

# Distribution of EARTHQUAKES

## ACTIVITY ONE

### WHERE IN THE WORLD?

#### RATIONALE

Knowing where earthquakes occur will allow students to formulate theories about what causes earthquakes and why earthquakes occur more commonly in particular locations.

#### FOCUS QUESTIONS

Where have earthquakes been known to occur?

Do earthquakes occur randomly, or mainly in specific areas?

#### OBJECTIVES

##### Students will:

1. Locate and plot the epicenters of earthquakes by latitude and longitude.
2. Recognize a pattern in the distribution of most earthquakes.
3. Postulate how the occurrence of earthquakes may be related to plate tectonic activity.
4. Postulate how deep earthquakes may be related to plate tectonic activity.

#### MATERIALS

- Student copies of Master 3.4a, Earthquakes of the Day, Tables 1-8 (one set of eight, plus extras as needed)
- One copy of Master 3.4b, Notable World Earthquakes, 1900-1992
- Eight copies of Master 3.4c, World Map (2 pages)
- Scissors and transparent tape
- Atlases, globes, or geography textbooks with detailed maps
- Pencils or pens, both black and red
- Four transparencies made from each page of Master 3.4c, World Map

#### VOCABULARY



**Epicenter:** the point on Earth's surface directly above the location (focus) of the earthquake below the surface.

**Focus (pl. foci):** the point within the Earth that is the origin of an earthquake, where stored energy is first released as wave energy.

**Latitude:** the location of a point north or south of the equator, expressed in degrees and minutes. Latitude is shown on a map or globe as east-west lines parallel to the equator.

**Longitude:** the location of a point east or west of the prime meridian, expressed in degrees and minutes. Longitude is shown on a map or globe as north-south lines left and right of the prime meridian, which passes through Greenwich, England.

#### TEACHING CLUES AND CUES



Do not reduce the map to one page. The scale will be too small to be of use.

- Three black transparency markers and three red ones
- Overhead projector
- Student copies of Master 2.2e, World Map Grid (key)

## PROCEDURE

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### Teacher Preparation

Borrow a number of globes and/or atlases in addition to the ones you keep in the classroom, so students can locate cities and countries as they plot latitude and longitude.

### A. Introduction

Briefly review the system of latitude and longitude and how these coordinates are used to pinpoint geographic locations. Ask the students what country or region of the world they think has the largest number of earthquakes in any given year. Note their answers on the chalkboard or on poster paper, but do not comment. Tell them that in this activity they will be working with real earthquake data.

### B. Lesson Development

1. Divide students into eight roughly equal groups. Distribute one of the eight tables in Master 3.4a, Earthquakes of the Day, to each group. Explain that each of the tables lists the earthquakes that occurred around the world on one day; all were recorded on the monthly listing from the U.S. Department of the Interior/U.S. Geological Survey, Preliminary Determinations of Epicenters. Give Master 3.4b, Notable World Earthquakes, to the group with Table I (1/1/90), along with one blank transparency.
2. Give each group a copy of Master 3.4c, World Map. Have students cut and tape the two pages together. Do not reduce to one page. Students in each group may take turns finding the epicenters and marking the maps.
3. Instruct students to distinguish the locations of earthquakes below 40 km from the more common shallow earthquakes by drawing rings around the dots that represent them with the red pencil or pen.
4. Distribute the other three transparency maps and markers to the three groups that complete their work first. Instruct students in each group to transfer the positions on their maps onto the transparency, using the black and red markers as above, and write the dates of the earthquakes depicted on the map. As each group completes its work it may pass the transparency on to another group until all the earthquakes from all nine tables have been recorded on the three transparencies.
5. Instruct the group working with Master 3.4b to plot those earthquakes on their separate transparency and label it.
6. Collect the transparency maps. Stack the three depicting earthquakes of the day (Tables 1-8) on the projector so that they are displayed simultaneously. Then distribute copies of Master 2.2e, the key to the World Map Grid from lesson 2.2.

## TEACHING CLUES AND CUES

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If your class is very large, you may want to give each group more than one copy of the tables and the map so students can work in smaller subgroups.

## TEACHING CLUES AND CUES

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Do not reduce the map to one page. The scale will be too small to be of use.

7. Ask students to compare the world map you have just distributed with the stacked transparencies. Ask:

- Can you detect any relationship between the locations of earthquakes below 40 km and the outlines of Earth's plates? (These earthquakes occur under the continents on the landward side of plate boundaries.)
- Do all the earthquakes occur at or near plate boundaries? (Some earthquakes occur in places that seem unrelated to plate boundaries.)
- Were any of the students correct in judging where earthquakes occur most frequently, at the beginning of class?

8. Ask students to note how earthquakes are distributed among the four geographic areas: north latitude/west longitude, north latitude/east longitude, south latitude/west longitude, and south latitude/east longitude. Ask them to speculate on the reasons for this distribution. (The northeast quadrant has the highest concentration of quakes. The main portion of the Ring of Fire is in this quadrant.)

9. Remind students that the eight tables represent earthquakes that occurred on just eight days. Ask them to count the total number of quakes and estimate how many earthquakes occur each year. (Students should calculate that more than 15,000 significant earthquakes occur each year.)

10. Ask students where the world's most powerful earthquakes have occurred. Record their hypotheses, then place the transparency of Master 3.4b on top of the others as a check. Ask students to predict where major earthquakes will occur in the future.

### C. Conclusion

Sum up in a discussion. Ask the class:

- Are people who live near the boundaries of major tectonic plates the only ones who have to worry about earthquakes? Why or why not? (No. The majority of earthquakes occur along plate boundaries, but some quakes do occur within the plates.) Invite students to speculate about the causes of intraplate earthquakes and faulting.
- Does the amount of damage an earthquake does depend only on its magnitude? (No. Population density, soil conditions, building types, and other factors determine the amount of damage. Students will learn more about these factors in subsequent units.)

## ADAPTATIONS AND EXTENSIONS

1. Obtain copies of Preliminary Determinations of Epicenters and have students plot other kinds of data on fresh copies of the map, such as:
  - a. Earthquakes having magnitudes greater than magnitude 5 for (1) the world; (2) a particular region of the country, or (3) a particular state or local area.
  - b. Earthquakes that have caused the greatest damage or loss of life.

### TEACHING CLUES AND CUES



Don't tell students how to calculate the total; challenge them to find a way. One procedure is for each group to report the numbers on its map (Tables 1 through 8), then for students to add the numbers and average them. The average of 42 quakes a day, multiplied by 365, yields a figure of 15,630.

## ACTIVITY TWO

### THE PLOT THICKENS: PLOTTING EARTHQUAKE FOCI IN THREE DIMENSIONS

#### RATIONALE

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This activity graphically illustrates the patterns in the distribution of earthquake foci in one relatively small area.

#### FOCUS QUESTION

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What would the pattern of earthquakes in one region look like if it could be observed in three dimensions over a period of time?

#### OBJECTIVE

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Students will plot location and depth for one group of earthquakes and observe their relationships.

#### MATERIALS

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*for the teacher*

- One copy of Master 3.4d, Central Japan (2 pages, left and right)
- Stiff cardboard, 30 cm x 60 cm (1 ft. x 2 ft.)
- Phillips screwdriver to punch holes for hanging
- Four pieces of cord or other support (See Teacher Preparation.)
- Glue or transparent tape
- Wall map of Japan or student atlases

*for each small group*

- One copy of Master 3.4d, Central Japan (2 pages, left and right)
- One copy of Master 3.4e, Selected Earthquakes Since 1980, Japan
- Pencils, pens, and metric rulers
- Transparent tape
- Small craft beads such as 12 mm or 8 mm
- Dental floss or other strong, fine string
- Scissors
- One size 8-d nail

#### PROCEDURE

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##### Teacher Preparation

Use a copier to enlarge the two-part map until it can cover most of the cardboard. Glue or tape the map to the top side of the cardboard. Attach cord to the four corners and hang it from the ceiling, or rest it on supports above the floor at a height that will be about eye level for most students. Make standard-size copies of the two-part map for desk use.

#### VOCABULARY

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**Epicenter:** the point on Earth's surface directly above the focus of an earthquake.

**Focus (pl. foci):** the point within the Earth that is the origin of an earthquake, where strain energy is first released as wave energy.

**Magnitude:** a number that characterizes the size of an earthquake by recording ground shaking on a seismograph and correcting for the distance to the epicenter of the earthquake. Magnitude is expressed in Arabic numbers.

## A. Introduction

Tell students that earthquakes occur in many locations and at different depths. The study of earthquakes has provided most of what we now know about the Earth's structure. The patterns of their locations provided much of the evidence that led geologists to hypothesize the existence of plates.

## B. Lesson Development

1. Divide the class into the same groups as for Activity One of this lesson. Give each group one copy of Master 3.4d, Central Japan (two pages, left and right) and Master 3.4e, Selected Earthquakes Since 1980, Japan. Instruct students to cut the left page of Master 3.4d along the dotted line and tape it to the right page.

2. Divide the list of earthquakes into as many equal sections as you have student groups, and assign one section to each group. It is not necessary to use all the earthquakes. (If you have eight groups, each will be responsible for 10 quakes.) Instruct students to begin plotting their assigned quakes from Master 3.4e on the map of Japan by latitude and longitude, then mark each epicenter with its reference number, depth, and magnitude. Point out that 10 small squares on their maps represent one degree of longitude and one degree of latitude.

