SEISMICITY OF THE EARTH

SEISMICITY OF THE EARTH AND ASSOCIATED PHENOMENA

By B. GUTENBERG and C. F. RICHTER
SEISMOLOGICAL LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY

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CONTENTS

Introduction 3

Materials Used 3

Methods Used 9

Classification of Shocks 10

Maps 11

Frequency and Energy of Earthquakes 16

Structure of the Earth 25

Introduction to Regional Discussion 28

The Circum-Pacific Belt 30
  General survey 30
  Aleutian arc 30
  Alaska to British Columbia 32
  California and adjacent areas 32
  Mexico and Central America 36
  The Caribbean loop 37
  Andean zone 40
  Southern Antilles 42
  Eastern and Southern Pacific 43
  Indian-Antarctic Swell 43
  Macquarie Island to Stewart Island 43
  New Zealand 45
  The Tonga salient 47
  New Hebrides 48
  Solomon Islands to New Guinea 50
  Caroline Islands 51
  Marianas Islands 51
  Japan and adjacent areas 53
  Kiushiu to Formosa 57
  Philippines 58
  Celebes and Moluccas 60
  Banda Sea 62
  Sunda arc 62

The Alpide Belt 64
  General survey 64
  Burma arc 64
  Himalayan arc 65
  Baluchistan 67
  Iran 67

- Caucasus, Crimea 68
- Asia Minor, Levant, Balkans 68
- Rumania 70
- Italy, Sicily 70
- Western Mediterranean to Azores 70

Non-Alpide Asia: Eastern Zone 72
- General survey 72
- The Pamir-Baikal active zone 72
- The Chinese active area 73

Oceanic Active Belts 74
- General survey 74
- Arctic belt 74
- Atlantic belt 77
- Indian Ocean 77

Rift Zones 79
- General survey 79
- East African rifts 79
- Hawaiian Islands 79

Seismicity Marginal to Stable Masses 80
- General survey 80
- Canadian Shield 81
- Brazilian Shield 81
- Africa 81
- Arabia 81
- India 82
- Australia 82
- Other marginal shocks 82

Minor Seismic Areas 82
- General survey 82
- North America 84
- Northeastern Asia 85
- Central and Western Europe 85
- Australia 87
- South Africa 88

Minor Seismicity 88

Stable Masses 89
- General survey 89
- Pacific Basin 89
- Canadian Shield 91
- Brazilian Shield 91

- Eurasian stable mass 91
- Africa 91
- Antarctica 93
- Australia, Arabia, India 93
- Other and minor stable masses 93

Tsunamis (Seismic Sea Waves) 94

Mechanism 97

Acknowledgments 102

Summary 103

References 104

Tables 117

Index 269

ILLUSTRATIONS

1. Index map of numbered regions 12
2. Index map of figures 13
3. World map of shallow earthquakes 14
4. World map of deep-focus earthquakes 15
5. Annual number of earthquakes per 1/10 unit of magnitude 17
6. Profile, northern Japanese region 29
7. Map, Alaska-British Columbia 31
8. Map, Western United States 35
9. Map, Mexico 37
10. Map, Caribbean region 38
11. Map, South America and adjacent Pacific 41
12. Map, South Pacific 44
13. Map, Region southwest from New Zealand 45
14. Map, New Zealand 46
15. Map, Tonga salient 49
16. Map, New Guinea-Marianas Islands 52
17. Map, Japan 55
18. Map, Kurile Islands-Kamchatka 56
19. Map, Formosa-Philippines 59
20. Map, Moluccas 61
21. Map, Sunda arc 63
22. Map, Sumatra-Burma 65
23. Map, Asia 67
24. Map, Asia Minor and eastern Mediterranean 69
25. Map, Europe 71
26. Map, Arctic 75
27. Map, Atlantic Ocean 76
28. Map, Indian Ocean 78
29. Map, Hawaiian Islands 80
30. Map, Australia 83
31. Map of epicenters and faults, southern California 88
32. Structural cross-section, Southern California 89
33. Map, Pacific stable mass 90
34. Maps, Continental stable masses 92

SEISMICITY OF THE EARTH

INTRODUCTION

The present work is intended: (1) to evaluate the present relative seismicity of various parts of the earth, and (2) to discuss the geography and the geological character of the zones and areas of seismic activity. This includes correlation with alignments of active volcanoes and gravity anomalies, and with oceanic deeps, mountain structures, and other topographic features. Mechanism is discussed, particularly with reference to crustal folding and block faulting.

This book supersedes two earlier publications (Gutenberg and Richter, 1941, 1945) and incorporates the results of two papers on the geography of deep-focus earthquakes (Gutenberg and Richter, 1938a, 1939a). There has been thorough correction and revision. Much new material has been added, including shocks of earlier date as well as those which have taken place since the previous papers were written. Certain technical details, referring chiefly to methods used in locating shocks and to the accuracy of the results, have not been repeated here. This does not imply rejection or modification of our previous judgment on these points.

Complete tables of all shocks investigated, segregated by regions, will be found in Tables 17 and 18 in the Appendix. A selection of data, appropriate for statistical discussion, is presented in Tables 13 to 16. These list large shocks in specified ranges of magnitude and depth; each list is fairly complete for the world in the period it covers. In addition, an attempt has been made to include all shocks of magnitude 6.0 to 6.9 from the beginning of 1932 through June 1935; magnitudes for most of these shocks are newly determined. Magnitudes for deep-focus earthquakes are assigned for the first time.

Except in the most recent literature, maps purporting to show the geographical distribution of earthquakes have been based at least in part on historical and macroseismic data. Historical data are in general available only for land areas, and are much influenced by the present and past distribution of culture. Maps based uncritically on instrumental data are likely to show a concentration of shocks where seismological stations are most numerous (as in Europe and Japan), and are exposed to gross errors of location, including those which arise when a deep shock has been taken to be shallow. Location and listing have always been comparatively incomplete for the southern hemisphere.

While reliable historical and macroseismic data have been considered in the textual discussion, the maps are based exclusively on revised instrumental data. Shocks have been distinguished carefully according to magnitude and focal depth. Where possible, errors in the source material have been corrected, and doubtful locations have been rejected.

The study is not geographically homogeneous. In each separate region detailed investigation of seismicity has been carried as far as the data warrant. In certain regions, especially where there are a number of good stations, this has led to a more complete coverage of the minor shocks than elsewhere, particularly (as in Europe) where large shocks are infrequent. In regions such as Japan, where the seismicity is high, many well-observed and accurately located smaller earthquakes have been omitted from the study, since they add nothing to the general information on seismicity and only crowd the maps and tables.

In the tabulations, times of all shocks are given in Greenwich Civil Time (Universal time). Where historical shocks are mentioned in the regional discussion, the date is usually according to local time which may differ by a day from the GCT date.

MATERIALS USED

Fundamental data for instrumental location of earthquakes are times recorded at the various stations. The chief source is the *International Seismological Summary* (Turner *et al.*, 1923-1948) which now (June 1948) covers shocks from the beginning of 1918 through 1936. It is a careful and accurate compilation of recorded times (but not amplitudes) from the individual bulletins of the stations, also including data otherwise unpublished. The *Summary* gives epicenters and origin times for each shock whenever the data appear sufficient; these results generally improve in number and quality from the earlier to the later years. This is due to an increase in the number of stations reporting, as well as to more accurate time-keeping which followed the establishment of radio time signalling. Otherwise, improvement reflects the progress of seismological science, and the effect of accumulated experience. An important contribution was made by Turner (1922, 1930), who discovered deep-focus earthquakes in the course of preparing the *International Summary*. With the year 1930 revised travel-time tables were brought into use; from this point the general accuracy of the *Summary* results is higher.

In the present publication no result has been accepted from the *International Summary* without careful examination and revision for epicenter, origin time and focal depth. Amplitudes reported by the stations have been applied to distinguish deep from shallow shocks; improved technique (Gutenberg, 1945a, p. 127) has developed this into a powerful criterion, and identification of shocks at intermediate depth is much more positive than in previous studies. However, assignment of numerical depths still depends on travel-time data. A number of small shocks, for which there is good evidence of deep focus, have been passed over because the time data were not adequate.

Epicenters have in general not been determined more closely than the nearest quarter degree of latitude and longitude except for unusually favorably situated shocks. More accurate revision would involve considering the effect of geocentric latitude, which may amount to as much as 0.4 degree in extreme cases (Gutenberg and Richter, 1933). The method used for revision has been described by Gutenberg and Richter (1936b, 1937). Travel times here used for *P* in shallow shocks are those given by Gutenberg and Richter (1934c, p. 82).

Origin times for recent shallow shocks given in the *International Summary* have usually been decreased by 5 or 6 seconds. Beginning with 1930 the Summary compilers have used tables (*Summary* for 1930, p. 10-18) with an arbitrary time zero 5 to 6 seconds later than the true origin time of the shock, very roughly coincident with the arrival of the first wave at the surface. This is not the case for deep-focus earthquakes. Data from atomic bomb tests show that the zero of the travel-time curves used for the present paper is accurate within the limits of error, estimated at about 2 seconds (Gutenberg and Richter, 1946).

Effective registration of distant earthquakes began on April 17, 1889, when an instrument at Potsdam wrote a record identified as that of a shock in Japan (Rebeur-Paschwitz, 1894, p. 436). The early instruments were very imperfect by present standards, and there were few observing stations; for years preceding 1904, despite the efforts of Milne and others, there are not even enough data to ensure reasonably complete cataloguing of the largest earthquakes. Milne (1912b, 1913) published epicenters for many shocks in the years 1904-1910 inclusive. Observed times have been taken from other sources. The principal compilations are by Rosenthal (1907) and Szirtes (1909a, 1910, 1912, 1913) for 1904-1908 inclusive with separate lists of small shocks (without epicentral determinations) and large shocks (epicenters and origin times worked out). For 1908 only part I, giving the small shocks, was published. For 1909 and 1910 Kurt Wegener (1912) has given determinations and some station data for a number of large shocks.

Epicenters for all the better-recorded shocks of 1913 were worked out by Turner (1917). For 1913, 1914, 1915, and 1917 he issued epicenters and time data in monthly bulletins of the British Association for the Advancement of Science. For 1916 Turner (1919) gave epicenters and times for the better-recorded shocks and incomplete information for others.

For all this earlier period, but especially for 1908-1912, it has been necessary to supplement the compiled material by reference to numerous individual station bulletins (see Table 1). Further information has been obtained by special correspondence.

Table 1 presents a conspectus (with some minor omissions) of data from individual station bulletins available at Pasadena for this investigation as of December 1947. One column is assigned to each year, 1904 to 1918. A capital letter indicates that the writers have had access to the complete data published or otherwise furnished by the station for the year; a small letter, that there are considerable gaps in the available files. A number of stations were equipped with small or insensitive instruments; a capital letter assigned to such a station may mean much less information for the year than a small letter for a better-equipped station.

Letters *A*, *a* indicate that the amplitudes of

TABLE 1

Time and amplitude data for 1904-1918 used in the present study.
(For symbols see text.)

Station	1904	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Summaries	T	T	T	T	t					T	T	T	t	T	T
Alger												C	C	C	
Apia			A	A	A	A	A	A	A	A	t	t	t	t	t
Athens									B	B	B	B	B		
Baku							c			c	c				
Balboa Heights						x	x	x	x	x		C	C	C	C
Barcelona											d	D	D	D	D
Batavia						C	C	c	c	c			c	c	c
Belgrade								a			a				
Berkeley							c	C	C	C	C	C	C	C	C
Budapest			C	C	C	C	C	C	C	C	c				
Cartuja					c	C	C	C	C	C	A	A	a		
Catania					C	C	C	C							
Cheltenham						c	c	c	c	c		C	C	C	
De Bilt	t				a	A	A	A	A	A	C	C	C	C	C
Ekaterinburg										c	c				
Eskdalemuir												c	c		
Florence (Xim.)	B	b			c	c	c	c	c	c	c				
Frankfurt										c	c				
Georgetown												C	C	C	C
German Stations								t							
Göttingen	A	A	A	A	A	A	A	A	A	A	a				
Graz											a	a			A
Hamburg	C	C	C	C	B	B	B	B	B	C	C	c			
Hohenheim											A		A	A	A
Honolulu										c		C	C	C	C
Irkutsk								t	c	C	c				
Italian Stations									C						
Jena		a	A	A	A	A	A	A	A						
Jugenheim									a						
Ksara										D	D				
La Paz										a	A	A	A	A	A
Laibach				t	T	t									
Lick								c	C	C	C	C	C	C	C
Manila					C	C	C	C	C	C	C	C	C	C	C
Mileto						c	c	c							
Mizusawa						t	t	t							
North American Stations											c	C	C	C	C
Osaka	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Ottawa					a	c	c	c	d	d	d	T	T	T	T
Paris							C	B	B	C	C	C	C	C	
Pilar	X	X	X	X	X	X	X	X	X						
Pulkovo					c	C	C	C	c	C	c				
Riverview						a	A	A	A	A	A	A	a	A	A
San Fernando		X	X	X	X	X	X	X	X	X	X	C	C	C	C
Sitka		T				c	c	c	c			C	C	C	C
St. Louis							C	C	C	C	C	C	C	C	C
Stonyhurst								x	X	X	X	X	X	X	x
Strassburg	x	A	A	A	A	A	A	A	A	A	A	A	a		
Tacubaya						B	C	C	C						
Tiflis	C	C	C	C	C	C				C	C	C	c		
Tucson								c	c	c		C		C.	C
Upsala	a	a	a	A	A	A	A	A	A	B	B	B	B	B	B
Vieques						c	c	c	c	c				C	C
Wien						A	A	A	A						
Zikawei			C	C	C	C	C	C	C	C	C	C	C	C	C

maxima are regularly reported, and those of *P, S*, etc., are given for most of the shocks; *B, b* that the amplitudes of maxima are usually given, with an occasional amplitude for *P, S*, etc.; *C, c* that amplitudes are frequently reported for maxima but not for other phases; *D, d* that an occasional amplitude is given; *T, t* that only time data are reported but that these are detailed and generally accurate; X, *x* that time data are approximate or very scant.

Collected data for "North American Stations" (Table 1) were published in the *Monthly Weather Review*, beginning with December 1914. Data for Tacubaya and auxiliary stations in Mexico are taken from successive issues of *Parergones del Instituto Geologico de Mexico*, Vols. 3-5 (1909-1913). Data for Italian stations for 1912 are from Cavasino (1934); those for German stations during the first quarter of 1912 are from *Gerlands Beiträge zur Geophysik*, Vol. 13, Kleine Mitteilungen, pp. 81-90 (1914).

Results for 1904 and 1905 depend heavily on the reports for Göttingen. These are extremely detailed, including not merely times and amplitudes but notes on the appearance of the seismograms which have been very valuable in identifying deep-focus earthquakes and in correcting misinterpretations in the work of compilers. A similarly detailed and useful report was that for Upsala, available from October 1904 to May 1905. These two stations supply practically the only data for magnitudes of deep shocks in 1904.

For nearly ten years the most useful station in South America was that first established at Córdoba, and moved in January 1905 to Pilar. This was equipped with a simple Milne instrument without damping, and rather insensitive; but the times are reliable.

Reports from Tiflis in the earlier years are of special value; amplitudes are usually given, and the data of the auxiliary stations Achalkalaki, Batum, Borshom, and Schemacha are occasionally helpful.

In 1931 the station Osaka published a bulletin covering the whole period from 1882 to 1929. Amplitudes are given regularly beginning with June 1901. The time is reliable beginning about 1905. The amplitude data are dependable, and very useful in assigning magnitudes to shallow shocks, although care in interpretation is demanded. Not rarely the amplitudes of *S* for deep shocks are given as those of maxima; these are then valuable for determining magnitudes.

For 1904, the times at all stations and the results derived from them are distinctly less dependable than those for 1905 and following years.

Bulletins from Upsala were resumed in July 1906, with considerable improvement in detail, and are among the most useful for subsequent periods. Reports from Apia are available beginning with 1906; this was the first good station (by later standards) in the southern hemisphere. During the following years there were improvements at Zikawei, Batavia, and Manila which are of much importance in studying shocks in the most active part of the world.

The Jena reports include, beginning with August 30, 1906, data from an exceptional vertical-component instrument (period about 6 sec., magnification about 2000) constructed by R. Straubel (Eppenstein, 1908). This provided records of a type not duplicated elsewhere for many years, and especially valuable for identifying and studying deep-focus earthquakes. The reports are very careful and detailed.

Data for the southern hemisphere were much improved by the establishment of the station at Riverview (near Sydney, Australia), beginning March 18, 1909. Father D. O'Connell has recently revised the readings, with special reference to deep-focus earthquakes (MS, and O'Connell, 1946).

A further improvement followed the installation at La Paz (Bolivia), with reports beginning May 1, 1913. La Paz at once became, and still remains, the most important single seismological station of the world. This is a consequence of its isolated location, the sensitive instruments, and the great care with which records were interpreted and reports issued under the direction of Father Descotes.

The first World War resulted in the discontinuing of some stations and the temporary suspension of others. During the later years of the war there was a notable falling off in the detail of reports. Reported times for these years are covered by the International Summary, which commences with 1918, and its predecessors. Data for amplitudes are comparatively scanty. For 1919 amplitudes of *P* and *S* are available regularly from Riverview; for 1919-1921 from La Paz, with less complete data from Zikawei, Berkeley and other American stations, Manila and Osaka. Amplitudes of maxima were published by a number of other stations. Beginning about 1922 there is a notable improvement in data for both times and amplitudes. Amplitudes of maxima are plentiful from 1922 to 1939.

The following is a partial list of other stations regularly reporting amplitudes of *P* and *S*: Cartuja, 1922-1924, 1929-1935; Toledo and other Spanish stations, 1924-1929; Sucre, 1926-1928; Tashkent, 1926-1927; La Plata, 1927-1935, 1940, 1945-date; Jena, 1928-1939; Göttingen, 1929-1937; various Japanese stations, 1930-1939; Perth, 1932-date; Belgrade, 1934-1939.

Beginning with 1937, data for times have had to be collected from various sources. The largest collections of times with preliminary epicentral determinations, are (1) the *Bulletin of the Union Géodésique et Géophysique Internationale,* currently issued from the Bureau Central Séismologique at Strasbourg (temporarily at Clermont-Ferrand during the German occupation), (2) the preliminary bulletin of the Jesuit Seismological Association, currently issued from St. Louis, (3) the *Seismological Bulletin* of the United States Coast and Geodetic Survey, issued from Washington (available through 1944; preliminary epicenter determinations, and manuscript data by special arrangement, current) giving readings for many stations in the United States as well as College and Sitka in Alaska, Honolulu, Bermuda, San Juan (Puerto Rico), Montezuma (Chile), Huancayo (Peru), and a few others. Other collections including amplitudes of maxima are: (4) the bulletin of the first-class stations of the Soviet Union (received up to August 1939; a preliminary bulletin was received for part of 1941 and a new series also including data for stations of the second class from June 1946 through July 1947); (5) the Indian stations, published by the India Weather Bureau (partly in MS), through 1946. There are several other important smaller groups of stations with current reports giving times and epicentral determinations, but not amplitudes, such as: (6) the New Zealand stations, issued from Wellington; (7) the Canadian stations, from Ottawa; (8) the northern California group, from Berkeley (to 1941; preliminary data current); (9) the Lake Mead stations, together with Grand Coulee Dam and Shasta Dam, from Boulder City; and (10) the Swiss stations, from Zürich. Much use has been made of the station bulletin from De Bilt (Netherlands); the readings are carefully edited, and until 1940 data from other stations were reproduced with determinations of epicenters and origin times.

Most of the North American stations continued active through the second World War with very few interruptions or changes; current reports are generally available. For South America, current reports are received only from Bogotá, La Plata, and La Paz. Readings for Rio de Janeiro are available through 1944. Huancayo reports important readings by telegraph to Washington. For information on Latin American stations see U.S. Coast and Geodetic Survey (1947).

Many gaps in data from Europe have been filled by receipt of delayed bulletins covering the war period. Fairly complete files, being extended by current reports, are at hand for the Spanish stations, Coimbra, Lisbon, the French stations, Stuttgart, Trieste, Bucharest, Istanbul, Uccle, and Upsala. Several European stations resumed with 1946. Tiflis is available through September 1939. Ksara (Lebanon) and Tananarive (Madagascar) continue to report regularly. Helwan (Egypt) is available through 1944.

From 1940 to 1946 no data were received from Far Eastern stations. The station at Hong Kong was closed in 1940. The station at Manila and its records were destroyed in 1945. The instruments at Amboina and Medan were also destroyed, but those at Batavia continued to operate. Bulletins for 1941 containing data for the last three were issued in 1947. Data for many Japanese stations down to 1946 for shocks in and near Japan are now available at Pasadena in manuscript, in the Japanese language *Journal of Seismology* (Vols. 1-13) and in the *Seismological Bulletin* of the Central Meteorological Observatory for 1938; monthly bulletins have been received beginning with May 1947.

Current bulletins continue from Apia, Brisbane, Perth, Riverview, and Wellington. Readings for a few important shocks have been supplied on request from Melbourne.

For determinations of epicenter, origin time, and magnitude, full use has been made of the original seismograms for Pasadena (with its auxiliary stations), and Huancayo (records filed at Pasadena). Original seismograms of the Tucson short-period vertical-component instrument have also been highly useful; these are regularly available at Pasadena by arrangement with the U.S. Coast and Geodetic Survey.

Up to the end of 1938 there are sufficient data for all the purposes of this study. For 1939, especially the later months, some important information is lacking. For the following years data rapidly become scantier. For the whole period amplitudes of *P* and *S* are available for the larger shocks as recorded at Perth (Australia), at La Paz through 1947 and for most shocks 1940-1945 at Riverview. Further valuable data have been provided by the Coast and Geodetic Survey; for April 1943 to March 1944 amplitudes at Bermuda and Honolulu have been included in the published bulletins. Amplitudes of maxima are available for Helwan through 1944, Upsala to June 1946, Sydney through 1944, and Spanish stations to date. The U.S.S.R. reports include amplitudes of maxima; recent reports from De Bilt and La Plata include amplitudes for *P, S* and maxima. It is to be hoped that in the future an increasing number of stations will report amplitudes (with corresponding periods) for *P, S,* and *PP*.

Macroseismic data have been used to supplement instrumental results in the regional discussion. An important source is the catalogue by Milne (1912a). Sieberg (1932a, with many references) has been consulted throughout. Much valuable information with references has been taken from Montessus de Ballore (1906, 1907, 1924). The international summaries published from Strassburg (Oddone, 1907; Christensen and Ziemendorff, 1909; Scheu, 1911; Scheu and Lais, 1912; Sieberg, 1917) have been used. Data for 1944-1945 are given by Rothé (1946). Numerous papers and short notes in the *Bulletin of the Seismological Society of America* have been consulted; only the most important of these are referred to in the bibliography. Press clippings have been used when the information seemed reliable; large collections of press reports have been issued from the station at Georgetown, printed and mimeographed under the title "Seismological Despatches." Notes and remarks in the various station bulletins have often been very helpful. This is particularly true for shocks in the region of the station itself. Other more regionally limited sources of macroseismic data will be referred to separately at the appropriate points. Only those consulted frequently are cited.

The checklist of active volcanoes given in the Appendix (Table 19) has been compiled from many sources by Mr. J. M. Nordquist. The principal source of general information has been the work of von Wolff (1929; 1930). Comparison has been made with the catalogue and map given by Kennedy and Richey (1947). Other sources, most of them applying to limited regions or to recent years only, include Anderson (1908), Brüggen (1947), Cloos (1936; 1942), De la Rüe (1937), Fisher (1939, 1940), Fujiwhara (1927), Jaggar (1945), Krijanovsky (1934), Milne (1884; 1886), Nielsen (1937), Neumayr (1920), Reck (1929-1936; 1935), Reck and Hantke (1935), Rittmann (1944), Rudolph (1887; 1895; 1898), Russell (1897), Sanchez (1944), Stehn (1927), and Tanakadate (1931-1939; 1937; 1940). The American Museum of Natural History provided a list of volcanoes active within the previous century which was formerly regularly reprinted in the *World Almanac*. This became obsolete and inaccurate; the writers are indebted to Dr. F. H. Pough for revised information.

Scattered notes from scientific and popular publications have been employed; these are too numerous to be cited individually. Files of the *Geographical Journal* have been searched thoroughly. Information from the press has been used only when it seemed unusually reliable or could be verified elsewhere; as on the most important details press notices are often wholly misleading. Thus in 1932 it was generally reported that a whole group of South American volcanoes were in simultaneous eruption, while in fact there was eruption of only a single volcano, Quizapú (Bobillier, 1932).

Many references and some first-hand information have been obtained by correspondence; these are noticed under Acknowledgments.

General data on gravity are taken from Meinesz *et al.* (1934), Meinesz (1933; 1939), Heiskanen (1936; 1939a; 1939b), and Woollard (1949). References to papers covering individual regions will be introduced in the course of discussion. Whenever possible, isostatically reduced gravity anomalies have been used. These are considered large when approaching 100 milligals. Evans and Crompton (1946) have pointed out the importance of considering the geology in reducing gravity observations.

The principal sources for submarine contours are Vaughn *et al.* (1940), charts issued by the U.S. Hydrographic Office, and maps by the American Geographical Society.

Seismological data on crustal structure have been summarized by Gutenberg (1943b).

The bibliography listing works to which reference is made is as complete as time, space, and library facilities permit. Many papers have been omitted as principally hypothetical or containing only minor items related to the present work.

METHODS USED

For all shocks epicenter, origin time, and depth were determined as previously described (Gutenberg and Richter, 1936b; 1937), using times at widely separated stations. Large shocks may be located fairly well with only a few stations in different azimuths; but most earthquakes require a better distribution of data. For example, the normal minimum requirement for locating a shock in South America is about five stations, including Pasadena, Berkeley, or Tucson, one good station in South America itself, one in eastern North America or the West Indies, and one in Europe. The greatest difficulty has always been experienced with locating shocks in far southern latitudes.

There are various causes of discrepancy between apparent epicenters found from macroseismic data and those determined instrumentally. Gross errors have occurred when concentration of population or works of construction in a small part of the shaken region has given an erroneous idea of the distribution of seismic intensity. Often the effect of ground is insufficiently considered; thus higher intensity in an alluviated valley may lead to a false epicenter. The distribution of intensity in deep focus shocks usually shows abnormal patterns not simply related to the location of the epicenter. On the other hand, even microseismic data from a number of stations are often not sufficient for an accurate location. Consequently, great caution is required, especially in regions where there are few local stations, in attempting detailed correlations between microseismic epicenters and geological structures.

Identification of deep shocks is sometimes difficult when the data are incomplete; but for well-observed shocks no such difficulty exists. The occurrence of shocks at all levels down to about 700 kilometers below the surface is established beyond reasonable doubt by concurrent lines of evidence. Any arguments to the contrary may be dismissed as special pleading.

Signs of great focal depth which present themselves in searching through catalogues and station bulletins are (1) difficulty in locating the shock and determining its origin time, supposing that it is shallow; (2) epicenter in an unusual region, or in a region where deep shocks are common; (3) surface waves reported as small at all stations (frequently *S* or *SS* is reported as the maximum of the seismogram); (4) an abundance of additional and usually unidentified readings, often accompanied by the suggestion that two or more shocks are superposed; (5) a distant earthquake mistaken for a local shock near the reporting station.

Accurate assignment of focal depth demands identifiable time observations of the reflected wave *pP*, or of such waves as *P′* and *SKS* which have passed through the core of the earth and consequently arrive as much as one minute earlier in deep shocks than in shallow shocks (Turner, 1922; Gutenberg and Richter, 1934a; 1934b; 1936b; 1937; Banerji, 1925; Berlage, 1924; Blake, 1937; 1941; Brunner, 1935; Byerly, 1925; Hayes, 1936a; Jeffreys, 1928; Miyamoto, 1933; Scrase, 1931; Stechschulte, 1932; Stoneley, 1931; Visser, 1936; Wadati, 1926-1928; 1931). Focal depth in the range 40 to 100 km. is often difficult to determine; in such cases extended use has been made of the relative amplitudes of surface and body waves, or more directly of the magnitudes determined from these (Gutenberg, 1945a, p. 127). In Tables 13, 14, and 17 omission of any remark as to depth does not exclude the possibility of a depth as much as 60 km.

The magnitude of an earthquake was originally defined (Richter, 1935), for shallow shocks in southern California, as the logarithm of the maximum trace amplitude expressed in thousandths of a millimeter with which the standard short-period torsion seismometer (period 0.8 sec., magnification 2800, damping nearly critical) would register that earthquake at an epicentral distance of 100 kilometers. Gutenberg and Richter (1936a) extended the scale to apply to shallow earthquakes occurring elsewhere and recorded on other types of instruments. The physical meaning of the scale was discussed, improvements were introduced, and a nomogram for its application (drafted by Mr. J. M. Nordquist) was presented by Gutenberg and Richter (1942). Revised tabulations, with the addition of local corrections for the individual stations of the world, were given by Gutenberg (1945c). Magnitudes of shallow earthquakes were then correlated with amplitudes and periods of *P*, *PP*, and *S*, making these available for magnitude determination (Gutenberg, 1945d).

Surface waves, such as were used for establishing magnitudes of shallow earthquakes, are small or nearly absent in deep shocks. The magnitude must be based on amplitudes of *P*, *PP*, and *S*. A further definition is required; a deep shock is taken to have the same magnitude as a shallow shock releasing the same energy in elastic waves. The determination of energy requires calculation from the observed amplitudes and periods, involving assumptions as to the propagation of seismic energy in the interior of the earth. This leads to tabulations and charts (Gutenberg, 1945a) connecting amplitudes, periods, and focal depth with magnitude. These tabulations and charts constitute the practical definition of magnitude for deep-focus earthquakes.

Magnitudes for well-observed shocks are assigned to the tenth of a unit, with an error ordinarily not exceeding two tenths. For the majority of shocks magnitude is assigned to the nearest quarter unit. Some of the largest shallow shocks present exceptional difficulty, since the surface waves are so large at many stations that the maxima are lost off the edge of the seismogram, or by the seismograph's striking against its stops; while determination of magnitude from *P* or *PP* requires an imperfectly known correction which increases with magnitude.

The relation of magnitude and energy was considered tentatively in the first publication on magnitudes (Richter, 1935) but was significantly revised in later discussion (Gutenberg and Richter, 1942), which yielded the equation

$$(1) \qquad \log E = 11.3 + 1.8M$$

where M is the magnitude and E is the energy of the shock in ergs. This equation may require modification for both theoretical and empirical reasons. The constant term is especially difficult to fix, but this does not affect the determination of magnitudes for deep shocks, nor the relative proportion of energy released in different shocks or in different years. It merely multiplies all calculated energies by a constant.

In deriving equation (1) the energy E was calculated as the mean kinetic energy of a progressing spherical elastic wave. An equal term representing its mean potential energy should be added to this; there is also the effect of the free surface (Gane *et al.*, 1946). Moreover, there appears to be approximately equal partition of energy between longitudinal and transverse waves, so that energy calculated for either alone should be doubled. This does not touch on the further question of what fraction of energy liberated in the earthquake is radiated in the form of elastic waves; see Fu (1945). For present purposes we have assumed for radiated energy the partly empirical equation

$$(2) \qquad \log E = 12 + 1.8M$$

The resulting value of log E may be in error by one unit or even more.

CLASSIFICATION OF SHOCKS

SHOCKS are here classed as shallow when the depth does not exceed 60 km.; intermediate when the depth is from 70 to 300 km.; deep when it exceeds 300 km.

