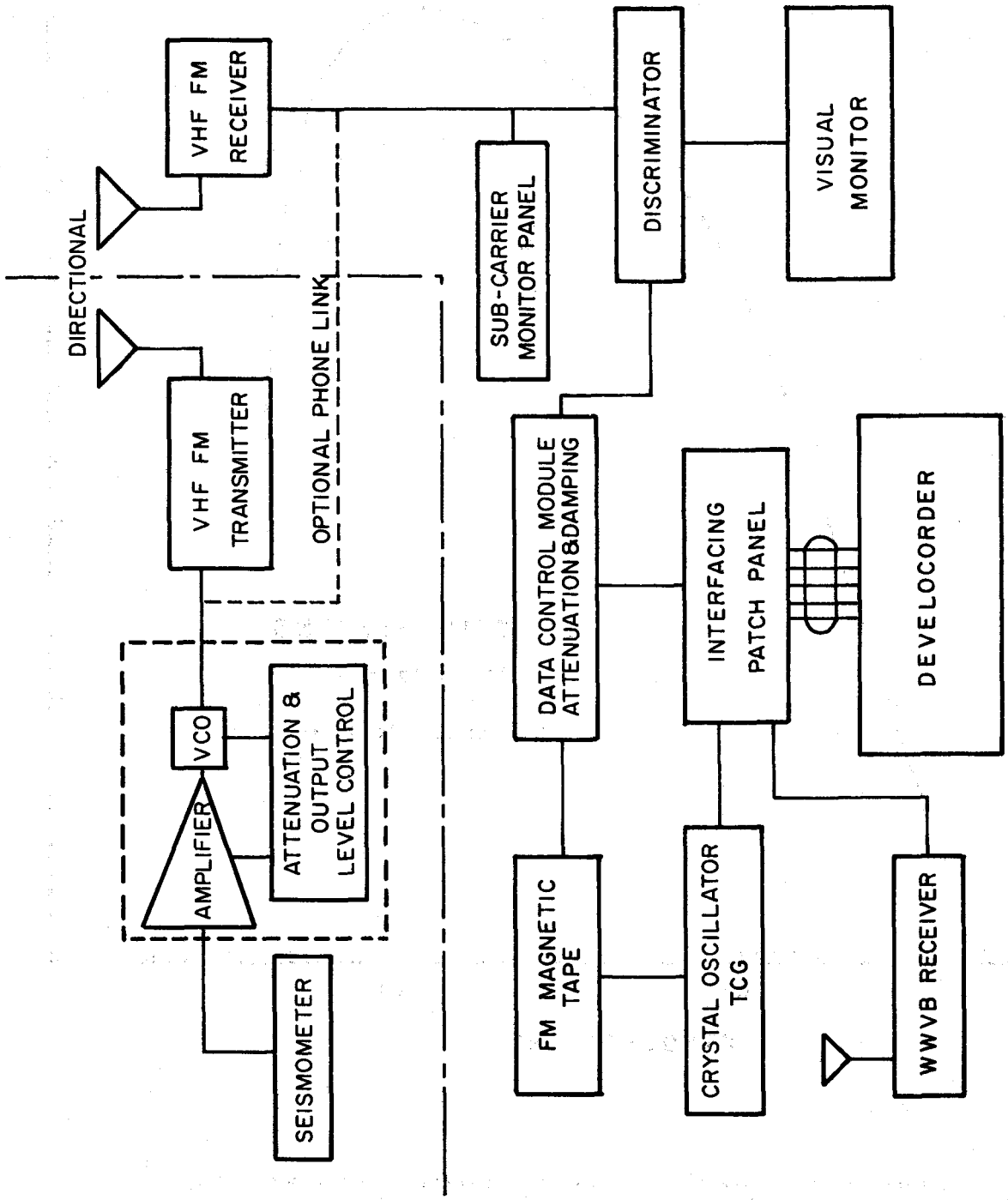

FIGURE 1.—Block diagram of seismograph telemetry system showing components of a typical field installation and the recording system.

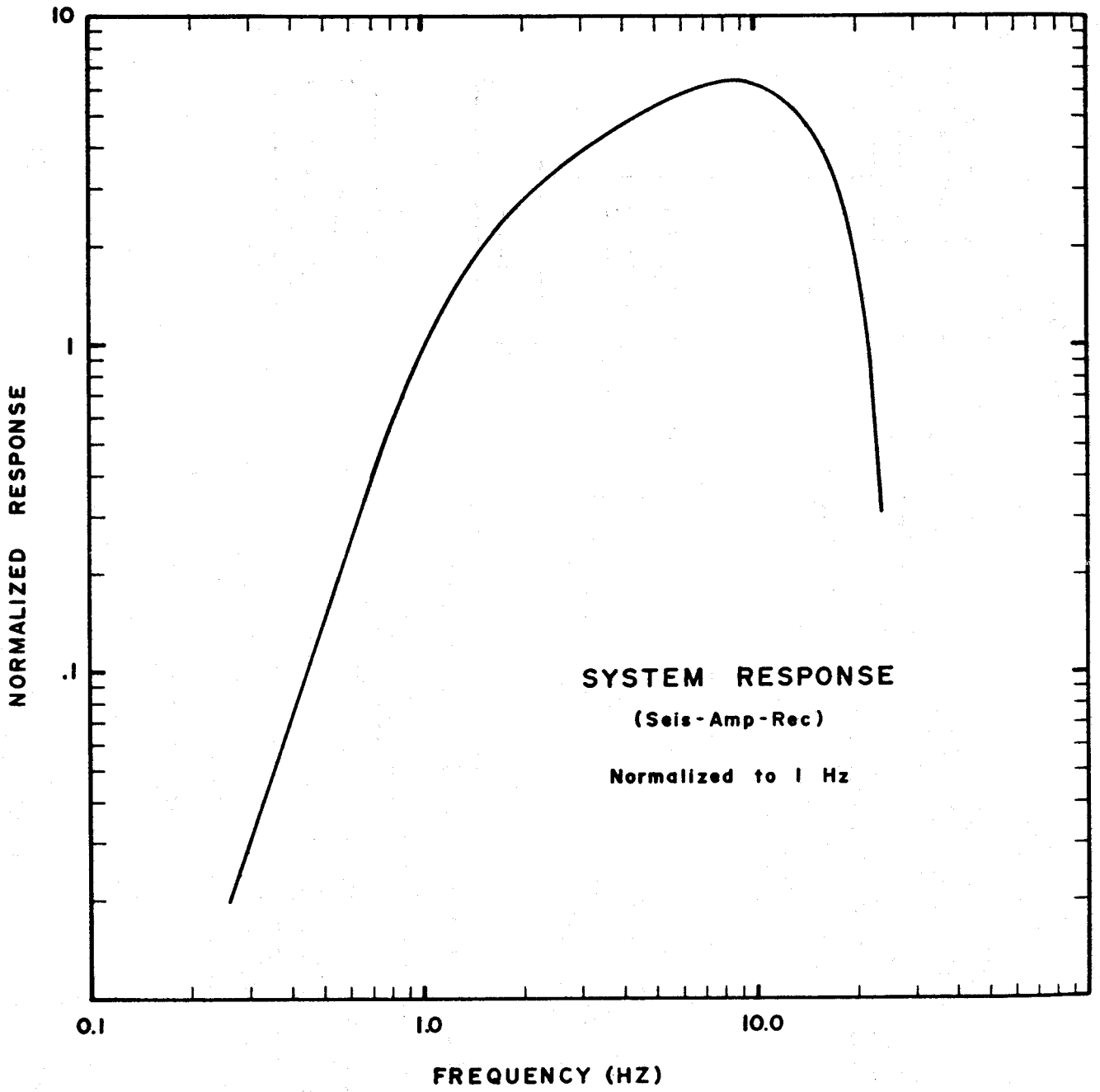

FIGURE 2.—Frequency response curve of recording system showing recorded output amplitude for given input ground motion (vertical) at various frequencies. Note that curve is normalized to unity at 1 Hz (cycles per second) frequency.

TABLE 1.—Summary of network station data

WESTERN WASHINGTON
SEISMOGRAPH TELEMETRY ARRAY

UNIVERSITY OF WASHINGTON
GEOPHYSICS PROGRAM

PERTINENT DATA

NAME	LAT DEG	LAT MN	LAT SEC	LON DEG	LON MN	LON SEC	ELEV KM	P DELAY SEC	INSTALL DATE	MAG AT 1 HZ	LOCATION
SPW	047	33	13.30	122	14	45.10	0.008	0.600	9/17/69	65000	SEWARD PARK
GMW	047	32	52.50	122	47	10.80	0.506	0.000	2/27/70	145000	GOLD MT
GSM	047	12	11.40	121	47	40.20	1.305	0.000	6/11/70	165000	GRASS MT
BLN	048	00	26.50	122	58	18.64	0.585	0.000	7/2/70	115000	BLYN MT
CPW	046	58	25.80	123	08	10.80	0.792	0.000	7/29/70	135000	CAPITOL PEAK
RMW	047	27	34.95	121	48	19.20	1.024	0.000	7/27/71	190000	RATTLESNAKE MT
JCW	048	11	36.60	121	55	46.20	0.616	0.000	2/18/71	120000	JIM CREEK
FMW	046	55	54.00	121	40	19.20	1.890	0.000	9/4/72	100000	MT FREMONT
BFW	046	29	12.00	123	12	53.40	0.902	0.000	10/25/72	150000	BAW FAW MT
SHW	046	11	33.00	122	14	12.00	1.423	0.000	10/25/72	45000	MT ST. HELENS
MBW	048	47	02.40	121	53	58.80	1.676	0.000	11/8/72		MT BAKER
MCW	048	40	46.80	122	49	56.40	0.693	0.000	11/8/72	70000	MT CONSTIT.
LON	046	45	00.00	121	48	36.00	0.853	-.110		60000	LONGMIRE
STW	048	09	0.75	123	40	12.00	0.308	0.000	6/27/73		STRIPED PEAK

SEISMOMETERS: VERTICAL, SHORT PERIOD, MATCHED
NATURAL FREQUENCY 1 HZ
DAMPING 0.7 CRITICAL

MODE OF RECORDING: GEOTECH DEVELOCORDER 16MM FILM, 15MM/MIN FILM SPEED, PLUS FM MAGNETIC TAPE AT 3/16 IPS

MODE OF READING: DEVELOCORDER VIEWER, X20 MAGNIFICATION

SYSTEM MAGNIFICATION: (P-P TRACE AMP.)/(P-P GROUND MOTION AT 1 HZ)

TIMING: LOCAL PRECISION TIME-CODE GENERATOR, 5 PARTS IN E9 OSCILLATOR SYNCHRONIZED TO WWV, PLUS WWVB CODE

is, they have the same relative recorded amplitude for ground motion of the same frequency. Figure 2 shows the standard response curve for each station. Calibration of each individual station is accomplished by placing an absolute scale on the vertical axis of Figure 2. This vertical axis represents the non-dimensional ratio: (Amplitude of recorded trace)/(Amplitude of ground motion). Typical "magnification" for a network station is about one million at 10 Hz (the peak of the response curve). Table I contains the basic data for all network stations in operation at the present writing. Approximate calibration factors are given for each station in table I; magnifications are omitted for stations that are uncalibrated. Station STW, which is included in table I, was not yet in operation when the data in this report were obtained.