3. When the first group has located all the quakes on its own section of the list, it can transfer those locations to the hanging map. Other groups can follow as they complete their sections. Give these instructions for transferring data to the hanging map:

a. For each earthquake, take two beads of the same color. Use one bead to represent the epicenter of each quake and the other bead to represent its focus.

b. Locate the latitude and longitude of the first quake on the hanging map. Mark its epicenter and punch a hole all the way through the cardboard with the nail. Thread dental floss through the small bead and tie a knot to hold the bead at the correct location. Calculate the distance below the map at which the large ball will be hung (the depth of the focus) by letting 1 cm stand for 5 km. The bead representing earthquake #1 will hang 2 cm below its epicenter. Tie knots to hold the beads in place.

c. Repeat this procedure until all the quakes have been plotted on the map. When students have finished, invite them to view this 3-D plot from many directions.

4. Ask:

- What pattern do you see? Where do the earthquakes concentrate? (on the lower right)
- What do you think is happening to the Earth's crust in this area? (Old crust is being broken off and pushed under the edges of the plate, in the process geologists call subduction.)

## TEACHING CLUES AND CUES



Deep-focus earthquakes produce seismograms very different from those produced by shallow-focus earthquakes. EPIC and some of the other non-print media sources listed in the resources for Units 2 and 3 can provide examples of both for you to show your students.

### C. Conclusion

Call students' attention to the atlas or wall map of Japan. Ask them if they view the map differently now that they can see what it represents in three dimensions. What kind of information would clarify their view further?

## ACTIVITY THREE

### WHERE IN NORTH AMERICA?

#### RATIONALE

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By plotting earthquake epicenters on a map, students will learn where earthquakes occur on the North American continent and that they can occur almost anywhere.

#### FOCUS QUESTIONS

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Where in North America do earthquakes occur?

How often do earthquakes occur in specific locations on the North American continent?

#### OBJECTIVES

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##### Students will:

1. Interpret data tables and plot locations on a map.
2. Discover that most areas are prone to earthquakes.

#### MATERIALS

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- Master 3.4f, North American Epicenters, 1990
- Classroom wall map of North America or transparency made from Master 3.4g, Map of North America
- Overhead projector
- Transparency markers in red, green, and blue
- Three transparencies made from Master 3.4g, Map of North America

*for each small group*

- Student copies of Master 3.4g, Map of North America
- One strip of earthquake epicenters cut from Master 3.4f
- Pencils or pens

#### PROCEDURE

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##### Teacher Preparation

Make a copy of Master 3.4f. Cut it into as many horizontal sections as you have groups, dividing the list of epicenters so each group has approximately the same number of earthquakes to plot.

## A. Introduction

From the other activities in this lesson, students have discovered where earthquakes occur worldwide and how seismologists locate them. Ask the class where earthquakes occur on the North American continent. Most of them will probably name California. Accept this, but try to elicit other locations as well. Some may be aware of the New Madrid, Missouri, earthquakes in the 19th century, or of other earthquakes close to home.

Remind students that earthquakes sometimes occur where volcanoes are present. Ask: Where on the North American Continent are volcanoes found? Students will probably identify the western United States. Tell them that at one time volcanoes erupted in the eastern part of the continent. The famous Palisades, a line of steep cliffs along the Hudson River in New York and New Jersey, were caused by volcanic activity. Tell students that in this activity they will use selected data from the U.S. Geological Survey to plot the locations of earthquakes of magnitude 4 or larger that occurred during 1990 on the North American continent.

## B. Lesson Development

1. Divide the class into groups of three or four students each.
2. Distribute copies of Master 3.4g, the blank map, and the epicenter strips. Review latitude and longitude if necessary.
3. Have students plot the locations of the epicenters on their maps. Give these directions:
  - a. As you locate each point, mark it with a small dot. Then write the depth and magnitude of the earthquake next to it in small numbers.
  - b. When you finish, transfer your data to one of the three transparencies of Master 3.4g, using the colored pens to code for magnitude. Green will represent magnitude 4, blue magnitude 5, and red magnitude 6 or greater. Mark each earthquake with an X in the appropriate color.
4. When all the data have been plotted, stack the transparencies on the overhead so you can display them simultaneously. Ask students to comment on the pattern they observe, and compare it with their findings in Activity One. Do they see a similar pattern? They should see once again that earthquakes occur primarily near plate boundaries (for the U.S., on the west coast) but are not limited to those areas. Is there a pattern to the depth of the earthquakes? (The deepest quakes occur at plate margins under continents. This pattern may not be evident in this data.)

## C. Conclusion

Remind students that these data are for one year only, and only for earthquakes of magnitude 4 or greater. Have them discuss what they would need to prepare an earthquake risk map for building codes or insurance rates. (The obvious answer will be more data, but point out to students some of the things they have already learned about

## TEACHING CLUES AND CUES



In the EPIC Data Base, times are given in 24-hour Universal Time (UT) and carried out to eight places—210117.90, for example, which would be approximately 9:01 pm. In Master 3.4f they have been shortened to four places (2101).

earthquakes, such as how waves travel through the Earth, and tell them that in later lessons they will learn about engineering to improve structural resistance to earthquakes.)

## **ADAPTATIONS AND EXTENSIONS**

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1. Obtain a copy of the EPIC software (free demonstration files are available) or the EPIC CD-ROM, and have students research earthquakes of different magnitudes and different locations. See the unit resource list.
2. Have students contact the National Earthquake Information Center (NEIC) and report back to class on data and services available. See the Unit 2 resource list.
3. Have students contact the Incorporated Research Institutions for Seismology (IRIS) and report back to class on data and services available. See the Unit 2 resource list.
4. The NEIC and IRIS maintain remote bulletin boards. Have students find out how to access them and research earthquakes. ▲



**Table 1. Earthquakes That Occurred on January 1, 1990  
as listed in "Preliminary Determinations of Epicenters," USGS-NEIC**

Time*	Latitude	Longitude	Depth (in km)	Magnitude**	Location
<b>North Latitudes and West Longitudes</b>					
0:22	62 N	150 W	39	2.9	Southern Alaska
1:10	16 N	63 W	33	3.6	Leeward Islands
13:22	37 N	122 W	15	2.6	California
18:03	7 N	73 W	158	5.3	Colombia
22:59	33 N	115 W	4	3.2	California/Mexico
23:17	38 N	119 W	11	3.1	California
23:29	52 N	179 W	33	4.4	Aleutian Islands
<b>North Latitudes and East Longitudes</b>					
2:47	36 N	27 E	145	3.3	Dodecanese Islands
3:25	44 N	7 E	10	1.6	Northern Italy
6:34	42 N	19 E	10	3.3	Albania
9:03	36 N	141 E	68	4.8	East coast, Honshu Japan
9:30	40 N	29 E	10	—	Turkey
16:20	43 N	13 E	10	—	Italy
16:38	47 N	10 E	5	3.1	Switzerland
17:13	50 N	174 E	33	4.6	Aleutian Islands
18:19	45 N	7 E	10	2.3	Italy
18:25	44 N	9 E	10	—	Italy
18:36	35 N	51 E	10	—	Iran
18:46	44 N	8 E	10	1.7	Italy
19:04	40 N	29 E	5	—	Turkey
19:50	44 N	7 E	10	1.7	Italy
<b>South Latitudes and West Longitudes</b>					
7:49	22 S	179 W	600	5.2	Fiji Islands region
9:38	24 S	180 W	541	4.8	South of Fiji Islands
19:31	33 S	72 W	10	—	Off coast, Chile
<b>South Latitudes and East Longitudes</b>					
14:10	9 S	107 E	32	4.7	South of Java
14:49	11 S	161 E	37	5.2	Solomon Islands
16:07	7 S	125 E	527	5.2	Banda Sea
17:21	19 S	167 E	10	5.2	New Hebrides

\*Greenwich time.

\*\*Value is the maximum magnitude determined for the event. A dash indicates that data were not available.

**Table 2. Earthquakes That Occurred on January 2, 1990**  
as listed in "Preliminary Determinations of Epicenters," USGS-NEIC