Symbols for classification by magnitude are:

Class	*a*	*b*	*c*
Magnitude	7¾-8½	7.0-7.7	6.0-6.9
Class	*d*	*e*	
Magnitude	5.3-5.9	below 5.3	

In general it is found that shocks of classes *a* and *b* are recorded at all stations; class *c* is well recorded up to a distance of 90° of arc (10,000 km. over the surface of the earth); class *d* up to about 45°; class *e* not beyond 10°.

As a result of applying data for the amplitudes of *P*, *S*, etc., and allowing for the effect of depth (especially for shocks 40-60 km. deep), previously estimated magnitudes for many shocks have been increased. This has occasionally raised a shock from class *c* to class *b*, or from class *b* to class *a*. Instances where the estimated magnitude has been decreased are much fewer. Numerical magnitudes are given to the nearest quarter or tenth of a magnitude for all shocks of classes *a*, *b*, *c*. Shocks have frequently been referred to class *d* on the basis of the extent and quality of instrumental recordings; for these, no numerical magnitudes are given. This is partly due to the fact that *P* and *S* amplitudes at distances less than 15° usually cannot be used to determine magnitudes.

For deep shocks the quality of determination is indicated in Table 18 by three capital letters referring in order to accuracy of epicenter, origin time, and depth, as follows:

	Probable limits of error		
	epicenter	origin time	depth
A, very accurate	1°	5 sec.	30 km.
B, good	2	8	50
C, fair	3	12	80
D, poor	—	—	—

In general no shocks where the epicenter seems uncertain by more than 3° are included except in far southern latitudes, where the difficulty of location is increased.

Since latitudes and longitudes of epicenters are usually assigned to the nearest degree, half, or quarter, the maps frequently show spurious definite alignment along particular meridians or parallels.

Epicenters later than 1936 should be considered preliminary, pending publication of the *International Summary*. Epicenters later than 1945 are not included in the regional lists.

Serial numbers have been assigned to the shocks within each numbered geographical region; detailed explanation will be found in the introduction to the regional discussion.

MAPS

All maps and figures have been drafted by Mr. J. M. Nordquist. Figure 1 is an index map showing the boundaries of the numbered geographical regions. Figure 2 is an index map showing boundaries of the separate areas mapped. Figures 3 and 4 are world maps, the former showing large shallow shocks, the latter large intermediate and deep shocks. These are the only figures which can be used directly for statistical purposes; they correspond to the tables of large shocks for limited periods (Tables 13-16).

The remaining maps show selected regions on a larger scale. Statistical completeness of mapping (years covered, fraction of the number of shocks occurring which are mapped) differs greatly between the different maps, and even to some extent between different areas shown on the same map.

The regional maps (Figs. 7-30) show all epicenters catalogued (Tables 13-18), except where crowding of plotted points has necessitated omitting small shocks. Within its area, each regional map shows the following (dates are inclusive):

(1) All known class *a* shocks, 1904-1947 (Table 13).
(2) All identified class *b* shocks, 1918-1946 (Table 14).
(3) All identified class *c* shocks, 1932-June 1935.
(4) All intermediate and deep shocks, 1904-1945, which can be located with the requisite accuracy including determination of depth, and those of magnitude 7 or over for 1946.
(5) Other shocks (class *d* or larger) which have been located because their epicenters contribute to seismogeographic information.

In certain limited areas, especially where seismicity is low, this includes every shock for which a reliable epicenter could be determined. These areas are specified in the discussion of individual regions. In the absence of such remarks, the general description applies. A few shocks in 1946 and 1947 are mentioned in the text and entered on the maps, but do not appear in the tables.

Aftershocks have been frequently omitted from the tables and maps; except when required for the statistics of shocks of given magnitudes under items (1), (2), and (3). Aftershocks within a few minutes have generally been disregarded. Magnitude determinations in such circumstances refer to the largest shock of the group, which may not be the first (to which the tabulated origin time refers).

Figures 33 and 34 are outline maps showing the relation of the stable masses to the seismic belts.

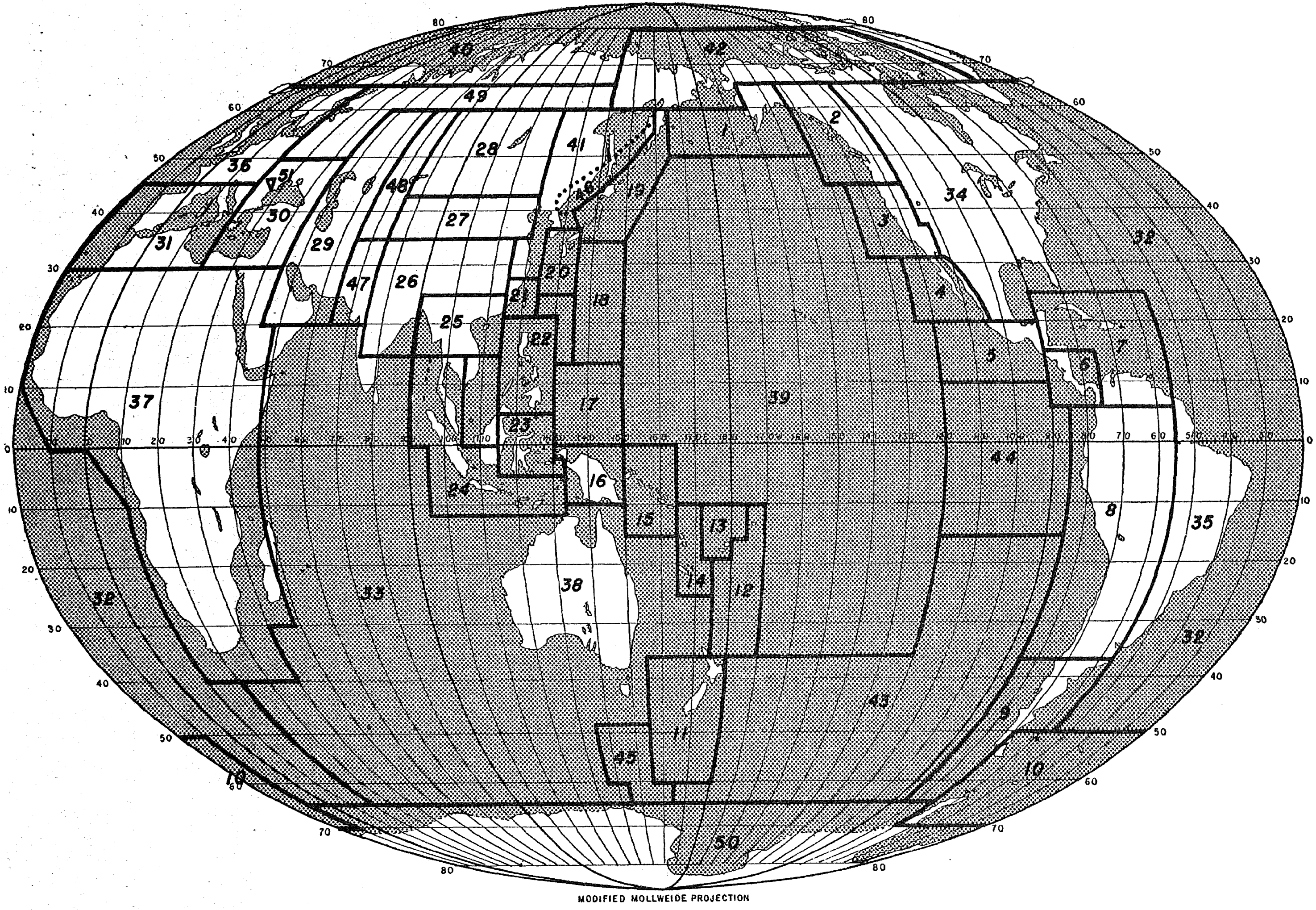

FIGURE 1. Index map of numbered regions.

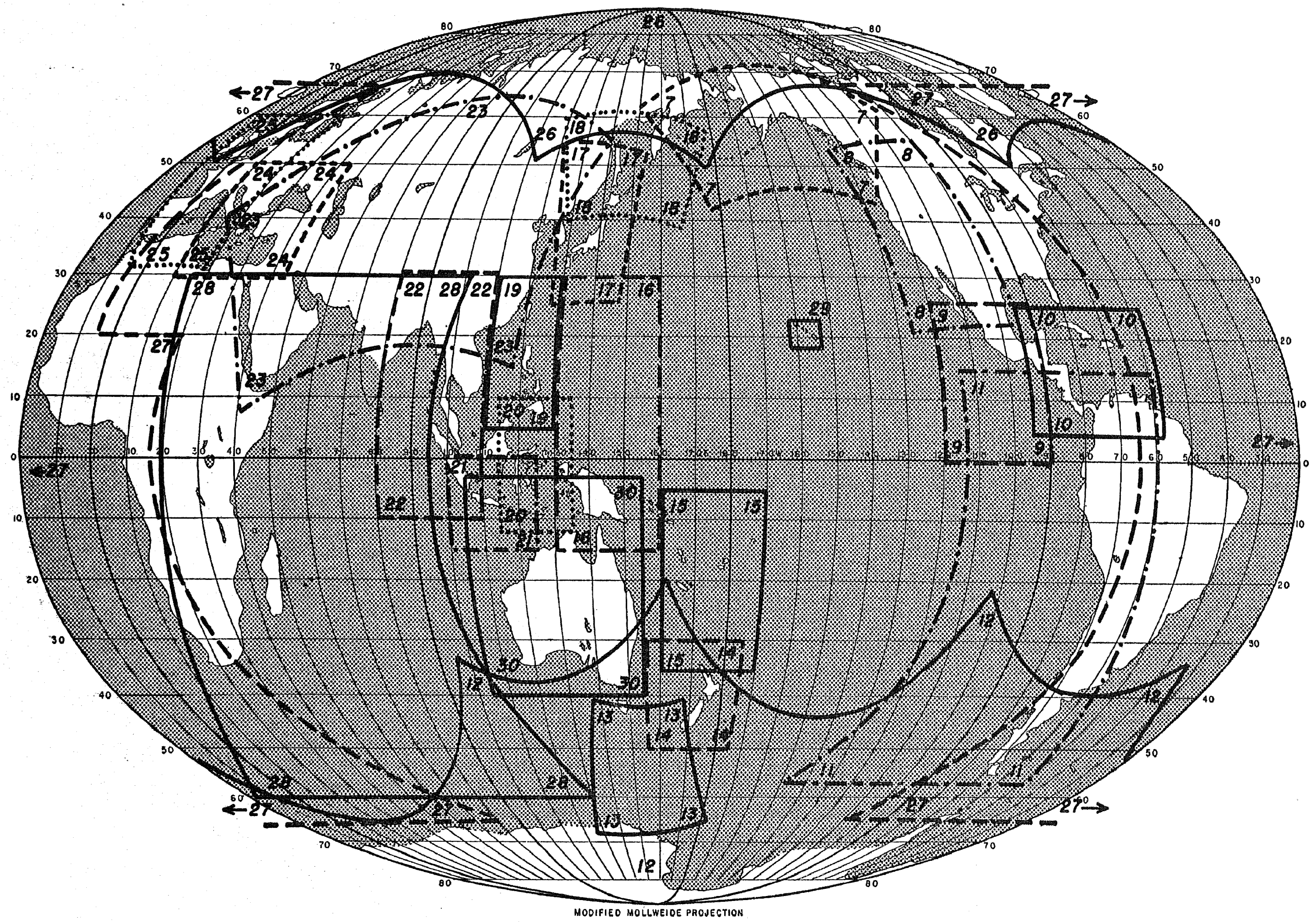

FIGURE 2. Index map of figures.

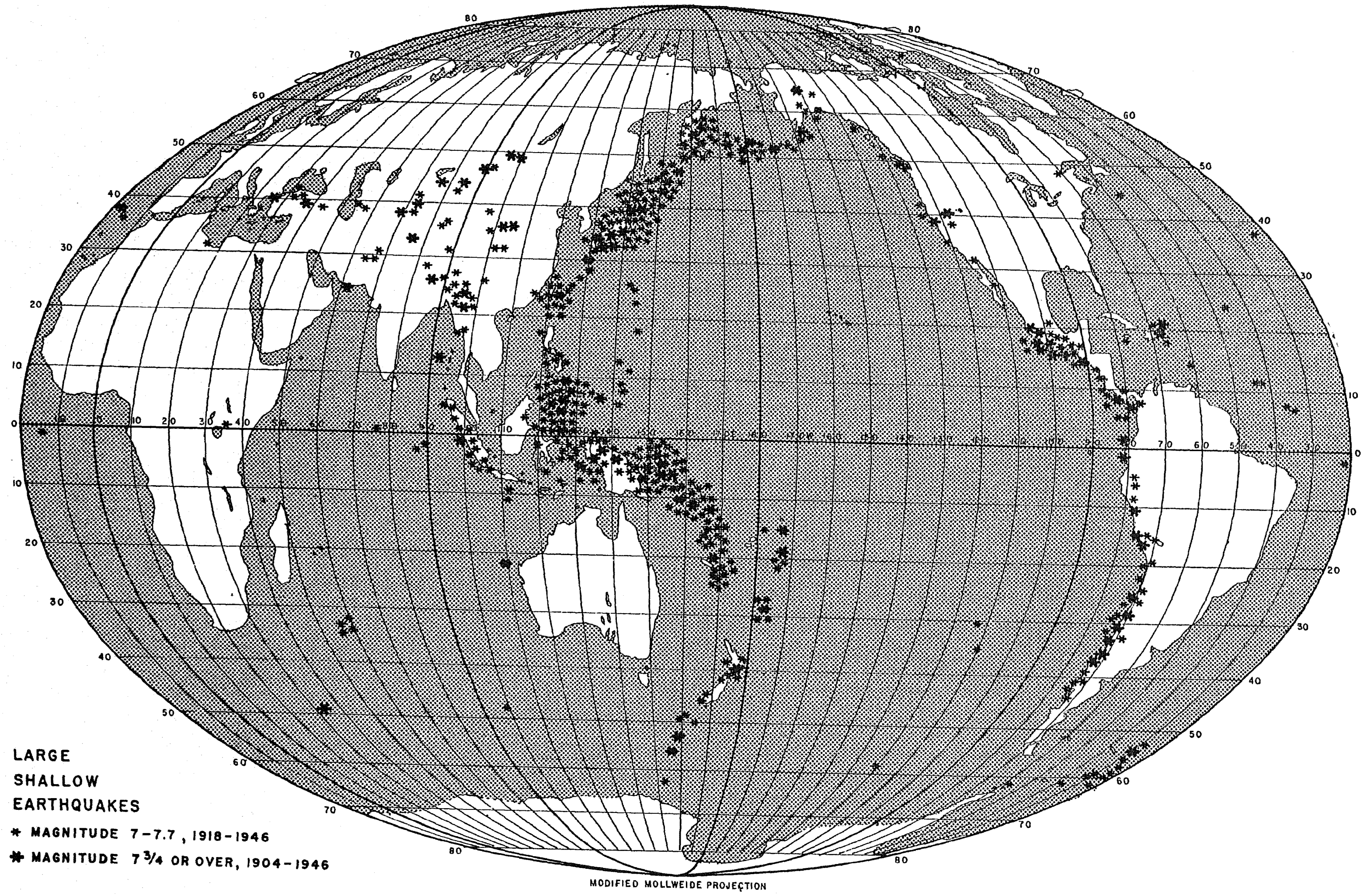

FIGURE 3. World map of shallow earthquakes: class *a* 1904-1946; class *b* 1918-1946.

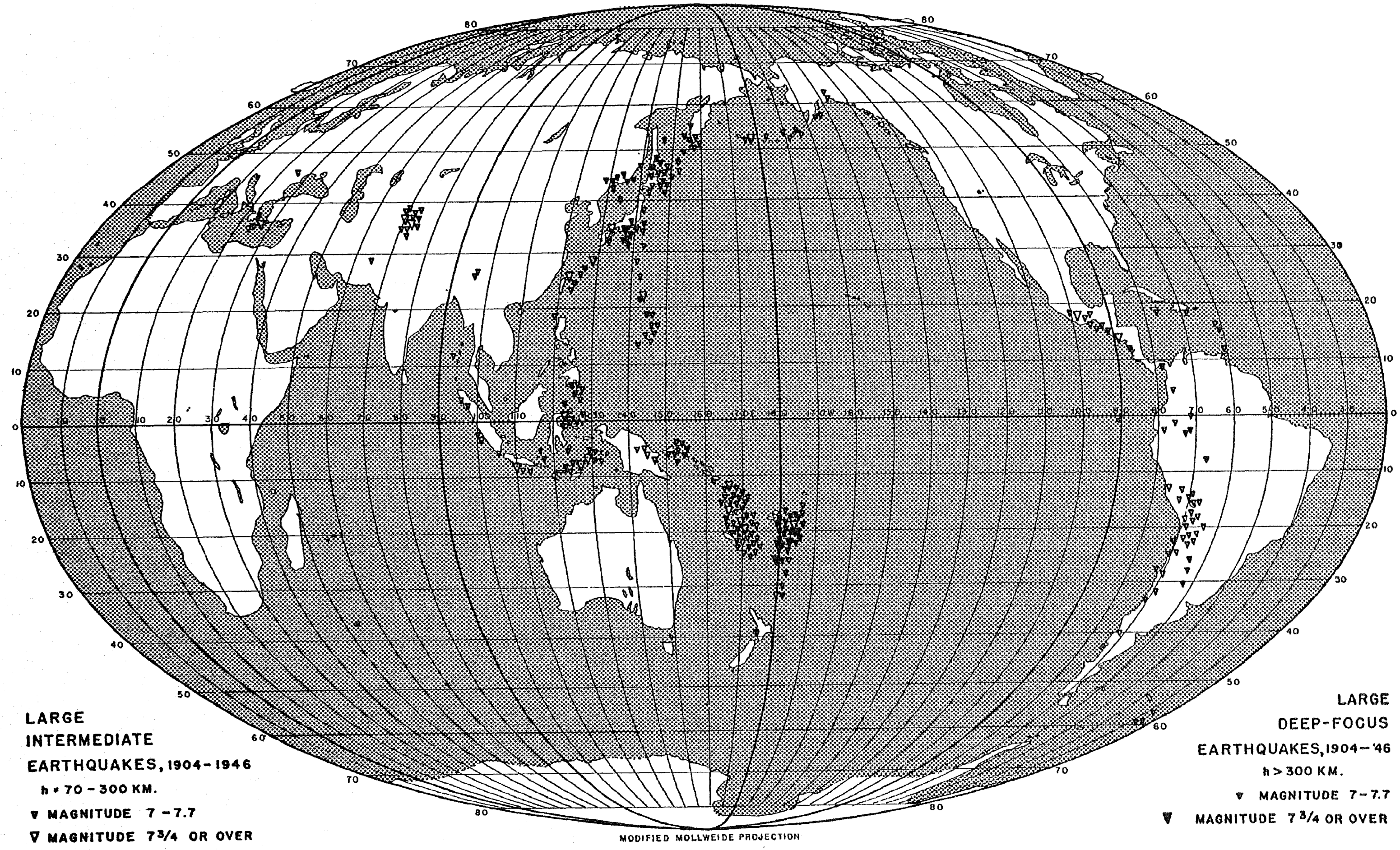

FIGURE 4. World map of deep-focus earthquakes: all known shocks of magnitude 7 and over, 1905-1946.

FREQUENCY AND ENERGY OF EARTHQUAKES

THIS section for the first time includes statistical results for deep-focus shocks on the same basis as for shallow shocks. However, cataloguing is unavoidably less complete for intermediate and deep shocks. Small deep-focus shocks are not always easy to identify, and cataloguing depends largely on number and equipment of stations in the region. The large number of local stations in Japan increases the number of catalogued shocks in the vicinity of Honshu. The European stations increase the catalogue for the Mediterranean area. Many intermediate Mediterranean shocks are newly identified. They were missed previously chiefly because most of the European stations are at distances such that the *P* and *S* waves, as well as the surface waves, are abnormally small. In South America much has always depended on readings at La Paz; but in recent years, availability at Pasadena of original seismograms from Huancayo has added many small intermediate shocks to the list.

There is particular difficulty in assigning magnitude to shocks in the region of the New Hebrides. Many of these are near the border line between shallow and intermediate shocks. The amplitudes of surface waves accordingly give too small magnitudes; frequently the amplitudes of *P* and *S* at Riverview are the only available data. Moreover, many of these shocks have magnitude near 7.0, the lower limit of class *b*.

Statistics for shocks at all depths may be considered complete for the whole world during intervals the length of which varies with the magnitude. Shallow shocks of class *a* are listed for 1904-1947 inclusive (Table 13; none occurred in 1947, the next being on January 24, 1948) and shocks of class *b* for 1918-1946 inclusive (Table 14). Both tables are practically complete. Shocks of class *c* are given only in the regional tabulation (Table 17); the listing for this magnitude is complete from 1932 to June 1935, inclusive, except that a small number of shocks in remote regions and near the lower limit (6.0) may have been missed. Intermediate and deep shocks of magnitude 7 or more are listed in Tables 15 and 16 respectively. These are not complete for the earlier years, but probably almost complete for 1918-1946. These lists would be appreciably lengthened if critical cases near magnitude 7 were included, especially in the southwest Pacific. Additions and changes in locations or magnitude made after July 1946 are not considered in Tables 2 to 11 of this section, which was completed before receiving the *International Seismological Summary* for July-September 1935.

For investigating the distribution of earthquakes in depth, we may use the complete list of identified deep shocks. This has the advantage of dealing with as large numbers as possible, although the process of identification may be slightly selective with respect to depth. The result appears in Table 2. The numbers decrease to a minimum at about 450 kilometers; there is a clear increase to a minor maximum at a depth of 600 kilometers, beyond which the numbers fall off very rapidly to the

TABLE 2

Total number of shocks listed at various depths. Depth in km. (range ± 25 km.)

Region	100	150	200	250	300	350	400	450	500	550	600	650	700
Aleutian Is., Alaska	17	2											
Mexico, Central America	41	10	3	1	1								
Caribbean, Venezuela	10	2											
Andes	83	39	25	12	3					1	11	12	
Southern Antilles	1	4											
Southeast Pacific			1										
New Zealand-Samoa	18	8	10	6	3	5	8	2	8	17	24	8	1
New Hebrides-New Guinea	59	31	13	6	2	4	3	2					
Sunda Arc	36	15	12	2		2	3		1	2	12	3	7
Celebes to Mindanao	16	11	14	2	4		1		4	2	3	1	1
Luzon to Kiushiu	16	8	8	2									
Japanese Is.-Manchuria	66	32	15	13	12	30	30	16	22	17	7	1	
Burma, except Hindukush	16	5	1										
Hindukush	3		33	32									
Rumania	3	7											
East Mediterranean	27	13	2	2	1								
Total	412	187	137	78	26	41	45	20	35	39	57	25	9

deepest shocks known just below 700 kilometers. These general results are confirmed by the use of the smaller aggregate numbers in the range of times and magnitudes considered statistically valid:

Depth (km.)	shallow	100	150	200	250	300	350	400	450	500	550	600	650	700
Number	800±	139	56	38	15	8	11	12	4	7	8	12	7	3

Table 3a shows the mean annual number of shallow, intermediate, and deep shocks within each tenth of a unit of the magnitude scale down to 6.9. For magnitudes 7¾ to 8.6, the data used are complete for 1904-1945 inclusive (shallow shocks), or 1905-1945 inclusive (intermediate and deep shocks). For magnitudes 7.0 to 7.7, the period is 1918-1945; for 6 to 6.9, 1932-June 1935. Where magnitudes were determined only to the nearest quarter, the numbers have been divided among the two or three nearest tenths.

For magnitudes between 6 and 6.9, the mean annual numbers have been determined for each quarter magnitude (Table 3b). The statistical period is 1932-June 1935. For the lower half of this magnitude range, data on intermediate and deep shocks are evidently incomplete. The numbers per quarter magnitude have been divided by 2.5 to make them approximately comparable with those per tenth magnitude in Table 3a. Combined annual numbers in each class are given in Table 3c. For actual numbers of shocks refer to Table 7.

The data in Tables 3a and 3b are plotted in Figure 5. They have been used for linear least-square solutions in the form

(3) $\log N = a + b\ (8 - M)$

where N is the annual frequency and M is the magnitude. Taking N as referred to M in steps of 0.1, the following values of a and b are found;

(4) Shallow shocks:
$a = -0.48 \pm 0.02 \qquad b = 0.90 \pm 0.02$

(5) Intermediate shocks:
$a = -1.2 \pm 0.2 \qquad b = 1.2 \pm 0.2$

(6) Deep shocks:
$a = -1.9 \pm 0.2 \qquad b = 1.2 \pm 0.2$

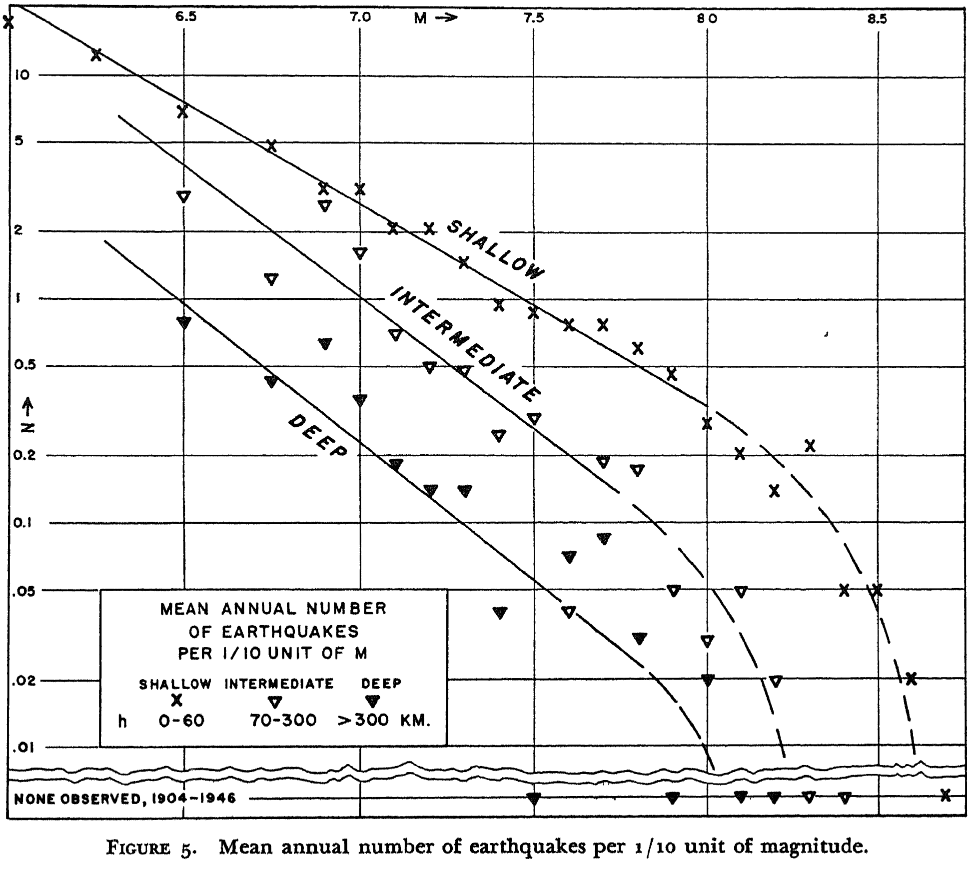

FIGURE 5. Mean annual number of earthquakes per 1/10 unit of magnitude.

These results imply that for shallow shocks a decrease of one unit in magnitude corresponds to an approximately eight-fold increase in frequency. For intermediate and deep shocks the corresponding factor is about 15 in place of 8.

TABLE 3

Mean annual numbers of shocks.

Class	Magnitude	Shallow	Intermediate	Deep
	(a) Magnitude > 6.9 (1/10 units of *M*)			
	8.6	0.02	—	—
	8.5	0.05	—	—
	8.4	0.05	—	—
	8.3	0.21	—	—
a	8.2	0.14	0.02	—
	8.1	0.21	0.05	—
	8.0	0.26	0.03	0.02
	7.9	0.46	0.05	0.00
	7.8	0.60	0.17	0.03
	7.7	0.75	0.19	0.09
	7.6	0.75	0.04	0.07
	7.5	0.86	0.29	0.00
	7.4	0.93	0.25	0.04
b	7.3	1.46	0.46	0.14
	7.2	2.14	0.50	0.14
	7.1	2.14	0.71	0.18
	7.0	3.00	1.64	0.36
c	6.9	3.1	2.6	0.57
	(b) Magnitude 6 to 6¾ (1/10 units of *M*)			
	6¾	4.7	1.2	0.43
	6½	6.9	2.9	0.79
c	6¼	12.2		
	6	16.5		
	(c) Annual numbers in classes *a* to *c*			
a	7¾-8.6	2.2	0.4	0.1
b	7.0-7.7	11.9	4.0	0.9
b+	7.0-7.9	13.1	4.3	1.0
c	6.0-6.9	108		

Reliable statistics for magnitude less than 6 can be set up only for limited regions. The following are mean annual numbers of shocks for two selected areas.

	Magnitude (range ±¼ unit)									
	8	7½	7	6½	6	5½	5	4½	4	3½
S. California	0	0	0.09	0.2	0.5	1.4	3.4	11.5	33	>62
New Zealand	0.02	0.04	0.09	0.0	0.6	1.8	6.0	16.2	46	?

That referred to as "Southern California," which includes a small part of Mexico, is bounded by the parallel of 32°N, the meridian of 115°W, the California-Nevada State line, the parallel of 38°N, the meridian of 120°W, the parallel of 36° and the continental margin. This includes about 300,000 square kilometers, or about 0.06 per cent of the earth's surface. That indicated as "New Zealand" which includes the most active area of the North Island and part of the South Island, is bounded by the parallels of 38° and 42°S, and the meridians of 172° and 178°E, including about 225,000 square kilometers.

The annual averages for Southern California are based on shocks from January 1934 to May 1943, inclusive. Those for New Zealand are taken from the bulletins issued from Wellington for the period October 1940 to January 1944, inclusive; they are based on torsion seismometers of the same type as those in Southern California, using the same methods of determining magnitudes.

The method of least squares was again applied to represent the dependence of the annual numbers N on the magnitudes M (in steps of half a magnitude unit) in the form $\log N = a + b\ (8 - M)$. For Southern California

$$(7)\quad a = -2.04 \pm 0.09 \qquad b = +0.88 \pm 0.03$$

and for New Zealand

$$(8)\quad a = -1.88 \pm 0.05 \qquad b = +0.87 \pm 0.04$$

In both areas the logarithmic law applies at least as far down as magnitude 4. Note that the values of a in (7) and (8) cannot be compared directly with those in (4).

Extrapolation of equations (3) and (4) to lower magnitudes leads to the following estimated annual numbers of shocks for the whole earth:

5.0-5.9	800
4.0-4.9	6,200
3.0-3.9	49,000
2.5-2.9	100,000

Since shocks of magnitude 2.5 are usually reported felt in settled districts, perceptible shocks number at least 150,000 annually, not counting aftershocks and swarms of small shocks. The total number of true earthquakes may well be of the order of a million each year. The frequency cannot go on increasing indefinitely with decreasing magnitude, since a certain minimum stress must exist to produce an earthquake.

Above magnitude 8¼ the number of observed shallow shocks falls off more rapidly than the simple formulas indicate. Thus we have for 42 years:

Magnitude	Calculated	Observed	Deficit
8.1- 8.5	39	28	11
8.6- 9.0	14	1 ($M=8.6$)	13
9.1-10.0	7	0	7

This is also to be expected, since there should be an upper limit to the strain which can be supported by rock before fracture. From isostatic data, Tsuboi (1940) calculated the maximum energy of an earthquake as 5.6×10^{24} ergs. This, however, is appreciably less than the largest energies calculated from the revised equation (2) for observed earthquakes since 1904, which appear to reach 10^{27} ergs.