The station designated LON (Longmire, Washington) is not in the telemeter network, but it is the World Wide Standard Seismograph Station network (WWSS) operated by the University of Washington. LON predates the installation of the network, and data from this station are regularly obtained and used as a part of the data set for this report.

Note that not all stations operate at exactly the same magnification due to inherent differences in instrumentation and variations in the level of background noise at different station locations. Variations in background noise require different instrument settings at different sites.

EARTHQUAKE ANALYSIS PROCEDURES

Sixteen-millimeter film records upon which all network data are recorded are scanned for all earthquakes of interest, including teleseisms (greater than 1,000 km. distance), regional events (less than 1,000 km. distance but outside network), and local events (nominally within the perimeter of the network). All events are assigned a unique event number, classified, and entered into a master catalog. Local earthquakes are flagged for special analysis, and events large enough to be well recorded on three or more stations are prepared for computer location runs. Each 160-foot reel of film represents 48 hours of recording time and may contain up to several dozen earthquakes. Of the total number of earthquakes observed during a two-day interval (as many as 20 or more), normally six or fewer can be located using network observations.

The data are processed by a computer program written especially for use with the western Washington array. The program is based on a standard nonlinear least squares inversion scheme known as Geiger's technique (Geiger, 1912). A crustal model is required for calculation of travel-times. The three-layer crust over a half-space is used and is described by Crosson (1972). It has been found by numerical experiment that the solutions are not highly sensitive to the crustal model assumed.

Magnitudes are determined using a coda or signal duration technique, which has proven to be highly effective. The method was investigated by Tsumura (1967) and applied to the Puget Sound earthquakes by Crosson (1972). Figure 3 illustrates the curve relating coda length to magnitude, which is used for the present report. This curve was originally established using standard Wood-Anderson seismograph records from the University of Washington station.

HYPOCENTER LISTING

A complete table of all earthquakes located from the time of first installation of the multistation network in July 1970 through the end of 1972 is contained in the Appendix. Data in the table are largely self-explanatory. However, a few specific comments might be of value. Solutions are based primarily on

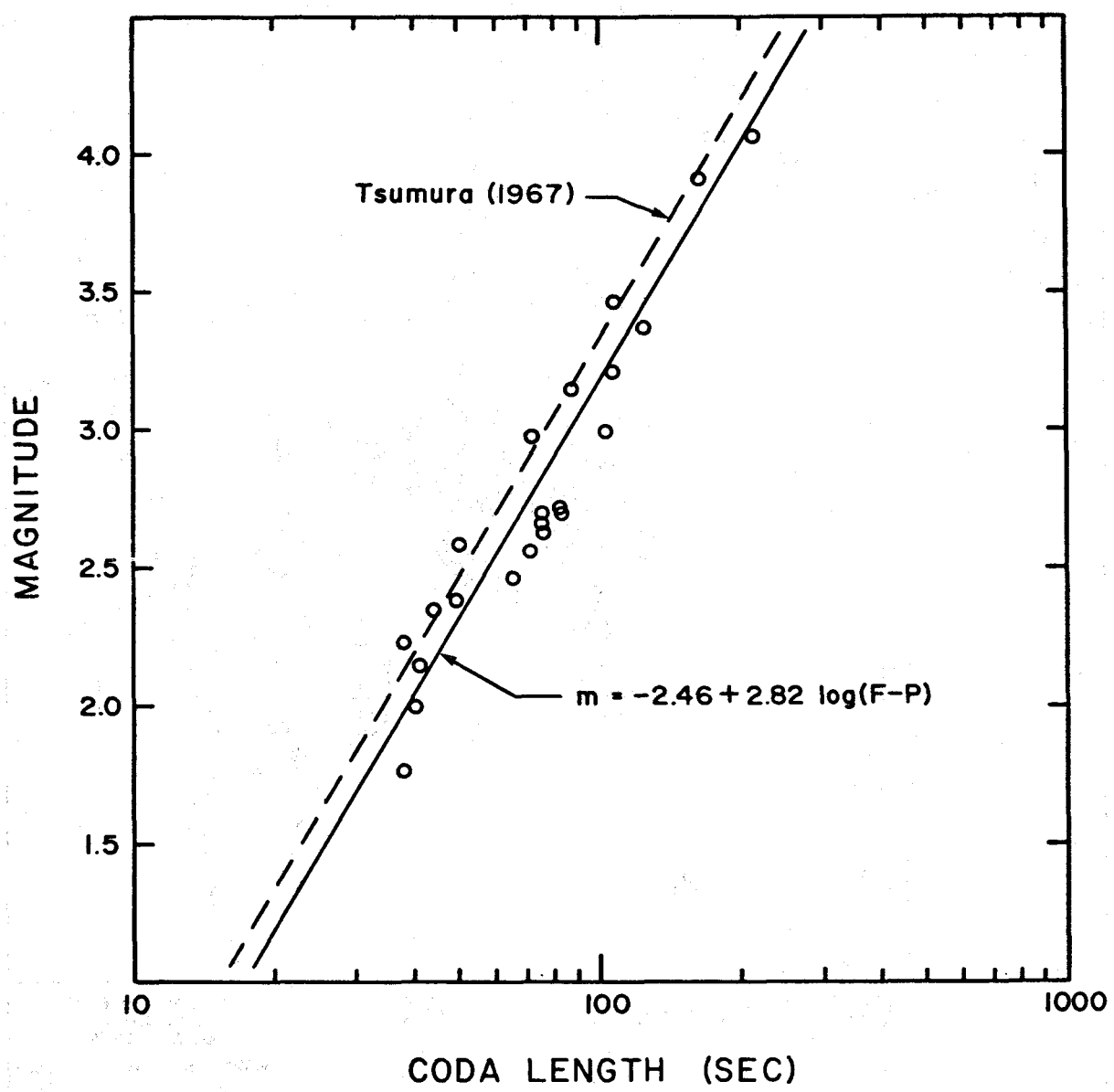

FIGURE 3.—Curve developed for magnitude determination using western Washington array data (solid line). Circles are observed data from Wood-Anderson seismograph.

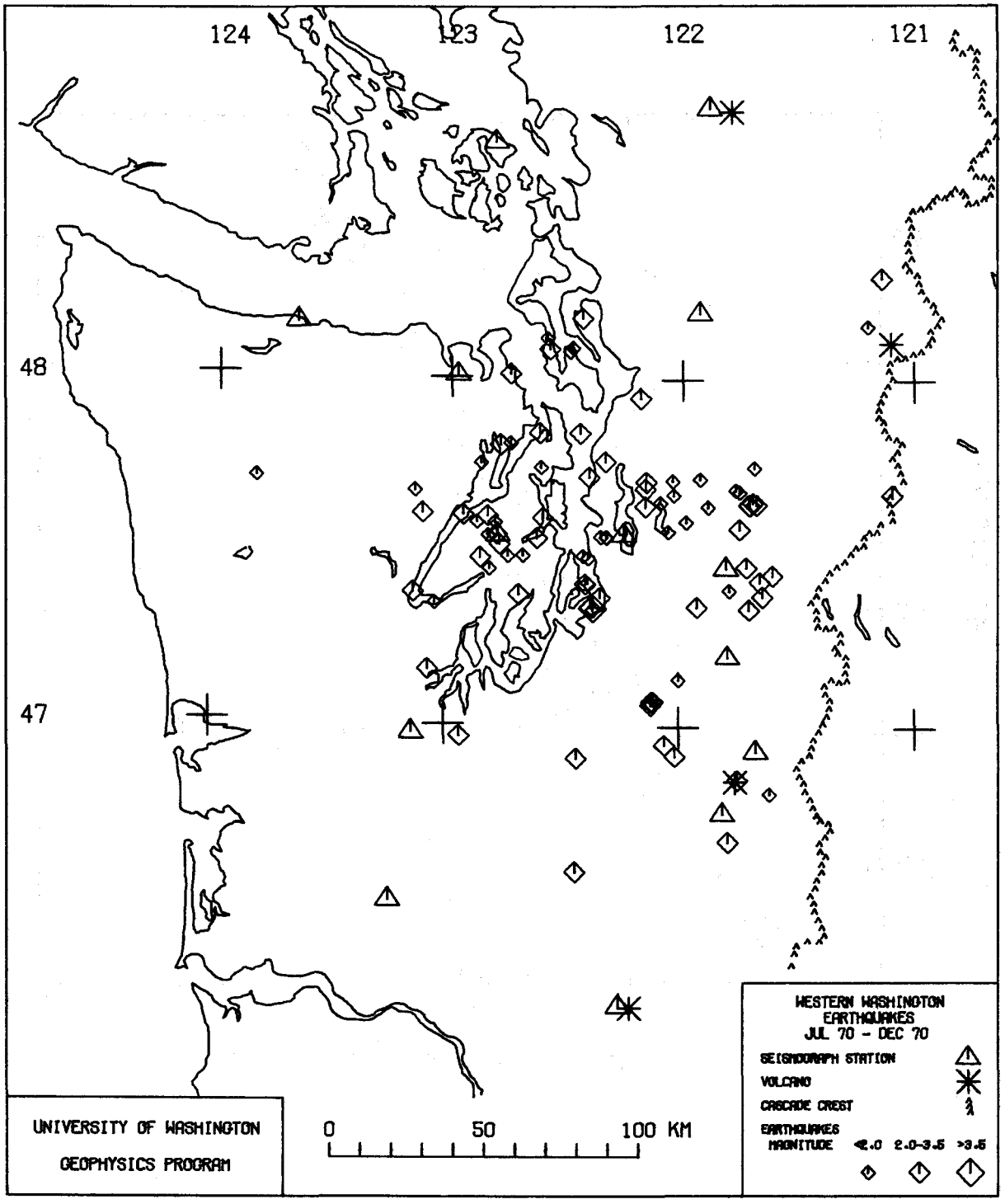

FIGURE 4.—Map showing epicenters for July - December 1970.