Time*	Latitude	Longitude	Depth (in km)	Magnitude**	Location
<b>North Latitudes and West Longitudes</b>					
6:30	43 N	1 W	10	1.0	Pyrenees
8:01	37 N	122 W	10	2.5	California
9:50	34 N	117 W	13	3.4	California
11:41	63 N	150 W	109	—	Alaska
12:13	61 N	146 W	32	—	Alaska
12:54	62 N	151 W	55	—	Alaska
13:50	43 N	1 W	10	1.2	Pyrenees
17:45	37 N	115 W	5	3.1	Nevada
22:09	46 N	111 W	1	3.7	Montana
<b>North Latitudes and East Longitudes</b>					
0:15	44 N	7 E	10	1.6	Italy
1:25	8 N	127 E	41	5.4	Philippine Islands
4:10	45 N	7 E	10	1.6	Italy
6:26	23 N	121 E	10	—	Taiwan
8:23	40 N	27 E	10	—	Turkey
13:23	36 N	146 E	33	—	Off coast, Honshu Japan
15:20	8 N	127 E	69	4.4	Philippine Islands
16:26	45 N	146 E	73	4.6	Kuril Islands
16:44	44 N	7 E	10	1.9	France
17:50	39 N	28 E	10	—	Turkey
18:50	48 N	17 E	10	2.1	Austria
20:21	13 N	144 E	136	5.7	Mariana Islands
20:35	39 N	24 E	10	4.6	Aegean Sea
20:43	44 N	7 E	10	1.7	Italy
21:03	39 N	24 E	10	—	Greece
21:38	41 N	79 E	10	4.9	Xinjiand, China
21:46	36 N	27 E	5	3.6	Dodecanese Islands
22:36	44 N	7 E	10	1.7	Italy
22:54	43 N	28 E	13	—	Bulgaria
22:57	44 N	7 E	10	1.7	Italy
23:24	37 N	26 E	26	4.4	Dodecanese Islands
<b>South Latitudes and West Longitudes</b>					
2:19	22 S	13 W	10	4.7	Atlantic Ridge
6:44	25 S	70 W	33	—	Chile
12:14	31 S	69 W	10	—	Argentina
20:51	33 S	72 W	10	4.7	Off coast, Chile
<b>South Latitudes and East Longitudes</b>					
1:36	38 S	175 E	249	—	New Zealand
2:27	12 S	122 E	33	4.1	Sulu Sea
4:33	3 S	146 E	33	4.6	Bismarck Sea
7:02	19 S	169 E	243	4.7	New Hebrides
7:36	11 S	166 E	140	4.7	Santa Cruz Islands
8:22	6 S	146 E	33	5.1	Near Papua, New Guinea
15:34	3 S	129 E	33	4.7	Ceram Sea
21:38	3 S	128 E	34	5.4	Ceram Sea

\*Greenwich time.

\*\*Value is the maximum magnitude determined for the event. A dash indicates that data were not available.

**Table 3. Earthquakes That Occurred on January 1, 1991**  
as listed in "Preliminary Determinations of Epicenters," USGS-NEIC

Time*	Latitude	Longitude	Depth (in km)	Magnitude**	Location
<b>North Latitudes and West Longitudes</b>					
0:06	18 N	106 W	35	6.6	Off coast, Mexico
2:19	18 N	106 W	33	5.0	Off coast, Mexico
3:19	18 N	106 W	36	5.9	Off coast, Mexico
10:28	39 N	120 W	12	3.4	California/Nevada
15:50	55 N	158 W	33	5.2	Alaska
16:59	61 N	152 W	97	—	Alaska
17:21	4 N	76 W	97	3.5	Colombia
19:49	4 N	76 W	10	2.6	Colombia
<b>North Latitudes and East Longitudes</b>					
0:11	35 N	28 E	42	4.9	Dodecanese Islands
3:51	43 N	19 E	10	4.0	Yugoslavia
4:18	40 N	24 E	10	—	Greece
4:50	29 N	139 E	402	4.4	South Honshu, Japan
5:53	44 N	19 E	13	2.8	Yugoslavia
7:29	48 N	8 E	10	2.6	Switzerland
7:30	41 N	23 E	10	—	Greece
8:25	38 N	22 E	10	2.8	Greece
9:26	38 N	22 E	19	2.8	Greece
10:42	23 N	144 E	25	5.2	Volcano Islands
12:01	43 N	19 E	10	2.0	Yugoslavia
12:06	36 N	141 E	58	5.1	Off coast, Honshu, Japan
12:14	1 N	126 E	78	4.4	Molucca Passage
14:03	39 N	15 E	28	—	Adriatic Sea
14:25	43 N	19 E	10	2.2	Yugoslavia
16:31	37 N	30 E	10	—	Turkey
17:43	43 N	22 E	10	2.1	Yugoslavia
19:18	43 N	22 E	10	1.9	Yugoslavia
19:18	40 N	48 E	61	4.9	Iran—Northern border
19:28	48 N	8 E	10	2.2	Switzerland
19:55	41 N	23 E	10	1.8	Macedonia
19:55	40 N	29 E	10	2.8	Turkey
20:40	5 N	96 E	66	4.6	Sumatra
23:57	37 N	71 E	33	4.2	Afghanistan—N.W. border
<b>South Latitudes and West Longitudes</b>					
2:03	10 S	78 W	33	4.2	Off coast, Peru
8:27	29 S	70 W	121	4.9	Chile/Argentina
11:15	15 S	172 W	33	4.9	Samoa Islands
16:42	17 S	69 W	188	4.4	Peru/Bolivia
17:28	21 S	174 W	29	5.7	Tonga Islands
20:40	20 S	177 W	487	5.1	Fiji Islands
<b>South Latitudes and East Longitudes</b>					
3:03	19 S	134 E	10	—	Australia
5:09	7 S	156 E	41	4.9	Solomon Islands
14:10	17 S	177 E	33	4.4	Fiji Islands
21:37	3 S	38 E	10	4.2	Kenya

\*Greenwich time.

\*\*Value is the maximum magnitude determined for the event. A dash indicates that data were not available.

Table 4. Earthquakes That Occurred on January 2, 1991 as listed in "Preliminary Determinations of Epicenters," USGS-NEIC

Time*	Latitude	Longitude	Depth (in km)	Magnitude**	Location
<b>North Latitudes and West Longitudes</b>					
1:27	4 N	76 W	33	3.1	Colombia
1:42	3 N	75 W	33	3.7	Colombia
5:31	37 N	119 W	2	3.1	California/Nevada
5:37	14 N	93 W	59	4.8	Off coast, Mexico
8:30	6 N	74 W	10	—	Colombia
10:16	59 N	137 W	9	—	Alaska
12:07	39 N	120 W	7	3.5	Nevada
12:16	39 N	120 W	2	2.3	Nevada
12:26	39 N	120 W	8	3.4	Nevada
12:46	39 N	120 W	6	3.4	Nevada
14:38	4 N	77 W	33	3.1	Coast of Colombia
16:29	39 N	120 W	3	3.8	Nevada
16:59	62 N	150 W	41	—	Alaska
17:21	4 N	76 W	10	4.2	Colombia
19:49	4 N	76 W	110	2.8	Colombia
21:02	3 N	80 W	33	2.1	Galapagos Islands
21:17	4 N	76 W	10	2.7	Colombia
22:19	66 N	26 W	10	4.9	Iceland
23:16	39 N	120 W	6	4.7	Nevada
23:23	37 N	4 W	10	2.4	Spain
23:44	39 N	120 W	10	3.5	Nevada
<b>North Latitudes and East Longitudes</b>					
0:13	43 N	29 E	10	—	Black Sea
1:08	40 N	20 E	10	2.9	Greece/Albania
1:34	59 N	161 E	33	4.5	Coast, Kamchatka
2:48	53 N	161 E	33	4.5	Coast, Kamchatka
2:58	38 N	100 E	13	5.1	Qinghai, China
5:37	43 N	21 E	10	2.4	Yugoslavia
7:17	30 N	21 E	5	3.5	Greece
8:37	48 N	155 E	33	4.4	Kuril Islands
9:35	40 N	29 E	10	2.7	Turkey
12:16	41 N	22 E	10	—	Greece
12:51	43 N	6 E	10	2.8	France
12:59	41 N	23 E	10	—	Greece
14:02	40 N	28 E	10	2.8	Turkey
14:04	41 N	22 E	10	—	Albania
15:48	40 N	29 E	10	2.7	Turkey
18:48	46 N	3 E	10	2.2	France
20:29	45 N	1 E	10	3.0	France
23:16	39 N	24 E	10	2.8	Aegean Sea
23:19	24 N	121 E	10	3.6	Taiwan
<b>South Latitudes and West Longitudes</b>					
1:48	22 S	69 W	33	—	Chile/Bolivia
4:54	18 S	79 W	115	—	Coast of Chile
15:16	23 S	66 W	10	—	Argentina
16:58	20 S	71 W	46	5.0	Coast of Chile
18:30	34 S	179 W	33	4.7	Kermadec Islands
<b>South Latitudes and East Longitudes</b>					
3:50	11 S	167 E	33	5.0	Santa Cruz

\*Greenwich time.

\*\*Value is the maximum magnitude determined for the event. A dash indicates that data were not available.

**Table 5. Earthquakes That Occurred on January 1, 1992**  
as listed in "Preliminary Determinations of Epicenters," USGS-NEIC