No shock has been assigned magnitude over 8.6. None of the greater shocks for which we have reliable accounts appear to have been of much higher magnitude, although a shock of magnitude 9½ would release about forty times the energy of the largest catalogued shock, and ought to occupy an exceptional place in the historical record. The great Indian earthquake of 1897 apparently did not much exceed magnitude 8½; the seismograms of the Alaskan shocks of September 1899 (Milne, 1900; Tarr and Martin, 1912) indicate magnitude between 8¼ and 8½. A more serious question relates to the magnitude of the Lisbon earthquake of 1755, since the phenomena of swinging of suspended objects, and of seiches indicate that the surface waves were very large over the whole of western Europe (Reid, 1914). This, combined with the enormous area perceptibly shaken, (regardless of the probability that shocks occurred with several different epicenters) suggests a magnitude between 8¾ and 9. A shock of magnitude over 10 should theoretically be perceptible in scattered areas over the whole earth; alleged historical accounts of such events probably rest on a confusion of different shocks occurring near the same time. In recent years such statements may refer to instrumental recordings.

For shocks at intermediate depth the falling off in frequency with increasing magnitude becomes rapid at a lower magnitude level (7.8) than for shallow shocks (Fig. 5). The entire distribution is shifted toward lower magnitudes. This may be attributed to smaller breaking strength at depth, making the accumulation of large strains less probable, or to greater plasticity, or to both. It is not likely that there is any sufficiently large systematic error in determining magnitudes for intermediate shocks. For magnitudes 7.9 and over, extrapolation of equations (3) and (5) calls for 14 shocks in 42 years, while actually only 6 were observed (none over magnitude 8.2).

Deep shocks show a still larger displacement of the distribution curve, but the numbers are so small that conclusions are less positive. Since 1904 there should have been three deep shocks with magnitude over 7.8; only one such shock (depth only 340 km.) has been observed (1906).

Table 4 includes the largest identified shocks in each group (1904-1947). Combining (2)

$$\log E = 12 + 1.8\,M$$

with (3)

$$\log N = a + b\ (8 - M)$$

we find

$$\log NE = c + k\,M \tag{9}$$

NE is the energy annually released within a range of 0.1 magnitude centered at the given M. This can be integrated, with the result

$$\log E^* = c + 0.64 - \log\ k + kM \tag{10}$$

which is sufficiently close (for shallow shocks) when M ranges from 4 to 8, but should not be applied beyond those limits. E^* is then the annual energy in ergs released in all shocks up to magnitude M.

Using (4), (5) and (6) the following values for c and k result:

	c	k
Shallow shocks	18.7	0.9
Intermediate	20.4	0.6
Deep	19.7	0.6

This gives for

(11) shallow shocks: $\log E^* = 19.4 + 0.9\,M$
(12) intermediate: $\log E^* = 21.2 + 0.6\,M$
(13) deep: $\log E^* = 20.5 + 0.6\,M$

Values for E^* in units of 10^{26} ergs calculated from these equations are given in Table 5. Equations (12) and (13) are probably not valid below magnitude 6½.

The ratios of energies released up to successive levels are well determined. Absolute values of E and E^* are less certain, because of difficulty in fixing the zero of the empirical magnitude scale in terms of absolute units.

Table 5 supports the conclusion that smaller shocks almost never are sufficiently frequent to approximate the energy released in larger shocks. This means that great shocks are essentially independent events, uninfluenced by the occurrence of smaller earthquakes, which are at most symptomatic of the regional strains released in major shocks. Data for southern California show that this relationship extends

TABLE 4

Largest shallow, intermediate and deep shocks, 1904 to 1947.

Date	Region	*h*	*M*	References
(a) Shallow shocks, magnitude near 8.5:				
1906 Jan. 31	Colombia		8.6	See Table 13
1906 Aug. 17	Chile		8.4	
1911 Jan. 3	Tien Shan		8.4	
1920 Dec. 16	Kansu		8.5	
1933 Mar. 2	Japan		8.4	
(b) Intermediate shocks, magnitude near 8:				
1910 June 16	Loyalty Is.	100	8.1	
1911 June 15	Ryukyu Is.	160	8.2	O'Connell (1946) gives $M = 8.4$
1914 Nov. 24	Marianas	110	8.1	
1926 June 26	Rhodes	100	7.9	Sieberg (1932b, pp. 163-173)
1939 Dec. 21	Celebes	150	8.0	
(c) Deep shocks, magnitude 7¾ and over:				
1906 Jan. 21	Japan	340	8.0	Szirtes (1909b)
1932 May 26	Tonga	600	7¾	Brunner (1938)
1937 Apr. 16	Tonga	400	7¾	Westland (1938)

TABLE 5

Annual energy release in units of 10^{26} ergs, calculated from equation (2).

	Energy release E^* up to magnitude			Energy release in interval		
	6	7	8	5-6	6-7	7-8
Shallow shocks	0.06	0.5	4	0.05	0.4	3.5
Intermediate shocks	?	0.3	1	?	0.24	0.7
Deep shocks	?	0.05	0.2	?	0.04	0.15

down to the lowest magnitude levels (Richter, 1935).

It follows that the larger strains accumulate with little reference to release of energy in minor shocks or along minor structures. In general it cannot be asserted that minor shocks function as a "safety valve" to delay a great earthquake. Rather, minor shocks on minor structures are evidence of a regional strain, only a small part of which is being transferred away from the major structures along which it will eventually find release in major earthquakes.

Table 6 shows energy released in units of 10^{26} ergs for each of the years 1904-1945, separating data for shallow and deep shocks; the lower lines of the table assemble the data for selected ten-year periods. Energy for the larger shocks has been calculated from equation (2), $\log E = 12 + 1.8\,M$, which gives the following results (with a large factor of uncertainty):

Magnitude	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6
E (10^{26} ergs)	.04	.06	.10	.13	.20	.32	.50	.79	1.0	1.6	2.5	4.0	6.3	7.9	13	20	25

Below magnitude 7 the second column of Table 5 has been used.

The rate of energy release is extremely irregular. The single year 1906 accounts for about one-eighth of the total, so that the average annual release 1907-1945 is only 8.7 units while the average 1906-1945 is 10.2. 1906 was followed by low activity (note the average 6.06 for 1907-1916).

Intermediate shocks show an energy maximum in 1910-11, owing to two large earthquakes in those years. Most striking is the notable falling off in activity in the intermediate depth range following 1922; except for one large shock in 1926, this activity did not again increase until 1939.

There are shorter intervals when activity is abnormally high, and others when it is unusually low. For a period of weeks significant activity may be concentrated in a limited region. These effects apparently are within the

TABLE 6

Annual energy release in 10^{26} ergs, calculated from equation (2).

Year	Shallow	Intermed.	Deep	All
1904	13.9	0.2	0.4	14.5
05	20.5	2.4	0.2	23.1
06	56.2	0.9	2.6	59.7
07	9.6	0.7	0.5	10.8
08	2.2	1.2	0.1	3.5
09	3.1	3.0	0.4	6.5
10	2.2	7.1	0.5	9.8
1911	19.5	7.8	0.4	27.7
12	5.6	0.8	0.4	6.8
13	4.7	1.6	0.1	6.4
14	4.0	5.1	0.1	9.2
15	5.6	1.9	0.3	7.8
1916	4.1	1.2	0.4	5.7
17	13.6	1.1	0.4	15.1
18	17.8	2.0	1.0	20.8
19	11.1	1.8	0.2	13.1
20	26.5	0.2	0.1	26.8
1921	1.4	1.5	0.6	3.5
22	9.6	0.8	0.6	11.0
23	18.3	0.2	0.1	18.6
24	10.2	0.6	0.3	11.1
25	2.4	0.2	0.1	2.7
1926	2.5	2.2	0.1	4.8
27	3.6	0.4	0.1	4.1
28	6.6	0.2	0.1	6.9
29	7.1	1.3	0.2	8.6
1930	1.2	0.2	0.1	1.5
31	9.2	0.5	0.3	10.0
32	8.6	0.2	1.1	9.9
33	21.8	0.2	0.1	22.1
34	17.0	0.4	0.2	17.6
1935	5.5	0.4	0.2	6.1
36	2.4	0.3	0.1	2.8
37	2.8	1.0	1.1	4.9
38	19.3	0.6	0.1	20.0
39	7.9	3.4	0.1	11.4
1940	3.6	2.0	0.2	5 8
41	14.7	0.7	0.1	15.5
42	9.6	0.8	0.1	10.5
43	10.1	1.6	0.1	11.8
44	5.0	1.3	0.1	6.4
45	9.2	0.4	0.1	9.7
Average	10.23	1.44	0.34	12.01
1946	15.8	0.7	0.2	16.7
1904-1913	13.75	2.57	0.56	16.88
1907-1916	6.06	3.04	0.32	9.42
1914-1923	11.20	1.58	0.38	13.16
1924-1933	7.32	0.60	0.25	8.17
1927-1936	8.30	0.41	0.25	8.96
1934-1943	9.29	1.12	0.23	10.64
1936-1945	8.46	1.21	0.21	9.88

limits of normal statistical fluctuation but may exceed them in certain regions (see Wanner, 1937). These highly irregular variations bear no evident relation to the minor periodicities which have sometimes been claimed. These periodicities, superposed on the large general fluctuation, are somewhat controversial; the reader should compare the findings of Tams (1931, pp. 419-433), Conrad (1932), and Davison (1938), and for deep-focus earthquakes those of Stetson (1935, 1937) and McMurry (1941).

Mean energy ratios among the groups for the whole earth are: shallow/intermediate, 7.2; shallow/deep, 30.0; intermediate/deep, 4.2. The equivalent percentages are: shallow, 85, intermediate, 12, deep, 3. These proportions are less significant than those for the separate regions (Table 8).

The calculated energy release of 12 × 10^{26} ergs annually is comparable with the annual flow of heat from the interior to the surface of the earth, which is 66 × 10^{26} ergs, corresponding to 10^{-6} calories per second per square centimeter (Bullard, 1945). Both seismic energy release and rate of heat flow decrease with depth.

The energy released by an atomic bomb is officially stated as equivalent to that in the detonation of 20,000 tons of TNT, hence of the order of 10^{21} ergs. This corresponds to a magnitude about 5, which agrees roughly with the fact that the seismic waves from the New Mexico test were barely registered at the distance of Pasadena. The magnitude derived from *P* waves from the Baker Day test at Bikini was about 5½ (Gutenberg and Richter, 1946); for energy calculations, it must be considered that there were no *S* waves.

Other artificial explosions are of much less consequence. Major quarry blasts rarely reach magnitude 2½ when their seismograms are interpreted on the scale for earthquake magnitudes.

Volcanic explosions do not give rise to earthquakes of consequence; this is to be expected, as even in the most spectacular cases, such as Krakatoa and Katmai, the greater part of the energy was released into the atmosphere. Rough computation suggests that even for these the total energy was less than in great earthquakes.

Table 7 exhibits the regional distribution of shocks in the statistical study, divided into magnitude classes *a*, *b*, *c*. The time limits for class *a* are 1904-1945. Those for class *b* are in general 1922-1945, and for *c* shocks 1932-June 1935; but in regions where an unusually small number of *b* and *c* shocks occurred during the period studied, while more were listed in earlier years, the statistical periods were extended in computing the annual average. These extended annual frequencies are placed in pa-

TABLE 7

Numbers and energy of shocks in various regions. (For periods used see text.)

	Total numbers used				Annual number					Number in % of all shocks of given column					Energy in %		
	Shall.		Int.	D.	Shallow			Int.	Deep	Shallow			Int.	Deep	Shall.	Int.	Deep
Region and No.	a	b	a, b	a, b	a	b	c	a, b	a, b	a	b	c	a, b	a, b			
Aleutian, W. Alaska, 1	6	15	5	0	0.14	0.54	9.1	0.16	0.00	6.5	4.5	8.4	3.6	0	4.4	2.8	
E. Alaska, Brit. Col., 2	0	3	0	0	0.00	0.11	(0.6)	0.00	0.00	0.0	0.9	0.5	0.0	0	0.1	0.0	
Calif., Nevada, 3	2	5	0	0	0.05	0.18	2.0	0.00	0.00	2.3	1.5	1.8	0.0	0	2.1	0.0	
Gulf of Mexico, 4	0	1	0	0	0.00	0.04	1.1	0.00	0.00	0.0	0.3	1.0	0.0	0	0.1	0.0	
Mexico S. of 28°, 5	7	12	4	0	0.17	0.43	6.0	0.12	0.00	7.8	3.6	5.5	2.7	0	4.2	4.3	
Central America, 6	2	8	1	0	0.05	0.29	3.4	0.04	0.00	2.3	2.4	3.1	0.9	0	1.0	0.7	
Caribbean, 7	1	2	0	0	0.02	0.07	1.1	(0.12)	0.00	0.9	0.6	1.0	2.7	0	0.3	0.7	
S. Amer. N. of 37°, 8	11	14	21	12	0.26	0.50	2.6	0.75	0.07	12.0	4.2	2.4	16.8	6	14.9	7.8	19
S. Amer. S. of 37°, 9	0	5	1	0	0.00	0.18	0.6	0.04	0.00	0.0	1.5	0.6	0.9	0	0.2	0.7	
S. Antilles, 10	1	10	0	0	0.02	0.36	1.4	0.11	0.00	0.9	3.0	1.3	2.5	0	0.6	0.7	
Galápagos, 11	0	0	0	0	0.00	0.00	0.9	0.00	0.00	0.0	0.0	0.8	0.0	0	0.1		
Easter I. Ridge, 12	0	2	0	0	0.00	0.07	2.9	0.00	0.00	0.0	0.6	2.7	0.0	0	0.1		
S. of Macquarie I., 45	0	1	0	0	0.00	0.04	(1.1)	0.00	0.00	0.0	0.3	1.0	0.0	0	0.1		
Macquarie-N. Zeal., 11	3	10	0	0	0.07	0.36	1.1	(0.02)	0.00	3.2	3.0	1.0	0.4	0	1.4		
Kermadec-Tonga, 12	3	6	8	13	0.07	0.21	3.7	0.13	0.44	3.2	1.8	3.4	2.9	41	4.4	5.0	25
Samoa-Fiji, 13	0	1	0	0	0.00	0.04	0.9	0.00	0.00	0.0	0.3	0.8	0.0	0	0.1		
New Hebrides, 14	2	19	23	0	0.05	0.68	6.6	0.78	0.00	2.3	5.7	6.1	17.4	0	3.2	16.3	
Solomon Is., 15	6	27	4	1	0.14	0.96	6.0	0.14	0.04	6.5	8.0	5.5	3.1	4	3.7	1.4	3
New Guinea, 16	4	15	2	0	0.10	0.54	3.7	0.07	0.00	4.6	4.5	3.4	1.6	0	3.0	0.7	
Palau-Guam, 17	1	4	0	0	0.02	0.14	0.6	0.00	0.00	0.9	1.2	0.6	0.0	0	0.5		
Marianas, 18	1	5	8	2	0.02	0.18	2.3	0.27	0.07	0.9	1.5	2.1	6.0	6	0.7	8.5	3
Japan-Kamchatka, 19	12	46	16	11	0.28	1.64	12.3	0.57	0.38	13.0	13.7	11.3	12.8	35	16.6	8.5	44
S.W. Japan, Kiushiu, Formosa, 20, 21	3	22	5	0	0.07	0.79	3.7	0.14	0.00	3.2	6.6	3.4	3.1	0	2.7	14.2	
Philippine Is., 22	4	19	4	1	0.10	0.68	5.1	0.14	0.04	4.6	5.7	4.7	3.1	4	5.5	1.4	3
Celebes, 23	2	16	4	0	0.05	0.57	2.6	0.12	0.00	2.3	4.8	2.4	2.7	0	2.0	7.1	
Sunda Is., 24	3	16	11	1	0.07	0.57	4.9	0.36	0.04	3.2	4.8	4.5	8.1	4	3.6	8.5	3
S. Burma, 25	1	6	0	0	0.02	0.21	0.9	0.00	0.00	0.9	1.8	0.8	0.0	0	1.0		
Himalaya, 26	2	8	2	0	0.05	0.29	2.0	0.07	0.00	2.3	2.4	1.8	1.6		3.0	0.7	
Kansu to Pamir, 27	2	5	0	0	0.05	0.18	0.6	0.00	0.00	2.3	1.5	0.6	0.0		5.7		
Baikal to Pamir, 28	5	2	0	0	0.12	0.07	0.9	0.00		5.5	0.6	0.8	0.0		7.4		
Hindu Kush (in 48)	0	0	7	0	0.00	0.00	(0.0)	0.23		0.0	0.0	0.0	5.1		0.0	5.7	
Baluchistan, Iran, 29, 47, 48	3	3	0	0	0.07	0.11	2.9	0.00		3.2	0.9	2.7	0.0		2.7		
Asia Minor to Italy, 30, 31, 51	2	5	3	0	0.05	0.18	2.9	0.09		2.3	1.5	2.7	2.0		1.2	4.3	
West. Mediterr., 31	0	0	0	0	0.00	0.00	(0.1)	0.00		0.0	0.0	0.1	0.0		0.1		
Spain to Azores, 31	1	1	0	0	0.02	0.04	(0.1)	0.00		0.9	0.3	0.1	0.0		2.0		
Arctic, 40	0	0	0	0	0.00	(0.02)	(0.5)	0.00		0.0	0.2	0.5	0.0	0	0.1		
Atlantic, 32	0	7	0	0	0.00	0.25	5.8			0.0	2.1	5.3			0.4		
Indian Ocean, 33	1	8	0	0	0.02	0.25	3.1			0.9	2.1	2.8			0.8		
Africa, 37	0	1	0	0	0.00	0.04	(0.6)			0.0	0.3	0.6			0.1		
Cent., East. North Amer., Baffin Bay, 34, 42	0	3	0	0	0.00	0.11	0.9			0.0	0.9	0.8			0.1		
Australia, 38	1	0	0	0	0.02	0.00	(0.2)			0.9	0.0	0.2			0.2		
Others 35, 36, 39, 41, 49, 50	0	1	0	0	0.00	0.04	0.09	0.00	0.00	0.0	0.3	0.8	0.0	0	0.1		
Circum-Pacific Belt	74	284	120	31	1.75	10.14	86	4.08	1.08	80.6	85.0	79.3	91.3	100	75.4	89	100
Transasiatic Belt	16	30	12	0	0.38	1.07	10	0.39	0.00	17.4	9.0	9.6	8.7	0.0	22.9	11	0
Others	2	20	0	0	0.04	0.74	12	0.00	0.00	1.8	6.2	11.0	0.0	0.0	1.8	0	0
All Shocks	92	334	132	31	2.2	11.9	108	4.47	1.08	99.8	100.2	99.9	100.0	100	100	100	100

TABLE 8

Annual energy release E^* in units of 10^{24} ergs, calculated from equation (2).

Region and No.	Energy E^* Shallow	Int.	Deep	Energy ratio Int./Sh.	Deep/Sh.	Deep/Int.
Aleutian Is., 1	45	4		0.09		
Mexico, 5	42	6		0.14		
Central America, 6	10	1		0.1		
Caribbean, 7	3	(1)		(0.3)		
South America (north), 8	151	11	6	0.07	0.04	0.5
South America (south), 9	2	¼		(0.1)		
S. Antilles, 10	6	1		0.2		
Easter Island Ridge, 43	1					
Macquarie-N. Zealand, 11	14	(¼)		(0.2)		
Kermadec, 12	45	7	8	0.16	0.18	1.1
New Hebrides, 14	32	23		0.7		
Solomon Islands, 15	38	2	1	0.05	0.02	(0.5)
New Guinea, 16	30	1		0.03		
Marianne Islands, 18	7	12	1	1.7	0.1	0.1
Japan-Kamchatka, 19, 46	168	12	14	0.07	0.08	1.1
Kiushiu-Formosa, 20, 21	27	20		0.7		
Philippine Is., 22	56	2	1	0.04	0.02	(0.5)
Celebes, 23	20	10	½	0.5	0.02	(0.1)
Sunda Is., 24	37	12	1	0.3	0.03	0.1
Burma, 25	10	½		(0.05)		
Himalaya, 26	30	1		0.03		
Hindu Kush, (in 48)		8		large		
Iran, 29	27	¼		(0.01)		
Asia Minor Mediterranean } 30, 31, 51	12	6		0.5		

rentheses in the table, and consequently do not correspond to the corresponding entries (often zero) in the columns showing total numbers of shocks in the statistical period.

Table 8 gives the annual energy released in shallow, intermediate and deep shocks in units of 10^{24} ergs in the various regions.

Table 9 shows the constants a and b of equation (3) as found for various regions, corresponding to quarter units of magnitude

TABLE 9

Constants a and b in equation (3) for selected regions giving annual frequency corresponding to ¼ units of M.

Region	No.	a	b
(a) Shallow Shocks			
Alaska	1, 2	—1.5 ± 0.1	1.1 ± 0.1
So. California	—	?	0.88 ± 0.03
Mexico, Central America	5, 6	—1.1 ± 0.1	0.9 ± 0.1
So. America ($h < 100$)	8	—1.1 ± 0.1	0.45 ± 0.1
New Zealand	—	?	0.87 ± 0.04
Kermadec Is.	12	—2.3 ± 0.1	1.3 ± 0.2
Solomon Is.	15	—1.23 ± 0.06	1.01 ± 0.07
Japan	19	—0.90 ± 0.08	0.80 ± 0.08
Sunda Is.	24	—1.5 ± 0.1	0.9 ± 0.1
Pamir to Eastern Asia	26, 28	—1.7 ± 0.1	0.6 ± 0.14
Turkey	30	—2.1 ± 0.1	0.9 ± 0.1
Atlantic	32	—2.4 ± 0.2	1.4 ± 0.2
Indian Ocean	33	—2.4 ± 0.2	1.3 ± 0.1

Region	No.	a	b
(b) Intermediate shocks			
Marianne Is.-Japan-Kamchatka	18, 19	—1.6 ± 0.1	1.2 ± 0.1
Loyalty Is.-New Guinea	14, 15, 16	—1.7 ± 0.1	1.4 ± 0.1
Western Asia, Mediterranean without Hindu Kush	29, 30, 31, 47, 48, 51	—2.1 ± 0.2	1.2 ± 0.2
Hindu Kush	(in 48)	—1.6 ± 0.1	0.6 ± 0.1
So. America, 5°S-25°S	8	—1.5 ± 0.1	1.0 ± 0.1
(c) Deep shocks			
Marianne Is.-Japan-Kamchatka	18, 19	—1.9 ± 0.1	1.3 ± 0.2
Kermadec and Fiji	12, 13	—2.3 ± 0.4	1.5 ± 0.4

TABLE 10

Yearly period, number of earthquakes of magnitude 7 or more.

	Total	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Shallow north of 20°N	158	8	14	10	10	14	11	12	14	11	10	24	20
Shallow south of 15°S	78	7	6	11	4	4	8	2	10	10	5	8	3
Intermed. } north of 20°S	81	7	7	5	8	4	10	9	3	6	10	8	4
and deep } south of 15°S	84	4	4	7	7	10	6	6	10	8	9	9	4
All shallow	421	34	32	37	29	33	36	28	37	37	32	47	39
All intermediate and deep	253	21	17	18	22	20	22	22	18	26	27	26	14
All shocks	674	55	49	55	51	53	58	50	55	63	59	73	53

(*not* tenth units). For shallow shocks magnitudes 6 to 8 are used, except for eastern and central Asia, where 8½ was included. For intermediate and deep shocks magnitudes were used from 6¼ to 8, except for intermediate shocks in the Loyalty Islands-New Hebrides area and deep shocks in the Tonga salient, where data for 6¼ were clearly incomplete and were not used, and for South America and the Hindu Kush, where magnitude 6 was included.

Attention is particularly called to the last lines of Table 7, showing that the circum-Pacific belt accounts for eighty per cent or more of every type of activity. The Japan-Kamchatka region is that showing the highest general level of seismicity. In South America, with about the same geographical extent, the release of energy is comparable, but this is due primarily to the larger shocks of class *a*; the Japanese area is much more frequently subject to class *b* shocks. The largest release of energy at intermediate depth occurs in the New Hebrides. Deep shocks are most frequent in the Kermadec-Tonga region. In the Marianne Islands more energy is released in intermediate than in shallow shocks.

The increase in frequency of shocks with decreasing magnitudes is approximately the same in all regions, with the following exceptions. In South America and in the region of central and east Asia the number of very large shocks is disproportionately large, while in the Atlantic and Indian Oceans the larger shocks are disproportionately rare. Among the Hindu Kush earthquakes at intermediate depth the larger shocks are abnormally frequent; the number of identified shocks increases with decreasing magnitude with exceptional slowness.

The shallow activity of the California-Nevada area appears from the tables as slightly exceeding two per cent of that of the world. The corresponding figure for the selected area in Southern California is not far from ½ per cent. The California-Nevada activity is about 90 per cent of that of the continental United States excluding Alaska.

The data can be used to investigate annual and daily periodicities. Of the shallow shocks, only the statistically listed class *a* and *b* shocks have been used, 420 in number. Of intermediate and deep shocks, all those of magnitude 7 and over have been used, with dates 1904-45. This gives 200 intermediate shocks and 53 deep shocks. Some minor changes were made during the calculations.

Table 10 shows distribution by months of the year for all these larger shocks. Separate lines show data for the northern and southern hemispheres, and for the various groups individually and in combination. There is a clear majority in the second half of the year (July-December) for both hemispheres. The data have been subjected to harmonic analysis. The results are:

Shallow north of 20°N.	$N = 13.2 + 1.6 \sin (x + 149°) + 2.9 \sin (2x + 0°)$
Shallow south of 15°S.	$N = 6.5 + 0.5 \sin (x + 200°) + 2.1 \sin (2x + 140°)$
Intermediate and deep N.	$N = 6.8 + 0.4 \sin (x + 239°) + 0.8 \sin (2x + 19°)$
Intermediate and deep S.	$N = 7.0 + 1.4 \sin (x + 241°) + 1.9 \sin (2x + 77°)$
All shallow.	$N = 35.1 + 3.7 \sin (x + 149°) + 1.8 \sin (2x + 18°)$
All intermediate and deep.	$N = 21.1 + 2.8 \sin (x + 216°) + 2.0 \sin (2x + 77°)$
All shocks.	$N = 56.2 + 5.3 \sin (x + 178°) + 2.9 \sin (2x + 44°)$

TABLE 11

Daily period. number of shocks of magnitude 7 or more.

Hour	Shallow	Intermediate and deep	All
0	18	11	29
1	15	7	22
2	19	17	36
3	23	7	30
4	19	14	33
5	19	19	38
6	17	11	28
7	26	11	37
8	17	8	25
9	16	6	22
10	18	14	32
11	18	8	26
12	19	9	28
13	15	6	21
14	13	15	28
15	15	15	30
16	19	8	27
17	23	11	34
18	18	11	29
19	10	11	21
20	20	5	25
21	15	11	26
22	12	9	21
23	16	9	25
Total	420	253	673

The data scatter considerably and tests for significance are not favorable; however, the annual terms in the various groups agree fairly well when taken individually. They do not agree with findings of Conrad (1933), Landsberg (1933), and Visser (1936a), which disagree among themselves (see also Davison, 1938; Conrad, 1932).

In an earlier paper (Gutenberg and Richter, 1938a) it was noted that 41 of 58 listed deep-focus earthquakes in the region Marianne Is.-Japan-Kamchatka had occurred in the first half of the year, and only 17 in the second half. The ratio is much smaller now, with 76 shocks in the first half and 54 in the second half; the figures for shocks of magnitude 7 and over are 13 and 6 respectively.

For the daily period, the hours of the same shocks have been reduced to local times at their epicenters, with the results shown in Table 11. Harmonic analysis has been carried out separately for shallow, intermediate and deep shocks, and for all together. The results are:

All show a maximum at about 6*h* local time. However, again the significance tests are not favorable. The period of 1/3 day, indicated in a previous paper, has not reappeared in this later study. Lunar periodicities in the present material have not been investigated.

The distribution over the years has been examined in relation to the sunspot period. Although the very seismic year 1906 corresponds to a sunspot maximum, other sunspot maxima do not show a clear correlation. In particular, the maximum of 1928 corresponds to rather low seismicity.

Correlation between earthquakes and meteorological phenomena has been investigated by Conrad (1932, 1946).

Leet (1938, p. 76) has pointed out a number of instances of deep-focus shocks in the same region at about the same day of the year. Such coincidences also occur in shallow shocks; statistical investigations (Nordquist and Geldart, 1948) indicate that they are due to chance. This, and many other detailed statistical investigations suggested by the data here presented, are outside the immediate scope of this book.

Shallow. $N = 17.5 + 1.8 \sin (x - 4^\circ) + 1.9 \sin (2x - 48^\circ) + 1.0 \sin (3x + 16^\circ)$

Intermediate and deep. $N = 10.5 + 0.9 \sin (x + 15^\circ) + 1.0 \sin (2x - 62^\circ) + 0.7 \sin (3x + 68^\circ)$

All. $N = 28.0 + 3.0 \sin (x + 2^\circ) + 3.6 \sin (2x - 41^\circ) + 0.4 \sin (3x - 9^\circ)$

STRUCTURE OF THE EARTH

THE interior core of the earth is separated from the exterior portion, or mantle, by a sharp discontinuity about 2900 kilometers below the surface. Earthquakes originate only in the mantle, from near the surface to depths not much exceeding 700 kilometers. Neither the wave velocities nor other seismic data indicate a discontinuity near the latter depth, although at about 1000 kilometers there is a rapid change in the rate at which velocity increases with depth.

At a depth of roughly 80 to 100 kilometers the velocity decreases slightly with depth, producing a shadow zone for seismic waves (Gutenberg and Richter, 1939b; Gutenberg, 1945b, 1948). This seriously hampers the work of locating and assigning magnitudes to shocks when using stations at distances less than 15°. It has been tentatively suggested that this corresponds to a transition from the crystalline to the glassy state. Widely divergent discussions of the temperature relative to the melting point and the depth are given by v. Wolff (1930, p. 44), Rittmann (1945), Kennedy and Anderson (1938), Daly (1946).

Isostasy and post-glacial uplift indicate that the strength (resistance to plastic flow) below 80± kilometers is less than 1/100 of that near the surface. There is no great change near this depth in the coefficient of viscosity which controls the speed of plastic flow.

Above the 80-kilometer level the structure is differentiated geographically. In general, there are no major discontinuities in the region of the Pacific basin between this level and the surface. There are relatively thin surface layers, chiefly sedimentary; and the large volcanic structures, such as those of the Hawaiian Islands, may have roots extending to considerable depth. Wave velocities in these layers and structures may be as low as those in continental rocks. Under the continents as well as in the areas of the Atlantic and Indian Oceans, there is a continental crustal structure separated from the underlying mantle by the sharp Mohorovičić discontinuity.

The surface features of the earth exhibit a corresponding division into two regions of different structure, the Pacific and Atlantic structures of Suess. These are associated with two correspondingly different types of eruptive rocks. This petrographic distinction has been used to draw the boundary which separates the Pacific basin proper from the partially submerged continental areas west and southwest of it (Marshall, 1912); this boundary is known as the andesite line or Marshall line (Fig. 33; Born, 1933, p. 759 and Fig. 306; Chubb, 1934; Bryan, 1944; Macdonald, 1945; Stearns, 1945a, b).