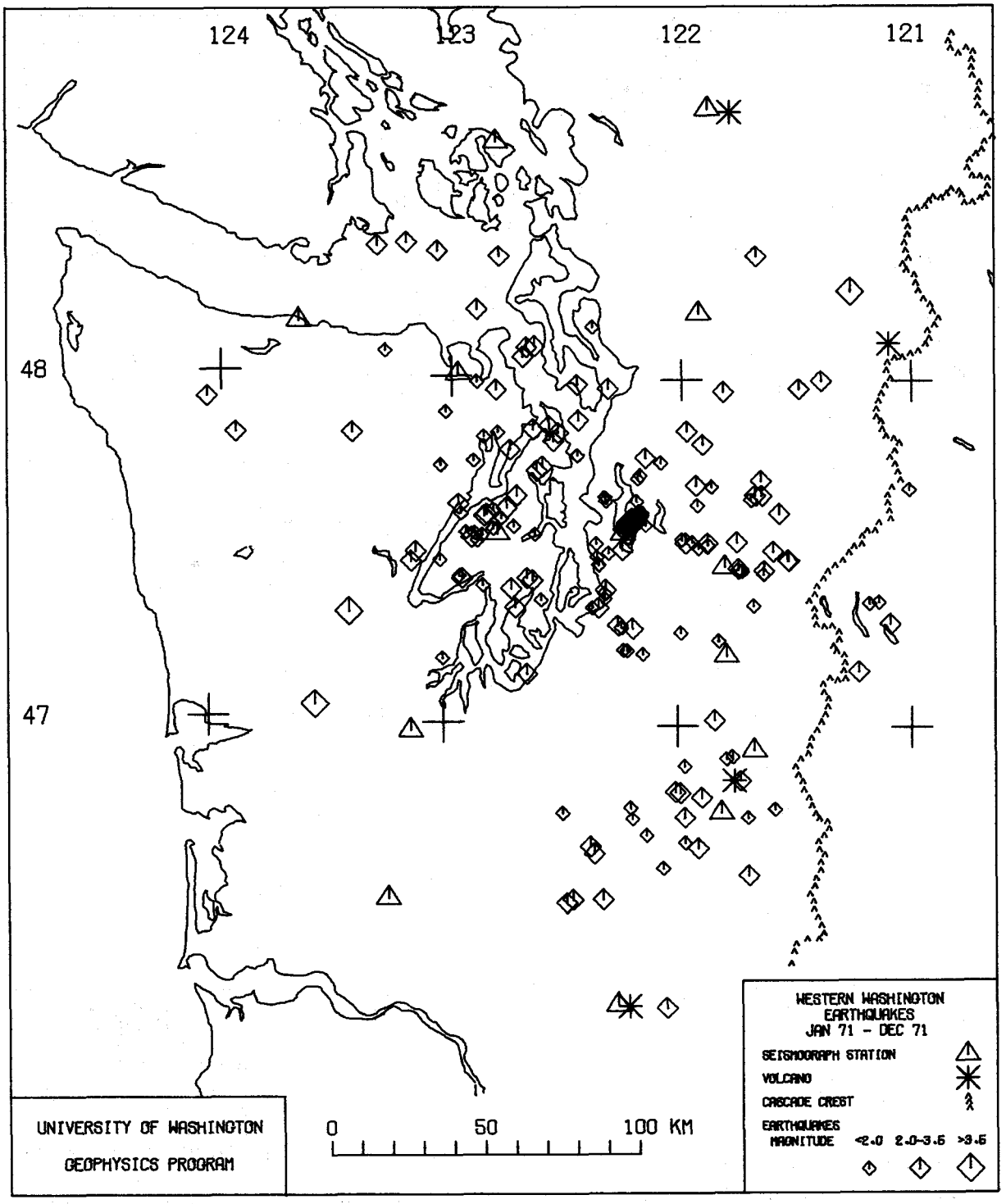

FIGURE 5.—Map showing epicenters for 1971.

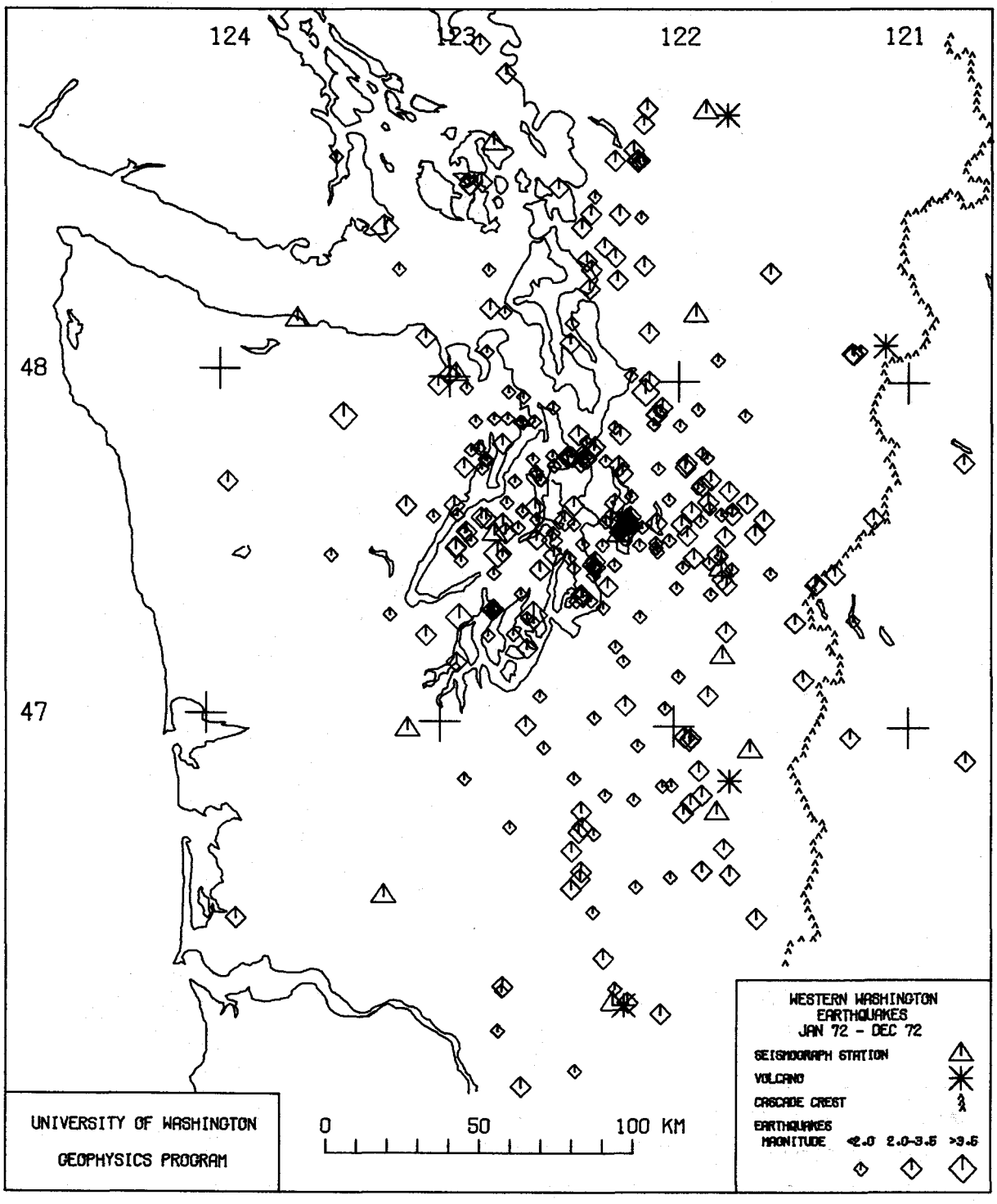

FIGURE 6.—Map showing epicenters for 1972.

first-arriving waves at various stations. The error of a given location is difficult to evaluate as a result of unknown influence of velocity variations in the shallow crust. The time residual at each station is the observed minus the predicted arrival time. Thus for each earthquake we may calculate the standard deviation of residuals (SDR), which is a number useful to indicate general quality of a solution. An SDR less than 0.1 indicates a solution that fits the observed arrival-time data very well. SDR's greater than 0.5 usually indicate poor solutions. It should be noted that when either 3 or 4 stations are used in the solution the SDR will always theoretically be zero although it is not necessarily zero in practice. It should also be noted that, in general, depths are less well determined than the epicenter locations. In particular, depths are well controlled in the solution procedure when at least one station is within approximately 30 km. laterally of the hypocenter. On occasion it is necessary to fix the depth arbitrarily in order to obtain an epicenter location. When this is done, the depth is tagged by an "F" immediately following. Normally only P wave first arrivals are used to obtain a solution. However when there are insufficient observations or when the solution is poorly constrained, S wave arrivals may be used to fix the origin time.

Figures 4, 5, and 6 show the locations of all the epicenters listed in the Appendix. Included are the seismograph station locations (triangles) for reference. Stations can be identified by their locations in table I. As a general rule those earthquakes located within the area of the network are most reliably located and probably have errors of less than 1 to 2 km. in epicenter position and less than 5 km. in depth. Earthquakes may be located up to several tens of kilometers outside the array but with reduced epicenter accuracy, and in particular, reduced depth accuracy.

Insofar as possible, explosions have been eliminated from the earthquake listing. Explosions are generally difficult to distinguish from earthquakes when the explosions occur at unusual locations and are nonrepetitive. Criteria that are useful in discriminating explosions are shallow depths, repetitions at particular times of day, first-motion polarity, size, and of course direct verification. The number of explosions included within the present data set is believed to be very small.

ACKNOWLEDGMENTS

Many individuals and organizations have contributed directly or indirectly toward obtaining the data presented here, and it is difficult to achieve full acknowledgment. In particular Jocelyn Nakashima did virtually all the seismogram reading and basic data handling, a task that must be carried out with extreme care and attention to detail. Leland Bond provided the necessary technical support, including in many cases design, construction, installation, and maintenance of the station hardware. The State of Washington Department of Natural Resources, the Weyerhauser Company, the U.S. Forest Service, the City of Seattle Parks Department, the Washington State Parks Commission, and the U.S. Navy have all generously permitted access to lands for the purpose of seismograph station installation. The U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, has provided support of radio telemetering operations in conjunction with the network operation. This research has been supported by the Earth Sciences Section, National Science Foundation, NSF Grant GA 12826.

GLOSSARY OF TERMS

Coda length, the duration of oscillation of earthquake waves on a seismogram.

Earthquake epicenter, point on ground surface directly above the hypocenter.

Earthquake hypocenter, apparent location in space and time of energy source of an earthquake. Location in space is sometimes referred to as focus of earthquake.

Frequency response, the description of the way in which the seismograph responds to earth motion of a range of different oscillatory frequencies.

Geiger's method, method of calculating earthquake location in which systematic changes are made to an initial guess in a manner that makes the differences between observed and calculated arrival times smaller.

Magnitude, empirical scale designed to indicate the size or energy release in an earthquake. Normally based on the maximum amplitude of ground motion at a specified distance from the earthquake source.

Response curve, the curve illustrating the relative manner in which a seismograph records waves of different frequency.

Seismogram, the end-recorded product of the seismograph system. An earthquake record.

Seismograph, the system of sensing, amplifying, and recording apparatus required to detect and record low-level earthquake signals.

Seismograph network, collection of several seismograph stations in localized region.

Seismometer, mechanical to electrical transducers used to "sense" ground motion and convert it to an electrical signal.

Standard deviation, statistical measure of scatter of series of measurements or readings. See text for definition.