Time*	Latitude	Longitude	Depth (in km)	Magnitude**	Location
<b>North Latitudes and West Longitudes</b>					
1:11	41 N	124 W	5	3.0	California
5:35	20 N	70 W	33	—	Dominican Republic
9:09	35 N	118 W	10	3.2	California
13:43	60 N	154 W	168	3.4	Alaska
14:28	37 N	119 W	5	2.9	California/Nevada
16:44	16 N	61 W	33	2.8	Leeward Islands
17:03	36 N	118 W	5	3.0	California
17:10	38 N	4 W	10	2.9	Spain
19:15	15 N	92 W	10	—	Mexico/Guatemala
20:39	60 N	153 W	101	—	Alaska
21:11	13 N	90 W	33	—	Off El Salvador
22:30	71 N	8 W	10	4.2	Jan Meyer Islands
23:46	18 N	99 W	10	—	Mexico
23:55	39 N	1 W	5	2.7	Spain
<b>North Latitudes and East Longitudes</b>					
0:50	45 N	7 E	10	2.1	Italy
5:54	54 N	159 E	92	4.3	Kamchatka
7:47	45 N	151 E	29	4.9	Kuril Islands
8:00	43 N	18 E	10	2.6	NW Balkan region
8:03	68 N	15 E	10	3.6	Norway
8:13	45 N	152 E	33	4.7	East of Kuril Islands
8:38	68 N	15 E	10	2.6	Norway
8:41	43 N	13 E	10	—	Italy
10:07	43 N	19 E	10	1.9	NW Balkan region
10:12	45 N	10 E	10	3.4	Italy
10:15	68 N	15 E	10	2.5	Norway
10:30	42 N	19 E	10	1.2	NW Balkan region
11:28	43 N	2 E	10	3.2	Pyrenees
11:38	45 N	10 E	10	—	Italy
14:45	42 N	20 E	5	2.2	NW Balkan region
15:18	43 N	18 E	8	4.3	NW Balkan region
16:34	38 N	7 E	10	3.9	Mediterranean Sea
16:38	14 N	96 E	33	4.1	Near Andaman Islands
16:40	44 N	10 E	10	2.7	Italy
17:32	41 N	24 E	5	—	Greece
21:23	45 N	11 E	18	2.6	Italy
21:35	43 N	19 E	10	1.7	NW Balkan region
21:46	26 N	100 E	33	4.4	Yunnan, China
22:01	43 N	18 E	5	2.4	NW Balkans
<b>South Latitudes and West Longitudes</b>					
3:32	34 S	71 W	70	3.4	Chile/Argentina
5:38	19 S	69 W	106	4.9	Chile
11:04	34 S	71 W	33	3.2	Chile
17:49	34 S	72 W	10	3.4	Chile
19:45	24 S	174 W	33	4.5	Tonga Islands
22:46	23 S	179 W	600	4.4	So. of Fiji Islands
23:43	22 S	178 W	366	4.9	So. of Fiji Islands
<b>South Latitudes and East Longitudes</b>					
15:30	8 S	155 E	370	4.4	Solomon Islands

\*Greenwich time.

\*\*Value is the maximum magnitude determined for the event. A dash indicates that data were not available.

**Table 6. Earthquakes That Occurred on January 2, 1992  
as listed in "Preliminary Determinations of Epicenters," USGS-NEIC**

Time*	Latitude	Longitude	Depth (in km)	Magnitude**	Location
<b>North Latitudes and West Longitudes</b>					
0:05	54 N	161 W	33	4.6	Alaska
6:10	18 N	61 W	10	3.4	Leeward Islands
7:42	35 N	119 W	10	2.3	California
11:41	62 N	150 W	45	3.1	Alaska
11:45	33 N	105 W	5	5.0	New Mexico
13:32	11 N	63 W	109	4.4	Venezuela
14:13	65 N	134 W	10	3.8	Yukon
16:05	62 N	146 W	34	3.1	Alaska
16:40	49 N	129 W	10	6.0	West of Vancouver Island
18:12	16 N	61 W	55	4.4	Leeward Islands
19:16	11 N	64 W	33	3.9	Coast of Venezuela
19:41	6 N	74 W	134	5.8	Colombia
21:29	16 N	60 W	22	2.9	Leeward Islands
22:09	49 N	129 W	10	3.9	West of Vancouver Island
<b>North Latitudes and East Longitudes</b>					
0:05	51 N	98 E	45	4.7	Russia/Mongolia
2:15	44 N	6 E	7	3.0	France
2:35	34 N	89 E	33	4.8	Tibet/China
4:07	51 N	98 E	32	4.7	Russia/Mongolia
5:28	51 N	98 E	33	—	Russia/Mongolia
5:37	41 N	71 E	33	5.2	Tajkistan
5:50	41 N	72 E	33	4.5	Kyrgyzstan
6:09	46 N	2 E	10	1.4	France
6:36	37 N	29 E	10	—	Turkey
8:09	41 N	20 E	5	2.9	Albania
10:20	46 N	27 E	137	—	Romania
10:49	45 N	152 E	33	4.7	East of Kuril Islands
12:30	45 N	10 E	25	3.5	Italy
12:59	51 N	98 E	33	4.6	Russia/Mongolia
13:44	45 N	10 E	27	3.5	Italy
17:06	35 N	27 E	63	3.9	Crete
19:59	13 N	125 E	33	4.9	Philippine Islands
21:17	0 N	122 E	167	4.7	Celebes
22:06	50 N	98 E	33	—	Russia/Mongolia
23:13	45 N	146 E	110	4.5	Kuril Islands
23:55	39 N	1 E	10	—	Spain
<b>South Latitudes and West Longitudes</b>					
1:47	34 S	70 W	10	4.3	Chile/Argentina
4:25	33 S	71 W	10	3.3	Chile
23:21	27 S	68 W	33	—	Chile/Argentina
<b>South Latitudes and East Longitudes</b>					
3:28	6 S	150 E	59	4.4	New Britain
4:49	7 S	151 E	51	4.8	New Britain
6:17	9 S	150 E	33	4.1	New Guinea
7:41	6 S	150 E	33	4.3	New Britain
22:17	22 S	180 E	673	4.6	So. of Fiji Islands
23:33	32 S	111 E	33	—	West of Australia
23:37	38 S	176 E	238	—	New Zealand

\*Greenwich time.

\*\*Value is the maximum magnitude determined for the event. A dash indicates that data were not available.

**Table 7. Earthquakes That Occurred on January 1, 1993  
as listed in "Preliminary Determinations of Epicenters," USGS-NEIC**

Time*	Latitude	Longitude	Depth (in km)	Magnitude**	Location
<b>North Latitudes and West Longitudes</b>					
2:09	36 N	5 W	10	2.9	Strait of Gibraltar
4:12	60 N	153 W	10	3.1	Alaska
5:08	36 N	82 W	4	3.0	North Carolina
5:36	31 N	114 W	10	3.6	Gulf of California
6:07	18 N	64 W	10	4.0	Virgin Islands
14:55	64 N	149 W	6	2.8	Alaska
15:57	48 N	112 W	5	3.4	Montana
<b>North Latitudes and East Longitudes</b>					
1:35	39 N	29 E	10	2.7	Turkey
2:05	39 N	29 E	10	2.8	Turkey
2:23	4 N	126 E	86	4.4	Talaud Islands
4:18	39 N	22 E	10	—	Greece
4:30	53 N	158 E	170	4.2	Kamchatka
5:35	38 N	15 E	10	—	Sicily
5:40	43 N	6 E	10	2.4	Coast of France
5:43	44 N	8 E	10	—	Italy
7:30	39 N	29 E	10	2.8	Turkey
8:19	39 N	143 E	37	4.7	Coast of Japan
14:25	38 N	27 E	10	3.1	Turkey
16:11	42 N	20 E	10	2.7	Albania
18:46	42 N	14 E	10	3.8	Italy
19:16	45 N	7 E	10	2.0	Italy
20:49	38 N	27 E	10	3.1	Aegean Sea
21:00	43 N	5 E	10	3.6	Coast of France
21:26	3 N	122 E	536	4.4	Celebes Sea
21:46	35 N	33 E	13	3.4	Cyprus region
23:49	23 N	95 E	96	4.3	India/Myanmar
<b>South Latitudes and West Longitudes</b>					
3:46	32 S	178 W	33	5.1	Kermadec Islands
4:02	32 S	68 W	100	—	Argentina
4:34	31 S	179 W	48	4.7	Kermadec Islands
5:48	28 S	177 W	65	4.7	Kermadec Islands
8:26	33 S	176 W	33	4.7	So. of Kermadec Islands
9:17	32 S	69 W	120	3.5	Argentina
9:56	32 S	72 W	27	5.4	Chile
10:06	36 S	74 W	100	4.0	Chile
13:09	25 S	178 W	203	5.2	So. of Fiji Islands
17:29	31 S	68 W	10	—	Argentina
<b>South Latitudes and East Longitudes</b>					
2:56	26 S	28 E	5	2.5	Rep. of So. Africa
5:00	7 S	128 E	33	—	Banda Sea
5:19	7 S	131 E	68	4.6	Banda Sea
6:24	6 S	147 E	74	4.7	New Guinea
8:58	7 S	144 E	23	5.2	New Guinea
10:56	7 S	132 E	122	—	Indonesia
12:35	39 S	177 E	59	4.4	New Zealand
12:48	38 S	179 E	182	—	New Zealand
21:36	67 S	164 E	10	5.6	Balleny Islands

\*Greenwich time.

\*\*Value is the maximum magnitude determined for the event. A dash indicates that data were not available.