The andesite line, where well marked, is the most decisive criterion for locating the boundary of the Pacific basin. Unfortunately, in many sectors the appropriate data are lacking, incomplete, or susceptible of opposite interpretation. Moreover, the underlying structure may be obscured locally by superficial layers of coral, oceanic sediments, or volcanic products. It is thus necessary to call upon other and less direct means of detecting it. The first of these is the velocity of seismic surface waves with periods of 20 seconds or less; the mean velocity of such waves on paths crossing the Pacific basin is over 20 per cent higher than on exclusively continental paths. (Corresponding velocities across the Atlantic and Indian Oceans are intermediate in value.) With increasing period and wave length this difference becomes comparatively insignificant, consistently with the hypothesis, in regular use in seismology, that there are no major horizontal differences below the 80-kilometer depth level.

Further, surface waves show considerable loss of energy in crossing the Pacific boundary. Normally it is not possible to tell at what point in the path this takes place; but it is possible to compare waves traveling along adjacent paths. Surface waves traveling for appreciable distances near the boundary are greatly decreased in amplitude (Gutenberg, 1945).

Reflected longitudinal waves (*PP*) show decreased amplitudes when reflection takes place in the Pacific area. This is explained as due to high velocities near the surface (Gutenberg and Richter, 1935; 1939c, p. 816ff.). Lastly, inferences may sometimes be drawn from the nature of the submarine topography, when soundings are sufficient in number. Foredeeps, however, are no evidence for the Pacific boundary, since they occur also where arcuate structures front on non-Pacific areas.

All these criteria have also been applied by deJersey (1946) to the limited data available in the Australian region.

The methods indicate continental structure in certain areas covered by the waters of the Pacific Ocean but outside the principal Pacific basin, such as the Philippine Sea and the area between the Easter Island Ridge and the American coast. Noting such exclusions, the boundary of the Pacific area is as follows (Fig. 33).

From New Zealand round the margin of the Tonga salient the boundary is the andesite line, practically as drawn by Marshall. The line certainly passes the Caroline Islands; the topography and structure suggest drawing it round by way of Halmahera and Yap to Guam.

From here north to Kamchatka the Pacific boundary must pass east of the island arcs with their andesitic volcanoes; evidence from surface waves and *PP* confirms this decision at various points. Similarly, it must pass south of the Aleutian arc.

Evidence from amplitudes of surface waves and *PP*, especially at Pasadena, combines with the character of the submarine topography to draw the Pacific boundary across the Gulf of Alaska, leaving a large submarine continental area on the northeastern side.

Off the Pacific coast of the United States and Mexico data are insufficient to draw the exact boundary, which must pass west of the islands off the California coast. Southwest from Mexico the boundary must be close to the Easter Island Ridge. Evidence from surface waves, and especially clearly from *PP* recorded at Huancayo (Peru), establishes continental structure in part of this area, which may possibly include isolated areas of Pacific structure. The Easter Island Ridge continues nearly to New Zealand, so that the boundary can be closed westward in that direction.

Outlying areas of Pacific structure probably include the interiors of the Caribbean and South Antillean loops, and the deep Arctic basin north of Alaska. The first and last of these are indicated by amplitudes of *PP*. If any such areas exist in the Alpide belt, they must be very limited and consequently have escaped detection.

The continental crustal structures have several internal divisions (cf. Fig. 32). The principal subdivision is into a lower group of several layers, supposed to be basaltic in character, and an upper granitic or granitoid layer, on which the sedimentary rocks are superposed. The number and thicknesses of these crustal layers, as well as the overall thickness of the whole crust, vary considerably in different regions. Local differences in wave velocities of the deeper layers suggest variations in material. The total thickness of the crust is notably less in the areas covered by the Atlantic and Indian Oceans than in the surrounding continental areas, but the transition appears to be gradual (Ewing *et al.*, 1937). As expected from the phenomenon of isostasy, the crustal structures extend to deeper levels under the great mountains (Gutenberg, 1943b). Under the Alps it is the granitic layer which is thickened; under the Sierra Nevada (Figure 32) it is one of the intermediate layers of presumably basaltic type. For regional variations in wave velocities and elastic constants see Gutenberg (1945b).

Wherever detailed investigation is possible, the majority of normal shallow earthquakes are found to originate at or near the base of the granitic layer. Consequently, this active level varies in depth from region to region. In the writers' investigation of wave velocities and times of propagation for the whole earth, the mean depth of shallow shocks has been assumed to be 25 kilometers; this is a partly arbitrary assumption. In many active regions small shocks are found originating at shallower depths, even within the sedimentary layers; in great earthquakes faulting occasionally extends to and ruptures the surface, so that aftershocks may originate considerably nearer the surface than the main disturbance. Also in most regions some shocks originate in the lower crustal layers, and even below the Mohorovičić discontinuity, where they grade into the group of earthquakes at intermediate depth.

Shocks at depths of 60 kilometers or less are listed as shallow, those at 70 kilometers as intermediate. This boundary does not correspond to any discontinuity, and should be redefined when more information on structures is available.

The surface structures of the earth exhibit a number of distinct types, different in their geological history, and each associated with a characteristic pattern of seismicity. The most active of these are the Pacific structural arcs. These are folds developed about the margin of the Pacific basin, and elsewhere where regions of different crustal structure are in contact. Where most clearly defined, these arcs are still active with earthquakes at all depths, and folding is still in progress. The similar arcs of the Alpide group are less active and show fewer of the characteristic features.

In limited sectors about the Pacific, as well as in other areas, there are conditions such that shearing and strike-slip faulting predominate. Long fault zones develop; displacement frequently ruptures the surface. Deep shocks are few or absent.

The geological history of the earth identifies a limited number of stable masses, which have undergone little deformation in the later geological periods. The largest of these is the basin of the central and northern Pacific Ocean; the others are the continental shields or nuclei—the Canadian Shield, the Brazilian Shield, the Baltic Shield, the Angara Shield in north central Asia, the African stable mass, the stable region of central and western Australia, and the stable masses of Arabia and southern India, with other smaller units.

For detailed discussion of many of the points touched in this section see Gutenberg (1939b).

INTRODUCTION TO REGIONAL DISCUSSION

FIGURES 3 and 4 together present the state of our knowledge of the geographical distribution of seismicity, so far as it is exhibited by the larger shocks. The regional maps give further detail. The principal geographical divisions are:

(1) The circum-Pacific belt, with many branches and subdivisions. This includes a large majority of shallow shocks, a still larger fraction of intermediate shocks, and all the deep shocks in the restricted sense.

(2) The Mediterranean and trans-Asiatic zone, with the Alpide belt. This accounts for most of the remaining shallow shocks, including nearly all those of class *a* outside the Pacific belt; the Alpide belt contains all the remaining intermediate shocks.

(3) Other narrow belts, including only shallow shocks. One of these extends through the Arctic and Atlantic Oceans; another, with several imperfectly known branches, through the Indian Ocean.

(4) Rift zones internal to the stable masses. The greatest and most seismic of these is that of East Africa, with which some authors have associated that of Palestine. The Hawaiian Islands mark an active rift zone interior to the Pacific mass.

(5) Active areas marginal to the continental stable masses. These are usually near seacoasts; but some are inland, as in central India.

(6) Minor seismic areas. These are extensive regions, mostly characterized by older orogenies, lying between the stable continental nuclei and the active belts of the first three groups.

(7) Stable masses. These include the continental nuclei of old rocks; but the great area of the north and central Pacific also belongs here. Very small shocks occur even in these regions, and indeed seem to take place occasionally almost anywhere.

In the following discussion, the active areas of the globe have been divided into the numbered regions shown on Figure 1. The numbering first makes the circuit about the Pacific, then covers the trans-Asiatic zone, and follows with the remaining active belts and regions of minor seismicity. Regions numbers 46 (Manchuria) and 51 (Rumania) are limited to deep and intermediate shocks.

Within each numbered region serial numbers have been assigned to the individual earthquakes (separately for shallow, intermediate, and deep shocks). The complete designation for each shock consists of the regional number, a letter *N, I* or *D* indicating "normal" shallow depth, intermediate depth, or deep focus below 300 kilometers, and a serial number in geographical order within the region. Thus 24I37 indicates region 24, shock 37 of intermediate series. In most series numbers have been assigned at spaced intervals from 1 to 999, thus providing for later additions. In the regional tabulation (Tables 17, 18) only the serial numbers for the shocks are given, the regions and depth being shown as subheads. For intermediate and deep shocks the new numbers supersede those used in previous papers. Shocks later than 1945 are not included in Tables 17 and 18.

The highest seismicity is reached in association with arcuate structures of Pacific type. Moderate and occasionally high seismicity is found associated with structures which are not arcuate. These are most notable in the northern part of the trans-Asiatic zone, in the Arctic-Atlantic and Indian Ocean belts, and in the various rift zones. However, the Pacific belt includes several sectors in which the structures are not arcuate and the displacements are primarily by shearing instead of folding, as in California, New Zealand, and Sumatra.

The Pacific arcuate structures typically display a unilateral ordering of structures and attendant phenomena, which have been described previously (Gutenberg and Richter, 1945; for gravity anomalies and volcanoes see also Meinesz, 1939) and assigned the following letters, beginning on the convex side of the arc:

(*A*) An oceanic trench, trough, or foredeep.

(*B*) Shallow earthquakes and negative gravity anomalies, occurring in a narrow belt on the concave side of the submarine trough. Frequently the ocean bottom here rises in a ridge, which may emerge into small non-volcanic islands.

(*C*) Maximum of positive gravity anomalies. Earthquakes at depths near 60 km., frequently large.

(*D*) The principal structural arc, of Late Cretaceous or of Tertiary age, with active or recently extinct volcanoes. Shocks at depths of the order of 100 km. Gravity anomalies decreasing.

(*E*) A second structural arc. Volcanism older and usually in a late stage. Shocks at depths of 200-300 km.

(*F*) A belt of shocks at depths of 300-700 km.

Figure 6 shows these features in a typical cross section. The details vary widely from region to region; often one or more features are poorly represented or unknown.

These features are unequally and unevenly represented on the maps of the present paper. Those involving seismicity are as clearly shown as available data permit. Near the main islands of Japan more shocks are located than can conveniently be mapped, while in the region of the Southern Antilles the epicenters are often so uncertain as to obscure the relation of the seismicity to the structural arc.

Only those volcanoes are mapped which have erupted within the last few centuries, as shown by historical records or by indirect dating from evidence on the ground. Volcanoes now in a late or solfataric stage, or those of whose eruption there is only doubtful tradition, are omitted. The intention is to provide an indication of volcanic lines for correlation with other features; the maps and the corresponding list (Table 19) are not offered as documents in volcanology.

Omission of recently extinct volcanoes removes some of the evidence for feature *E* from the maps. This is unfortunately necessary, since extensive mapping of this kind raises numerous problems which must be left for expert volcanologists.

Submarine contours are fairly well known near most of the active arcs. Gravity anomalies, on the other hand, are very incompletely known, most of the data being from the submarine expeditions of Meinesz and others; several important arcs have not been investigated at all.

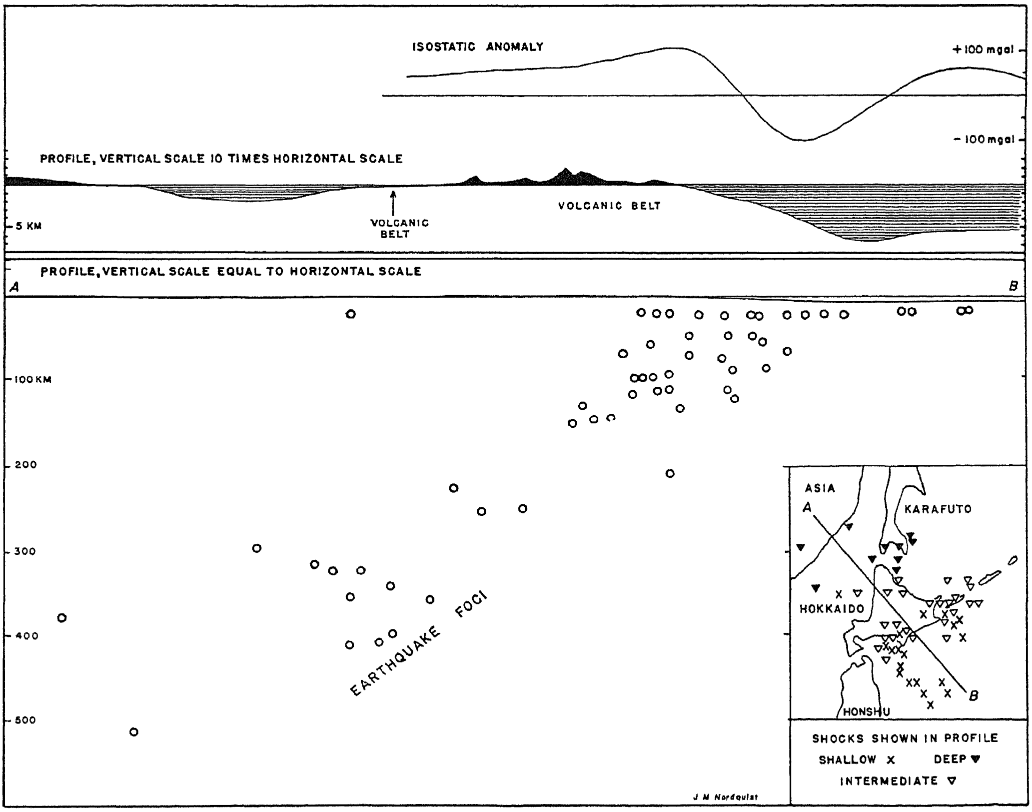

FIGURE 6. Profile, northern Japanese region, showing earthquake hypocenters, relief, and isostatic gravity anomalies.

THE CIRCUM-PACIFIC BELT

General survey

The order of description is clockwise around the Pacific in the main active belt, beginning with the Aleutian Islands. On the American side this includes two active loops extending eastward—the Caribbean or Antillean loop, and the South Antillean loop through South Georgia and the South Sandwich Islands. There is also an active branch including the Galápagos Islands and the Easter Island Ridge.

On the western side there are two branches. One begins south of New Zealand and follows the andesite line by way of the Tonga and Melanesian island groups to a point west of New Guinea, where it turns sharply northeastward through Halmahera, the Caroline Islands, and the Marianas Islands to Japan, the Kurile Islands, and Kamchatka.

The other western branch separates in central Japan, passing south through Kiushiu, Formosa, and the Philippines, and by way of Celebes round the Banda Sea and along the arc of the lesser and greater Sunda Islands to the Nicobar and Andaman groups. The Sunda arc, though remote from the Pacific Basin, exhibits all the characteristics of the Pacific type. The earthquakes of Burma are discussed with the trans-Asiatic zone.

South of New Zealand an active belt extends westward to connect with those of the Indian Ocean; there is a less well indicated connection between the South Antillean loop and the southern end of the Atlantic belt.

Deep shocks occur in belts which locally diverge widely from those characterized by shallow and intermediate shocks.

Aleutian arc

The Aleutian arc (region 1, Fig. 7) extends from the Commander (Komandorski) Islands into central Alaska. The submarine topography, including the Aleutian Trench, has been discussed by Murray (1945).

This is a typical Pacific active arc, although some of the characteristic features are not well shown. Volcanic activity is high; data have been taken from various sources, and revised in accordance with data from Coats (1946) and Robinson *et al.* (1947). The most eastern known active vent is Mount Wrangell. There are no data for crustal structure, and gravity observations are few.

The nearest seismological station is College (near Fairbanks, Alaska). Location is usually good for the larger shocks. The area is surrounded to the east, north, and west by stations at favorable distances in America, Europe and Asia; at larger distances to the south there are several good stations. However, it is sometimes difficult to determine the depth of focus precisely, since many of these earthquakes are near the boundary between shallow and intermediate shocks.

East of 155°W (and outside the main active belt west of 155°W) every shock which could be located has been tabulated and mapped. West of 155°W in the main active belt the mapping corresponds to the general description.

In general, seismicity at shallow depth follows the northern concave side of the Aleutian Trench. Activity is lower in the area of the Commander Islands. Near the east end of the arc there is higher activity in the vicinity of Kenai Peninsula (near 150°W). The arc as a whole is one of the more active sectors of the Pacific belt, although its seismicity is exceeded by those of Japan, Mexico, the Solomon Islands, and others.

Over the whole active length of the arc, from about 175°E to 145°W, shocks are frequently in the range from 50 to 80 kilometers depth which crosses the boundary between shallow and intermediate earthquakes. Intermediate shocks at depths from 100 to 170 km. occur along the north side of the island arc and the Alaska Peninsula from 176° to 160°W. No deeper shocks are known in this region.

Macroseismic data for most of the Aleutian arc consist of shocks felt on shipboard. Numerous shocks are felt at Dutch Harbor on Unalaska, and in the regions of Seward and Fairbanks. For recent macroseismic reports on Alaska refer to the United States Coast and Geodetic Survey publications under the serial head *United States Earthquakes* (Heck and Bodle, 1930, 1931; Neumann, 1932-1943; Bodle 1941, 1944, 1945).

Of the characteristic Pacific arc features, *A* is the Aleutian Trench, which extends from about 170°E south of the island arc and the Alaska Peninsula into the Gulf of Alaska almost to Yakutat Bay (Murray, 1945, with

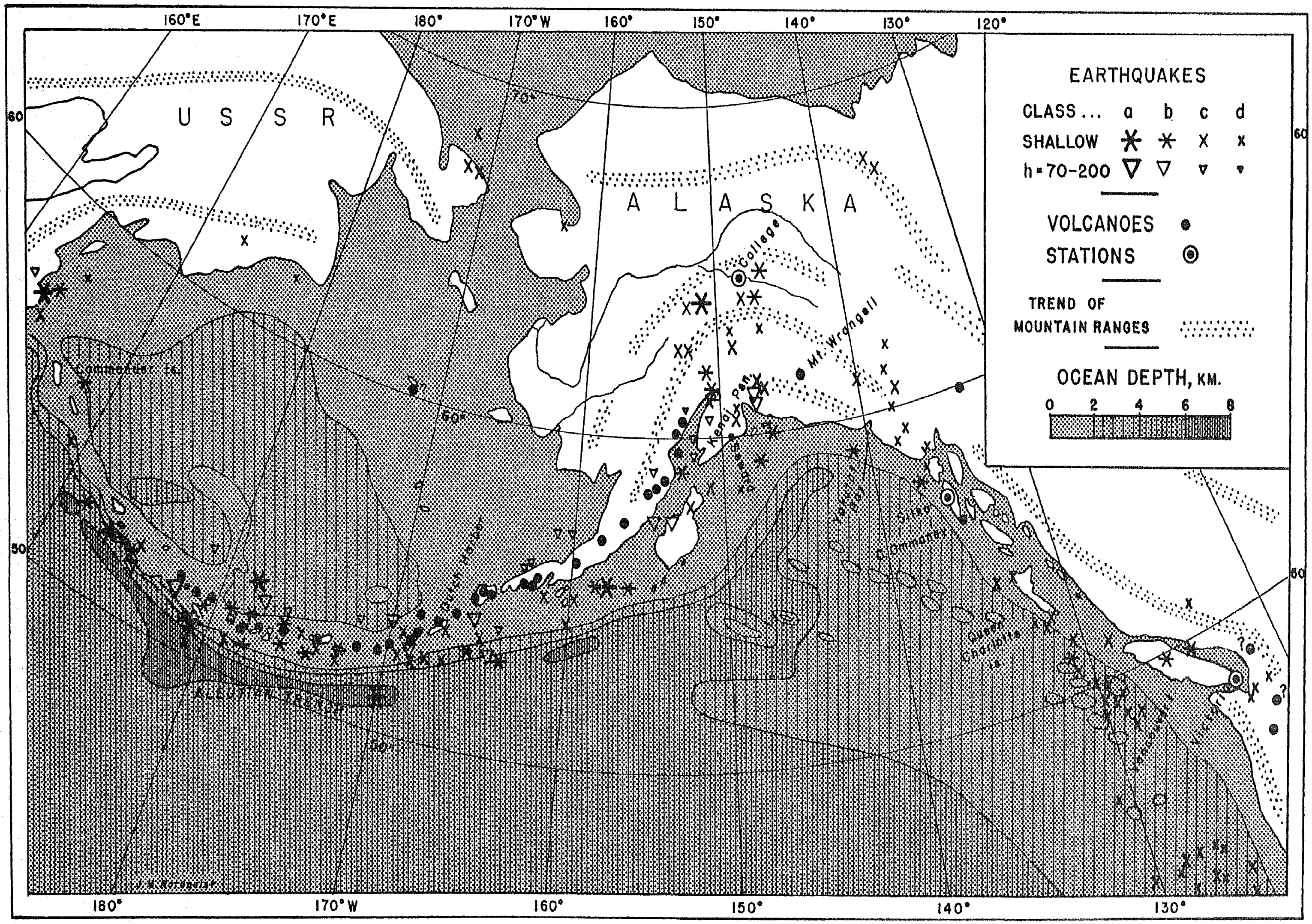

Figure 7. Alaska-British Columbia.

maps and profiles). Feature *B* is expressed in the occurrence of shallow earthquakes between the island arc and the Trench; it is more easily distinguishable from *C* and *D* at the east, where there is an outer chain of non-volcanic islands off the Alaska Peninsula, accompanied by some shallow seismicity. Feature *C*, indicated by earthquakes at depths near 70 km., extends along the whole arc; in the main western portion it is closely limited between the belt of shallow earthquakes and the volcanic islands. At the eastern end in the region of Kenai Peninsula and Cook Inlet, these shocks occur well to the southeast of the volcanic line. Feature *D* is this volcanic line, including the entire chain of the Aleutian Islands and extending up the coast of the Alaska Peninsula, accompanied by shocks at depths of 100 km. and over. Of these, the most westerly now known occurred on February 4, 1946, about 05:44:48, near 53°N, 176°W, at a depth of 150 km. Features *E* and *F* are not represented.

The shallow shocks in the interior of Alaska represent an interior structure, related to the Pacific coastal arc as the Rocky Mountains are related to the Pacific coast ranges.

Alaska to British Columbia

This is region 2 (Figs. 7 and 8), extending from southeastern Alaska to Puget Sound. It includes an area of fiord and island topography southward from Sitka and Juneau, as well as the more isolated group of the Queen Charlotte Islands, and Vancouver Island separated from the mainland by narrow straits. There are no marked oceanic deeps or troughs. Structurally this is not one of the Pacific active arcs, but one of the intervening regions in which block faulting is dominant. Though shearing may occur, the drowned topography indicates vertical displacement. This is confirmed by the evidence of the visible faulting accompanying the shocks of September 3 and September 10, 1899, in the region of Yakutat Bay; their magnitudes are of order 8¼ to 8½, as derived from seismograms reproduced by Milne (1900) and by Tarr and Martin (1912). The latter from evidence of raised shore lines (observed in 1905) established uplifts along fault coasts reaching a maximum of 47 feet, which is the largest known displacement attributable to a single group of earthquakes (summary in Davison, 1936, Chap. XI).

There is no topographical evidence to mark the boundary of the Pacific Basin in this sector. Amplitudes of reflected longitudinal waves indicate that in latitude 48°N it is at about longitude 130°W (Gutenberg and Richter, 1935, p. 324).

No present volcanic activity is known. Ash and other evidences of recent eruption have been reported at several points. There is a questionable report of a submarine eruption, probably near Cape Ommaney, in 1856 (Rudolph, 1887, pp. 234, 338).

For this region all shocks which could be located have been tabulated and mapped. Locations depend largely on the data of the two nearest stations at Sitka and Victoria. The principal seismic zone extends west of the islands to about 48°N, where it ends abruptly. Seismicity is only moderate. Macroseismic data are few; shocks are occasionally felt on the Queen Charlotte Islands and Vancouver Island. A class *b* shock on June 23, 1946, 17h, originated near 49¾°N, 124½°W off the east coast of Vancouver Island, and is definitely east of the principal seismic zone. This is true of all shocks in the region of Puget Sound, including those which have been especially studied (Coombs and Barksdale, 1942; Barksdale and Coombs, 1946). One epicenter (2N880) is in southeastern Washington (Brown, 1937). Shocks in Idaho and Montana are part of the activity of the Rocky Mountains, discussed with minor seismic areas.

California and adjacent areas

This includes regions 3 and 4 (Figs. 8 and 31). Here also the boundary between the Pacific Basin and the continental structures is not well known; evidence from submarine topography and from seismicity indicate that continental structures underlie a large submarine area extending northwest off the coasts of California and Oregon. A somewhat similar area off Southern California and Lower California, with a few small islands and complicated submarine relief, is a submerged part of the continent; there is strong evidence of structures like those of the mainland. Revised submarine contours for the region are given on charts of the U.S. Coast and Geodetic Survey, Nos. 5101, 5202, 5302, 5402, 5502, 5602. Charts with detailed discussion are given by Shepard and Emery (1941). No oceanic deeps exist.

The present structure is largely determined by block faulting, although older folded structures exist, and folding appears to be still in progress in the Coast Range. The geology has been summarized, chiefly stratigraphically, by Reed (1933). Known faults have been mapped by Willis and Wood (Willis, 1923), and by Jenkins (1938). In the Coast Ranges the most conspicuous and most active faults are strike-slip features associated with characteristic rift topography. Chief of these is the San Andreas fault, with several branches and parallel structures. The general trend of these faults is northwest-southeast, and the southwest side regularly shows displacement northwest relative to the northeast side. Such strike-slips occurred in the southern California earthquake of January 9, 1857, as well as in 1906 (Lawson *et al.*, 1908) and 1940 (Buwalda and Richter, 1941; Ulrich, 1941) when the displacement on the San Andreas fault ruptured the surface. The direction of relative displacement is confirmed by field evidence of recent motion on this and other faults (Buwalda, 1929; 1937). This has been extended to even very small shocks in southern California, on evidence of the direction of first motion recorded at the local stations (Gutenberg, 1941b).

The Garlock fault appears on Figure 8 as a northeastward trending branch of the San Andreas fault. It is also a strike-slip fault, with displacements toward the northeast on the southeast side. Small strike-slip of similar character accompanied a shock in the central Mojave Desert on April 10, 1947.

An important zone of faulting is that termed the Nacimiento fault by Reed (1933, p. 41). The displacements are chiefly dip-slip; there are no conspicuous rift structures or fresh scarps. Reed and others subdivide the coastal region by the presence or absence of the Franciscan series of probably Jurassic age overlying the granitic basement rocks. Between the San Andreas and Nacimiento faults the Franciscan is absent. Further south, these rocks are lacking northeast of the Inglewood fault, and are missing from the east-west transverse belt of structures just north of latitude 34°. Most of southern California, also including the region of the Mojave Desert between the Garlock and San Andreas faults, belongs to the area of granitic basement. This is accompanied by a comparative uniformity in the propagation of seismic waves, with clearer seismograms and more accurate location of epicenters.

The major Sierra fault, and the north-south trending faults paralleling it to the east, are part of the structures of the Great Basin. Displacements are predominantly vertical, but strike-slip has also occurred, as in the great Owens Valley earthquake of March 26, 1872 (Hobbs, 1910; Davison, 1936, Chap. VII). A 14-foot vertical displacement took place in 1915 on one of the Basin Range faults in Nevada (Jones, 1915; Page, 1935; shock 3N330).

The transverse belt of structures between 34° and 35°N is associated chiefly with thrust faults, except where it is traversed by the San Andreas fault and its associated structures, which are offset roughly 50 miles eastward in crossing it from north to south.

Volcanic activity is low; the period for which historical information bearing on eruptions can be used is comparatively short. There is no doubt of the activity of Tres Virgenes in Lower California, nor of Mount Lassen in California. The latter, however, is in a very late stage, and there is some question as to the nature of the eruption in 1914 (Day and Allen, 1925). The latest eruption of Cinder Cone, a few miles east of Mount Lassen, is very recent and usually dated about 1850. Several of the peaks of the Cascade Mountains, such as Mount Baker, Mount Rainier, and Mount Hood, are considered by some authorities to have had true eruptions within historic time; contemporary accounts are very incomplete, and evidence now on the ground is inconclusive. Evidence, both historical and on the ground, for an eruption of Mount St. Helens in 1843, is distinctly better (Jillson, 1917). Tres Virgenes, Lassen, Cinder Cone, and St. Helens are indicated definitely on the map (Fig. 8); the others are indicated with question.

Very recent appearing sites of eruption in Oregon and Idaho are omitted for lack of authoritative dating.

The crustal structure of Southern California has been worked out from seismometric data by Gutenberg (1943a, 1943b). The most recently revised results are given by Gutenberg (1944, pp. 158-159).

Sediments are unevenly scattered over the region. In the Sierra Nevada and some other mountainous areas they are practically absent; elsewhere they accumulate in deep basins which extend to depths of 10 kilometers and over. (Uhrig and Schafer, 1937; Gutenberg and Buwalda, 1936.) Thus the top of the granitic layer varies in level almost 15 kilometers. There is certainly not so much variation in the level of its base, which is generally at a depth of about 18 kilometers; the foci of most of the earthquakes are in or close to this level. There are at least two intermediate layers between the granitic layer and the Mohorovičić discontinuity. The upper of these appears to have a nearly constant thickness of about 15 kilometers. The lower varies greatly, from a thickness of a few kilometers in the coastal areas to roughly 30 kilometers under the Sierra Nevada (Fig. 32). Isostatic compensation for the Sierra block thus depends on the increased thickness of this lowest crustal layer. The Mohorovičić discontinuity, which is the lower boundary of the continental crust, consequently lies at a depth increasing from about 35 kilometers in the coastal areas to 60 kilometers under the Sierra Nevada.

In central California, the depth of the Mohorovičić discontinuity has been placed by Byerly (1938b; 1939) at 32 kilometers, with a thickness of 9 kilometers for the granitic layer near Berkeley. In a study of wave velocities for shocks originating in the California coast ranges, Byerly (1938b) found a delay in the arrival times at stations in the Owens Valley, which he correctly interpreted as due to obstruction by the downward projecting "root" of the Sierra Nevada.

Gravity observations (Meinesz *et al.*, 1934) indicate considerable negative gravity anomalies off San Francisco, and off Lower California near 27°N. Data from the U.S. Coast and Geodetic Survey show negative anomalies approaching 100 milligals in the Puget Sound area.

There are now more than twenty seismological stations, including eight belonging to the southern California network centered at Pasadena, six in central and northern California with headquarters at Berkeley, and a group of five (Grand Coulee Dam, Shasta Dam, and three stations in the Lake Mead area) with headquarters at Boulder City, as well as Tucson, Ukiah, and Santa Clara. This makes the region now one of the best covered by local stations; in earlier years this was far from the case. The first installation of modern instruments was at Berkeley in 1910, and the Pasadena group of stations began issuing reports in 1931.

All shocks of magnitude definitely exceeding 5 (class *c* or higher) which could be located well enough for a significant mapping have been included. This involves rejecting many class *c* shocks in the region of the Gulf of California where data are often insufficient for location.

There is a geographic gap between the seismicity of this and the previously discussed region. Shocks off the coast are apparently missing between 48°N and 44°N. The seismic zone to the south (Byerly, 1937; 1938a) is definitely out of line with that to the north. Beginning off the coast of Oregon, it extends southeastward into California, with a trend aligned with that of the San Andreas fault and its associated structures, suggesting that they continue offshore. Roughly a third of the shocks of the region occur in this north coastal zone. North of 40°N soundings show a large east-west submarine scarp, indicating a transverse structure which does not appear to affect the trend of the seismic belt (Shepard and Emery, 1941; Byerly, 1940). The transverse structures at about 34°N are associated with a very distinct eastward deflection of the seismic belt, which then passes southward through Imperial Valley and down the Gulf of California.