Telemetry, transmission of seismograph signals to common data collection point for centralized recording. Normally achieved by radio or telephone transmission.

Teleseism, generally a large earthquake, magnitude greater than 3.5, recorded at a distance greater than 1,000 km.

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APPENDIX

CATALOG OF EARTHQUAKES (JULY 1970 - DECEMBER 1972)

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 is that calculated for the earthquake on the basis of multistation arrival times. It is given in Greenwich Civil Time (GCT) in hours, minutes, and seconds. To convert to Pacific Standard Time (PST), subtract eight hours.

b) In most cases the depths 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.

c) The residual standard deviation (SD) is only meaninfgul as a statistical measure of goodness of the solution when 5 or more stations are used in the solution.

d) NO is the number of station observations used in the earthquake solution. A minimum of 3 observations are required and generally the greater the number of observations used, the better the solution quality.

e) MAG is the Richter local magnitude as calculated using the coda-length method discussed in the text.

f) SDMAG is the magnitude standard deviation. If the column contains an (*), the magnitude was calculated from a single-station reading and no standard deviation is calculated.

EARTHQUAKES - 1970

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
JUL	8	0	0	12.0	47-20-50	121-55-41	.3	0.0	3	2.7	.8
	9	1	0	32.0	47-33-46	122- 3-18	20.8	.0	4	1.3	.5
	10	5	46	5.2	47-23-42	121-47-24	34.4	.5	3	1.7	.5
	11	1	59	50.0	47-27-44	121-43- 3	20.7	.1	3	2.3	.4
	11	10	24	28.4	48-17-49	121- 8-26	29.2	.0	4	3.0	.2
	14	16	25	9.4	47-35-25	121-58-44	7.9	.0	4	1.9	.8
	14	23	37	24.0	47-29-28	122-40-39	28.9	.0	3	1.4	.5
	18	10	6	10.1	47-38- 6	122- 9-14	35.8	.0	4	2.1	.8
	19	11	52	12.0	48- 5-24	122-28-37	13.8	.1	3	1.9	.5
	20	6	37	11.0	47-41- 2	121-45-55	22.7	.0	4	1.6	.9
	21	11	42	6.0	48-10-33	122-26-16	.3	.0	3	2.0	.1
	22	1	32	43.8	47-42-10	123-49-49	70.9	.0	4	1.3	.3
	23	1	34	6.5	47-35- 5	122-47-55	24.8	.0	3	1.2	0.0
	24	8	53	6.0	47-34-19	121-44-54	25.9	.1	4	2.2	.8
	25	15	14	3.0	46-54-58	122- 0-57	15.3	.0	3	2.2	.1
	28	10	37	57.0	48- 9-28	121-11-59	21.2	.2	3	2.0	.2
	29	4	7	27.0	47-48-28	122-46-57	26.1	.0	3	2.2	.2

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
AUG	2	14	39	24.0	47-42-52	121-55-15	62.6	.0	3	1.8	.6
	2	18	50	12.8	47-50-34	122-36-56	18.3	.0	4	2.2	1.1
	5	9	52	23.5	47-48-45	122-44-23	19.8	.0	3	1.3	.2
	7	6	43	30.2	48- 5- 9	122-34-37	12.6	.0	4	2.1	.4
	8	5	53	10.1	47-29- 5	122-23-49	27.5	.0	5	1.4	.9
	8	22	36	39.1	47-22-46	123- 8-41	36.7	.1	5	3.0	.5
	11	4	26	10.3	46-40- 9	121-47- 6	10.9	0.0	4	2.1	.5
	11	7	37	27.5	48- 4-44	122-29-18	16.0	.2	3	1.8	.3
	14	23	59	53.9	47-42-20	122- 9- 5	35.1	.1	5	2.1	.8
	17	0	0	2.0	46-54-26	122-26- 6	.5	.1	3	2.0	.6
	21	19	45	23.5	47-38-51	121-41-33	16.5	.0	5	2.8	.2
	21	19	47	40.5	47-40-43	121-44-56	8.4	0.0	4	1.7	.7
	22	14	50	56.7	47-38-29	121-42-28	16.5	.1	5	2.9	.4
	22	16	17	29.7	47-38-33	121-40-35	24.5	.0	4	2.2	.4
	23	8	41	41.6	47-38- 5	121-53- 7	27.5	.0	5	1.6	1.0
	23	12	12	46.3	47-40- 4	122- 1-59	15.8	.0	4	2.0	.4
	24	4	44	37.1	47- 4-18	122- 6-56	9.8	.0	4	2.7	.3
	30	15	49	43.6	47-29-20	122-44-33	27.6	.0	4	1.8	.5
SEP	3	3	38	38.4	46-58- 0	122-56- 3	32.4	.1	5	2.1	.5
	4	1	47	1.8	46-56-51	122- 3-39	11.2	.1	5	2.9	.8
	4	10	21	34.5	47-38-25	121-42-18	16.8	.1	5	3.2	.4
	24	5	27	59.4	47-28-60	122-51-37	27.6	.0	4	2.1	.6
	24	21	41	32.0	47-21- 3	123- 3- 6	38.6	.0	4	2.0	.3
	25	0	2	24.5	47- 3-47	122- 7- 8	9.1	0.0	4	2.3	.4
	25	0	29	13.1	47- 4-53	122- 6-45	9.2	0.0	4	1.7	.7
	25	8	19	1.7	47- 3-55	122- 7- 8	9.2	.0	4	1.9	.5
	27	9	52	56.9	47-45-17	122-51-52	19.1	.0	4	1.5	.9
	27	23	20	30.0	47-50-36	122-26-24	28.7	.1	5	2.8	.5
	30	8	35	53.3	47-40-19	123- 8-50	40.1	.0	4	1.5	.9
	30	19	34	5.1	47-44-54	121-41-14	6.1	.0	4	1.9	.5
OCT	1	23	55	50.5	47-45-46	122-19-45	31.5	.1	5	2.1	.9
	2	0	54	18.0	47-29-26	122-25- 9	27.7	.0	5	2.0	.7
	3	19	30	52.9	47- 4-22	122- 6-39	9.9	0.0	4	2.3	.3
	7	12	41	42.0	47-35- 5	122-52-43	18.0	.6	3	1.6	.5
	11	0	27	45.5	47-32-46	122-19-11	29.4	.0	4	1.6	.9
	10	4	18	58.0	47-32-39	122-19-11	30.0	.0	4	1.7	.6
	12	11	12	26.3	47-40-16	121- 5-33	3.4	.0	5	2.2	.9
	13	4	32	23.1	47-32-46	122-20-42	28.2	.0	4	1.7	.7
	16	4	41	17.6	46-50-54	121-44-51	13.1	.1	6	2.7	.6
	16	9	49	45.4	46-48-31	121-36-41	14.3	0.0	4	2.0	.4
	16	21	35	9.8	47-43- 2	122-23-56	27.6	.0	4	2.0	.6
	18	13	9	12.0	47-36-10	122-49-54	19.9	.0	4	2.8	.4
	23	14	53	44.4	47-22-19	122-20-39	20.0	0.0	3	2.1	.4
	24	22	32	7.1	47-20-26	122-22-27	23.1	.0	5	4.1	*.0
	25	8	32	26.7	47-26-21	121-36-20	97.6	.1	5	2.2	.7
	27	4	51	49.2	47-41- 8	122- 9-17	14.3	.2	4	2.0	.3
	31	10	48	41.1	47-20- 8	122-22-32	21.2	.0	5	2.0	.8
	31	19	17	24.3	47- 8- 9	122- 0-10	9.4	.0	4	2.0	.7

APPENDIX—Continued

NOV	7	0	37	49.9	47-24-37	122-24-29	31.2	.0	5	2.1	.8
	11	12	46	38.5	47-27- 7	122-49-15	15.7	0.0	4	2.0	1.0
	20	13	46	29.6	47-20-28	121-42-17	21.5	.0	5	2.6	.8
	20	18	50	21.7	47-36-17	122-56-14	21.4	.0	4	2.1	1.2
	21	12	37	38.7	47-38-40	122- 5-23	27.4	.0	4	1.9	.5
	22	19	24	3.3	47-44-37	122-36-26	.5	.4	3	1.7	.5
	25	21	11	39.1	47- 9-26	123- 4-27	34.2	.0	4	3.0	.6
	28	3	26	1.0	47-42-31	122- 2-15	29.0	.1	4	1.9	1.1
	29	2	15	53.9	47-25-11	121-39-35	13.9	.3	5	3.3	.5
	29	7	48	32.2	47-35-54	122-35-40	31.3	0.0	4	2.1	.7
DEC	8	9	4	8.2	46-34-43	122-25-50	19.6	.0	3	2.2	.4
	8	19	28	58.8	47-32-26	122-37- 5	33.2	.1	5	2.1	.7
	19	1	48	44.1	47-22-40	122-41-33	30.2	.0	5	2.7	.5
	25	8	16	33.6	48- 0-46	122-44-39	13.4	.0	4	2.1	.4
	26	11	44	55.4	47-33- 2	122-47-26	23.7	.0	5	2.2	.8
	27	2	24	27.0	47-32-47	122-49-41	27.6	.0	3	1.5	.2

EARTHQUAKES - 1971

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
JAN	7	8	40	4.0	47-23-51	122-50-40	25.1	.0	3	1.5	.4
	12	1	21	39.0	47-52-45	122-26-46	21.6	.3	5	2.3	.5
	12	15	4	24.5	47-32-38	122-51- 9	26.1	.0	4	1.7	.3
	14	3	26	19.6	47-57-48	122-48-20	15.4	.1	5	3.0	.1
	14	8	29	36.8	47-18-46	123-24-53	35.0	.1	5	3.8	.3
	25	21	37	52.6	48-22-23	123-20-17	40.4	.0	4	3.5	.3
	28	1	20	18.0	47-49-51	123-25-28	33.3	.3	5	2.8	.6
FEB	5	15	18	22.8	47-38-48	122-11-17	32.5	.0	5	2.0	.7
	5	17	4	33.2	47-41-39	121-55-51	18.6	.1	5	2.3	.7
	7	23	58	57.8	47-24-59	122-56- 0	45.3	.0	5	3.0	.5
	8	23	12	3.4	47-26-59	121-38- 3	18.4	.0	6	2.2	.4
	21	13	56	33.5	47-51- 4	121-58-31	17.0	.0	4	2.2	.6
	23	12	23	8.9	47-20-55	121-40-46	89.4	.1	5	1.8	.5
MAR	15	6	28	28.5	47-39-31	122-42-19	17.8	.0	4	2.3	.7
	16	17	4	56.8	47-53-50	123- 1-18	10.2	.3	3	1.8	.4
	16	18	9	11.8	47-20-17	122-22-18	26.7	.0	4	1.9	1.1
	25	3	16	12.3	47-14-47	121-49-46	23.9	.0	4	1.8	.2
	30	22	33	38.5	47-25-14	122-39-16	47.5	.1	6	2.7	.7
APR	4	10	26	4.5	48- 4-10	123-17-24	35.1	.1	3	1.8	.5
	7	21	3	53.7	47-46-20	122- 9- 7	29.9	.0	5	2.1	.4
	11	18	11	48.0	47-36-15	122-56-48	19.6	.1	3	1.7	.4
	12	6	16	25.5	47-29- 3	122-21-19	33.9	.1	5	2.0	.3
	20	2	49	57.1	47-59-58	121-23-34	7.0	.1	5	2.5	.6
	21	9	46	25.0	47-58-34	121-29-26	8.7	.3	6	2.8	.6
	24	1	49	45.0	47-33-43	122-48-23	19.7	0.0	4	1.6	.2
	24	7	53	24.2	47-46-37	122-26-48	.5	.6	3	1.9	.6
	29	2	39	29.2	47-39-57	121-38-50	14.2	.2	5	2.1	.8