**Table 8. Earthquakes That Occurred on January 2, 1993**  
as listed in "Preliminary Determinations of Epicenters," USGS-NEIC

Time*	Latitude	Longitude	Depth (in km)	Magnitude**	Location
<b>North Latitudes and West Longitudes</b>					
1:57	7 N	76 W	24	4.5	Colombia
2:39	7 N	80 W	10	4.3	So. of Panama
5:45	19 N	67 W	19	—	Mona Passage
6:03	18 N	66 W	70	—	Puerto Rico
6:39	45 N	111 W	5	3.5	Yellowstone, WY
6:44	10 N	83 W	10	3.8	Panama/Costa Rica
7:09	61 N	150 W	41	2.5	Alaska
8:54	62 N	151 W	72	—	Alaska
9:49	60 N	153 W	122	—	Alaska
14:32	39 N	124 W	3	3.1	California
<b>North Latitudes and East Longitudes</b>					
1:48	39 N	29 E	10	3.1	Turkey
2:32	39 N	29 E	10	2.6	Turkey
3:42	31 N	50 E	33	4.3	Iran
7:55	44 N	6 E	10	2.2	Coast of France
8:39	30 N	51 E	36	4.7	Iran
14:53	29 N	81 E	15	4.9	Nepal
15:10	34 N	142 E	44	4.6	Coast of Japan
17:45	37 N	24 E	33	3.3	Greece
22:09	46 N	3 E	10	1.9	France
22:38	41 N	23 E	10	—	Greece
<b>South Latitudes and West Longitudes</b>					
3:09	31 S	69 W	132	—	Chile/Argentina
4:04	30 S	177 W	10	4.9	Kermadec Islands
6:15	33 S	71 W	80	3.1	Chile/Argentina
11:35	34 S	71 W	33	4.2	Chile
13:40	34 S	71 W	60	3.3	Chile
14:31	33 S	72 W	25	3.4	Chile
15:00	33 S	72 W	10	3.1	Chile
16:24	33 S	71 W	33	3.5	Chile
17:48	29 S	67 W	161	—	Argentina
<b>South Latitudes and East Longitudes</b>					
1:07	38 S	176 E	253	—	New Zealand
4:55	9 S	121 E	84	4.5	Savu Sea
6:29	40 S	86 E	10	5.5	SE Indian Ridge
9:30	7 S	129 E	173	3.8	Banda Sea
9:49	9 S	123 E	150	4.3	Indonesia
11:12	39 S	176 E	142	—	New Zealand
12:32	38 S	176 E	224	5.0	New Zealand
17:56	6 S	151 E	54	4.1	New Britain
19:01	7 S	130 E	33	—	Banda Sea
19:29	39 S	175 E	249	—	New Zealand

\*Greenwich time.

\*\*Value is the maximum magnitude determined for the event. A dash indicates that data were not available.





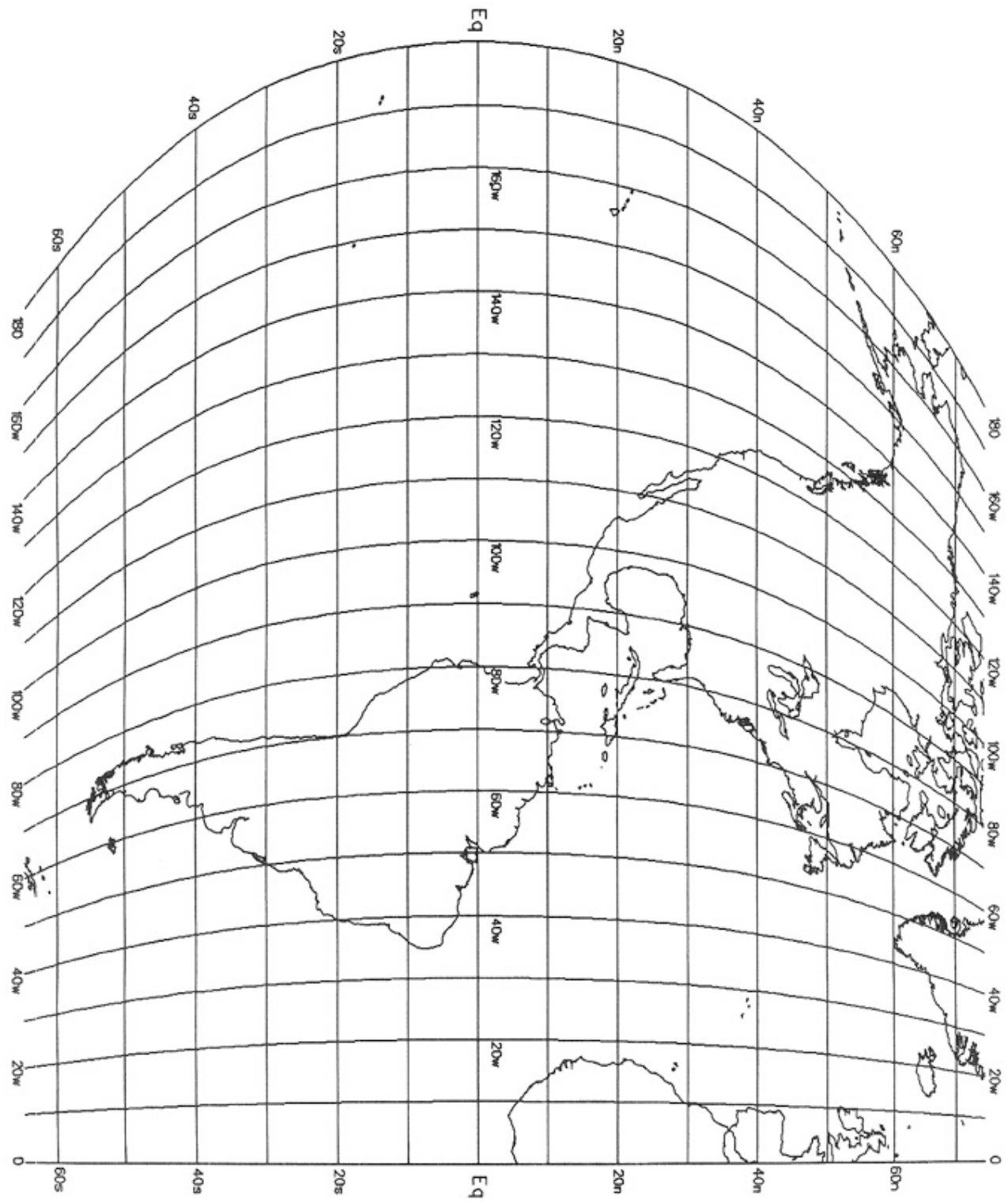
# Notable World Earthquakes 1900 – 1992\*

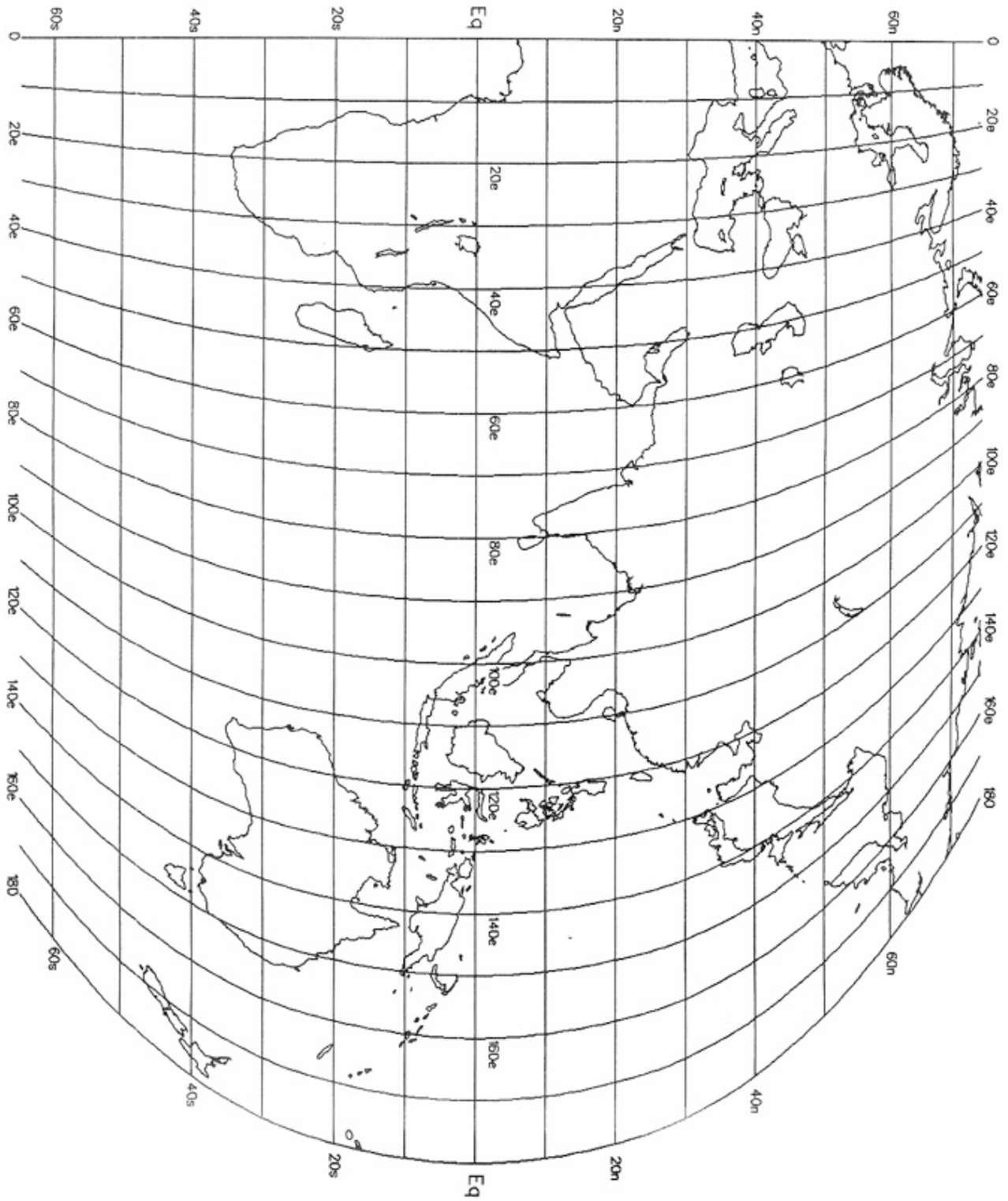
Time	Latitude	Longitude	Depth (in km)**	Magnitude	Location	Deaths
<b>North Latitudes and West Longitudes</b>						
4/18/06	38 N	123 W	—	8.3	San Francisco, CA	700
2/29/60	30 N	10 W	—	5.9	Morocco	14,000
3/28/64	61 N	148 W	33	8.5	Alaska	131
2/9/71	34 N	118 W	13	6.7	San Fernando, CA	65
12/23/72	12 N	86 N	5	6.2	Nicaragua	5,000
2/4/76	15 N	89 W	5	7.5	Guatemala	22,000
9/19/85	18 N	103 W	—	8.1	Mexico	9,500
10/10/86	14 N	89 W	8	5.4	El Salvador	1,000
3/6/87	0 N	78 W	33	6.9	Ecuador	1,000
10/18/89	37 N	122 W	19	7.1	Loma Prieta, CA	63
6/28/92	34 N	117 W	—	7.1	Landers, CA	1
<b>North Latitudes and West Longitudes</b>						
12/28/08	38 N	15 E	—	7.5	Messina, Italy	120,000
1/13/15	42 N	13 E	—	7.5	Central Italy	30,000
12/16/20	37 N	106 E	—	8.5	China	180,000
9/1/23	35 N	140 E	—	8.2	Kwario, Japan	143,000
12/25/32	40 N	97 E	—	7.6	China	
12/26/39	40 N	40 E	—	8.0	Turkey	23,000
6/28/48	36 N	136 E	20	7.3	Honshu, Japan	5,121
9/1/62	36 N	50 E	20	7.3	Iran	14,000
7/26/63	42 N	22 E	5	6.0	Macedonia	1,200
8/31/68	34 N	59 E	13	7.3	Iran	11,600
2/4/75	41 N	123 E	33	7.4	China	“Few”
5/6/76	46 N	13 E	9	6.5	Italy	
7/14/76	40 N	118 E	23	7.8	Tangshan, China	250,000
3/3/77	46 N	27 E	94	7.2	Romania	2,000
10/10/80	36 N	1 E	10	7.4	Algeria	
11/23/80	41 N	15 E	10	6.9	Italy	3,000
6/11/81	30 N	58 E	33	6.9	Iran	3,000
7/28/81	30 N	58 E	33	7.3	Iran	1,500
5/28/83	41 N	139 E	24	7.8	Japan	107
10/30/83	40 N	42 E	33	6.9	Turkey	1,342
8/20/88	27 N	87 E	71	6.6	Nepal	1,450
11/6/88	23 N	100 E	10	7.6	Burma	730
12/7/88	41 N	44 E	10	6.8	Armenia	25,000
6/20/90	38 N	50 E	10	7.6	Iran	<40,000
7/16/90	16 N	121 E	36	7.7	Philippines	1,700
<b>South Latitudes and West Longitudes</b>						
1/25/39	36 S	72 W	60	8.3	Chillan, Chile	30,000
8/6/49	2 S	78 W	60	6.8	Ecuador	6,000
5/22/60	40 S	73 W	—	8.5	Chile	5,700
5/31/70	9 S	79 W	43	7.8	Peru	66,000
12/12/79	2 S	79 W	32	7.9	Ecuador	600
3/3/85	33 S	72 W	—	7.8	Chile	177
<b>South Latitudes and East Longitudes</b>						
8/5/49	2 S	119 E	3	8.0	Indonesia	3
8/1/89	5 S	139 E	33	5.9	New Guinea	90
12/27/89	33 S	152 E	15	5.4	Australia	13