That central California appears low in seismicity is partly an expression of temporary conditions; historical data suggest that since the earthquake of 1906 the activity of central California has been abnormally low relative to that of southern California.

Epicenters in eastern California and western Nevada represent activity which probably is not independent of that nearer the coast, although it belongs to a different structural province. A few *c* shocks in this area may have been missed, since the records are imperfect, and shocks of this group record with abnormally small amplitudes at distant stations. For the latter reason, several well-located shocks with magnitudes between 5.3 and 6 (as calculated from the data of the nearer stations) have been omitted and are treated as of class *e*. Historical data are almost lacking, so that it is impossible to tell whether the activity shown is fairly representative. What appears on the map as the westernmost of this group, the central California shock of February 8, 1940, is notable for peculiar seismograms and for focal depth probably in excess of that normal for Southern California and Owens Valley, which is about 18 kilometers (Gutenberg, 1943a).

One epicenter (28°N. 126½°W) is far to the west of the chief active belts. Shocks far to the east in the Cordilleran structures are discussed under "Minor Seismic Areas."

The historical record of earthquakes in California begins at a very late date (1769). Most of the data are collected in a catalogue (Townley and Allen, 1939) which extends to 1928. Data for more recent shocks are given in the

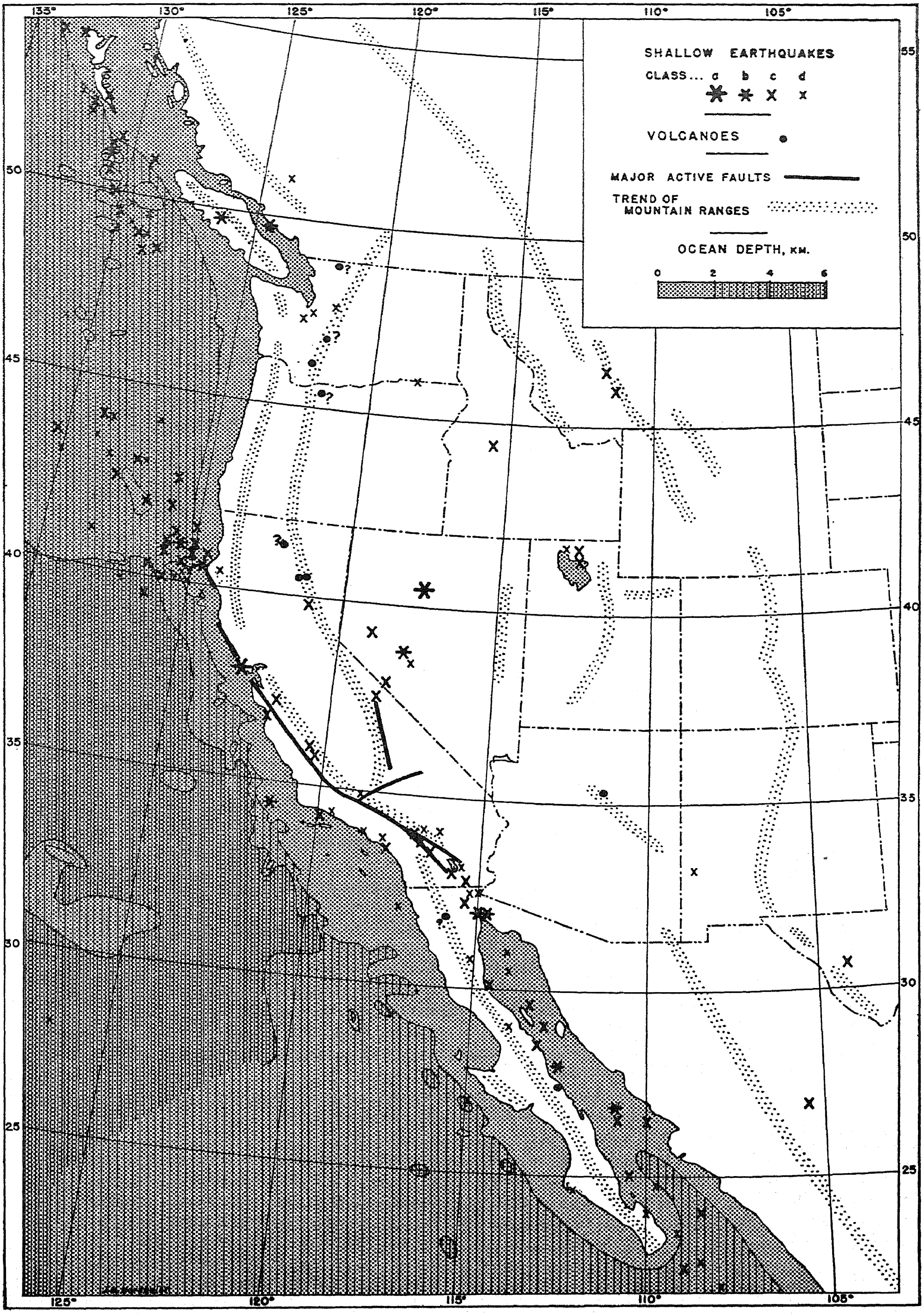

FIGURE 8. Western United States.

U.S. Coast and Geodetic Survey serial *United States Earthquakes* (Bodle, Heck, Neumann), and many other reports are published in the *Bulletin of the Seismological Society of America.* References to special papers on the larger shocks are given in Tables 13 and 14. Papers on some of the smaller shocks are entered in the bibliography under Arnold (1918); Blackwelder (1929); Byerly (1938a); Byerly and Wilson (1935); Callaghan and Gianella (1934); Gutenberg, Richter, and Wood (1932); Laughlin *et al.* (1923); Mitchell (1928); Neumann (1941); Richter (1947); Sparks (1936); Townley (1918); Ulrich (1941); Wood (1933b; 1937); Willis, Byerly, *et al.* (1925).

The San Andreas fault is the principal seismic locus of the region, with two great shocks, in 1857 and 1906, and many others of lesser magnitude. Its branches, the San Jacinto and Hayward faults, have been the origin of several strong shocks. Others have occurred on the parallel Elsinore and Inglewood faults, and on faults associated with the transverse structural belt.

The great earthquake of 1872 was associated with the major Sierra fault system. A shock of magnitude 6¼ occurred further south at 35.7° N, 118.0°W on March 15, 1946. Other north-south faults in the Basin Range region have shown activity; the class *a* shock in Nevada in 1915 was on one of these. The Garlock fault, though an important and well-marked rift structure, has shown only minor activity in the short time for which information in the desert region it traverses is available. Many small shocks are known in the general region of the Nacimiento fault, but locations are not accurate in that region. A larger shock on April 11, 1885, which reached destructive intensity north of San Luis Obispo, may have been from this source.

Further details are included in the section on minor seismicity. The frequency of shocks of all magnitudes in the area has been discussed by Gutenberg and Richter (1944).

Mexico and Central America

This includes regions 5 and 6 (Figs. 9 and 10), following the Pacific coast from Colima to Panama. Offshore are the Guatemala Trench and the Acapulco Deep (Whitcroft, 1944). The structure is that of a succession of active arcs, complicated by the branching off of the Caribbean loop.

There are two active volcanic lines, one extending roughly east and west across central Mexico from Colima to near Vera Cruz, the other beginning in Guatemala (Anderson, 1908) and extending southeastward through Central America.

Gravity data include a few offshore observations by Meinesz, and the partly reduced results of a limited number of stations in Mexico (Ruiz, 1937).

The only first class seismological station in the region is at Tacubaya, D.F. (near Mexico City), with reports available beginning with 1909. Several secondary stations have been operated in Mexico. For earlier years the absolute times reported for these secondary stations are inaccurate; but the time intervals between *P* and *S* are reliable, and have often been used in completing locations when other data were scanty.

Bosch-Omori instruments were installed at Ancon (Canal Zone) in December 1908. The installation was moved to Balboa Heights in October 1914. At first the time control was not satisfactory, but this was later overcome. These instruments were not highly sensitive, but their readings are of great value for shocks originating not far from Panama. Wood-Anderson torsion seismometers were installed in 1932.

For shallow shocks, the seismicity of the Pacific coast of central Mexico is the highest in the western hemisphere. Our map shows local concentrations of epicenters due to high activity in Oaxaca in 1931 and Jalisco in 1932; the intervening coast (Guerrero) has been active at other times, notably in 1911. This chief active belt continues southeastward near the coast to western Panama, but with comparatively low seismicity. It leaves the coast to turn southward across the Gulf of Panama. In the vicinity of Oaxaca a less well-defined active zone branches southward and westward, with a further trend toward the Galápagos Islands.

Intermediate shocks closely follow the volcanic belts. For the shock 5I175 supposed faulting is described by Urbina and Camacho (1913). No deep shocks are known.

Especially for the earlier years, when instrumental data were scanty, use has been made of the macroseismic reports collected at Tacubaya.

The Mexican region presents many of the typical features of a Pacific arc. Feature *A* is the trough of the Acapulco Deep and Guatemala Trench. Feature *B* is indicated by the belt of high seismicity. The mountains of the

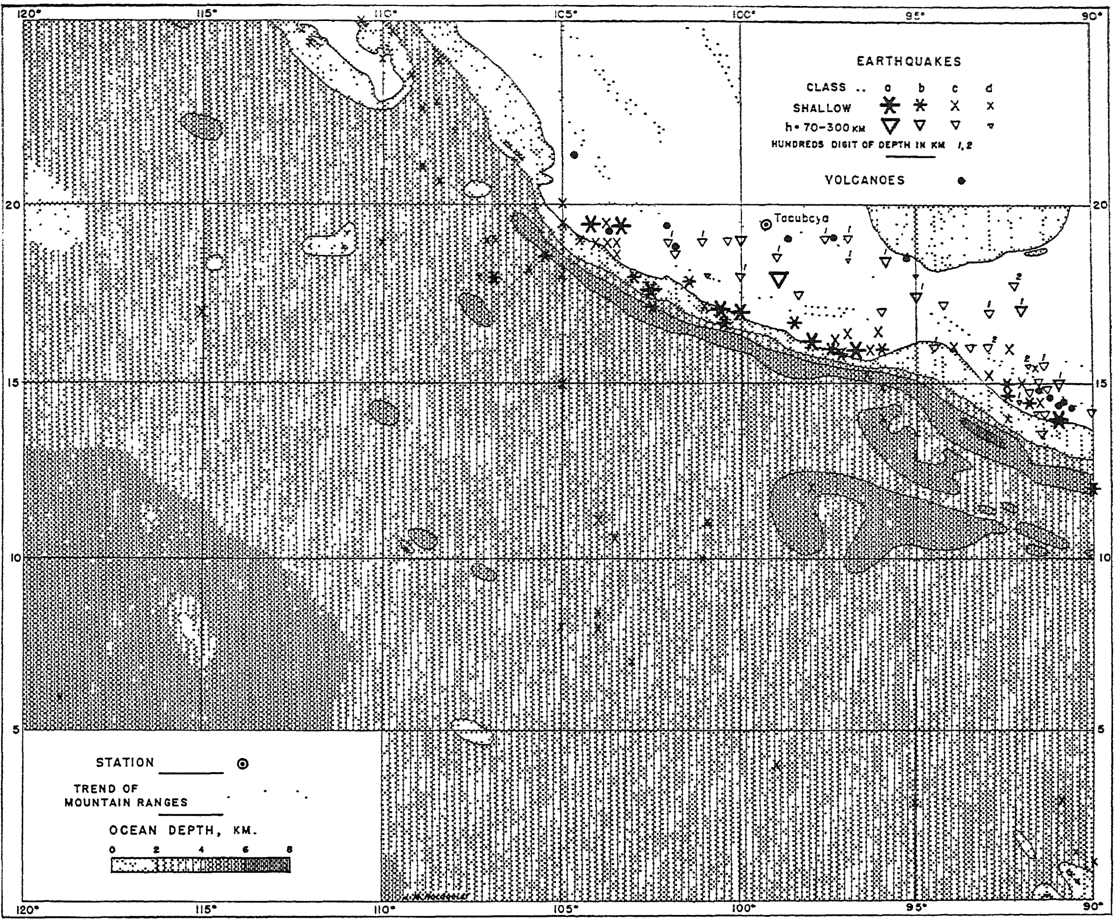

FIGURE 9. Mexico.

Mexican coast correspond in position to geologically young (nonvolcanic) submarine ridges elsewhere. A few observations by Meinesz indicate negative gravity anomalies off the coast. On land there are negative anomalies in and north of the volcanic belt; between this and the coast observations are few and scattered. Feature *D* is the main volcanic axis of Mexico, accompanied by shocks at depths of 100 kilometers or more. There is a divergence in trend between this and the coastal belt of shallow shocks, apparently connected with the branching off of the Caribbean loop.

Off Central America feature *B* is represented by a zone of shallow shocks, less active than the Mexican zone. The line of feature *C* is indicated by slightly deeper shocks. Feature *D* is marked by active volcanoes and by shocks at depths near 100 kilometers. A few shocks at depths over 200 kilometers, associated with extinct volcanoes, represent feature *E*, notably in Chiapas and Guatemala. South of 10° north latitude all the features are less well marked, except the belt of shallow shocks, which spreads out southeastward and no longer suggests an arcuate structure.

The Caribbean loop

This is region 7 (Fig. 10). The Caribbean structural loop extends from Yucatan and Honduras round the arc of the West Indies, returning through Venezuela and Colombia to join the Andean structures. The deep Puerto Rico Trough is external to the loop on the north; the Cayman Trough (which contains the Bartlett Deep), passing from the Gulf of Honduras between Cuba and Jamaica, is directly involved in the loop.

The eastern portion of the loop, including the Lesser Antilles, has most of the features of a Pacific active arc. On both north and south

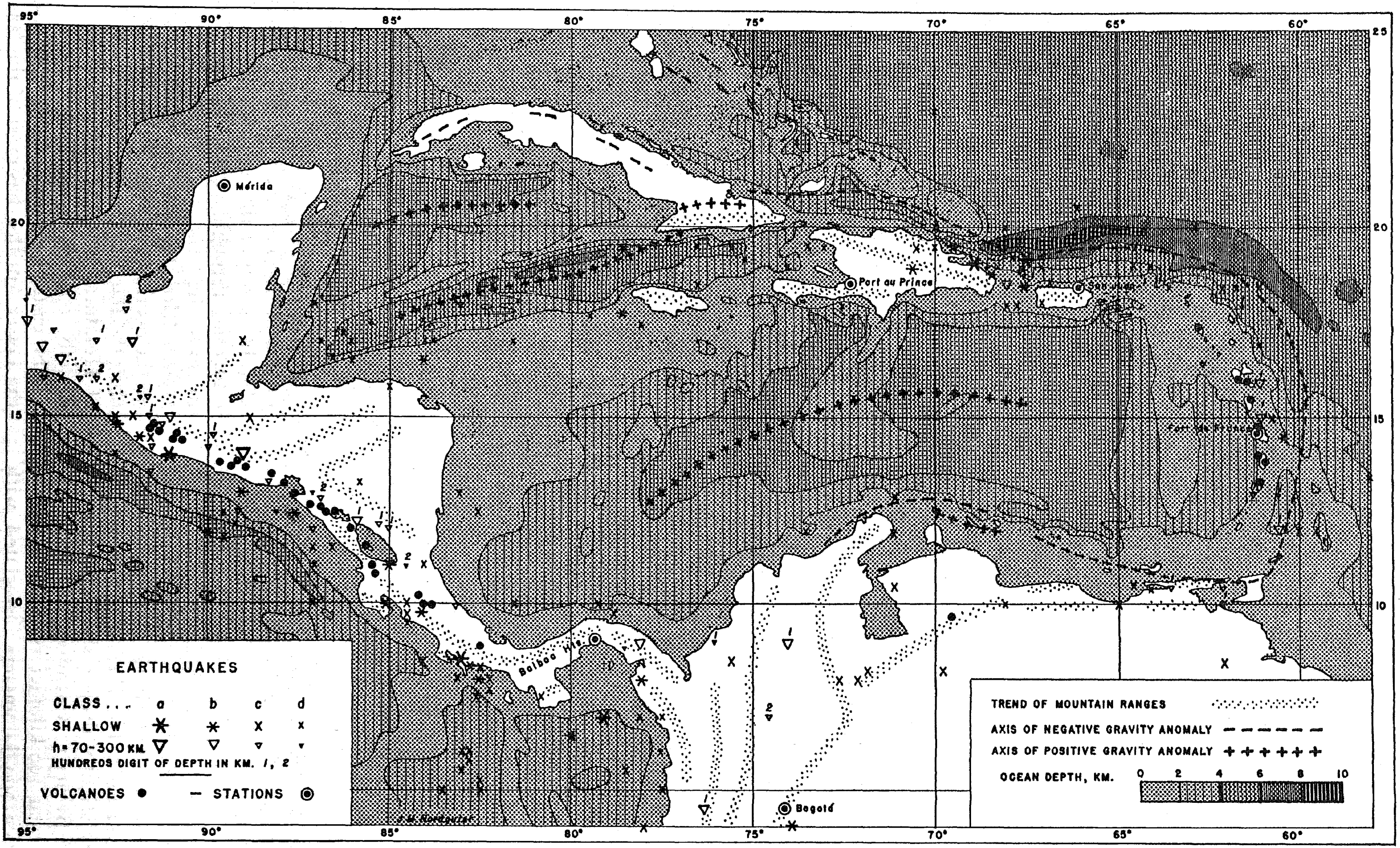

Figure 10. Caribbean region.

limbs there is division into branches of different character. The Cayman Trough represents one of the two northern branches; the other follows the curving structures of Cuba to Yucatan. The southern division occurs near Trinidad, with one branch following a line of small islands including the Dutch West Indies, while the other extends inland in South America.

Almost all the active volcanoes are in the Lesser Antilles (Perret, 1939). A possibly active vent (Sanare) in the interior of Venezuela is described by Centeno-Graü (1940, pp. 143-153).

There are no local seismic data bearing on the deeper crustal structures; amplitudes of seismic waves reflected at points in the interior of the loop and recorded at distant stations indicate Pacific rather than continental structure (Gutenberg and Richter, 1935, p. 324). Certain shocks north of the loop, particularly in the vicinity of 20°N, 70°W, have peculiarities in the observed travel times. The *T* waves (Linehan, 1940) have been identified by Tolstoy, Ewing and Press (oral communication) as traveling through a low-velocity layer in the ocean. There is evidence of unusually high wave velocity near the surface in the region of Puerto Rico. Owing to the numerous structural discontinuities in the area, surface waves are rapidly broken up and dissipated; this creates difficulties in the assignment of magnitude to shocks in this area, so far as it depends on the amplitudes of surface waves. The microseismic project established by the U.S. Navy in connection with hurricane forecasting established a considerable loss of energy in surface waves between Cuba and Puerto Rico, and between Cuba and Florida (Gutenberg, 1947).

Gravity data are from surveys by submarines of the U.S. Navy (Ewing, 1938). The data have been discussed by Hess (1938; 1939). A clearly marked belt of negative gravity anomalies follows the arc of the Lesser Antilles; its northern and southern limbs show some indication of a branching following the structures. Serpentinite intrusions are found along the belt on the northern limb; these continue westward through Cuba, where no large negative anomalies now occur. Hess suggests that these mark the trace of a former extent of the belt, in which the forces formerly maintaining it have now relaxed.

Seismological stations are located at San Juan, Puerto Rico (formerly at Vieques), at Port au Prince, at Fort de France (Martinique), and at Bogotá. In the Caribbean loop proper all shocks have been mapped which could be located with any useful degree of accuracy. Depth determinations, especially in the earlier period, are less accurate than the average. The seismic belt follows the structural loop, with some indication of the branching described. On the north limb, most of the seismicity follows the Cayman Trough; the northern branch here is indicated only by a few rare shocks in northern Cuba. The one shown on the map (7N900) was strong at Remedios. There was a destructive shock in 1880 at San Cristóbal.

The greatest activity in the loop during recent years is north of Mona Passage between Hispaniola and Puerto Rico. The general activity of the remainder of the loop in recent years is lower than the historical record suggests as normal. However, even this still indicates a level of activity well below average for the Pacific belt. The historical record, extending over four centuries, includes a number of locally destructive shocks which have given the region an undeserved reputation for high seismicity.

Seismicity at shallow depth is lowest in the eastern part of the loop. A shock on May 21, 1946, near 15°N, 61°W, magnitude 6¾, was destructive on Martinique. The majority of the intermediate shocks, some of them large, occur under the Lesser Antilles. On the southern limb of the loop the greatest activity is in the southern branch, passing through Venezuela. The coastal cities of Caracas and Cumaná are in this branch. The more northerly branch, passing through the Dutch West Indies, is less well indicated by recent instrumental data, but there is a history of strong shocks at Cartagena and Barranquilla. As in many other regions, the active line here appears to follow the 2000-meter isobath, which suggests drawing it west and north to include epicenters north of Panama and Costa Rica.

Macroseismic data for the West Indies have been given by Scherer (1912) and Taber (1920; 1922). The whole region, with special reference to Venezuela, has been discussed by Centeno-Graü (1940).

Nearly all the strong earthquakes of Cuba have been near Santiago, the most notable being those of 1678, 1755, 1766, 1932 and 1947. Faulting in this region has been described by Thayer and Guild (1947). Shocks in 1692 and on January 14, 1907, were very destructive on

Jamaica. Taber (1920) considers that both originated off the north coast. A class *b* shock in 1941 (7N170) was strongly felt on Jamaica. Both the northern and southern structures of Hispaniola have been associated with very destructive shocks—the former in 1842, the latter in 1751 and 1770.

For the Puerto Rico earthquake of 1918, with epicenter in Mona Passage, see Reid and Taber (1919a; 1919b). The only shocks assigned to class *a* in the entire region are those of July 29, 1943, and August 4, 1946, with epicenters farther north.

The arc passing through the Lesser Antilles is a Pacific-type structure, although it fronts on a non-Pacific area. Feature *A* is most evident in the very deep Puerto Rico Trough, but the depths are not so great opposite the arc of small islands. Feature *B* is marked by shallow earthquakes, which are most frequent and intense opposite the Puerto Rico Trough, and by the strong belt of negative gravity anomalies. This feature also includes the non-volcanic Barbados Ridge. Feature *D* is the main volcanic arc, accompanied by shocks at depths of 100 kilometers and over. Intermediate shocks in Venezuela east of Cumaná apparently continue this feature; but the structural and other relations are imperfectly known and are complicated by branching. Features *E* and *F* are unrepresented.

Andean zone

This zone falls chiefly in region 8, but structurally includes parts of regions 6, 7, 9 (Fig. 11). In addition to the Andes proper, it involves the active coastal Cordillera on the west, and on the east a belt of activity at great depths beyond the mountains, as well as the Mendoza region. Marked oceanic troughs occur off the coast. For geological references see Weeks (1947) and Oppenheim (1947).

Until recently the only available gravity data were those of land stations (Aslakson, 1942). These are insufficient to clear up the evident complications. The Office of Naval Research, in collaboration with Columbia University, has initiated a long-term program of submarine gravity observations intended eventually to survey the entire Pacific area. This work is under the supervision of Dr. Maurice Ewing. In 1947 a number of profiles were run off the South American coast by Mr. Paul C. Wuenschel on board the U.S.S. *Conger*, using Vening Meinesz apparatus. According to the information kindly supplied by Dr. Ewing during the printing of this volume, preliminary calculations on three traverses, off Guayaquil, off Chiclayo, and off Antofagasta, show gravity minima, with the free air anomalies reaching 150 milligals at about the foot of the continental slope. The zones of pronounced negative anomaly appear to be about 100 kilometers wide.

Especially in the southern part of the Andean Zone, the structures and features of Pacific-type arcs occur. In the region of Peru these features are obscured and partly obliterated by a shear-type structure; here conspicuous recent fault scarps with forms suggesting those found in regions of strike-slip faulting, show that displacements reach the surface (Rich, 1942). The class *b* shock of November 10, 1946, produced a scarp 4 kilometers long and up to 2.5 meters in height (Silgado, 1947).

Location of South American earthquakes depends heavily on the reports from La Paz for the entire period since that station was established. The station at Huancayo (Peru) began recording in August 1932. Since the seismograms to 1944 are on file at Pasadena, comparison with records written in California has been very useful. Other important stations are La Plata, Rio de Janeiro, Santiago de Chile (to 1938, and since 1946 together with Punta Arenas and two other stations). The new station at Bogotá has been very helpful in the northern part of the area. Many minor stations have been operated in South America, some only for a few years, some with unreliable time service, some with insensitive and obsolete types of instruments. The most important of these, all with good timing, are Córdoba-Pilar, Montezuma, and Sucre. Pilar, with a Milne instrument of the older type, was often the only source of data on South American shocks until the establishment of the La Paz station in 1913. Montezuma is situated in a region where there are many shocks at intermediate depth.

Shocks have been mapped whenever the location was dependable. Many otherwise well-recorded shocks have been rejected because it was not possible to determine the depth, which usually leads to uncertainty in the epicenter. The number of intermediate shocks located in the region of Peru is disproportionately high, owing to the use of the Huancayo seismograms. Many others with well-determined depth could not be placed accurately; often all the reporting stations are to the north.

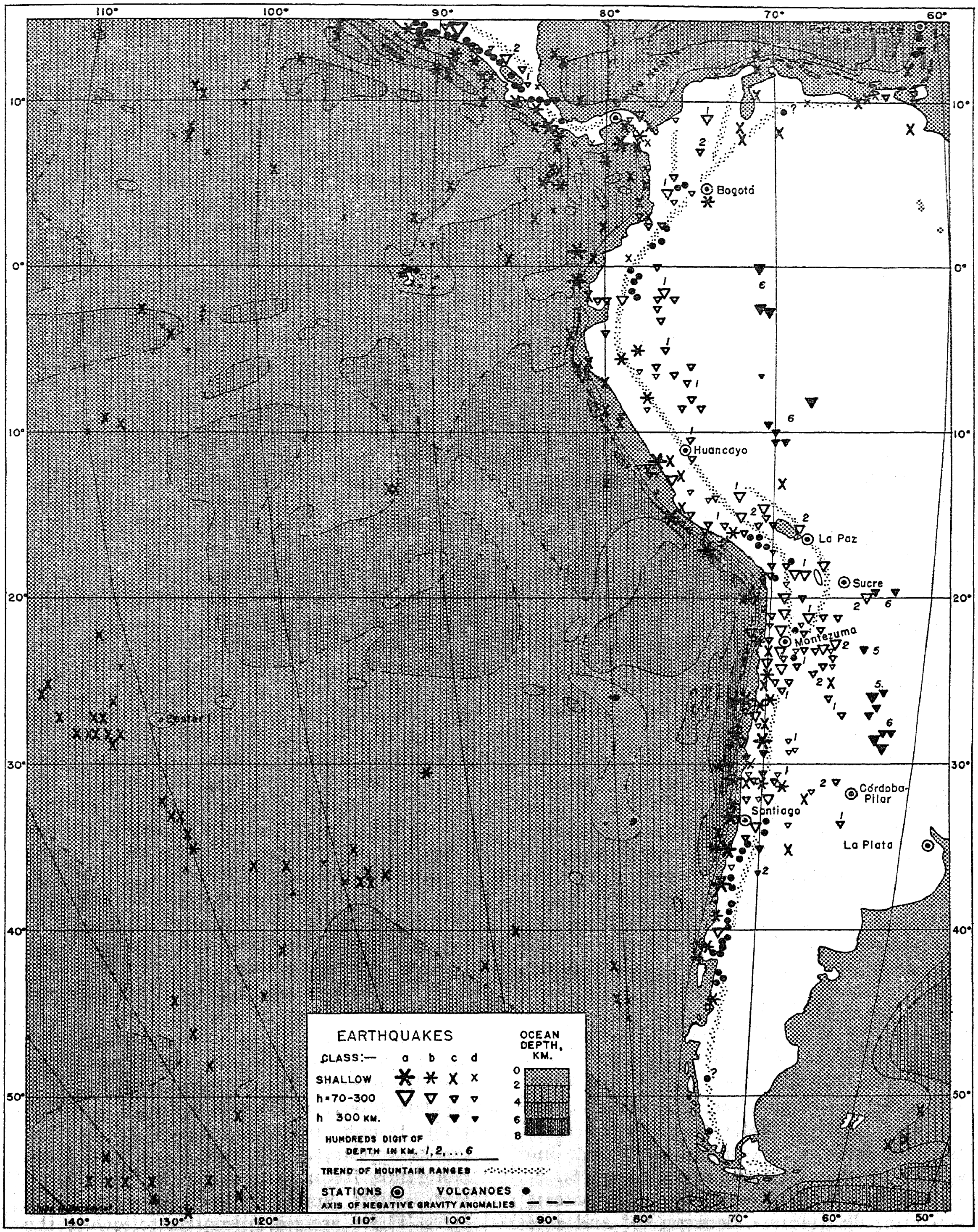

FIGURE 11. South America and adjacent Pacific.

Shocks of the largest magnitudes are more frequent relative to smaller earthquakes than in most other active regions. Except in the region of Peru, the overwhelming majority of located shocks show indication of focal depth greater than usual. Even shocks listed as shallow frequently can be placed at depths of 40 to 60 kilometers. In general, shallow shocks occur near the coast, intermediate and deep shocks farther inland. In Peru some shallow shocks, which are occasionally destructive, occur several hundred kilometers inland. The Mendoza region of western Argentina lies east of the Andes; here shocks occur which are shallow and sometimes locally disastrous, as at Mendoza in 1861 and San Juan in 1944 (Castellanos, 1945). This is a region of Mesozoic folds which branch eastward from the main Andean system.

The epicenter of the shock 8N840 of 1931 is revised to a point off the coast north of San Antonio, the only locality where it was reported felt (Bobillier, 1933a). This shock is notable for disproportionately large surface waves at distant stations as well as at Santiago. It appears to be an unusually shallow shock for the region.

Seismicity decreases south of 37°S; no recent shock has been found south of 45°S. From these latitudes a minor active belt extends westward. A strong shock occurred in 1879 near the Strait of Magellan.

Macroseismic data for current shocks, as well as historical summaries, appear in bulletins issued from Santiago. Among recent general publications is that of Brüggen (1943).

Of the typical Pacific arc features, *A* is represented by oceanic troughs extending with interruptions to about 37°S. Feature *B* is well established by the negative gravity anomalies lately observed, which are in the typical position with respect to the shallow shocks and the oceanic troughs. Shallow and slightly deep shocks, (feature *C*), some of large magnitude, follow the coast to about 37°S. The structural line of feature *D* is continuously followed by shocks at depths of 100 to 150 kilometers. Active volcanoes occur along this line, but are absent between 2° and 15°S. Only one intermediate shock is known south of 37°, but active volcanoes continue to at least 43°S.

Feature *E* is typically developed in the eastern Puna de Atacama, between 20° and 25°S at about 67°W, where shocks at depths of 200 kilometers and more are very frequent; they follow a line of nearly extinct volcanoes (Brüggen, 1947). Similar shocks occur elsewhere along the eastern Cordillera.

Feature *F* is represented by deep shocks east of the Andes. Most of these are at depths near 600 to 650 kilometers, with a few as shallow as 550 kilometers. These shocks are infrequent, although some of them are large (8D80 and 8D81, magnitude 7.6; Inglada, 1943). Not enough of them are well located to establish the existence of a continuous belt.