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
MAY	9	23	26	33.8	46-34-12	121-41-28	23.6	.0	4	2.0	.2
	10	11	56	37.4	47-48-47	121-54-18	22.0	.1	6	2.8	.3
	14	17	37	39.9	47-30-20	122-14-51	32.1	.0	6	2.2	.2
	21	5	54	15.2	47- 9-36	121-13-34	9.0	.1	6	2.1	.7
	25	18	9	30.7	47-16- 8	121-59-30	.5	.2	3	1.6	.4
	28	10	42	5.7	46-29-42	122-25- 9	22.1	.1	6	3.4	.5
	28	18	7	5.4	46-29-47	122-18-30	16.8	.1	5	2.1	.1
JUN	5	6	2	4.3	47-17-17	122-15-41	23.4	.1	6	2.3	.6
	5	13	16	39.6	47-32-59	122-55-20	24.4	.1	5	1.9	.4
	6	18	36	5.8	46-44-10	121-41-49	11.0	0.0	3	1.8	.2
	8	12	40	48.4	47-30-20	121-35-48	14.0	.0	5	2.1	.3
	8	15	55	52.1	47-26-49	121-43-49	16.2	.0	5	1.9	.7
	9	14	35	5.4	46-45-39	122-11-52	.5	.4	3	1.5	.2
	12	8	11	13.3	46-38-52	122-21-51	13.4	.4	6	2.7	.5
	12	19	58	26.3	47- 1- 2	121-50-29	17.1	.1	5	2.1	.6
	14	0	11	15.7	45- 3-35	122-41-28	14.8	.3	6	2.4	.9
	16	14	33	10.8	47-41- 6	121- 0-26	2.9	.0	4	2.0	.1
	16	22	49	33.5	46-44-36	122-29- 6	22.8	.3	5	1.7	.3
	23	0	12	3.9	47-25-24	122-56-48	24.2	.1	5	1.8	.6
	23	9	21	48.3	47-36-18	122-10-55	27.9	.1	5	1.5	.5
	23	10	32	49.2	47-36-25	122-10-47	28.0	.0	6	2.3	.4
	23	11	21	12.5	47-36-38	122-10-34	28.9	.1	5	1.4	.4
	23	13	41	15.9	47-35-31	122-12-14	28.2	.0	6	2.2	.4
	24	2	26	51.9	47-35-51	122-11-13	28.5	.0	6	3.3	.3
	24	18	6	56.4	47-36-47	122- 9-54	28.0	.1	5	1.6	.7
	25	13	45	39.1	47-35-25	122-11-57	27.9	.0	6	3.0	.5
	25	14	30	37.1	47-35-56	122-11-41	27.9	.0	5	2.0	.3
	25	17	22	23.3	47-36-10	122-10-54	28.7	.1	6	2.3	.3
	25	22	48	53.0	47-35-35	122-12-51	28.4	0.0	4	1.6	.9
	26	19	47	30.5	46-11- 8	122- 1-56	10.3	.2	5	2.3	.3
	26	22	2	13.5	47-35-41	122-11-18	29.2	.0	6	3.3	.4
	26	22	3	40.3	47-34-39	122- 8-54	31.7	.0	4	*.0	*.0
	29	7	40	52.9	47-49-36	122-51-20	15.3	.0	3	.9	.5
JUL	4	19	54	48.1	47-36- 3	122-11- 7	27.7	.0	5	1.6	.4
	11	2	57	2.4	46-54-20	121-47-29	12.5	.0	3	1.9	1.3
	12	12	37	54.9	47-35-41	122-11-41	29.0	.1	5	2.0	.5
	13	9	56	11.6	46-44- 8	121-57-53	19.4	0.0	5	2.4	.3
	16	20	37	2.3	45-45-41	121-34-55	12.9	.0	3	1.9	.0
	18	9	46	4.4	46-54-46	121-45-53	9.7	.0	3	1.8	.3
	18	18	41	22.0	47-31-38	121-58-31	25.3	.1	6	2.3	.6
	19	18	16	59.5	47-51- 2	122-38-31	19.9	.1	5	2.5	.5
	22	17	29	31.0	47-26-20	121-38-17	14.3	.1	5	1.5	.4
	24	14	5	58.6	47-45-25	122-53-44	18.4	0.0	4	1.7	.8
	24	17	7	21.8	47-50-31	122-31-56	26.3	.2	6	2.3	[illegible]
	28	6	20	47.8	48- 8-59	122-23-28	8.9	.1	5	2.0	[illegible]
AUG	6	10	32	19.2	47-39-58	121-40-34	13.9	.2	7	2.2	[illegible]
	6	13	4	29.7	46-39-45	121-57-48	18.9	.2	5	1.7	[illegible]
	6	20	1	58.1	47-35-31	122-46-18	26.5	.0	4	1.8	[illegible]
	7	16	2	22.6	47-39-10	121-41-41	19.3	.2	5	2.8	[illegible]
	10	20	26	47.0	47-35-27	122-12-22	27.1	.1	7	3.1	.3
	11	13	41	2.7	47-35-52	122-11-38	28.0	.1	7	2.3	.4

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
	13	3	39	41.7	47-51-41	122-34-22	18.0	.1	6	2.2	.2
	14	17	36	41.3	46-50-35	121-43-51	13.2	0.0	4	2.1	.2
	15	5	58	19.2	47-36-37	122-10-35	26.5	.2	6	1.8	.3
	16	6	18	35.9	47-31-23	121-52-44	16.2	.0	4	1.9	.2
	17	14	53	9.5	47-26-43	121-31-43	12.9	.1	6	2.3	.3
	18	1	14	44.4	47-23-24	122-18-56	23.9	.1	7	2.0	.3
	21	1	37	34.6	46- 8-57	121-33-54	4.8	.0	4	2.0	.2
	23	12	15	24.3	47-34- 7	122-43- 5	46.3	0.0	3	1.2	.2
	24	10	46	16.0	47-27-46	123- 9-20	35.6	.1	7	2.6	.1
	24	13	7	26.4	47-21-36	121- 8-23	7.8	.0	4	1.7	.1
	25	9	53	31.3	46-48-23	121-59-13	15.8	.1	5	2.5	.3
	26	13	0	37.2	47-21-22	121-10-49	7.0	.1	7	1.8	.2
	26	13	35	8.4	47-59- 6	122-53-23	20.0F	.2	4	1.9	.2
	27	1	24	46.3	47-29-30	123- 8-10	43.5	.1	7	2.6	.2
	30	8	27	31.5	47-24-53	122-37-49	20.2	.2	7	2.6	.1
SEP	6	18	31	10.5	48-20-58	122-48-23	35.2	.1	4	2.2	.1
	6	23	17	59.8	46-48-31	122- 0-27	14.8	.1	5	2.0	.2
	8	13	32	1.7	47-57-57	121-49- 9	15.0	.1	7	2.7	.2
	9	20	32	57.8	47-35- 9	122-12-28	28.0	.1	7	3.5	.1
	9	23	30	34.6	47-41-24	121-51-51	30.0	.1	6	1.9	.2
	10	4	28	14.9	47-35- 4	122-13-19	28.1	.1	5	2.0	.3
	10	6	54	3.0	47-35-41	122-12-20	29.2	.1	6	2.3	.1
	12	12	19	6.0	47-16-44	122-11-54	19.9	.2	7	2.4	.2
	14	13	31	31.1	46-29- 5	122-27-41	11.8	.2	5	2.5	.1
	16	19	4	2.3	47-32-15	121-59-27	23.7	0.0	3	2.0	.2
	20	1	21	17.0	47-44-30	123- 2-17	12.5	.0	4	1.5	.1
	20	4	35	6.7	47-39-24	122-19-23	25.3	.1	5	1.9	.1
	21	22	44	28.5	47-28-50	121-31-52	10.6	.2	6	2.2	.1
	23	7	57	6.4	47-27-46	122-20-53	29.0	.0	4	1.2	.4
	24	9	16	44.2	48-21-43	123- 4-28	17.1	.3	6	3.0	.2
OCT	3	17	33	13.9	47-35-47	122-12-20	27.7	.1	7	2.3	.3
	3	20	3	29.3	47-36-14	122-12-36	26.2	.0	4	1.8	.6
	4	18	45	20.0	48-11-44	122-53-51	18.3	.2	7	3.2	.2
	4	20	38	10.5	46-35-19	122- 3-13	29.6	.0	4	2.0	.1
	5	18	34	38.2	47-38-13	121-55-32	19.6	.0	3	1.6	.2
	7	6	57	13.7	47-27-17	121-44-45	26.9	.1	6	2.1	.2
	8	2	30	44.9	47-27- 6	121-44-50	26.2	.1	5	1.8	.2
	9	14	14	40.5	46-43-44	122-11-17	6.7	.1	5	1.8	.2
	11	4	8	37.2	47-20-18	122-20-42	30.4	.0	5	2.1	.1
	12	12	54	18.7	46- 5-32	122-38-29	1.4	.1	5	2.1	.1
	17	9	49	24.3	47-44-38	122-35-48	20.4	.3	7	2.4	.3
	20	8	9	56.3	46-38-48	121-54-24	11.8	.2	6	3.3	.6
	[illegible]	10	1	58.6	47-43-53	122-37-16	29.7	.1	7	2.8	.3
	[illegible]	2	1	50.3	47-12-21	122- 9-16	32.1	0.0	4	1.7	.3
	[illegible]	[illegible]	5	31.9	47-23-22	122-43-22	22.1	.0	4	2.1	.3
	[illegible]	[illegible]	[illegible]	30.4	47-36- 1	122-12- 5	27.5	.1	5	1.8	.2
	[illegible]	[illegible]	5	40.5	47-35-60	122-11-22	23.1	.1	7	2.3	.1
	[illegible]	[illegible]	28	23.7	47-47-25	122-44-25	55.2	.1	7	3.0	.2
	[illegible]	[illegible]	53	34.7	48- 5-17	122-40-36	12.4	.1	5	2.4	.3