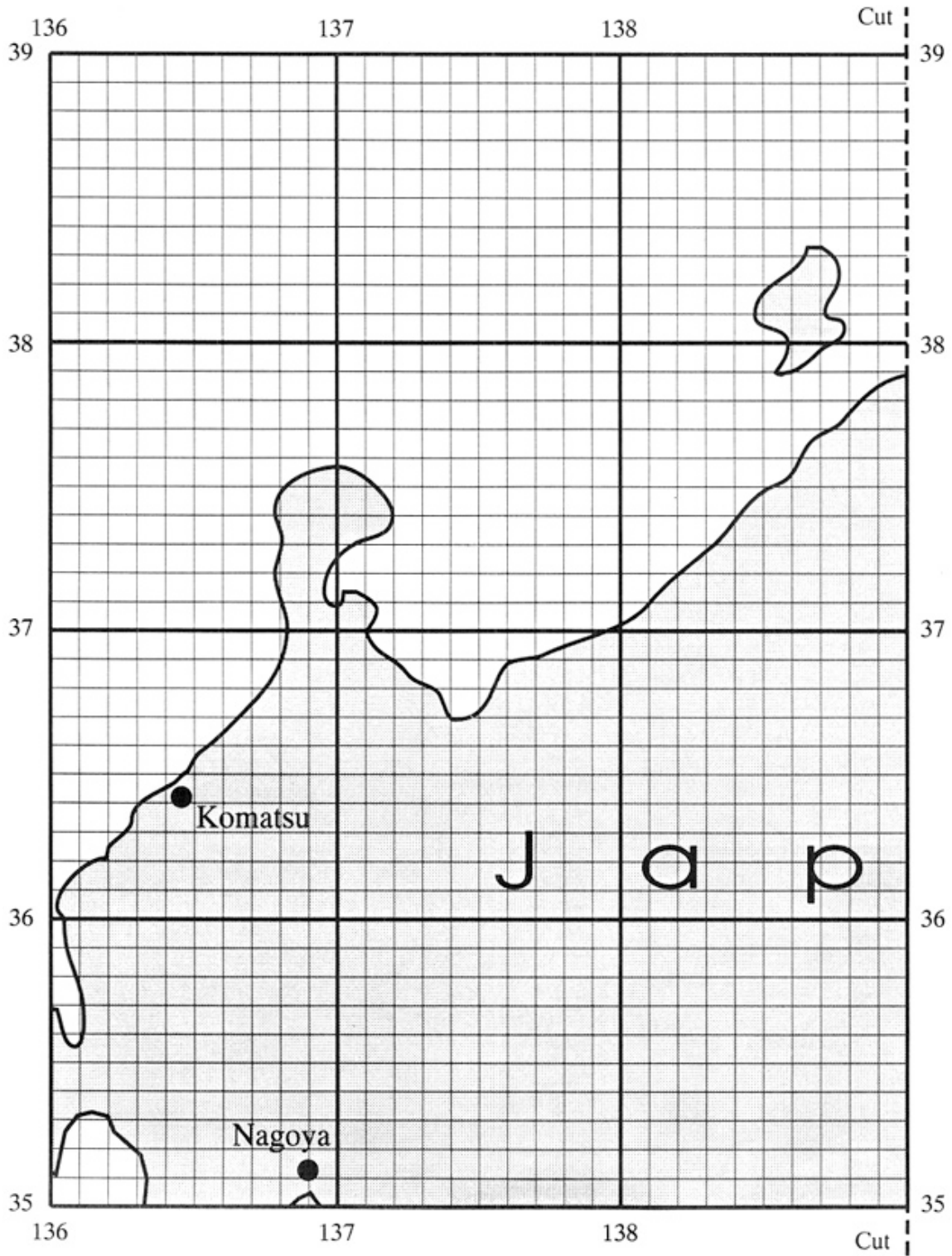
\*From Bolt, 1993, and “Catalog of Significant Earthquakes 2000 B.C.-1990,” a NOAA publication in preparation.

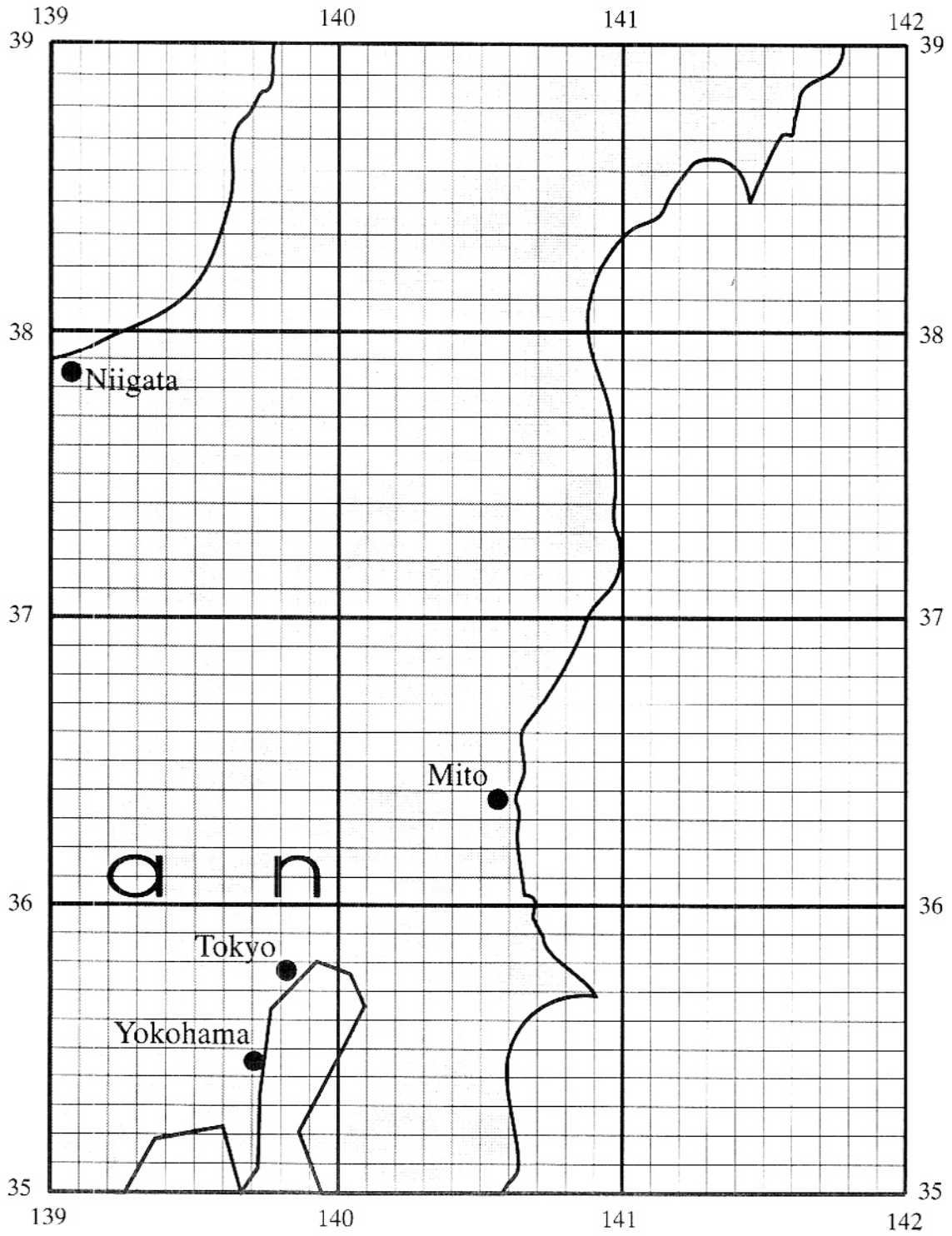
\*\*Where data are lacking, assume earthquakes were shallow.