Southern Antilles

Region 10 (Figs. 12 and 27). The name was applied by Suess to the island arc connecting South America with the Antarctic. It includes the South Shetlands, South Orkneys, South Sandwich Islands, and South Georgia. The Falkland Islands to the north are geologically different. East of the arc lies the deep South Sandwich Trench. This and the topography of the entire area are well shown on the Hydrographic Office chart of Antarctica (No. 2562), accompanying the Sailing Directions for Antarctica (Hydrographic Office, 1943), which include valuable information of all kinds for the area south of 60°S.

Fragmentary geological data indicate that the arc is an active structure of Pacific type analogous to that of the Caribbean loop. There is some indication of a ridge or rise closing the loop in a position analogous to that of the Isthmus of Panama.

There are probably three active volcanoes in the South Sandwich Islands, and four others less well-documented in the region of Palmer Peninsula on the Antarctic arm of the loop.

Seismic mapping is difficult in this area, which is remote from all stations. Location depends principally on the records at La Paz, with data from La Plata, Cape Town, Tananarive, and stations in Australia and New Zealand. Some of the epicenters mapped may be in error by as much as 5°.

The seismicity of this region is somewhat higher than that of the Caribbean loop. It was first discussed by Tams (1930a; 1930b). Intermediate shocks are found in the South Sandwich Islands only. Epicenters of shallow shocks appear to follow the structural loop, being most frequent also near the South Sandwich Islands. None have been located south of 63°S. There are no epicenters following the probable structural connection with the Andean zone. There is a definite line of epicenters extending from near 60°S, 25°W eastward and somewhat northward in the direction of Bouvet Island, following a ridge which extends into the southern Indian Ocean, and so connecting with the seismic belt there.

Of the typical arc features, *A, B,* and *D* can be identified in the region of the South Sandwich Trench and South Sandwich Islands. Gravity data are lacking, and the comparative uncertainty of locating epicenters in this remote region prevents detailed investigation.

Eastern and Southern Pacific

Regions 43 and 44 (Figs. 11 and 12). The southeastern boundary of the Pacific basin in the limited sense appears to be marked by a series of oceanic ridges and rises which trend southward from central Mexico, pass west of the Galápagos group, and follow the Easter Island Rise into the Antarctic south of New Zealand. Much of the oceanic area southeast of this boundary appears to be a region of continental crustal structure (Gutenberg and Richter, 1935, p. 314; 1941, p. 37; many more observations are now available). Data of all kinds are scanty. Soundings are few, and are completely lacking in many large areas. The state of information in the southern portion is well shown on the Hydrographic Office chart of Antarctica.

The absence of intermediate shocks, and the scattered epicenters of the few located shocks, indicate that in this region there are no active arcs of the Pacific type. It is probable that the seismicity corresponds rather to shear type structures. Active volcanoes occur in the Galápagos group, near the Juan Fernandez Islands and on San Felix.

Location of epicenters is increasingly difficult with increasing south latitude. In the far south it is more uncertain than in almost any other active area. La Paz and Huancayo are the only first-class stations at moderate distance. For the larger shocks, North American and New Zealand stations can be used. Papeete was useful during its short period of reporting (1937-1939; resumed in 1948). Special effort has been made to include far southern shocks, and every observed time of *P, PP,* or *S,* has been used to check the epicenters. Shocks are listed even when the location is in doubt by five degrees.

The principal belt of seismicity follows the line of rises referred to as forming the boundary of the Pacific basin. Off Colombia and Panama is an area of probably complicated structure, with scattered epicenters. Near the Galápagos group the line of activity is deflected to the east. From that vicinity southward the principal seismicity closely follows the Easter Island Rise. There are also epicenters southeast of Easter Island along a belt extending toward the South American coast. Shocks 44N990 and 44N991 at 13½°S, 92½°W are far from any others. These recorded with relatively small surface waves.

A few of these shocks are near the boundary between shallow and intermediate depth. One in 1918 (43N800) had been assigned a depth of about 200 kilometers from the travel times, but the surface waves are well developed though not large, corresponding to a depth of about 60 kilometers. The epicenter, at 30½° S, 92½°W is fairly well determined and is remote from any others.

No shocks had been located along the Easter Island Rise west of about 150°W, until one of magnitude 7 occurred on December 15, 1947, 19:20:26, near 60°S, 161°W. There remains a gap to 66°S, 175°E, where one shock (50N500) is known.

Macroseismic data consist of a few reports of seaquakes felt on shipboard. Rudolph (1895, p. 581) reports a typical example in 1884 at 54°57′S, 128°34′W.

Indian-Antarctic Swell

Region 45, Figures 12 and 13. This structure appears as a continuation of the Easter Island Ridge. Lines of sounding cross it at widely separated points. Seismicity is definitely higher than that of the preceding region, and over 40 epicenters have been located, depending chiefly on readings at the stations in Australia and New Zealand. Only shallow shocks are found. The principal group does not extend west of 135°E, but there are a few epicenters following the rises into the Indian Ocean (Fig. 12).

Macquarie Island to Stewart Island

Region 11, Figures 12 and 13. Submarine ridges trending southwest-northeast here form the southern extremity of the New Zealand structures. The smaller shocks can be located only from stations in New Zealand and Australia; but seismicity is moderately high, and two class *a* shocks have been located. The belt of shallow shocks follows the ridges mentioned. Some shocks west of this have been assigned

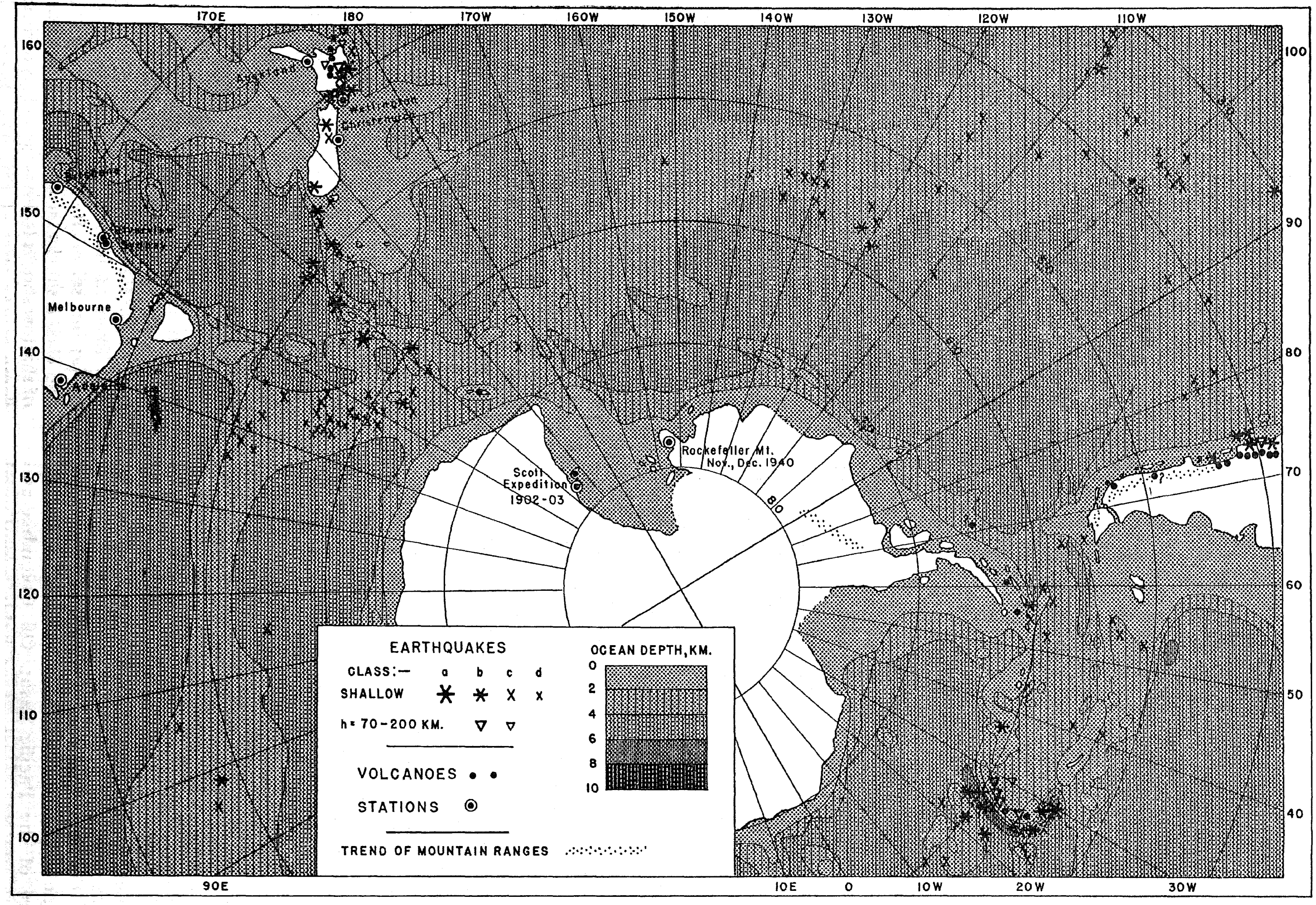

FIGURE 12. South Pacific.

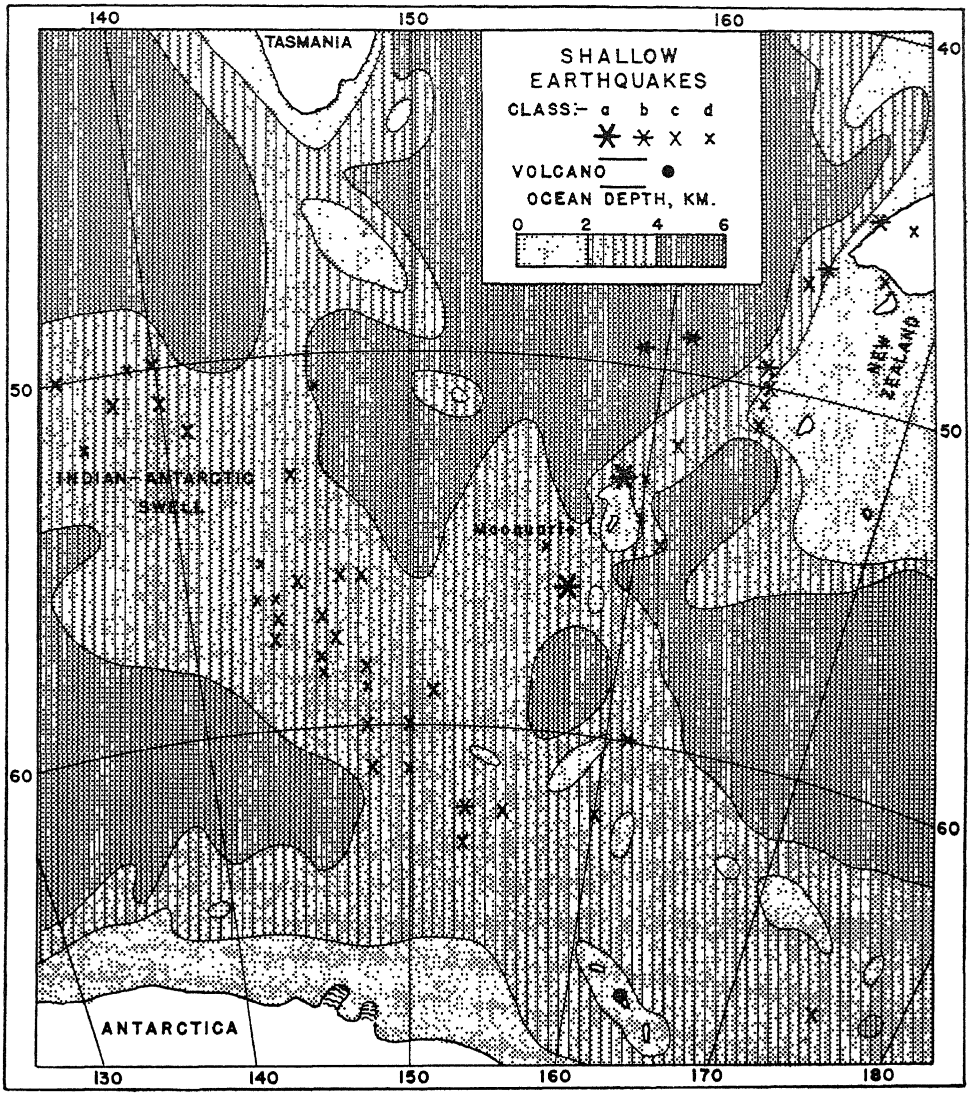

FIGURE 13. Region southwest from New Zealand.

slightly greater depths, but are not true intermediate shocks. Determination of depth is troublesome in this region. *P′* is often very weak and late, even where large amplitudes are to be expected. A rather journalistic account of a shock felt on Macquarie Island has been reprinted from the *Sydney Gazette* of June 22, 1816 (Anonymous, 1917).

New Zealand

Region 11, Figure 14. New Zealand includes areas which differ in structure and seismicity. Except at the extreme southwest, the southern part of the South Island is one of the relatively stable blocks which intervene even in the most active parts of the Pacific Belt. The North Island and the northern part of the South Island form the southern extremity of the active arcs of the Tonga salient, with a transition southward from the arcuate forms to a block structure. The Auckland Peninsula is relatively stable. Structures and associated faults have been discussed by Henderson (1929), with a large-scale fault map. A general account is given by Cotton (1942, especially Chap. XIII). The block structure has developed since the middle Tertiary. Henderson considers New Zealand as the uplifted edge of a gigantic continental block which has bowed up and

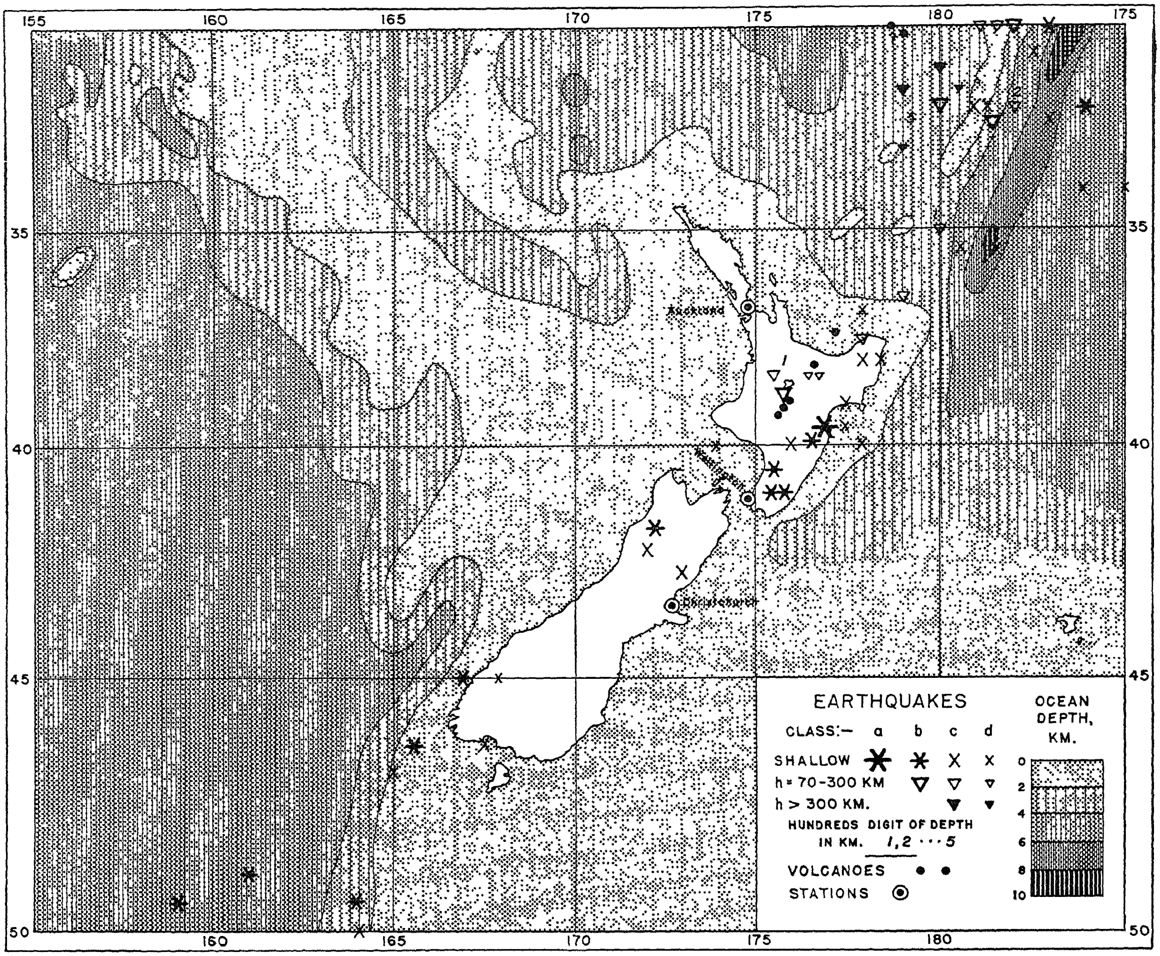

FIGURE 14. New Zealand.

shattered under pressure. However, it is clear that the displacements have been accompanied by shearing. This is suggested by the long rift structures (trending northeast-southwest) which traverse the North Island and the northern part of the South Island, and is confirmed by large strike-slip components observed in several cases when faulting has broken the surface. Some of these rift structures show a recent reversal of vertical faulting (Cotton, 1947). The character of the surface rock is such as to produce frequent enormous landslides, which interfere with the observation of trace and rift features. A list of recent fault scarps, with a map, is incorporated in the paper by Ongley (1943b). The more important instances, with references, are discussed by Ferrar and Grange (1929). The Alpine Fault of the South Island has been discussed by Wellman and Willett (1942) and by Cotton (1947b). There are indications of Quaternary movement of the west side northward by about one mile.

The Awatere earthquakes on the South Island in October 1848 led to the discovery of a remarkable rift, but it is uncertain whether there was surface displacement due to these shocks.

The earthquake on the North Island on January 23, 1855, is the subject of one of the earliest published notices of actual faulting accompanying an earthquake (Lyell, 1868). Ongley (1943a) has investigated present evidences of this displacement. He finds that some of the features described and figured by Lyell are not on the trace of the active fault.

Principally strike-slip displacement occurred on a fault near Glenwye, South Island, in the Amuri earthquake of September 1, 1888 (Mc-

Kay, 1890, 1892, summarized by Montessus de Ballore, 1924, pp. 209-210). Both horizontal and vertical displacements occurred in the Buller or Murchison earthquake in the West Nelson district of the South Island on June 16, 1929 (Fyfe, 1929; Henderson, 1937). Small displacements were found after the earthquake of 1942 (Ongley, 1943b). Displacements of trigonometric points were found following the Wairoa earthquake of 1932 (Ongley *et al.*, 1937; discussed by Bartrum, 1939).

No oceanic trough is known off the New Zealand coast. The well-known volcanic activity is discussed by Cotton (1942); there is a brief notice in Henderson (1943). Ruapehu has been added to the active list by a recent eruption (1945-1946).

Crustal structure has been derived from the data of local earthquakes by Hayes (1936c) and by Bullen (1936; 1938; 1939). The Mohorovičić discontinuity is found at the very shallow depth of 30 kilometers. Bullen (1939) finds two upper layers with a combined thickness of about 12 kilometers, and one or more intermediate layers between these and the Mohorovičić discontinuity. Below this, the wave velocities are the same as at corresponding levels in other regions.

Since early in 1931 an active group of local seismological stations has been maintained, with reports issued from the Dominion Observatory, Wellington. Reports from Wellington and Christchurch begin much earlier, with Milne instruments of the old type. Modern instruments were installed at Wellington in 1924 and at Christchurch in 1931. Several of the stations are now equipped with Wood-Anderson torsion seismometers, which has made possible direct application of the magnitude scale for local shocks (Hayes, 1941b) in the form developed for Southern California.

Epicenters for many small earthquakes are regularly reported from Wellington. In the present study only those are included which were fairly well recorded at distant stations. Minor local shocks are not considered, following the rule here applied also to California, Europe, and Japan.

The historical period in New Zealand is very short, but much information has been assembled. The catalogue by Bastings (1935) begins with 1835. The evidence has been discussed geographically by Bastings and Hayes (1935), Hayes (1941c; 1944), and Henderson (1943). Instrumental locations from 1931 to 1940 were revised by Hayes, and the results mapped (Hayes, 1941a). Numerous other papers on New Zealand seismology have been published, especially in the *New Zealand Journal of Science and Technology.*

The principal seismic area of New Zealand includes the northern part of the South Island and the eastern part of the North Island. Seismicity is comparable with that of Southern California. The map by Hayes (1941a) shows a scattering of epicenters for small shocks similar to that found in California and other regions; the epicenters fail to mark out the structural features. Intermediate shocks at depths near 100 to 200 kilometers follow the volcanic line which trends northeast-southwest through the center of the North Island. In the fiord region at the southwest of the South Island shocks are frequently felt. Macroseismic data as well as instrumental readings for some of these indicate depths greater than those of the shallow shocks of the northern active area. They form the northern extremity of the active zone discussed in the previous section.

The Tonga salient

Regions 12 and 13, Figure 15. Northward from New Zealand the andesite line outlines the margin of the submerged Australasian continental area, trending northeast toward the Samoa group, then westward north of the Fiji Islands (Marshall, 1912). The eruptive rocks of Samoa are of Pacific type, comparable with those of Hawaii. The boundary between continental and Pacific rocks, defining the andesite line in the Samoa-Fiji region, has been discussed by Macdonald (1945) and Stearns (1945a). This eastern and northeastern Australasian borderland is here referred to as the Tonga Salient. It includes many small islands in addition to the Fiji group, notably the Tonga and Kermadec groups along the east front. Opposite these are the deep Tonga and Kermadec trenches.

Investigation of crustal structure in this area from seismic data has been attempted by de Jersey (1946). Seismograms at Apia are often unusual in character. Angenheister (1921a,b) derived abnormally high velocities in the region of Apia from the data of a number of shocks, assuming normal focal depth; but several of these certainly were instances of deep focus, and it is to be suspected that others were. Consequently, Angenheister's result must now be received with reserve.

The only gravity data are those of Hecker

(Heiskanen, 1936, p. 932; Schmehl, 1931, p. 240), using boiling-point observations to find negative gravity anomalies of about 200 milligals over the Tonga Deep and positive anomalies of about the same amount over the Tonga Plateau.

Except for large shocks, location in this region depends mainly on readings at Apia, supplemented by those at stations in New Zealand and Australia. A Milne instrument was set up at Suva; but the times were generally inaccurate. Recently this installation has been improved; readings available for July-December 1943 were very useful.

Along the east front of the salient shocks are frequent, and only those which were required for statistics or were unusually well observed have been listed. Some shallow shocks appearing farther east than might be expected have been investigated with special care. Deep shocks are common but data are frequently insufficient for determination of location and depth, and only well-recorded shocks have been worked out. Recently many definitely deep shocks had to be rejected for lack of data required to fix the epicenter. Along the north front of the salient, and outside of it toward Samoa, every shock that could be located with reasonable accuracy has been worked out and plotted.

In general, shallow shocks occur along the andesite line, which runs east of the Kermadec and Tonga Islands, and curves westward from a point south of Samoa to pass north and west of the Fiji group, thence apparently northwestward toward the New Hebrides. This is the boundary of the Tonga salient, but a few exceptional shallow shocks are just outside it in the Pacific area. The seismicity represented by shallow shocks is somewhat above average for the Pacific belt.

Intermediate shocks are frequent; and the area southeast of the Fiji Islands is one of the most active sources of deep shocks in the world, including two of the largest known (12D130, Brunner, 1938; 12D340, Westland, 1938). Deep shocks in this area are included in studies by Hayes (1936b; 1939). Father D. O'Connell (1946) has revised the readings at Riverview, especially during earlier years and with particular reference to deep shocks. Many additions to our catalogue of deep shocks are the result of correspondence with him.

Macroseismic data are scanty. Shocks are frequently felt at Apia, and the reports of that station and the New Zealand group occasionally refer to shocks felt on Raoul (Sunday) Island in the Kermadec group, at Nukualofa (Tonga), and elsewhere.

Features of the Pacific arc type are well developed in association with the eastern front of the salient. Feature *A* is the trough including the Tonga and Kermadec Deeps. Feature *B* is indicated by shallow shocks between these deeps and the islands; Hecker's negative gravity anomalies are in line with this. Feature *C* is strongly suggested by shocks near the boundary between shallow and deep earthquakes; usually there is uncertainty as to exact depth which affects the epicentral determination, making it not sure whether these are in the position to be expected between the preceding and following features. Feature *D* is marked by the line of islands, including several active volcanoes, extending into the North Island of New Zealand, and by shocks at depths of 100 to 200 kilometers. Feature *F* is well marked by the north-south belt of deep shocks centering about 179°W. Between this and feature *D*, shocks occur at depths of 300 to 400 kilometers.

The north front of the Tonga salient is indicated by shallow shocks. No oceanic deeps are known, and the other Pacific features are doubtful or poorly represented.

The structural and seismic transition to the next region is uncertain. The map gives the impression of an offset between the southern New Hebrides and the northern Tonga Islands, conceivably due to tectonic displacements. There is a small group of shocks in the vicinity of 16°S, 174°E.

New Hebrides

Region 14, Figure 15. This region has the character of a narrow Pacific type active arc which fronts to the southwest, away from the Pacific basin. The oceanic deeps are adjacent to the islands on that side. The volcanoes have been described by de la Rüe (1937). A preliminary note on a submarine gravity expedition across the Pacific (Anonymous, 1949) indicates that the circum-Pacific seismic belt was crossed by it five times in 1948. One of these profiles was run between the Santa Cruz Islands and the New Hebrides. Large negative gravity anomalies were found on all five crossings.

The nearest seismological stations are Suva and Apia and those of Australia and New Zealand. Location of shocks in this region has

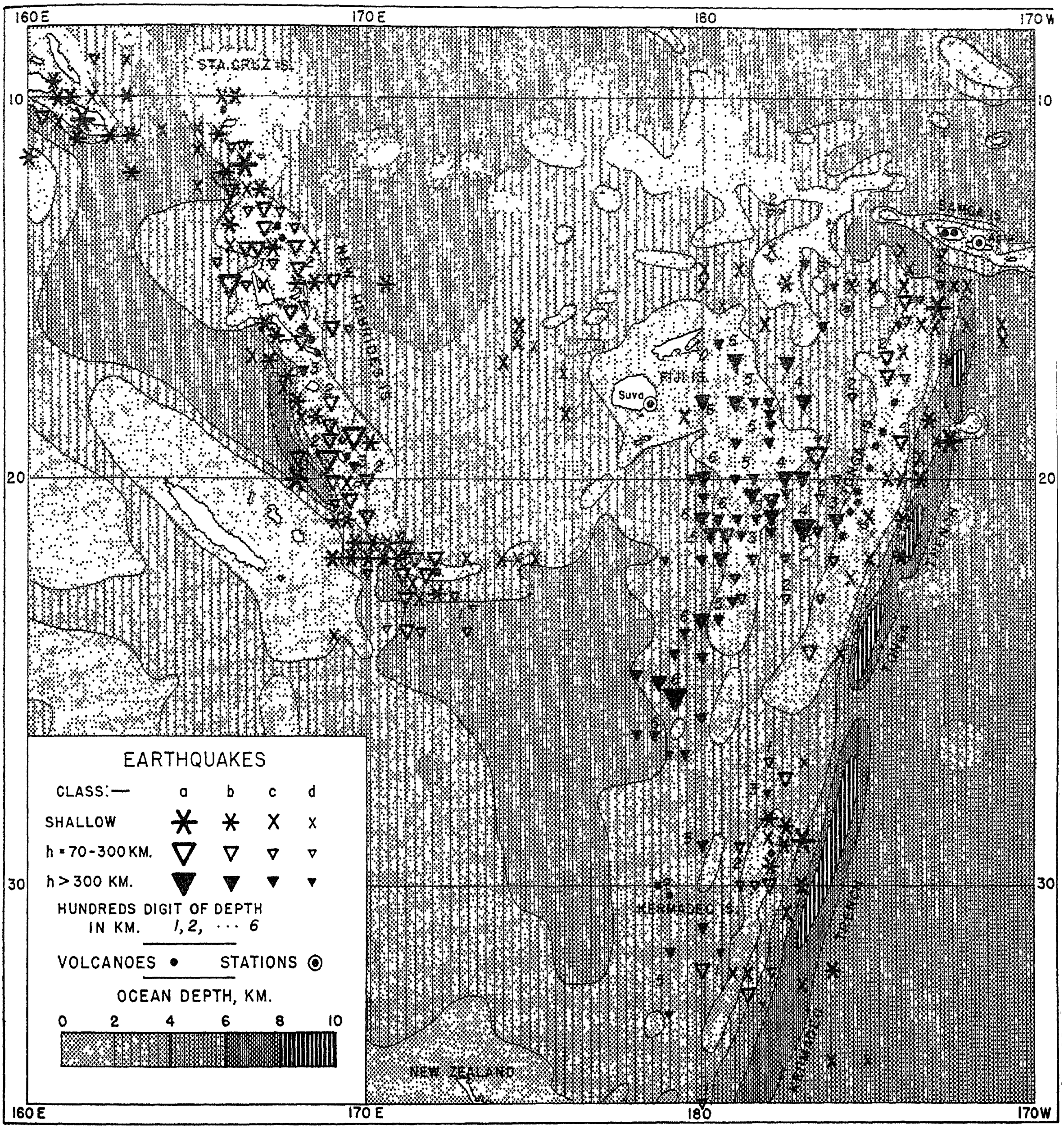

Figure 15. Tonga salient.

always been difficult; it is complicated by the occurrence of shocks in the whole range of shallow and intermediate depths. The establishment of the station at Brisbane in 1937 improved the situation materially. With September 1943, the Brisbane readings are taken from Benioff instruments. This new first-class installation has added much new data for the study of all shocks in the southwest Pacific.

In general, only the larger shocks have been tabulated and mapped. Shocks with unusual epicenters and depths have been included whenever the data were sufficient to establish them. It is frequently difficult to distinguish shallow shocks from those in the upper part of the intermediate range. This is one of the regions like the coast of South America, in which the deeper shocks are relatively frequent, and those shocks classified as shallow are largely in the deeper part of that range. The region is one of the most active sources for intermediate shocks.

A few shallow shocks appear to be disassociated from the main structural arc; those near 15°S, 170°E suggest a connection with the shocks west of the Fiji Islands, and those near 22°S, 174°E follow a structure trending east and then north toward the Fiji group.

Feature *A* is indicated by the oceanic deeps near the islands. As in South America, the depths indicated for the nearest shocks suggest feature *C* rather than *B*. Feature *D* is shown by the volcanic islands and accompanying intermediate shocks. The only representatives of features *E* or *F* are two shocks (14D200 and 14D700) at depths somewhat exceeding 300 kilometers.

Solomon Islands to New Guinea

Regions 15 and 16, Figures 15 and 16. This includes at least three structurally different regions: (1) the principal group of the Solomon Islands, which resembles that of the New Hebrides in being an arcuate structure of Pacific type fronting away from the Pacific basin, (2) the anomalous arc of the Bismarck Islands, with structures extending into New Guinea, and (3) the region of central New Guinea, with only shallow earthquakes and no typical arcuate structures. (See van Bemmelen, 1939.)

Data for certain of the volcanoes have been taken from Fisher (1939, 1940). The submarine gravity survey in 1948, mentioned in the preceding section, included one profile between Bougainville Island and New Britain, with large negative anomalies near the seismic belt.

Location of shocks in this region is somewhat less troublesome than for the New Hebrides, on account of the shorter distances from stations in the Netherlands East Indies and from Manila.