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
NOV	6	5	25	28.1	47-12-58	122-14-17	14.6	.0	4	1.3	.2
	6	15	28	46.9	47-17-51	121- 5-23	8.1	.0	5	2.8	.3
	11	21	1	48.8	48-21-33	121-40-56	.5	.2	5	3.2	.3
	12	22	2	16.6	47-31-50	121-56-45	30.6	.0	4	1.7	.1
	16	0	18	54.5	47-58-18	122-19-15	69.2	.1	6	2.8	.2
	16	13	24	48.8	47-16-54	122-14-51	42.9	.0	4	1.4	0.0
	16	15	9	21.9	47-38-46	122-19-17	5.9	0.0	4	1.1	.6
	16	18	6	7.7	47-32-52	122-37-31	22.9	0.0	4	1.1	.2
	20	20	56	44.9	47-36-40	122-11-17	26.9	.2	5	1.6	.3
	22	6	8	24.1	47-50-24	122-47-42	17.1	.0	3	1.7	.2
	23	2	12	12.6	48-15-31	121-15- 3	.2	.2	7	4.1	.0
	28	6	1	16.2	47-12-57	122-13-16	14.8	.1	5	1.9	.1
	28	17	35	44.8	47-22-49	122-19-11	21.4	.0	6	1.9	.1
	28	18	52	41.1	47-49-18	123-55-39	32.0	.2	7	3.4	.1
	28	19	49	42.0	47-55-18	124- 3-23	64.8	0.0	4	2.5	.1
DEC	4	14	55	20.9	46-40-55	122- 7-41	19.8	.0	4	1.6	.3
	4	21	26	46.9	47-31-22	122-21-36	33.4	.0	5	1.7	.2
	6	0	11	22.8	47-30-48	121-55-10	10.4	.0	3	1.2	.1
	6	4	51	28.9	47-21-54	122-19- 8	19.9	.1	6	2.0	.1
	7	3	29	59.7	47-29-48	122-18-25	20.0F	.1	4	1.4	.3
	7	5	30	.9	47-42-40	122-11- 6	24.9	.1	5	1.9	.0
	7	13	23	59.0	47-42-30	121-39- 5	18.6	.1	6	2.6	.1
	8	20	14	32.8	47-35-53	122-50-48	25.1	.0	5	2.2	.2
	12	19	46	59.6	47-49- 4	122-33- 7	36.4	0.0	4	2.0	.2
	13	20	59	2.3	47- 2-33	123-32-59	28.8	.1	6	3.6	.1
	14	21	5	2.9	47-35-15	122-13-17	27.7	.1	5	2.6	.1
	15	19	37	12.6	47-36-50	121-34-20	18.1	.1	6	2.3	.2
	19	5	51	43.4	47-31-52	121-45-18	19.9	.2	5	2.3	.1
	20	12	30	26.3	46-53- 4	121-58-10	8.7	.2	5	2.0	.2
	21	20	6	48.4	47-28- 7	123- 1-54	13.3	0.0	4	1.8	.1
	21	22	43	36.6	47-58-55	122-27-14	15.0	.1	6	2.6	.1
	22	20	46	53.1	47-32- 7	122-53-54	21.0	.0	6	3.4	.1
	25	14	33	17.0	47-43-16	122-10-25	34.3	.0	5	1.8	.2
	27	2	18	39.4	47-33-55	122-14-41	29.0	.0	5	2.1	.1
	27	12	55	45.0	47-36-10	122-50- 9	29.4	.1	6	2.2	.1
	27	13	23	44.0	47-36-60	122-48-22	26.6	0.0	4	1.7	.1
	28	7	49	59.6	47-34-58	122-12-59	27.4	.1	8	4.4	.1
	28	7	54	32.4	47-35-21	122-12-53	25.2	.2	8	0.0	0.0
	28	7	55	36.4	47-34-11	122-14-27	28.9	.0	5	0.0	0.0
	28	7	55	46.5	47-33-35	122-13-47	29.1	.1	5	1.5	.2
	28	7	57	53.7	47-34-14	122-13-28	27.8	.1	6	2.2	.1
	28	9	30	33.4	47-33-59	122-14-33	29.1	.0	5	1.8	.1
	28	12	19	8.7	47-34- 4	122-13-30	27.7	.1	5	1.8	.2
	29	15	31	15.7	46-37-39	122-20-51	2.5	.2	6	2.4	.1
	30	14	32	16.8	47-37-18	122-45- 2	18.7	.0	7	3.2	.2
	31	1	45	14.4	47- 8-39	122-38-54	29.2	.2	6	2.9	.2
	31	14	8	14.0	47-31-36	122-52-22	27.1	0.0	4	1.2	.2

APPENDIX—Continued

EARTHQUAKES - 1972

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
JAN	1	9	49	48.5	47-35-23	122-12-44	25.8	.1	6	2.6	.1
	2	5	1	31.3	47-35-33	122-29- 7	27.4	0.0	5	2.1	.1
	4	8	52	7.4	47-10-24	122-56- 1	2.8	.2	5	2.3	.1
	5	1	43	20.0	47-36-54	122-40- 3	51.8	.0	3	1.2	.2
	5	22	47	20.7	47-43-51	122-36-49	19.4	.0	4	1.9	.1
	10	10	1	26.8	47-35-58	122-12-47	25.2	.1	5	2.6	.1
	13	22	6	16.3	47-18-60	122-36-29	38.9	.4	6	3.6	.1
	14	9	20	24.1	47-22-22	122-23-55	24.7	.1	6	2.2	.1
	14	15	34	6.6	47-29-42	121-48-22	74.8	.1	5	2.0	.1
	14	20	17	21.3	47-30-18	122-57-10	26.0	.1	5	2.8	.1
	15	7	35	5.4	47-37- 4	122-40- 3	25.8	.0	4	1.9	.1
	15	12	15	44.6	47-50-38	122-15- 7	27.7	.1	6	2.3	.1
	15	13	35	5.9	46-59-42	122-37-55	13.0	.0	4	2.1	.1
	16	17	4	50.4	47-22-37	122-24-15	23.1	.0	6	2.9	.0
	17	2	7	27.7	47-39- 4	121-51-55	23.8	.1	6	3.0	.2
	18	10	2	31.7	46-41-49	122-41-20	50.7	.0	3	1.5	.2
	19	18	10	28.9	47-31-31	122-24-17	29.9	.0	5	1.9	.2
	21	0	50	5.6	47-36-22	122-11-55	27.4	.1	6	2.8	.3
	25	9	13	47.1	47-37-25	121-56-11	30.9	0.0	4	2.3	.1
	25	17	25	52.7	47-40-26	123-56-48	60.7	.1	4	2.6	.1
	27	10	51	52.8	47-38-34	122-16-10	18.9	0.0	4	2.2	.0
	28	14	46	30.2	47-31-30	122- 9-32	16.7	0.0	3	1.4	.1
	30	7	28	42.7	47-32- 2	122-32-15	26.7	0.0	5	2.3	.1
FEB	4	20	16	16.1	47-20-30	122-18-35	18.3	0.0	3	1.4	.1
	9	2	58	58.4	46-42-12	122-22-46	17.3	.1	6	2.2	.2
	12	13	45	30.3	46-38-49	121-46-37	18.2	.0	5	2.2	.3
	22	12	35	4.2	47-19-50	122-46-53	16.8	.0	8	3.4	.1
	25	21	6	30.6	47-37-41	122-57-48	18.7	.1	7	2.4	.2
	26	2	55	10.0	47-39-24	122- 2- 9	25.3	.3	5	1.8	.2
	27	8	27	55.6	48- 6-43	123- 6-27	50.3	.1	5	2.4	.1
	28	6	39	19.1	47-47-32	121-53-40	30.3	.0	5	1.6	.1
	29	0	35	3.8	47-35- 8	122-12-54	26.9	.1	6	2.3	.1
MAR	2	12	8	35.0	47-15-31	122-41-37	51.2	0.0	4	1.7	.1
	2	20	12	12.4	47-46-18	122-24-19	25.9	.1	7	2.5	.1
	2	22	36	22.9	47-46-20	122-23-50	25.5	.1	7	2.5	.1
	4	15	10	42.9	48- 6-23	122-28-34	11.6	.1	5	2.1	.1
	9	5	53	60.0	46-58- 7	121-57- 7	16.6	.2	8	3.0	.2
	10	2	15	31.9	47-18-22	123-13-36	11.2	.0	3	1.6	.1
	10	12	36	54.3	47-35-14	122-12-21	25.9	.1	5	2.0	.1
	13	1	48	51.2	47-50-26	122-26- 2	28.2	.1	6	2.2	.1
	19	9	16	9.1	47-49-16	122-23-56	20.4	0.0	4	1.6	.1
	21	7	25	18.4	47-19-39	122-47-10	22.5	.0	5	2.3	.2
	29	3	58	2.9	47-27-27	122-20-59	28.9	.0	5	1.5	.2
	31	10	16	22.1	46-41-12	122-23-43	16.8	.2	8	2.3	.2
APR	4	11	1	52.6	47-54-13	122- 5-41	26.3	.2	7	3.0	.2
	4	11	6	36.9	47-54- 7	122- 5-34	20.0F	.3	6	2.3	.2
	4	11	11	30.4	47-54-48	122- 4-39	34.8	.0	4	1.6	.1
	10	1	36	21.5	47-24- 7	122-17-31	18.2	.1	6	2.1	.2
	17	10	36	30.2	47-27-37	122-21- 6	28.6	.0	6	1.8	.3
	17	10	53	35.5	47-28-27	123-29-20	44.8	.0	4	1.9	.3