# Selected EARTHQUAKES

## Since 1980, Japan

This is a listing of events of Magnitude 5 which occurred in the polygon bounded by 34N 144E, 38N 134E, 39N 136E, and 35N 146E, centered around Tokyo, Japan. Data are from 1980 to 1993. Use the reference number in the first column (under the heading Evt. for Event) to mark the location of each earthquake on your map.

Evt	Mo	Da	Hr	Min	Yr	Lat	Long	Dpth	Mag	#Stns
1	12	7	9	38	90	37.22 N	138.48 E	10	5.4	179
2	12	30	0	38	86	36.66 N	137.89 E	10	5.5	260
3	2	7	13	27	93	37.63 N	137.25 E	11	6.6	673
4	8	9	0	46	82	35.67 N	142.02 E	13	5.5	293
5	8	26	15	43	85	36.21 N	142.35 E	13	5.5	267
6	7	23	17	54	82	36.10 N	141.89 E	14	6.2	499
7	2	15	16	51	93	37.61 N	137.26 E	15	5.0	117
8	12	7	9	40	90	37.31 N	138.46 E	15	5.1	64
9	10	16	10	39	83	37.19 N	137.91 E	17	5.1	93
10	4	8	4	34	89	36.38 N	141.96 E	21	5.0	67
11	3	24	12	49	87	37.44 N	137.86 E	23	5.7	339
12	12	13	10	13	90	35.50 N	140.93 E	23	5.0	59
13	7	23	15	5	82	36.19 N	141.97 E	24	5.1	169
14	5	22	13	31	82	35.22 N	141.22 E	25	5.0	51
15	10	18	3	22	85	37.64 N	136.90 E	25	5.9	546
16	8	6	14	49	91	35.72 N	141.04 E	29	5.9	404
17	5	9	16	51	87	36.22 N	141.89 E	30	5.2	365
18	7	16	10	8	90	36.12 N	141.35 E	33	5.0	108
19	5	18	15	31	81	37.02 N	137.71 E	35	5.4	28
20	1	6	18	52	88	36.38 N	141.80 E	36	5.0	172
21	7	25	9	10	82	36.21 N	142.03 E	36	5.0	86
22	8	23	16	40	82	36.35 N	141.48 E	36	5.8	273
23	7	23	14	23	82	36.19 N	141.70 E	37	6.8	271
24	9	3	19	39	81	35.29 N	141.08 E	37	5.7	378
25	2	10	16	23	87	35.58 N	143.01 E	38	5.2	114
26	10	4	4	11	81	35.23 N	140.96 E	38	5.0	85
27	7	25	8	1	82	36.41 N	141.79 E	39	5.5	454
28	1	17	11	13	84	36.44 N	141.22 E	40	5.6	218
29	11	28	22	29	86	36.34 N	141.17 E	41	5.7	272
30	2	11	17	46	90	36.33 N	140.91 E	46	5.4	228
31	12	8	17	23	89	36.55 N	140.91 E	47	5.4	235
32	1	29	2	44	83	36.70 N	141.51 E	50	5.1	166
33	3	11	3	1	85	36.41 N	141.01 E	50	5.8	179
34	8	6	5	58	85	36.44 N	141.03 E	50	5.3	307
35	8	15	16	58	82	36.49 N	141.03 E	50	5.4	223
36	10	2	0	32	83	36.46 N	141.18 E	50	5.1	145
37	1	27	1	30	87	35.57 N	140.94 E	51	5.1	277
38	7	23	14	29	82	36.37 N	141.24 E	51	5.3	87
39	9	2	9	24	81	35.82 N	141.02 E	51	5.6	443
40	9	13	1	20	81	36.14 N	141.17 E	51	5.0	218
41	3	16	0	45	84	36.76 N	141.56 E	52	5.0	179
42	6	4	21	11	84	36.45 N	141.18 E	52	5.0	157
43	12	1	16	15	80	35.90 N	140.95 E	52	5.0	118
44	1	3	10	2	88	35.33 N	140.88 E	53	5.0	67

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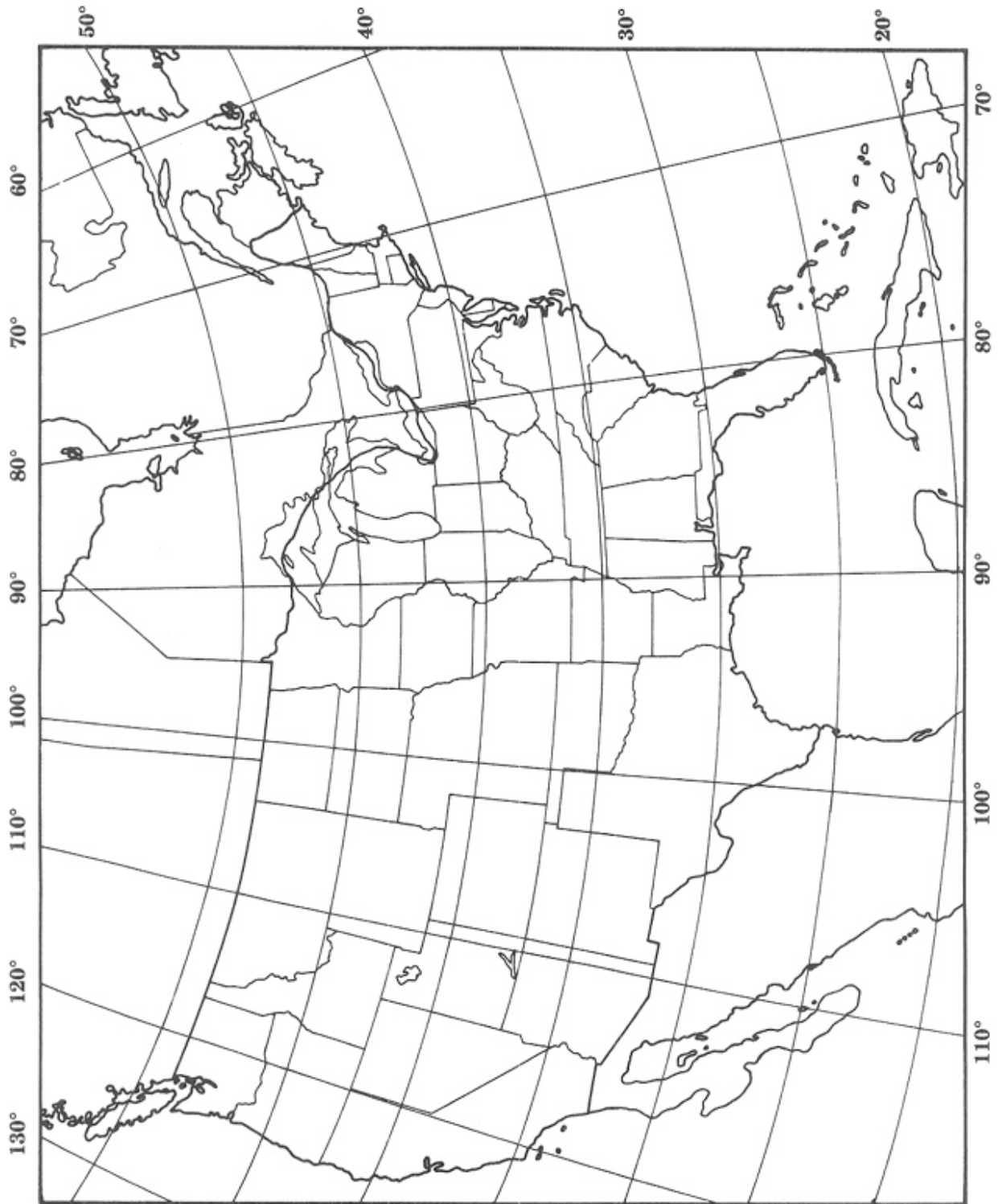
45	8	13	21	14	82	36.53 N	141.11 E	55	5.4	381
46	4	14	3	3	92	36.17 N	139.78 E	57	5.0	158
47	9	2	3	5	83	36.68 N	141.01 E	57	5.2	227
48	12	30	2	30	83	35.69 N	140.66 E	58	5.4	378
49	5	11	10	7	92	36.46 N	140.52 E	59	5.2	208
50	8	13	21	15	82	36.45 N	140.93 E	59	5.4	194
51	2	13	10	1	87	36.64 N	140.96 E	60	5.1	324
52	2	19	12	27	88	35.96 N	139.78 E	60	5.5	287
53	9	10	15	25	83	35.60 N	140.64 E	60	5.0	45
54	2	3	10	11	88	36.57 N	141.13 E	62	5.0	22
55	6	25	3	49	91	36.60 N	140.88 E	62	5.0	147
56	8	27	4	9	92	36.11 N	139.81 E	63	5.0	132
57	5	3	7	45	90	36.44 N	140.51 E	64	5.4	269
58	6	10	2	0	80	35.89 N	139.55 E	64	5.1	64
59	10	15	2	58	83	36.11 N	139.81 E	64	5.1	52
60	5	28	17	58	92	35.63 N	140.52 E	65	5.0	131
61	9	20	3	4	86	36.47 N	140.70 E	66	5.1	252
62	1	7	18	18	83	36.07 N	139.87 E	67	5.1	168
63	6	1	1	22	90	35.52 N	140.33 E	67	5.8	367
64	6	29	22	9	84	36.17 N	139.79 E	67	5.4	22
65	7	26	4	30	84	36.17 N	139.98 E	67	5.0	88
66	12	5	19	47	84	36.41 N	140.66 E	67	5.0	82
67	2	21	23	23	81	36.47 N	140.72 E	68	5.0	146
68	3	6	23	14	82	36.48 N	140.61 E	68	5.6	386
69	4	10	10	59	87	36.12 N	139.81 E	68	5.1	287
70	6	30	9	17	87	36.17 N	139.98 E	70	5.0	159
71	10	28	1	50	83	36.21 N	139.98 E	70	5.2	247
72	3	10	0	37	87	36.44 N	140.83 E	76	5.1	122
73	2	27	12	14	83	35.93 N	140.08 E	78	5.9	566
74	4	17	7	33	87	35.72 N	140.07 E	78	5.1	324
75	10	10	6	28	88	35.56 N	140.10 E	78	5.0	152
76	7	3	18	3	90	35.92 N	140.04 E	79	5.1	139
77	12	17	14	49	84	35.57 N	140.09 E	81	5.1	204
78	2	21	11	51	84	36.15 N	140.09 E	83	5.1	241
79	10	4	12	25	85	35.84 N	140.09 E	83	6.2	648
80	9	23	19	10	80	35.98 N	139.78 E	88	5.4	362
81	11	9	23	37	82	36.57 N	140.62 E	111	5.0	72
82	7	14	14	19	91	36.41 N	138.33 E	188	5.2	102
83	9	18	21	42	88	37.15 N	136.96 E	262	5.1	276
84	5	17	1	4	90	37.06 N	136.88 E	267	5.2	340
85	3	11	22	22	84	38.39 N	135.48 E	351	5.3	307