In the region of the Solomon and Bismarck Islands seismicity reaches a high level (with a relatively large number of class *b* shocks), probably exceeded only in the Japanese area. Accordingly, only those shallow shocks needed for statistical study have been included, except for smaller shocks north and west of the Bismarck Islands, where the epicenters are of interest for structural reasons. Intermediate and deep shocks have been included whenever the data were adequate.

In the Solomon Islands large typically shallow shocks are frequent. Many of these generate enormous surface shear waves of the Love type (*G* waves), with periods of more than one minute and actual ground amplitudes of several centimeters even at large distances. Those of shock 15N100 are discussed by Gutenberg and Richter (1934c, pp. 68-73) and attributed to displacement of large crustal blocks.

Feature *A* is represented by oceanic troughs south of the Solomon group; large shallow earthquakes occur next to this in the position of feature *B*. Here it is feature *C* which is uncertain. Feature *D* is represented by rather lower volcanic activity than in the New Hebrides, with fewer intermediate earthquakes. Feature *E* may perhaps be associated with the northeastern, less actively volcanic, islands of the group. Feature *F* is apparently represented by the following shock: 1947, May 26, 19:40:55 (with small foreshock at 17:33:55) located tentatively at 8½°S, 158°E, depth 560 kilometers, magnitude about 6¼.

The active arc of New Britain, while presenting many of the typical features, fronts in an unusual direction. It has a definite foredeep (feature *A*) off the convex southern coast. Shallow and slightly deep shocks (features *B*, *C*) occur chiefly in the northern part of the arc. Feature *D* is well represented by intermediate shocks and by volcanoes. The volcanic line extends westward through the line of islands off the north coast of New Guinea; it is paralleled by intermediate shocks south of it. Deeper shocks, possibly referable to feature *E* or *F*, occur in the area of northern New Britain. At 7°S, 153°E is shock 15D500, doubtfully assigned a depth of 450 kilometers. This epicenter is probably not in error by more than 2°. It falls between the New Britain arc and the Solomons, in an extremely disturbed region.

The structures including New Ireland and the Admiralty Islands, accompanied by shallow shocks, may be regarded either as a loop in continuation of the New Britain arc or as an extension of the northern line of the Solomon Islands. The frequent intermediate shocks of northeastern New Guinea fall in the volcanic line which passes west from New Britain through small islands off the New Guinea coast (Fisher, 1940). However, they all also fall into a structural arc extending from Central New Guinea into the southeastern peninsula, where there are active volcanoes. North-central New Guinea is a region of frequent shallow earthquakes, some of them large, and there is a foredeep off the north coast. Other typical features do not appear.

A small group of shocks centering about 1°S, 151°E is anomalously far north of the active belts.

Western New Guinea is associated with the structures of the Banda Sea region, discussed later.

Caroline Islands

Region 17, Figure 16. The interpretation of the circum-Pacific belt here adopted connects the active zones just discussed with that of the Caroline Islands. This involves a very sharp change of direction in the vicinity of Halmahera. The structures of that island constitute an active arc of Pacific type, with its convex front to the west. The associated seismicity and other features support this interpretation. Details will be found in the section dealing with the Moluccas. From Halmahera the structural zone continues northeast by way of Yap to Guam.

An unsuccessful search has been made for epicenters which might establish an active connection across the area between Guam and the Bismarck Islands. There are reports of shocks felt on Ponape. An earthquake in 1925, doubtfully assigned to this area in previous papers, has been rejected. The few shocks north of the Bismarck Islands near 1°S, 151°E are probably marginal outliers of the southern active zone. On the northwest, a number of epicenters are definitely southeast of the structural line indicated by oceanic troughs, etc., but a wide gap is left unclosed.

The line of islands, and the submarine contours, clearly indicate a structure passing by way of Palau and Yap. (See also Hess, 1948.) Only the northern part is associated with seismicity; between Halmahera and Palau no epicenters are known.

The location of the andesite line here is somewhat uncertain. The western Carolines, including Yap, are andesitic; the eastern Carolines are islands of Pacific type. Chubb (1934) and others have drawn the boundary rather far to the east, crossing from the region of Yap to that of the Bismarck Islands; but there seems to be no direct evidence for this (Bridge, 1948).

A good station was operated by the Japanese at Palau. A small station without absolute timing was in operation at Agaña, Guam. Stations at Manila and in the Netherlands East Indies have supplied essential data for small shocks in this region. Many shocks occur in the vicinity of Guam, and only a representative fraction of these have been studied. Every shock which could be located in the rest of this region has been worked out and tabulated. Magnitude determination here is exceptionally difficult; the surface waves are abnormally diminished, either by slight focal depth, or by loss of energy in crossing the various structural boundaries surrounding the region. No true intermediate shocks have been found, except near Guam.

Some of the Pacific arc features can be identified in the region of Yap. There is a foredeep (feature *A*), and negative gravity anomalies (feature *B*) appear on a profile run by Meinesz crossing Yap. Shallow shocks appear to occupy the corresponding position. No deep-focus shocks are known, and there are no active volcanoes.

Marianas Islands

Region 18, Figure 16. The arc of the Marianas extends from about 12° to 20° north latitude, Guam being the largest and one of the most southerly of the group. In a paper just received, Hess (1948) has discussed the submarine topography and the structural features of this and adjacent areas.

Location of the larger shocks in this area is fairly reliable, especially for those years in which extensive data from Japanese stations are available. Most of the activity is at intermediate focal depth; consequently shallow shocks have been searched for. The arc includes the active area off Guam, where only a few representative shocks have been added to those needed for the statistical cataloguing.

Macroseismic data exist chiefly for Guam, for which Repetti (1939) published a long catalogue of felt earthquakes.

Feature *A* is shown by oceanic troughs, including the Nero Deep. Feature *B* is shown by shallow shocks between the island arc and the deep, and is further supported by negative anomalies appearing on a gravity profile by Meinesz approaching Guam. Feature *C* is well developed, many of the shallow shocks being at depths approaching 60 kilometers, as in South America and the New Hebrides. Feature *D* is shown by true intermediate shocks following the line of islands, where there are

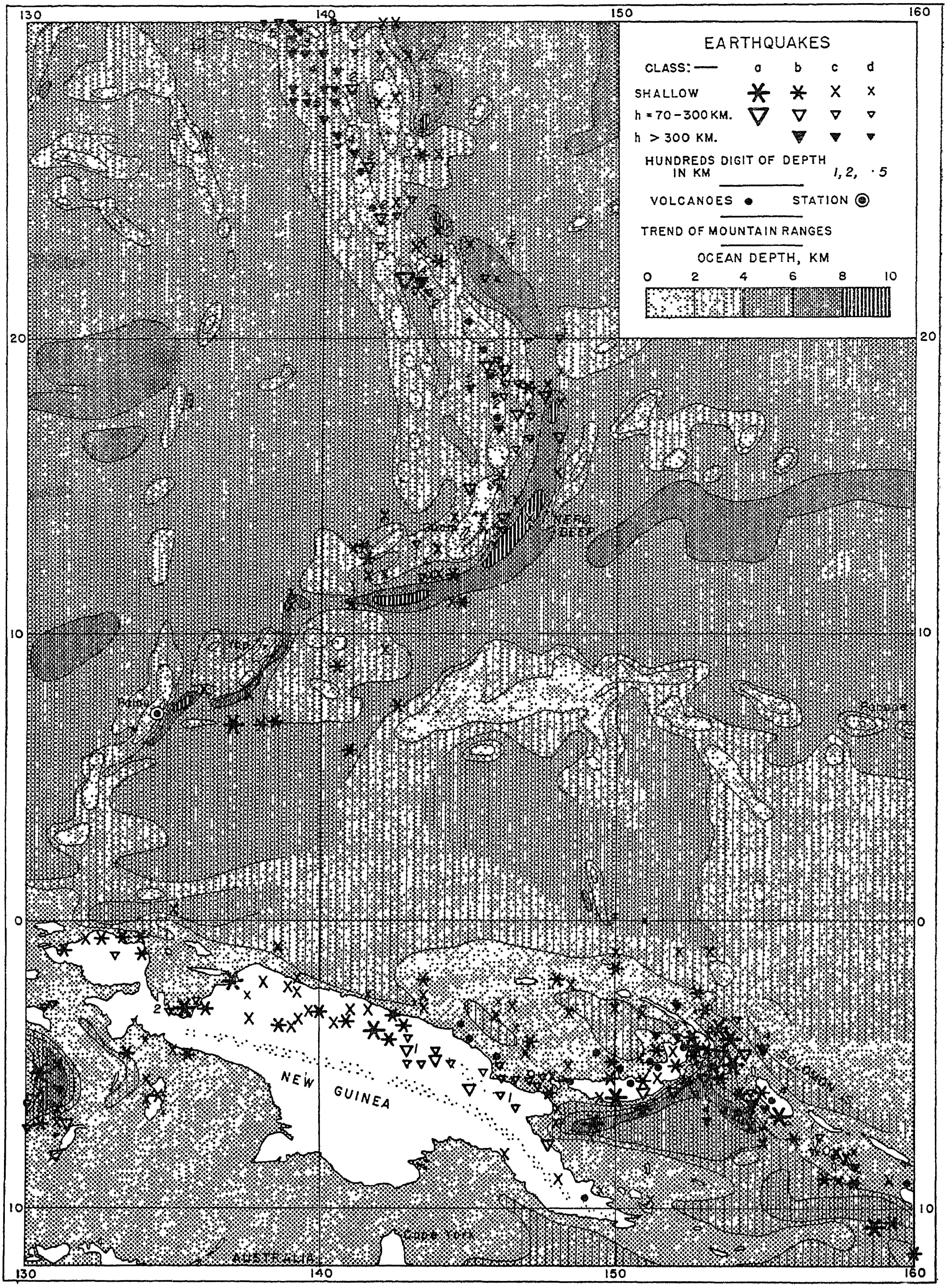

FIGURE 16. New Guinea-Marianas Islands.

active volcanoes (Tanakadate, 1940). Shocks in a considerable range of depth occur among the islands, so that features *D*, *E*, and *F* appear to be almost coincident. In the northern islands, where the volcanism is highest, the intermediate shocks approach 200 kilometers in depth. Near these are two shocks deeper than 500 kilometers. To the northwest of the northern end of the island arc are several shocks with depths near 300 and 400 kilometers.

Japan and adjacent areas

Regions 18, 19, 20 and 46, Figures 17 and 18. This area is complex both in structure and in the pattern of seismicity. It includes the principal branching of the circum-Pacific belt, which descends from Kamchatka and divides in Honshu into a branch southward toward the Marianas and a branch southwestward through Kiushiu to Formosa. It also involves the two belts of deep shocks originally described by Wadati (1934, 1940), one crossing Japan transversely to Manchuria, the other extending from Manchuria across southern Sakhalin into the Sea of Okhotsk.

Structurally the region includes a series of Pacific-type active arcs, complicated by branching; but the northern coastal region of Honshu, fronting on the Japan Sea, shows active faulting with a considerable shear component associated with a well-developed block structure. This was clearly demonstrated by the fault displacements at the surface following the Tango earthquake of 1927 (Davison, 1936, pp. 212-245) and the Tottori earthquake of 1943 (Tsuya, 1944; Miyamura, 1944). Honshu is crossed by the active fault displaced at the time of the Mino-Owari earthquake of October 28, 1891, when both vertical and horizontal motions were large (Koto, 1893). To the east of this is the Fossa Magna, a zone of fissuring and volcanic activity extending from the Idzu Peninsula and Fujiyama directly across Honshu.

Data for the numerous active volcanoes of Japan have been assembled from many sources, notably Krijanovsky (1934), Milne (1886), and Tanakadate (1931-1939; 1937). For the Kurile Islands data have been taken from maps compiled by the U.S. Army Map Service, Washington, D.C., 1944, from Japanese maps and charts, including supplementary information on location and activity of some volcanoes assembled by the U.S. Geological Survey.

Crustal structure for Honshu should be derivable from the seismograms of the Japanese stations. Most of the data would be suited by a depth of about 45 kilometers for the Mohorovičić discontinuity. Suda (1925) considered that the continental layers are thinner on the Pacific side of Honshu than toward the Japan Sea. Several authors have suggested a major structural difference on the two sides of the Fossa Magna. In some of the earthquakes it has been possible to determine velocities for longitudinal waves of about 5.6 and 6.2 kilometers per second, corresponding to those found for the granitic layer and that next below it in other regions. Details call for much further investigation, with sensitive seismographs and precise timing.

Gravity observations are numerous. Detailed oceanic surveys by a Japanese submarine were reported by Matuyama (1934; 1936). These and observations on land are discussed by Kumagai (1940). The entire group of data have been summarized and reduced by Heiskanen (1945).

An exceptional wealth of data, both macroseismic and instrumental, is available for the study of earthquakes in and about Japan. It has been necessary to reject data for many well-observed minor shocks, as these would not be available for study in most other regions, and only serve to blur the general description.

An important development in seismology occurred about 1880, with the founding of Tokyo Imperial University and the bringing in of such men as Gray, Milne, and Ewing. The rapid progress made both instrumentally and in field study is recorded in the publications of the Seismological Society of Japan for the following years.

Among the earliest established stations capable of recording distant earthquakes were those at Tokyo and Osaka. For the latter we have a summary publication giving readings from 1882 to 1929. For Tokyo there is a similar catalogue (Yasuda and Kodaira, 1938), giving all shocks recorded from 1872 to 1897, and those strong enough to be perceptible to persons in Tokyo from 1898 to 1923. This is much less valuable for general purposes than the Osaka report; it contains only Japanese shocks, and the timing appears to be less reliable.

Timing at many Japanese stations was not of the best during the earlier years. However, some apparent inconsistencies in reported times were removed by the discovery that many clearly recorded shocks in the region are deep-focus earthquakes.

The development of secondary stations in Japan was largely under the auspices of the Central Meteorological Observatory. A list of over 100 such stations was presented to the Edinburgh meeting of the International Geodetic and Geophysical Union in 1936.

The disastrous earthquake of 1923 led to great expansion in the government seismological program in Japan. A new organization, the Earthquake Research Institute, was set up at Tokyo Imperial University. Its objectives only partly overlapped those of the program connected with the Central Meteorological Observatory.

The Central Meteorological Observatory issued a bulletin reporting observations at all the stations, with determinations of epicenters. Copies were sent to Oxford, and the data are incorporated in the *International Seismological Summary* so far as it has proceeded. The issue for 1938 is available at Pasadena. Many observations and epicenters reported from Tokyo were found in separate bulletins published from Zinsen, Taihoku, Nagoya, and Osaka, as well as in the *Geophysical Magazine*, issued under the auspices of the Central Meteorological Observatory. Many valuable papers were published in this periodical.

The Bulletin of the Earthquake Research Institute contains numerous valuable theoretical and observational papers, including geodetic data bearing on crustal deformations. A group of stations in the region of Tokyo provided material for epicenters of shocks perceptible at Tokyo; these are listed quarterly beginning in 1932, and a summary publication gave data for 1924 to 1930.

One of the oldest independent stations with reliable time was at the international station at Mizusawa. For 1933 to 1937 excellent and detailed reports were available from Kobe (including secondary stations at Sumoto and Toyooka). Bulletins from Taihoku and Zinsen summarize data for the stations in Formosa (Taiwan) and Korea (Chosen) respectively.

Among the stations outside Japan which are important for studying shocks in this region are the long-established station at Zi-ka-wei (near Shanghai), the station at Vladivostok operated intermittently since 1930, and the first-class station operating from 1931 to 1937 at Chiufeng (near Peking).

Historical data for Japan are exceptionally useful, since the long record includes many great shocks. The following is quoted from Imamura (1937, p. 144).

"Although the first recorded earthquake of authentic history bears date of A.D. 416, the number of those recorded is very small until the great Nankaidô earthquake of November 29, A.D. 684. While even as early as A.D. 684, Central Japan was more or less cultured, and earthquake records are fairly comprehensive, this cannot be said of localities remote from the centre of culture; but from 1596 and onwards, the records for the whole country may be regarded as fairly complete." Imamura lists 66 destructive earthquakes from 1596 to 1935.

The belt extending from near Tokyo up the east coast of Honshu, and then past the Kurile Islands to Kamchatka, is the most active source of shallow and intermediate shocks in the world. Ten class *a* shocks are mapped; in order from south to north these are the earthquakes of 1923, 1933, 1905, 1918 (2), 1915, 1904, 1915, 1923, 1917. (The 1904 epicenter represents three shocks.) The class *a* shock on the Japan Sea coast is the Tango earthquake of 1927. Large intermediate and deep shocks occur relatively frequently in the region; the deep shock of 1906 (19D160) in central Japan is the largest known, and the intermediate shock (20I250) of 1911 south of Kiushiu is one of the largest in its depth range.

Typical Pacific arc features are found between the Marianas and Honshu. To the east is a deep trench (Feature *A*). Feature *B* is indicated by a strongly marked belt of negative gravity anomalies west of the trench. It is accompanied by shallow shocks, mostly small in this sector. Feature *C* is indicated by a few shocks at slightly greater depth. The line of volcanic islands (feature *D*), is associated with a few intermediate shocks at depths of 100-200 kilometers. West of it is a second line of ridges, largely submerged, with volcanism in a later stage corresponding to feature *E*. Seismicity of features *E* and *F* cannot be separated readily. It consists of a broad and very active belt of deep shocks which diverges from the other features with a northwesterly trend; shocks at depths near 200 kilometers occur near its eastern margin, and shocks deeper than 500 kilometers at the west. This belt continues directly across Honshu and probably crosses the Japan Sea. On Honshu it is apparently paralleled to the east by a belt of relatively low gravity, which interrupts the otherwise well-marked belt of positive anomalies running up the east coast of Honshu. Shallow shocks near Tokyo fall in this low-gravity belt.

This arc is followed in order northward by

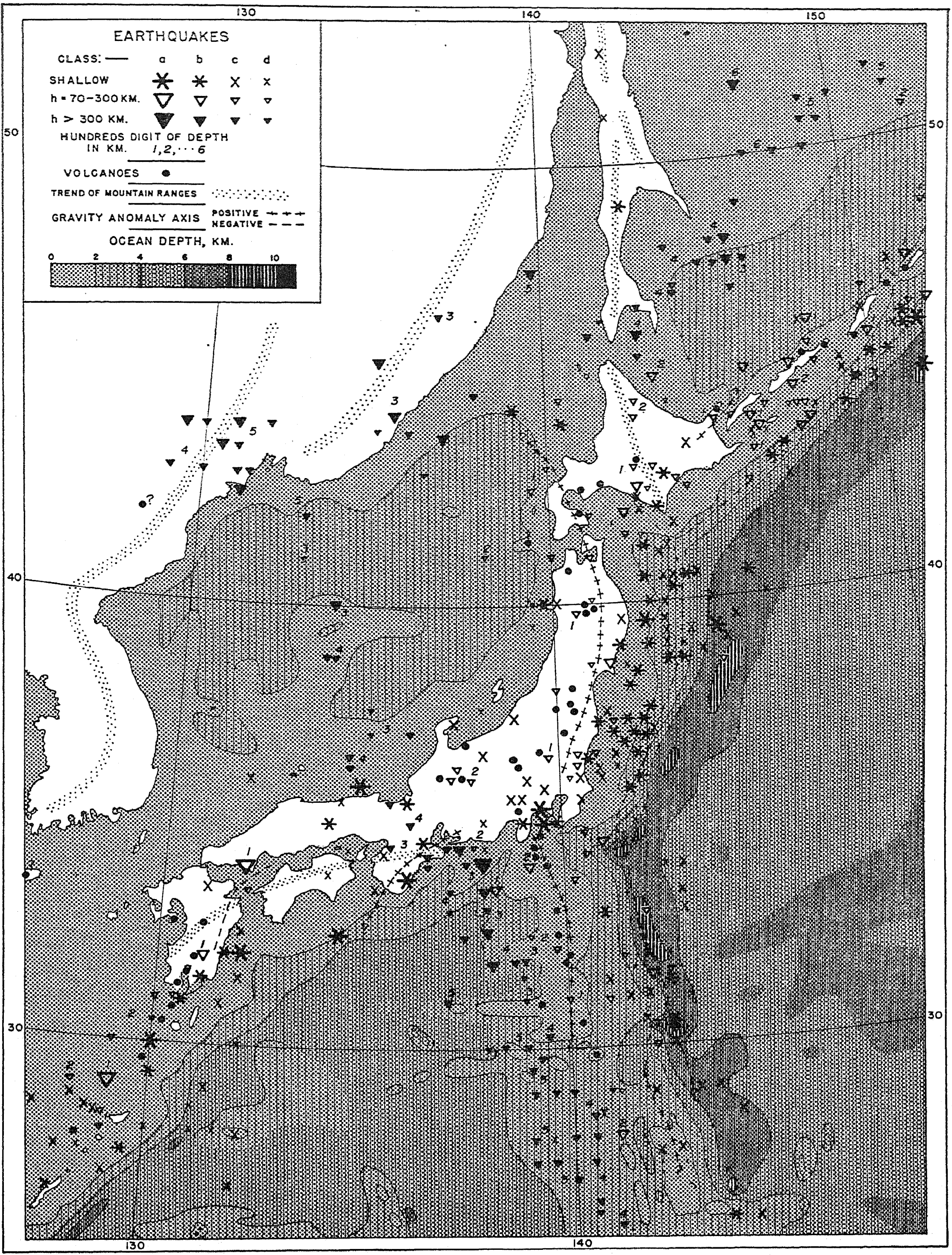

FIGURE 17. Japan.

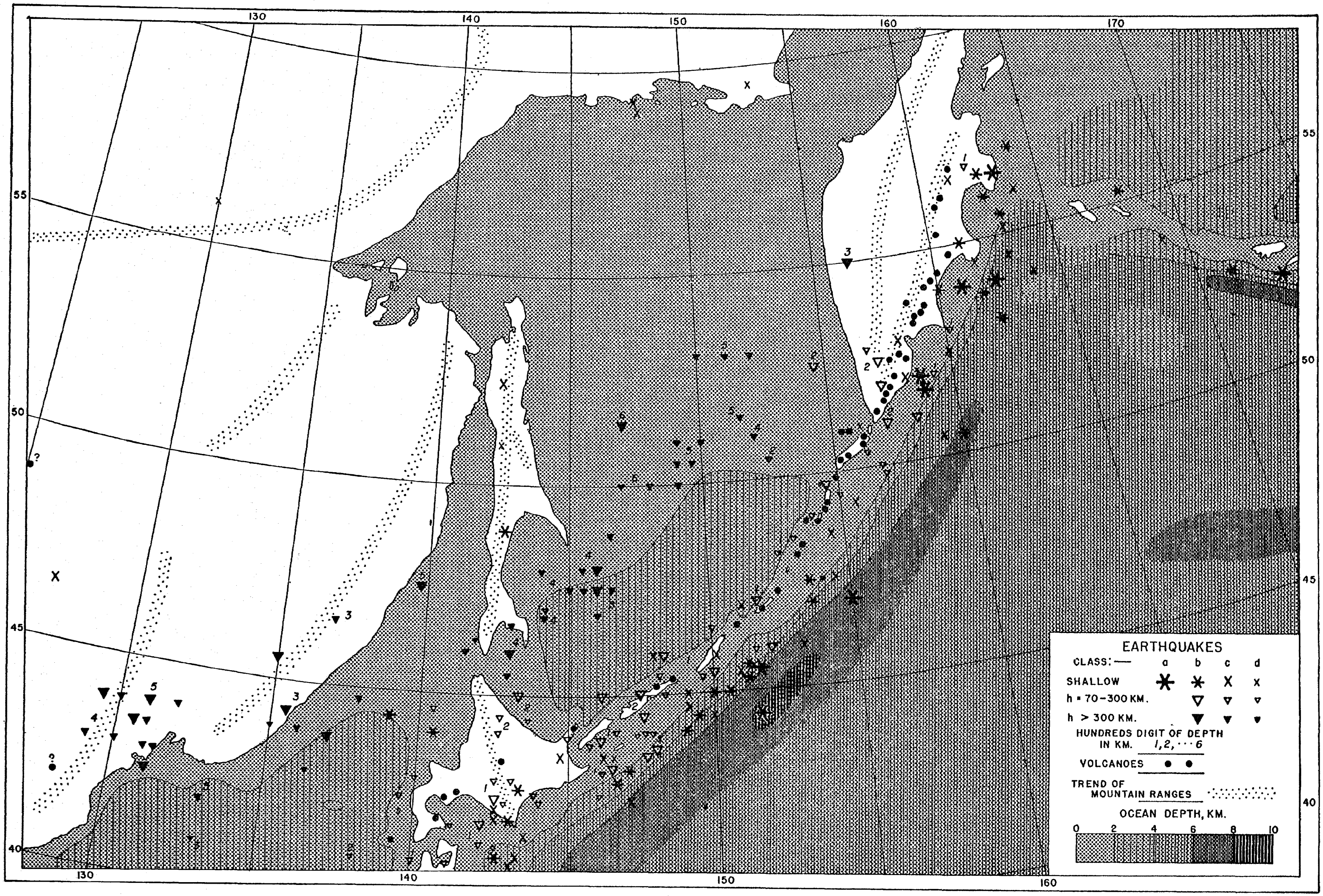

FIGURE 18. Kurile Islands-Kamchatka.

two others, one associated with Honshu, the other extending from Hokkaido through the Kurile Islands to Kamchatka. At about 41°N these arcs meet at a sharp angle which is expressed in the alignment of all the features, possibly including the angle formed by the principal belts of deep shocks meeting in Manchuria. The Honshu arc features are complicated by the branching of the Pacific belt; it will simplify their discussion to describe first the northern arc.

Here feature *A* is the Kurile Trench. Feature *B* is represented by many shallow shocks, frequently large, on the Pacific side of the islands; approaching Hokkaido, negative gravity anomalies are known. Feature *C* is marked by shocks definitely assigned to depths of the order of 70 to 100 kilometers, between the shallow earthquake belt and the island arc. The latter, with active volcanoes and intermediate shocks, represents feature *D*, extending into Kamchatka. Feature *E* is indicated by a few shocks at depths over 200 kilometers on the concave side of the arc. It is clearly evident in Kamchatka, where there are two volcanic lines, the eastern now active, the western practically extinct (Reck and Hantke, 1935). Feature *F* is the "Soya deep-focus earthquake zone" of Wadati, with foci mostly deeper than 400 kilometers and descending below 600 kilometers, which crosses the Sea of Okhotsk to Manchuria. The profile (Fig. 6) shows all these features.

Off the Pacific coast of Honshu, feature *A* is the Japan Trench, which is essentially continuous with the foredeeps to the south and north. Most of the large shallow shocks of the Japanese region occur in the belt of strong negative gravity anomalies (feature *B*) on the west side of the Japan Trench. The convexity of the Honshu arc is clearly evident between latitudes 35° and 41°. Feature *C* is shown by numerous shocks at depths of 70 to 100 kilometers; shocks at depths of over 100 kilometers are associated with the main volcanic line (feature *D*). A few shocks at depths of 200 kilometers and over occur inland or in the Japan Sea (feature *E*?). Feature *F* is presumably represented by the transverse belt of deep shocks across Honshu and the Japan Sea.

Superposed on the arcuate structure is a belt of block structure associated with shallow earthquakes, constituting the northern terminal of the western branch of the circum-Pacific belt. The principal activity follows the Japan Sea coast, including several shocks west of Hokkaido (one of magnitude 7.1, November 4, 1947, 00:09:10, 44°N, 140½°E). The Tango earthquake of 1927 (Davison, 1936) is probably the largest of these during the historical period; it was accompanied by block movements with both vertical and horizontal components. The region shows no extended longitudinal rift structure such as might indicate predominant strike-slip displacement like that in California. The coastal active zone appears to have secondary branches which strike south into eastern Honshu north of Tokyo. Such branches probably also account for the occasional strong shocks in and near the Inland Sea north of Shikoku.

The Mino-Owari earthquake zone crosses Honshu between the Fossa Magna and the transverse belt of deep shocks. Recent data indicate very little activity here, suggesting a period of quiet following the great shock of 1891.

Many maps of the seismicity of Japan show a submarine active belt including the shocks off the east coast of Honshu, but continuing along the entire Pacific coast of the islands past Shikoku to Kiushiu. Large shocks have occurred in the vicinity of the Kii Peninsula east of Shikoku. The great shock of 1707 was destructive on both, and caused large tsunamis entering the channels on both sides of Shikoku. At 33½°N, 135½°E is the epicenter of the Wakayama shock of January 11, 1938 (Minakami, 1938). The great shock of December 7, 1944, has been located at 33¾°N, 136°E. That of December 20, 1946, originated near 32½°N, 134½°E.

For the region of Shikoku itself Figure 17 shows only one small shock (class *d*). There appears to be a real gap in the seismic belt; at least, the conditions of activity differ widely from those to east and west. This corresponds to the absence of any deep trench off the coast, and to the lack of strong negative gravity anomalies. There is also a gap in the belt of active volcanoes. Very small shocks occur in this region, and are recorded by local stations; such shocks occur everywhere in Japan.

Kiushiu to Formosa

Regions 20 and 21, Figure 17. This includes the arc of the Riukiu Islands with the masses of Kiushiu and Formosa (Taiwan) at the ends; it is an active zone within an area of primarily continental structure. The Philippine Sea, on which the arc fronts, is rather of continental than of Pacific character as indicated by the velocities of surface waves crossing it.

Data for this region are mainly from the same Japanese sources to which reference has been made in the preceding section.

Kiushiu and Formosa are very different structurally. Kiushiu is at the active northern end of a volcanic belt, associated with an active arc. Formosa is non-volcanic, although there is active volcanism southeast and south of it. It has a block structure, with both horizontal and vertical fault displacements reaching the surface, as in the earthquakes of 1906 (Omori, 1907b) and 1935 (Miyabe *et al.*, 1936; Nishimura, 1937). In the latter case the displacements occurred on two different fault systems intersecting at an angle, recalling those observed after the Tango earthquake of 1927 on Honshu. Otuka (in Miyabe *et al.*, 1936, p. 70) writes as follows:

"During this earthquake of Central Taiwan, Mr. D. Ho and K. Kwo observed at Sintakusan and Roppun in Sitan-syô, respectively, that the Siko earthquake fault formed *after* their houses were destroyed by the earthquake shocks, and not simultaneously with the initial shock.

"The late F. Omori has left on record that the Neo valley earthquake fault, the well-known earthquake fault that formed at the time of the Mino-Owari earthquake, 1891, formed after the destructive shocks took place. According to N. Nasu similar phenomenon is observed along Yamada earthquake fault at the time of the Okutango earthquake, 1927.

"These observations show that earthquake faults, at least those exposed on the land surface, are not the cause of the earthquake motions, but the result of it."

Seismological stations were fairly numerous, with several on Kiushiu and a few in the Riukiu Islands; the group of stations on Formosa was organized as a network publishing its own bulletins from the chief station at Taihoku. Observations at Manila, Hong Kong, Zikawei (Shanghai), Chiufeng, and Nanking are important in this region.

Shallow seismicity about Formosa is higher than for the rest of the arc, which is nearer the average level for a Pacific arc and lower than that of eastern Japan. About Kiushiu the number of located intermediate shocks increases notably; this is only partly due to the position of the stations.

Of the Pacific arc features, *A* is represented by a trench less deep and less sharply defined than the Japan Trench, intervening between the Riukiu Islands and the Philippine Sea. Shallow shocks and the non-volcanic chain of the principal islands form feature *B*. The deeper shocks of feature *C*, the intermediate shocks and volcanoes of feature *D*, and shocks at a depth near 200 kilometers (feature *E*) follow in regular order, particularly in the vicinity of Kiushiu. No deep shocks corresponding to feature *F* are known.