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
APR	17	18	20	50.2	47-35-59	122-14-32	18.0	0.0	4	1.9	.1
	18	20	6	47.6	47-52-60	122-44-27	43.4	.1	5	1.9	.2
	18	23	55	55.6	47-52-18	121-59-24	20.5F	.1	5	1.8	.3
	19	6	27	49.4	46-19-23	122-16-50	9.0	.3	7	2.5	.1
	19	10	16	9.6	48-17-29	122-16-30	5.1	.1	6	2.8	.3
	19	10	56	3.7	47-26- 3	122-47- 5	24.9	0.0	4	1.5	.3
	21	1	43	24.3	47-17-41	122-36-25	40.9	.0	5	2.0	.1
	21	22	40	41.5	46-55-51	122-33- 9	20.0F	.1	4	2.0	.1
	24	4	9	58.0	46-38-14	122-17-42	7.8	.2	7	2.4	.1
	26	4	35	48.0	47-36- 3	122-56-59	44.9	.1	7	2.0	.1
	27	0	13	14.1	47-18-58	122- 8-60	18.2	0.0	4	1.8	.2
	27	16	19	17.9	47-52-34	122-37-24	26.8	.2	6	2.0	.2
	29	8	6	44.8	48-26-31	122-26-17	16.0F	.2	7	2.4	.2
	29	8	58	29.5	46-49-41	122- 0-17	14.3	.3	6	2.0	.1
	29	9	27	16.3	47-41-53	121-53-32	19.3	.1	4	2.2	1.5
	29	11	42	30.0	47-38- 8	122-26-48	29.6	.0	8	3.0	.1
	29	12	50	18.3	46-56-31	122- 9- 4	4.4	.0	5	1.9	.2
	29	18	41	57.7	47-47-44	122-51-55	20.0F	.1	4	1.5	.1
	29	21	2	27.3	48-28-55	122-23-56	9.0F	.2	5	2.2	.2
MAY	1	22	22	18.9	46-41- 1	122-19-50	22.0F	.1	4	1.2	.2
	2	13	31	58.6	47-35- 3	122-12-48	27.1	.2	6	1.9	.2
	3	7	35	6.2	48-28-31	122-10-36	18.5	.0	4	1.8	.3
	4	16	32	33.9	45-48- 3	121-52-23	5.2	.1	6	2.0	.1
	8	19	6	9.6	47-34-57	122-12-33	26.7	.1	7	2.5	.1
	12	2	50	4.2	47-36- 6	121-37-21	12.9	.1	5	2.0	.2
	12	6	41	15.4	47-33-14	121-57-13	25.9	.1	7	2.3	.2
	14	17	26	14.7	47-35-40	123- 3-13	17.1	.0	5	0.0	0.0
	18	0	50	31.2	47-31-41	122-53-14	21.1	0.0	4	1.7	.1
	18	5	7	35.4	48-34- 1	122-52-55	9.8	.4	6	3.1	.1
	20	7	1	52.5	47-27-56	122-21-25	29.6	.1	7	2.8	.1
	20	16	32	19.9	48-15-52	122-23-52	4.7	.3	6	2.9	.1
	20	19	56	19.7	48-20-45	122-24-45	6.0F	.3	6	2.8	.1
	20	21	8	10.1	47- 3- 7	122- 2-15	5.2	.2	5	1.6	.1
	20	21	18	46.2	45-57-59	121-55-29	10.3	.2	6	2.7	0.0
	21	1	17	25.0	47-52-22	122-41- 5	41.3	.1	5	2.0	.2
	22	5	23	42.2	47-30-32	122-57- 2	20.4	.1	6	2.4	.1
	23	22	48	9.4	48- 0-52	122-12-27	39.5	0.0	3	1.7	.1
	25	7	43	52.1	47-33-43	122-14- 8	9.7	.0	3	1.0	.1
	25	8	17	4.9	47-33-57	122-13-59	9.9	.0	3	.9	0.0
	26	13	53	46.6	47-25-39	121-47-58	24.0	.2	6	2.3	.2
	29	11	56	15.7	46-46-38	121-55-16	12.6	.2	6	3.0	.2
	30	19	45	52.0	47- 3-31	122-12-29	18.7	.1	6	2.2	.1
	31	18	25	9.5	46-26-42	121-38- 2	15.4	.1	5	2.4	.2
JUN	2	10	18	28.2	47-46-40	122-24-10	23.9	.1	7	1.9	.2
	5	20	17	30.1	47-18-15	121-23- 0	13.0	.1	5	2.5	.1
	8	8	57	.6	47-44-58	122-32- 9	28.6	.0	6	1.6	.3
	9	21	58	56.7	47-45-44	121-57-41	19.3	.0	5	3.3	.2
	10	2	34	26.8	47-45- 3	121-58- 1	18.3	.1	5	2.3	.1
	13	19	22	6.4	47-29-16	122-44-57	28.7	.0	4	1.7	.2
	13	22	48	37.6	47-43-20	122-36-37	19.3	.0	4	1.5	.4

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
JUN	16	2	57	45.9	47-15-13	122-48- 5	19.2	0.0	4	1.8	.2
	16	9	55	31.6	46-44-55	122-23- 7	8.9	.3	7	2.4	.1
	16	11	15	42.9	46-50-40	122-25-13	3.1	.3	5	1.9	.3
	16	18	27	29.7	47-37-59	121-51-34	31.1	0.0	4	1.5	.3
	16	20	50	22.8	47-35-18	122-12-55	26.1	.1	8	2.7	.1
	17	21	2	58.9	47-29-58	121-49-15	25.8	.2	5	2.2	.0
	19	5	41	8.9	47-45-45	122-50-12	19.6	.1	5	1.0	.3
	19	23	57	56.9	48- 5- 8	121-14-36	7.9	.2	7	3.2	.2
	21	13	8	19.5	47-42- 7	122-42-15	26.3	0.0	4	1.6	.3
	24	15	41	15.8	47-35-33	122-36-14	44.6	.0	5	1.4	.1
	25	1	42	21.3	47-58- 3	122- 8-36	22.1F	.1	7	4.0	.1
	25	1	49	30.2	47-59-60	122- 7-39	37.8	.1	6	2.5	.3
	26	13	20	59.6	47-16-35	121-46-48	18.7	.0	4	2.2	.1
	28	4	33	29.6	47-13- 4	122-37-58	49.7	.1	7	2.6	.2
	28	18	16	51.2	48-33-20	122-32-38	12.0F	.2	7	3.2	.1
	30	1	41	3.3	46-58-13	121-14-42	14.9	.1	5	2.2	.3
	30	21	18	36.3	47-58-31	123- 2-52	51.6	.1	6	2.7	.2
JUL	5	7	32	50.7	47-28-33	121-51-28	24.5	0.0	4	1.9	.2
	5	14	7	49.5	47-41- 1	121-46-32	20.7	.1	7	2.1	.3
	5	18	46	11.9	48-53- 2	122-47-19	1.8	.0	4	2.1	.1
	7	10	40	49.6	48- 5-29	121-12-23	6.1	.0	6	2.0	.2
	8	20	9	7.5	47-55-29	122- 4-10	10.2	.1	6	2.5	.2
	16	3	49	13.4	48-37-36	123-31-30	46.3	0.0	4	1.8	.3
	17	11	44	30.9	47-35-41	122-12-27	18.6	0.0	4	1.8	.1
	17	14	13	55.7	48-18-48	122-50-28	20.0F	.1	4	2.0	.1
	17	16	9	45.7	47-18-22	122-38- 5	26.8	.1	5	1.4	.2
	17	21	8	47.9	47-33- 2	122-54-52	22.3	.1	7	0.0	0.0
	17	21	9	36.0	47-33-12	122-54-27	23.5	.1	8	3.1	.1
	18	16	0	5.9	46-50- 4	122-53-18	20.0F	.2	4	1.6	.2
	19	11	12	53.7	47-35- 8	121-58-44	19.8	.1	6	2.2	.2
	23	17	19	31.8	47-27-44	121-58-12	28.4	.1	5	1.7	.1
	24	19	21	20.9	47-32- 8	122-36-14	50.5	.0	5	2.2	.1
	25	22	25	30.0	47-24-52	121-23-51	10.4	.0	5	2.3	.1
	26	7	27	13.8	48- 4-33	122-50-21	58.5	.0	3	1.0	.3
	27	3	14	46.4	47-36-55	121-48-25	17.1	.1	5	2.0	.2
	27	6	44	19.7	47-34-25	122-14-21	29.3	.0	5	1.8	.1
	28	15	4	.6	47-46-38	122-28- 7	28.1	.1	7	3.0	.1
	28	15	25	6.3	47-46-31	122-28-51	32.2	.0	6	2.0	.2
	28	23	13	10.5	47-25- 3	121-23-34	10.4	.1	6	2.1	.2
	29	1	57	55.5	48-57-59	122-54-25	95.7	.1	6	2.4	.2
	29	3	55	12.4	47-27-35	122-20-54	28.6	.0	7	2.3	.1
	30	17	54	31.4	47-52-19	122-52-49	17.7	.1	6	1.9	.2
	31	2	55	17.0	48-31-57	122-23- 4	8.0	.0	3	1.7	.4
AUG	1	22	11	44.2	47-47-17	122-53-55	17.4	.1	5	1.7	.3
	2	22	25	35.6	47-35-48	121-53-48	23.8	.0	4	1.6	.1
	3	3	5	38.8	46-49-31	122- 2-38	4.7	.1	6	1.7	.3
	4	23	14	14.1	48-11-28	122-45-56	21.3	.1	6	1.8	.3
	5	3	3	52.1	47-24- 5	121-59-45	16.7	0.0	4	1.6	.4
	11	12	28	6.5	47-29- 3	122-27-42	40.8	.0	3	.8	.7
	13	12	55	14.3	47-24-44	121-46-46	21.4	.1	8	3.0	.1

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
AUG	14	14	58	15.6	47-46-58	122-24-36	51.8	.0	5	2.0	.1
	15	5	23	31.9	47-52-26	122- 6-20	20.0F	.1	4	1.6	.2
	16	9	45	9.2	47-33-11	121-47-24	16.1	.1	7	2.1	.3
	19	17	12	30.6	47-29-23	121-55-20	15.3	.1	7	2.2	.4
	20	9	59	13.3	47-27-49	122-21-11	28.4	.1	7	1.4	.1
	20	10	39	48.2	47-47-58	122-21-53	34.7	.0	6	1.4	.2
	26	16	8	56.1	47-31-25	122-19- 7	34.5	.0	3	1.6	.3
	26	20	33	56.3	47-45-53	122-18-48	32.0	.0	5	1.9	.2
SEP	3	11	37	12.6	47- 4-50	122-34-29	9.6	.1	5	1.3	.3
	5	9	37	7.5	47-19-46	122-46-45	20.5	.1	6	1.4	.2
	5	10	45	22.9	47-20-17	122-46-53	25.3	.0	4	1.0	.3
	6	10	27	34.6	47-19-38	122-46-53	19.8	.1	5	2.0	.2
	6	14	50	43.3	48-12- 1	122-49-51	65.4	.1	5	2.3	.2
	6	16	13	49.5	47-14-57	123- 4- 9	30.6	.1	6	2.0	.3
	7	17	55	15.0	46- 8-27	122- 8- 1	7.0	.0	3	2.1	.3
	8	4	28	1.1	47-35-34	122-49-27	26.9	.1	7	2.2	.2
	10	18	21	10.8	47-38-58	121-41-45	19.6	.1	6	2.4	.1
	11	4	12	44.6	47-35-24	122-18-24	16.8	0.0	4	1.8	.1
	13	5	18	51.3	47-45- 7	122-25-18	28.8	.1	6	1.8	.2
	13	11	33	50.0	47-35-42	122-50-44	21.7	.1	6	2.5	.1
	15	1	3	27.6	47-26-43	121-18-53	9.3	.1	6	2.2	.2
	15	2	16	14.3	47-53-18	122-31-57	29.7	.0	4	1.2	.5
	16	11	47	58.5	47-34-35	122- 8-53	4.5	0.0	4	1.4	.3
	19	4	33	4.1	47-13-42	122-15- 8	13.1	.0	4	1.6	.3
	19	19	30	7.3	48-18-25	123-14- 2	27.8	.0	3	1.8	.2
	21	20	31	47.5	47-33- 7	122-44-17	11.8	.1	5	2.1	.2
	26	10	30	23.8	47-32-23	122- 1-49	27.6	.2	5	2.0	.2
	26	14	38	45.7	48- 0-22	122-59-59	53.8	.2	5	2.8	.0
	30	13	31	37.7	47-27-20	122-26-21	7.4	.1	5	1.6	.2
OCT	4	12	38	50.2	48-21-30	122-17-10	11.6	.1	8	3.2	.2
	6	7	58	18.9	47-57-38	122-44-22	8.9	0.0	4	1.6	.1
	7	0	52	15.3	46-51-24	122-25-17	1.0F	.2	6	2.5	.3
	7	11	1	46.9	45-59-38	122-23-26	32.9	.1	6	2.0	.2
	8	6	27	13.2	47-21-40	122-21-48	32.9	.1	5	1.3	.2
	8	13	2	26.4	46-47- 6	122- 9-49	10.0F	.4	3	1.3	.3
	10	1	46	3.5	47- 5-24	121-51-20	8.6	.0	6	2.2	.4
	10	7	38	54.5	47-42-30	122-35-37	1.0F	.6	3	.9	.3
	10	9	58	18.7	47-34- 7	122-41- 5	32.3	0.0	4	1.1	.4
	10	11	26	54.0	48-23-12	122-20- 6	8.1	.1	9	2.7	.1
	11	7	3	23.4	46-57-32	121-55-54	12.2	.1	7	2.5	.2
	11	23	12	31.5	47-48-25	122-21-36	23.1	.1	6	2.4	.1
	12	1	36	46.4	47-38-22	122-44-11	26.4	0.0	4	1.5	.3
	12	13	7	36.1	48-20- 3	122- 9-34	13.1	.1	9	2.9	.2
	12	14	27	40.5	47-53-37	121-39-38	17.0	.1	5	2.1	.3
	13	5	51	4.1	47-48-35	122-45-45	20.1	.0	6	2.0	.1
	13	8	0	52.6	47-35-56	122-17- 2	12.3	.3	7	2.5	.1
	13	20	9	13.7	46-47-49	122-17-11	10.0F	.2	4	0.0	0.0
	13	20	9	45.4	46-34-27	122-22-51	1.0F	.4	4	2.4	.0
	13	20	11	49.6	46-33-10	122-23- 5	1.0F	.3	4	2.6	.3
	13	22	59	9.5	47-30-22	122- 4-48	7.8	.3	5	1.9	.1