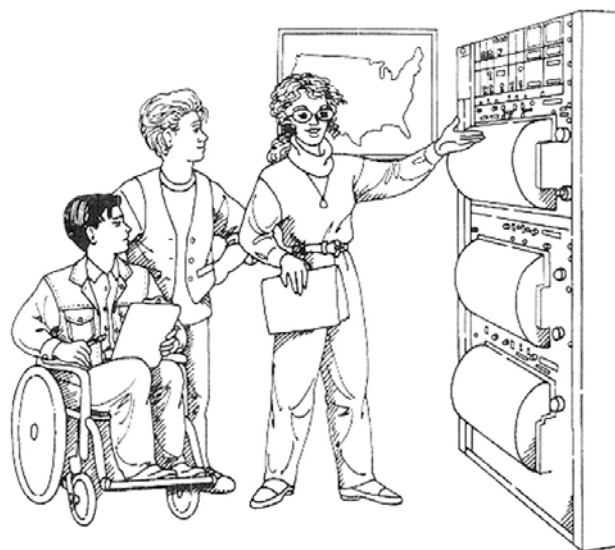


MO.	DAY	TIME (UTC)	LAT. (N)	LONG. (W)	DEPTH (KM)	MAGNITUDE
01	11	0122	35.22	118.22	4	4.1
01	13	0547	30.22	114.44	10	4.6
01	13	2005	27.60	115.09	10	5.1
01	15	0529	37.99	118.21	5	5.0
01	24	1820	38.13	86.43	5	4.1
01	26	0220	26.08	110.12	10	4.8
01	27	0628	30.12	113.73	10	4.2
01	28	0459	43.31	102.50	5	4.0
01	29	1316	34.46	106.88	12	4.8
01	31	0108	34.44	106.86	10	4.0
02	18	1552	33.51	116.45	9	4.1
02	28	2343	34.14	117.70	5	6.2
03	01	0323	34.15	117.72	11	4.8
03	02	1726	34.14	117.69	6	4.6
03	07	0716	37.47	118.62	11	4.0
03	10	1600	37.11	116.06	0	5.1
03	10	1726	37.11	116.06	0	4.0
03	16	1552	24.90	109.04	10	6.1
03	16	1646	24.40	108.80	10	4.7
03	20	0707	24.50	109.10	10	4.3
03	31	2259	32.38	115.24	6	4.3
04	04	0854	32.97	117.81	6	4.5
04	17	2232	34.11	117.72	4	4.7
05	20	1715	20.27	63.26	78	4.3
06	11	0452	27.39	111.26	10	4.8
06	13	1600	37.26	116.42	0	5.7
06	21	1047	33.16	115.63	1	4.0
06	21	1815	36.99	116.00	0	4.3
07	12	0903	24.02	108.52	10	4.7
07	12	1327	23.02	108.96	10	4.2
07	25	1500	37.21	116.21	0	4.7
08	17	2101	36.79	83.34	10	4.0
08	31	0338	33.25	116.05	8	4.2
09	06	0524	27.20	110.56	10	4.1
09	26	1318	37.17	89.58	12	5.0
10	11	0314	21.18	99.69	10	4.0
10	12	1730	37.25	116.49	0	5.6
10	13	0356	31.72	115.91	6	4.0
10	19	0701	46.47	75.59	13	5.1
10	24	0615	38.05	119.16	12	5.7
10	25	0324	23.83	108.71	10	5.1
11	05	0716	38.03	119.17	10	4.2
11	08	1046	34.45	106.86	6	4.4
11	14	1917	37.23	116.37	0	5.4
11	15	1347	47.13	76.22	18	4.1
11	28	0248	38.67	116.46	10	4.3
11	30	1130	47.77	113.16	5	4.0
12	18	1656	35.37	118.85	6	4.2
12	24	0254	44.78	111.20	5	4.0
12	31	0353	47.58	72.56	18	4.4









To obtain U.S. Department of the Interior/U.S. Geological Survey Preliminary Determinations of Epicenters, write to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Annual subscription, \$21.

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*Eos, Transactions, American Geophysical Union*. A weekly newspaper of geophysics. American Geophysical Union, 2000 Florida Avenue NW, Washington, DC 20009; 800-966-2481. See especially August 17, August 24, and September 14, 1993.

## NON-PRINT MEDIA

EPIC Retrieval Software for the Global Hypocenter Data Base CD-ROM. United States Geological Survey, National Earthquake Information Center. A demonstration disk and information packet are available free: Phone 303- 273-8406; Fax 303-273-8450; E-Mail [hdf@neis.cr.usgs.gov](mailto:hdf@neis.cr.usgs.gov) (Internet). Federal Center, Box 25046, Mail Stop 967, Denver, CO 80225-0046. Through EPIC, you can access enormous amounts of national and international data ranging from 2100 BC to last month.

Jones, Alan L. *The Dynamic Seismicity Program*. version 1.00 level 93.03.02. New York: State University of New York, at Binghamton, 1993. Three computer disks and instruction manual. Also, PC shareware available on Internet [@sunquakes.geol.binghamton.edu](mailto:@sunquakes.geol.binghamton.edu).

*Hidden Fury: The New Madrid Quake Zone*. 27-minute video available from Bullfrog Films, P.O. Box 149, Oley, PA 19547; 1/800-543-FROG.

IRIS Database. United States Geological Survey, National Earthquake Information Center, Incorporated Research Institutions for Seismology, 1616 North Fort Myer Drive, Suite 1050, Arlington, VA 22209-3019.

Seismograph Model. For sale by Nasco, 800/558-9595. Includes a recording needle, a support with a suspended weight, a recording tape, and a teachers guide.

Science ToolKit, Module 2: Earthquake Lab. Broderbund Software (Dept. 15, PO Box 6125, Novato, CA 94948-6125), 1986, for the Apple. Grades 4–12. Requires Science Toolkit Master Module.

*Seismological Data Acquisition Software.* Described in the Gerencher and Jackson article above. Apple software and 64-page user's manual available from J. J. Gerencher, Physics and Earth Sciences, Moravian College, 1200 Main Street, Bethlehem, PA 18018-6650.

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