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SDMAG
OCT	13	23	39	1.0	47- 8-16	121-26-48	11.6	0.0	4	2.2	.1
	16	22	8	33.2	48-40- 5	122-12-48	1.0F	.2	7	3.0	.1
	18	0	13	58.8	46-31-57	122- 8-52	1.0F	.2	8	2.0	.2
	18	14	55	8.7	47-18-39	121-14- 0	1.0F	.1	6	1.9	.1
	19	2	1	46.6	47-34-35	122-12-53	25.3	.1	7	1.7	.2
	19	10	35	9.7	47-55-10	121-54-47	15.0	.0	5	1.6	.3
	20	21	35	8.6	46-34-53	121-52- 7	10.4	.1	6	2.1	.2
	22	6	50	56.3	47-31-52	122- 5-18	22.8	.2	6	1.3	.4
	22	6	57	22.7	47-55- 5	122-32-40	18.6	.0	5	1.7	.3
	22	9	16	28.0	47-34-26	122-12-60	24.8	.1	8	3.8	.1
	23	3	51	33.4	47-11-10	122-13- 3	14.9	.1	7	2.0	.2
	25	2	19	12.4	46-52-19	121-53-18	9.3	.1	6	2.9	.2
	26	3	29	50.0	47-58- 7	122-55-26	21.8	0.0	4	1.4	.1
	27	0	54	9.5	46-37-57	122-25-24	1.0F	.2	9	2.1	.3
	28	0	5	48.0	45-51-42	122-45-15	5.3	0.0	3	1.9	.2
	30	20	28	43.7	48-19-10	122-23-26	1.0F	.1	6	2.1	0.0
NOV	3	1	51	52.6	47-21-30	122-25-39	24.6	.1	5	1.5	.3
	3	11	57	57.8	47-34-45	122-45- 3	21.3	.1	8	3.0	.2
	3	23	48	31.2	47-44-17	122-55-33	47.6	.1	10	3.0	.1
	4	3	51	15.6	46-27-21	122-13-40	10.0F	.1	7	1.8	.1
	6	18	38	39.0	47-18-11	122-55-41	24.7	.1	10	3.7	.1
	7	7	50	29.7	47-54-11	121-42-25	24.1	0.0	4	1.8	0.0
	9	4	19	19.1	48-25-28	123-18-15	42.6	.1	12	4.1	.1
	10	11	55	35.2	46-11-49	122-10-25	24.1	.0	7	2.1	.3
	10	21	18	18.6	47-36-54	121-45-35	18.1	.2	11	2.5	.2
	13	4	34	35.1	48- 9-49	122-28-16	1.0F	.0	4	1.7	.6
	14	18	26	24.0	47-45- 8	122-15-18	19.6	.2	12	3.3	.2
	15	1	55	15.4	47- 8-41	121-58-52	15.4	.2	7	1.8	.7
	15	11	14	6.7	47-41-32	121-54-38	31.5	0.0	4	1.3	.1
	16	1	30	40.6	47-46- 0	120-45-30	10.0F	.6	9	2.5	.2
	17	2	15	24.8	45-56-42	122-36-54	7.3	.3	10	3.1	.7
	17	6	52	17.4	47- 1-16	122-20-25	24.4	.0	7	1.2	.5
	18	9	39	26.2	47-52-20	122-40-29	19.4	.1	8	1.7	.3
	18	23	2	35.0	47-45-59	122-37-46	19.6	.0	5	1.4	.1
	18	23	9	.8	47-34-56	122-26-41	17.8	.2	10	1.8	.4
	20	9	9	41.4	47-33-26	122-14-25	24.5	.2	8	1.9	.3
	22	12	38	26.2	48-38-26	122-11-43	1.0F	.1	8	2.4	.2
	22	13	58	49.8	48-38-17	122-11-17	1.0F	.1	6	2.0	.1
	22	22	39	14.9	48-19- 4	121-35-16	2.8	.1	8	2.3	.2
	23	6	29	42.6	45-52-32	121-48-10	1.0F	.3	10	2.5	.7
	23	15	55	40.5	46- 9-52	122- 2- 8	14.5	.1	7	2.3	.6
	25	6	58	26.7	47-36-24	121- 8-52	.2	.2	8	2.1	.3
	25	10	53	8.3	47-31- 1	122- 5-18	24.9	.1	6	1.5	.5
	28	22	27	47.9	47-52-53	122-47-56	42.7	.1	9	2.0	.4
	29	9	13	52.6	48-38-12	122-11-43	1.0F	.1	8	2.4	.3
	29	9	21	36.0	48-38-23	122-10-17	1.0F	.1	5	1.9	.1
	29	21	48	12.9	47-45-38	122-49-35	10.9	.2	8	1.5	.4
	29	21	49	29.9	47-44-11	122-50-55	11.1	.2	7	1.5	.3
	29	23	46	20.2	46- 3-49	121-49-47	8.1	.0	5	1.7	.4
	30	15	12	47.1	47-39-54	122-11-52	10.0F	.4	3	1.3	.4

APPENDIX—Continued

	DY	HR	MN	SEC	LAT N	LONG E	DEPTH	SD	NO	MAG	SD MAG
NOV	30	18	40	15.6	49-10-56	121-37-27	1.0F	.0	4	2.2	.5
DEC	1	20	26	6.2	46-54-11	120-45-10	10.0F	.1	5	2.2	0.0
	2	16	29	7.4	48-28-55	122-16-20	17.4	.2	5	2.1	.0
	3	10	17	41.6	47-29-30	122-46-14	19.1	.1	11	3.6	.2
	4	14	15	2.6	47-37-50	121-45-34	19.6	.2	6	1.9	.3
	5	2	37	50.9	47-34-52	122-11-16	25.6	.1	6	1.3	.4
	5	7	25	56.9	47-34-13	122-15-12	22.5	.1	7	1.4	.2
	6	10	32	26.8	47-52-33	123-27-19	42.7	.1	11	3.9	.2
	6	17	35	53.5	47-46-32	122-27-36	20.4	.2	12	3.3	.0
	6	19	42	26.1	47-56-50	122-40-30	9.2	0.0	4	1.7	.4
	9	1	55	34.5	48-33-27	122-56-16	8.6	.3	11	3.3	.1
	9	1	57	36.6	48-34-20	122-56-40	10.0	0.0	5	2.0	.1
	9	13	14	37.4	48-47-23	122- 9-28	6.5	.3	11	2.7	.3
	9	13	30	47.6	48-44-41	122-10-18	1.0F	.2	9	2.6	.4
	9	15	54	37.8	45-34-15	121-44-58	10.4	.2	10	2.5	.3
	9	16	54	35.3	47-26-48	121-35-28	5.0	.4	7	1.8	.2
	9	19	56	46.8	47-29-25	122-31-43	25.8	.2	11	2.7	.2
	9	22	0	41.3	46- 6-19	122-43- 7	8.0	0.0	3	1.7	.1
	12	10	9	28.2	46-44-57	121-57- 6	8.1	.1	11	2.8	.2
	12	12	45	4.3	47-37-20	123-10-17	41.6	.2	12	2.8	.3
	13	4	17	36.5	47-46-46	121-52-21	29.3	.2	9	2.0	.2
	16	6	24	4.5	47-23- 3	121-50-57	14.7	.1	6	1.8	.2
	17	22	57	15.2	45-46-37	123- 7-23	10.0F	0.0	4	2.0	.3
	23	22	11	38.4	46-24-31	123-50-10	10.0F	.2	8	2.5	.3
	24	8	2	39.3	47-46-37	122-32-41	23.2	.1	6	1.9	.3
	25	3	58	13.8	47-26-52	122-35-10	20.6	.1	8	2.1	.2
	25	13	34	39.8	46-14- 4	122-42-11	1.0F	.1	4	2.3	.2
	25	23	18	37.4	47-33-38	122-15-32	26.4	0.0	4	1.9	0.0
	26	4	29	23.1	46-13-20	122-42-22	1.0F	.0	4	2.0	.2
	27	12	18	19.7	46-14- 7	122-13-42	10.0F	.5	4	1.8	.5
	27	16	45	49.1	47-27-56	122-15-50	29.5	.0	5	1.3	.2
	28	11	50	45.6	47-27-29	121-45-28	27.0	.1	6	1.6	.2
	28	18	5	27.8	46-33-42	122- 0- 5	1.0F	.2	5	1.8	.4
	29	8	20	53.0	47-22-32	122-39-54	24.9	.1	7	1.8	.4
	30	14	43	.9	47-51-45	122-16-28	19.0	.1	6	1.8	.4