Philippines

Region 22, Figure 19. The structures of the Philippines have been discussed by Willis (1937, 1940, 1944). There is a great complication, with intersecting structures of different types and trends. The western branch of the Pacific belt descends from Formosa into an area of low activity and uncertain structure, which passes into a more active arc following the west coast of Luzon. Extending across Luzon and into the southeastern islands is a rift structure including a great fault with strike-slip displacement, referred to by Willis, following Becker, as the Philippine Fault. Repetti (1935) calls this the Master Fault. On the map published by Willis (1944) it appears as the Visayan rift zone. Where the islands Mindanao and Samar front on the Philippine Sea is an arcuate Pacific structure with strongly developed features. West of this is the central part of the archipelago, including structures with a southwesterly trend; one of these follows through Palawan into northern Borneo.

Gravity data are chiefly from the work of Meinesz. The principal seismological station was Manila, which operated continuously from 1884 until its destruction by the Japanese. Several secondary stations with less sensitive instruments and incomplete time service were maintained.

The mapping is not uniform. Shocks are very frequent in the region of the Mindanao Trench, and here only the larger shocks needed for statistics have been plotted. Deep shocks have been searched for with special attention. In the less active central and southwestern part of the archipelago, all shocks capable of satisfactory location have been included. Finally, in the vicinity of Manila a number of small shocks have been omitted.

Macroseismic data for the Philippines extend back over three centuries; they have been summarized by Masó (1927a; 1927b), and a detailed catalogue has been published by

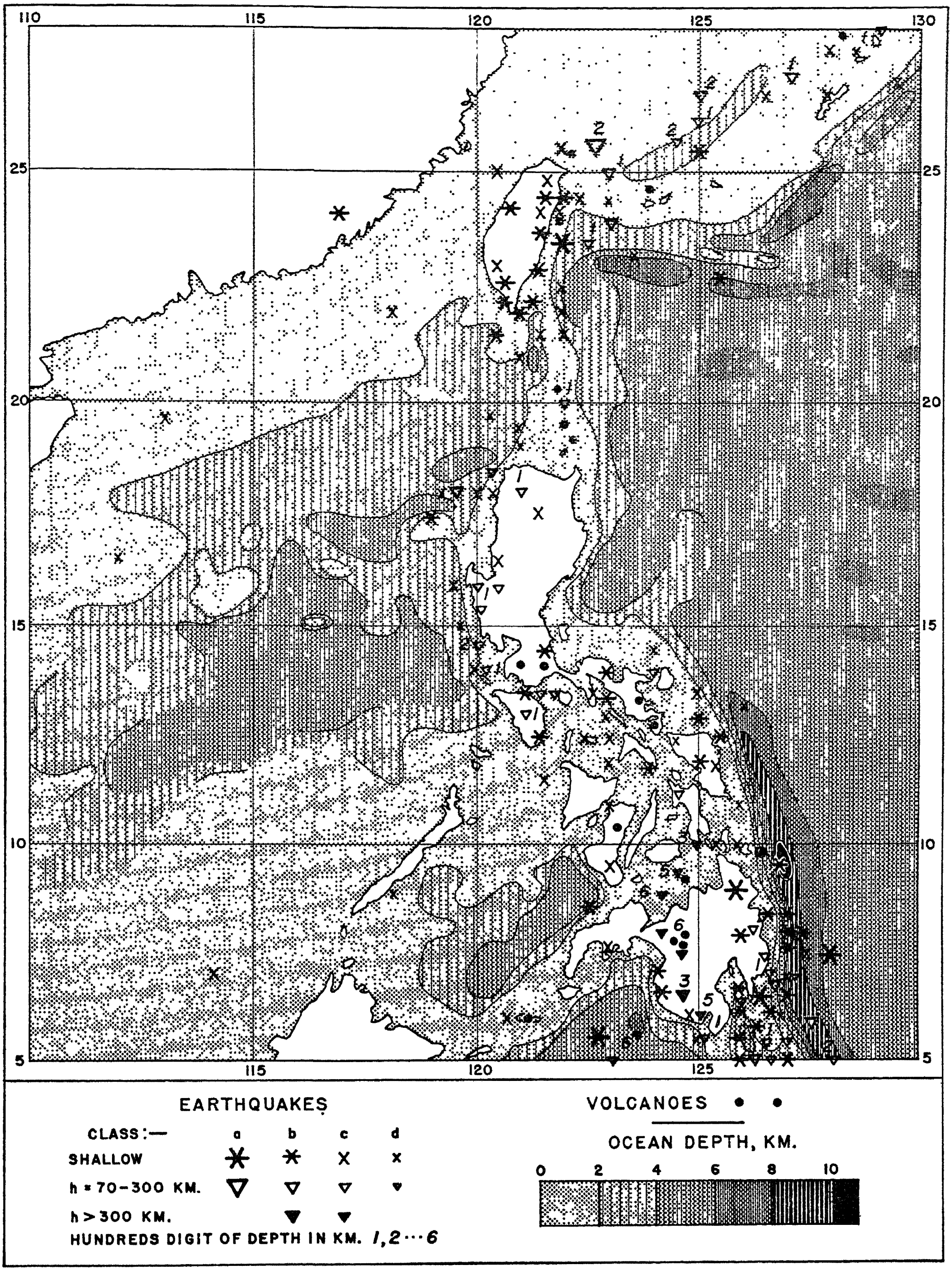

FIGURE 19. Formosa-Philippines.

Repetti (1946). Reports of each year were regularly given in the bulletins issued from Manila; recent earthquakes and the distribution of instrumental epicenters were discussed by Repetti (1931a; 1931b; 1931c; 1932; 1935; 1940). A map based on Repetti's data, showing instrumentally located epicenters, was published by Willis (1944). This map includes a number of small and doubtfully located earthquakes not considered in the present study.

Seismicity is high in the region of the Mindanao Trench, moderate in the vicinity of

Luzon, and relatively low elsewhere in the Philippines.

There is some indication of a Pacific type arc, probably fronting eastward, extending from Formosa into northeastern Luzon. It is marked by a few shallow shocks, by submarine volcanism southeast of Formosa, and by active volcanoes in the Batan and Babuyan Islands, where there is a well-determined shock (22I-900) with a depth of 170 kilometers.

The following arc fronts west toward the China Sea, as indicated by the convex west coast of Luzon. No definite trench exists. Shallow and slightly deep earthquakes are frequent off this coast, while intermediate shocks occur near the coastal line on an arc extending from Luzon into Mindoro. These are associated with active volcanoes, including Taal.

The principal structural arc of the eastern Philippines extends from Luzon at least to the Talaud Islands. Feature *A* is the Mindanao Trench or Philippine Deep, the most profound foredeep known. Feature *B* is marked by numerous and often large shallow shocks just west of the trench. Meinesz's data show large gravity anomalies on one cross profile near 10°N, and on closely spaced profiles in the southern part of the arc. Feature *C* is suggested by a few shocks at depths near 70 kilometers. Feature *D* appears plainly in the northern part of the arc, where there are active volcanoes (including Mayon), and at least one intermediate shock (22I450). At the south there are shocks at depths over 100 kilometers under eastern Mindanao, but no accompanying volcanism. Volcanoes here are farther west, suggesting feature *E*; Camiguin is active. Feature *F* is positively indicated by a series of very deep shocks, with epicenters close to the volcanic line.

The remaining structures are indicated, rather incompletely, by shallow shocks. A number of these follow the Visayan fault zone, from Luzon across Leyte and Mindanao; this includes shock 22N590 in 1937, destructive at Manila, and possibly the Agusan Valley earthquakes (22N290) in 1911 on Mindanao. The activity in general is much lower than that of the feature *B* zone west of the Philippine Deep; in the Mindanao region it is often difficult to tell whether an imperfectly recorded shock belongs to one or the other of these two lines.

The belt of shallow shocks west of Luzon appears to continue southward through Panay and Negros including the class *a* shock of January 24, 1948, crossing the narrowest part of Mindanao and then turning eastward south of that island. It may be compared with the belt of shallow shocks on the north coast of Honshu.

The structures diverging southwestward toward Borneo are represented each by one epicenter: 22N810 in the Sulu Islands, and 22N840 on Palawan.

Celebes and Moluccas

Region 23, Figures 19 and 20. South of Mindanao the structural and geophysical complexities increase. Between northern Celebes and Halmahera the two principal branches of the Pacific belt approach each other and may be said to be in contact. One structural arc, belonging to the series followed in the preceding sections, extends from Mindanao to Celebes, and is convex to the east. It is faced by the westward fronting arc of Halmahera, which connects the structural and seismic belt of northern New Guinea with that of the Caroline Islands extending toward Palau and Yap.

The most probable southward continuation of the structural belt on the basis of present information is that which follows a loop through eastern Celebes to connect with Buru and Ceram, and so directly into the arc which surrounds the Banda Sea (Meinesz *et al.*, 1939; Schuppli, 1946).

The highly important gravity observations by Meinesz (1934, 1940) are involved at every point. His reports include maps from official sources which have been used in studying submarine contours and other features.

Data on volcanoes in the Netherlands East Indies were originally taken from Escher (1937). These have been supplemented from an extended summary of historical eruptions (van Bemmelen, 1941).

This region is not near enough to first-class stations to be studied with the precision it deserves. The only station actually in the area was that at Amboina (south of Ceram), which suffered from frequent interruptions in service and occasional difficulty in time determination. In consequence, it is not always possible to find satisfactory epicenters for the large shocks of the region, and only limited use can be made of the frequent smaller shocks, epicenters for which might otherwise assist in interpreting the structural relations of the high seismicity. Activity is well above average for

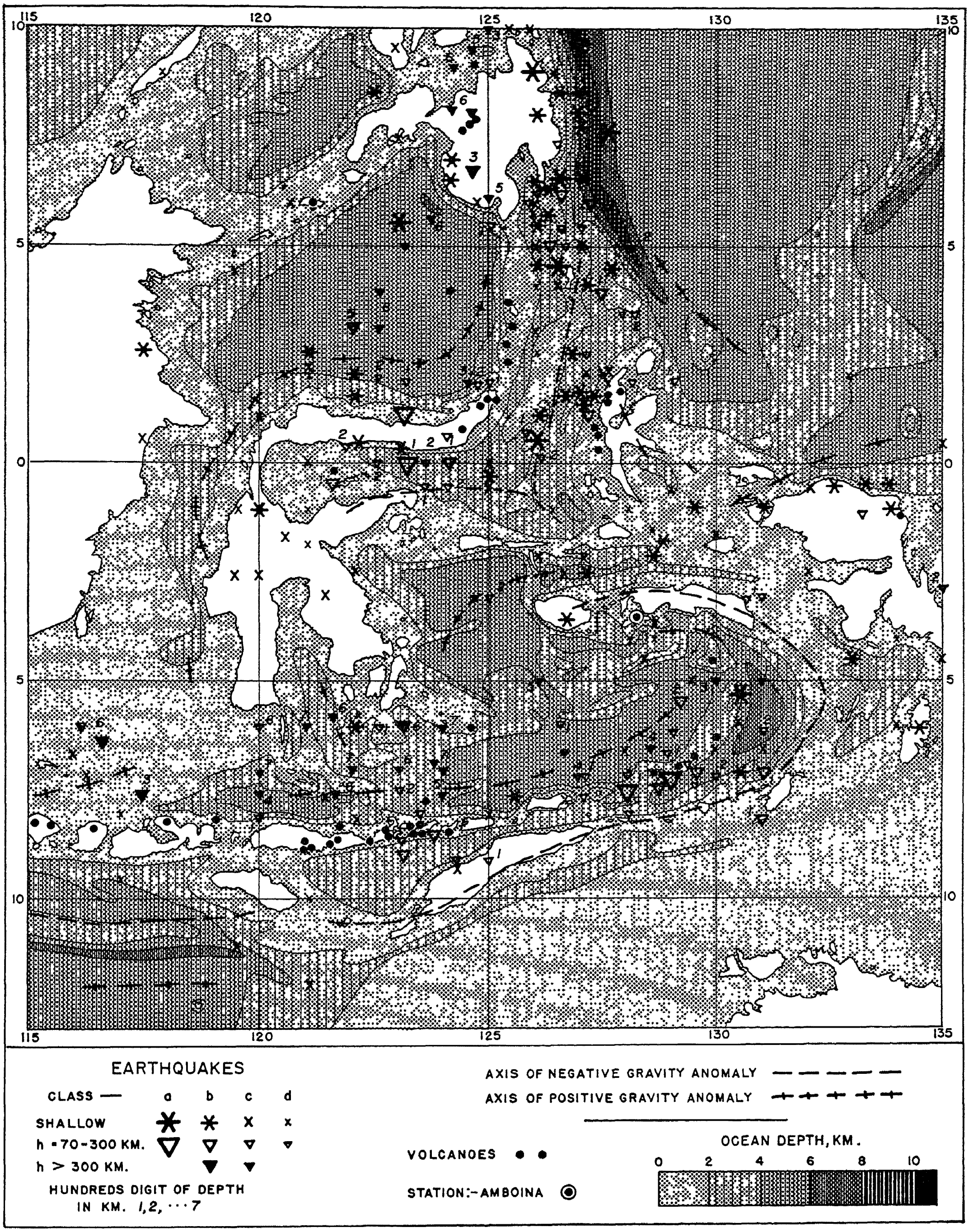

FIGURE 20. Moluccas.

the Pacific belt; intermediate shocks are very numerous, and some of them (notably in northern Celebes) are among the largest known. Deep shocks are fairly frequent.

At the north, both opposing arcs—that of Celebes and the Sangi Islands, and that of Halmahera—show all the characters of feature *D*, with active volcanoes and accompanying intermediate earthquakes. A number of intermediate shocks just south of the northern peninsula of Celebes are plotted on the equator, although their latitudes may be in error by a quarter or a half degree. This gives the effect of a spuriously definite line of activity.

Between the opposing arcs is a ridge which includes the Talaud Islands, and is an axis of very large negative gravity anomalies as well as a source of shallow earthquakes. This may be considered as a feature of type *B* common to both arcs. The ridge is apparently continuous with the elevated area of eastern Mindanao. Deep shocks representing feature *F* occur to the west under the sea between Celebes and Mindanao; there are none known to the east, corresponding to the Halmahera arc.

Scattered shallow shocks occur about the coasts of Borneo and Celebes. Some of these are associated with Macassar Strait, an interior fracture of the stable mass of which Borneo is a part. Shallow shocks, some of them large, occur south of Celebes in the Flores Sea. Here they are close to the epicenters of a number of large deep shocks, which belong to feature *F* of the Sunda arc, discussed later.

Earthquake epicenters fail to confirm the hypothetical extension of the Celebes arc southward and then eastward toward Buru. This structural connection is based on the geology and a few gravity observations. It is possible that this represents a part of the active belt which has been distorted into such a position that the forces are now relaxed and the features are beginning to disappear. Compare Hess's hypothesis as to the West Indies loop and its extension through Cuba; there is even an analogous occurrence of peridotites on Celebes and Buton (as reported by De Roever, Pacific Science Congress, 1949). The change in stresses may account for some peculiarities of the Banda Sea arc.

Banda Sea

Regions 23 and 24, Figures 19, 20 and 30. The structural arc round the Banda Sea through Buru, Ceram, and the Tenimber Islands has most of the Pacific-type features, although it fronts against the masses of New Guinea and Australia rather than against the Pacific. The expression of the features is uneven and in part abnormal. There is an exterior trough (feature *A*) between the principal arc and New Guinea. Feature *B* is well shown by the strong belt of negative anomalies extending as far as Timor. The northern part of the arc is also a locus of shallow earthquakes (including the great shock of 1938, which was felt as far away as Port Darwin); in the southern part few shallow shocks have been identified. Feature *D* appears as an inner arc of small volcanic islands, with epicenters of intermediate earthquakes. The Weber Deep, between these and feature *B*, represents an exaggeration of the depression which normally occurs in the corresponding position. Feature *F* is suggested by a few shocks at depths near 400 kilometers.

Seismicity is high. Shocks at almost all depths occur, and uncertainty as to the depth often adds to the general difficulties of accurately locating epicenters in this region. Very few shallow shocks can be located more closely than within two degrees. Shocks have been added to the tables and maps whenever sufficiently well located to assist in interpreting the structural relations; most of these occurred during the periods when the data for Amboina were useful.

Sunda arc

Region 24, Figures 21 and 22. This appears to be a single long arc of Pacific type, extending through the lesser and greater Sunda Islands to the Nicobar and Andaman Islands. There is considerable doubt as to how, if at all, the northwestern end of the arc should be connected with the structures of Burma. At the east is a disturbed region marked by the outlying islands of Timor and Sumbawa. For its relation to the Australian mass see Figure 30. In the region of Sumatra the arcuate thrust structure begins to be disturbed by a superposed block structure with horizontal faulting. An earthquake in 1892 produced displacements of triangulation points by more than one meter (Reid, 1913).

The geology of the region has an extensive literature. Summaries are given by Umbgrove (1938; 1942; also in Meinesz *et al.*, 1934), and by Schuppli (1946). Sources for data on gravity anomalies and volcanoes are the same as those for the two preceding sections.

For the western part of this area the chief station is Batavia. Secondary stations were maintained at Amboina, at Malabar (privately owned), and in Sumatra at Medan and for a short time at Soengi Langka. The stations in India, particularly Calcutta, are very useful here; to the north are Phu-Lien and Hong Kong, and to the south are the Australian stations, of which Perth is here the most valuable for large shocks. More of the larger shocks have

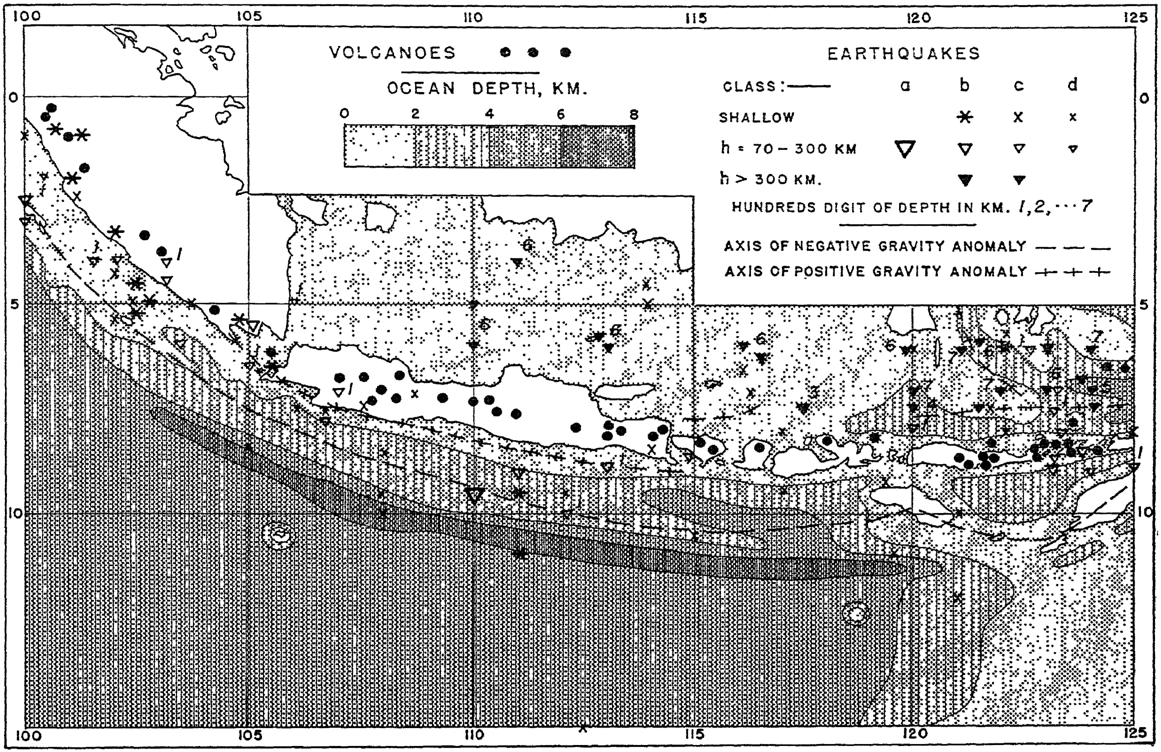

FIGURE 21. Sunda arc.

been included here than in previous papers, since study of amplitudes has improved the distinction between shallow and intermediate shocks, thus diminishing an uncertainty which affected epicenters as well as depth.

Seismicity at shallow depth, which is moderately high off Sumatra, decreases eastward past Java to Timor. The belt of intermediate shocks through the main line of volcanic islands is more evenly active. Very deep shocks occur under the Java Sea and Flores Sea. (Berlage, 1937; 1940.)

The Pacific arc features are in general well developed along the Sunda arc, but show much variation. From the south and west the floor of the Indian Ocean rises gradually to shallow depths, emerging at Christmas Island, which is an old volcano. North of this shallow sea is a steep descent into the Java Trough (feature *A*). Off Sumatra this descent is less steep, and the trough is shallower. Next inland, off the Sumatra coast, is a line of small islands separated by shallow straits. These mark feature *B*. The line continues eastward as a submarine ridge off the coast of Java. The belt of strong negative gravity anomalies practically coincides with this ridge. Between Java and the Java Trough these anomalies are large, but there is very little accompanying seismicity; while among the islands off Sumatra the gravity anomalies are less marked, and seismicity is intense, consisting exclusively of shallow shocks. Inshore slightly greater depths again are found before the coast of Sumatra and Java are reached. This coastal belt is a region of positive gravity anomalies and earthquakes at depths in the upper part of the intermediate range (feature *C*). Beyond these is the volcanic belt of the two large islands, with earthquakes at depths of about 100 kilometers (feature *D*). This feature is perfectly continuous through the entire length of the Sunda arc, extending east of Flores through the interior volcanic islands of the Banda Sea arc. The exterior features, however, show a great disturbance from about 120° to 123°E, in the vicinity of Soemba. Here there is a gap between the Java Trough and the Timor Trough which lies east of it; the belt of negative gravity anomalies is interrupted, several observations in this area giving positive anomalies; and the trends of the structures are distorted. Timor may belong, with the Tenimber Islands, to feature *B* along with the small islands off Sumatra; but Soemba at least is out of line.

Feature *E* is indicated by a few shocks, including two northeast of Medan in Sumatra, at depths of 150 to 200 kilometers.

Feature *F* is well developed, with fairly frequent shocks, some of them large, in a belt crossing the Java Sea and Flores Sea at about 6°S. The depths determined for these shocks generally exceed 600 kilometers, and some exceed 700 kilometers; these are the deepest shocks known. Two shocks at depths near 400 kilometers are south of these.

THE ALPIDE BELT

General survey

This is the southern and more active portion of what has been referred to in previous papers as the trans-Asiatic zone. It consists of a succession of arcuate structures extending from Burma across Asia, through the Alpine structures of Mediterranean Europe, and into the Atlantic probably as far as the Azores. Such areas as the Caucasus and Crimea are included for convenience of discussion.

The belt crosses the numbered regions noted in the following discussion. Maps are Figures 22, 23, and 24. Structural lines shown are taken from Born (1933), Arni (1939), Egeran (1947), Willis (1939), Clapp (1940), Mushketov (1936a,b), Wilser (1928) and Gregory (1929).

The frontal structures of the belt in Asia are a series of arcs convex to the south (except the Burma arc, which is convex to the west). In spite of certain differences to be pointed out in the course of the detailed discussion, these are usually regarded as analogous to the Pacific active arcs. Although of about the same age, their activity is lower, and the characteristic features are generally less well defined. The belt includes all known intermediate shocks outside the circum-Pacific belt. No shocks appreciably deeper than 300 kilometers are known.

Foredeeps (feature *A*) are much less evident than for the Pacific arcs. The alluviated depression of the Ganges has been considered to represent such a feature. In India and in the Mediterranean area belts of negative gravity anomalies are found in the position of feature *B*, accompanied by shallow earthquakes. A few volcanoes indicate feature *D*; intermediate shocks are fairly numerous, and distributed along practically the whole belt. There are two remarkably persistent sources of intermediate shocks: one under the Hindu Kush at about 36.5°N, 70.5°E, at a depth of about 230 kilometers, the other in Rumania near 46°N, 26½°E, with shocks at depths of 100 to 150 kilometers. The frequent repetition of earthquakes from nearly the same hypocenter in these two instances is an exceptional phenomenon, suggesting mechanical conditions differing in some way from those controlling the occurrences of most other earthquakes.

Burma arc

Regions 25 and 26, Figures 22 and 23. Seismic data do not suffice to settle the question of connection between the Burma arc, which is the first of the Alpide series of Asia, and the Sunda arc. This is really a question of connection between the circum-Pacific belt and Alpide belt. A few small shallow shocks appear to continue the Sunda arc northward from the Andaman Islands, but there is a gap between these and the mainland. Structures associated with shallow shocks, some of them large, trend north and south through Burma at about 96°E; a few shallow shocks occur along the projection of this trend off northern Sumatra and in the intervening sea.

Location of shocks in this region depends largely on Phu-Lien, Hong Kong, and the Indian stations. All even moderately well-recorded shocks have been examined with care.

In the Burma arc the characteristic features are less definite than in the Sunda arc. Few, if any, shallow shocks are located along the western, curved mountain arc. The larger shallow shocks of the area belong to the north-south zone farther east. There is a belt of negative gravity anomalies up to –75 milligals following the lines of maximum uplift in the hills separating Assam from Burma, and a gravity maximum follows a line of minor and probably dying volcanism to the east of this (Evans and Crompton, 1946). Intermediate shocks are frequent near 24°N, 93°E; but this is directly on the principal mountain arc, and not in a volcanic region. It suggests rather a

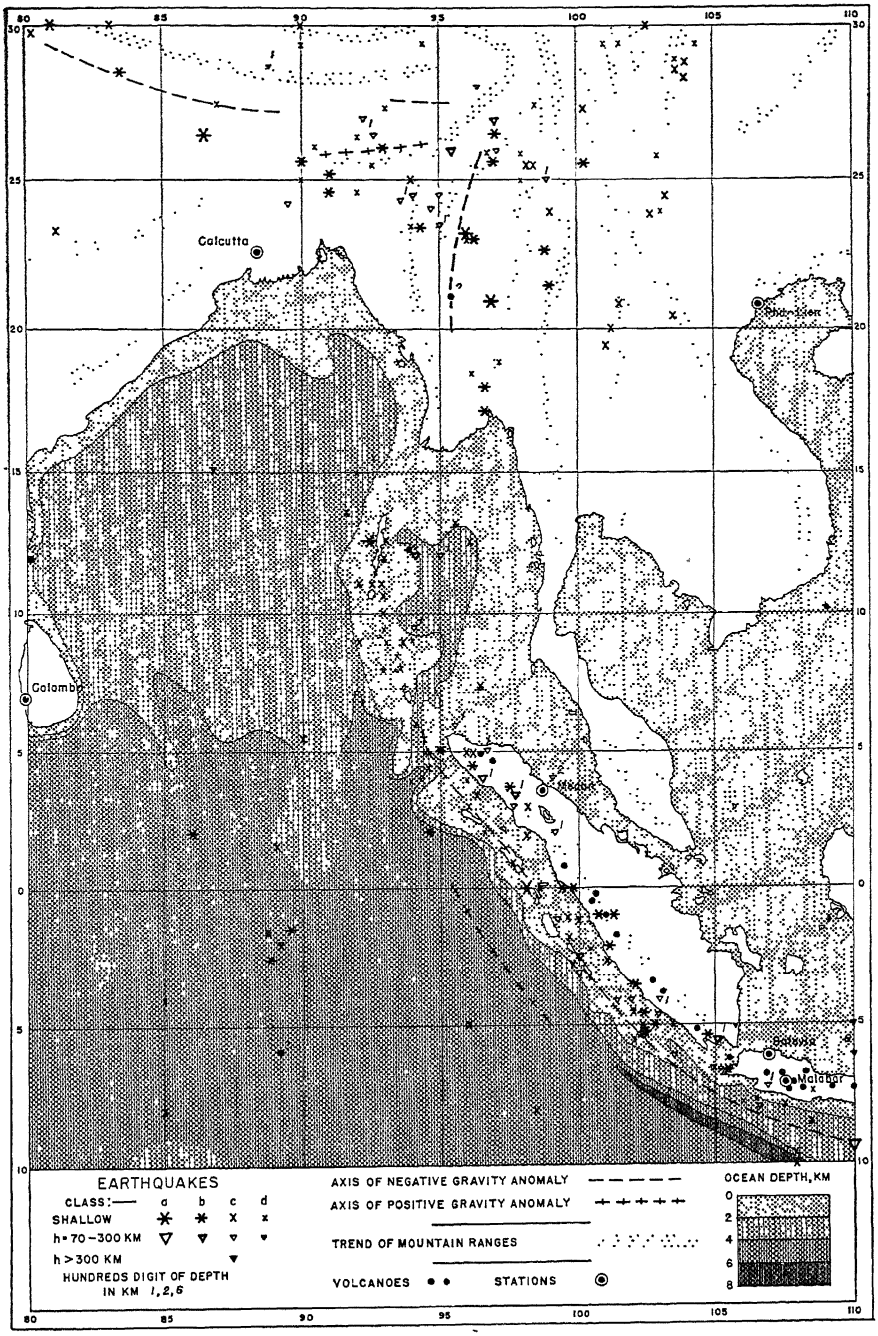

FIGURE 22. Sumatra-Burma.

locus of repeated intermediate shocks from the same source, resembling that in the Hindu Kush. Like the latter, it lies near a sharp angle formed by the intersection of two structural arcs. However, there appears to be less concentration of these epicenters in Burma; they extend for two or three degrees along the arc.

Himalayan arc

Region 26, Figure 23. The arcs of Burma, the Himalayas, and Baluchistan front toward the stable mass of peninsular India. The Himalayan arc is the most active and most clearly developed of the Asiatic arcs. Structural and geophysical information is available in considerable detail. Much of this is included in publications of the Geological Survey of India. Gravity observations have been presented and discussed by Glennie (1935) and J. de Graaff Hunter (1932, with maps); see also *Survey of India* (1939). A valuable supplement is provided by the corresponding data for the territory of the Soviet Union adjoining to the north (Oczapowski, 1936).

The principal seismological station is at Colaba Observatory, Bombay. Other long-established stations are at Alipore (Calcutta), Colombo, Kodaikanal, Hyderabad (Deccan), and Dehra Dun. In 1929 a good station was added at Agra; in August 1942 the instruments were moved to New Delhi, which is now headquarters for the Director-General of Observatories.

For the years 1927 to 1937, and for parts of 1946 and 1947, reports are available for an important network of stations operated by the Soviet Union in Central Asia—Andijan, Alma-Ata, Frunse, Samarkand, Tchimkent, Semipalatinsk. These, with the long-established first-class stations at Tashkent and Irkutsk, add much to our data for the entire region. Moreover, the newer stations, equipped with short-period seismometers, often report times for *P* for distant shocks not otherwise recorded in southern Asia.

Locations in this region are often very good even for the smaller shocks. Accordingly, except when needed for statistical purposes, only well-located shocks have been added to the tables and maps.

For shallow shocks at least, the Himalayan arc is the most seismic sector of the entire Alpide belt. This makes its activity comparable with that of California, or a little higher. It falls well below the more active parts of the Pacific belt.

Macroseismic data are of some importance. In spite of the antiquity of culture in northern India, useful historical records do not extend far into the past, since older shocks are chiefly reported as destructive to weak structures on the deep alluvium of the Ganges basin, but some important shocks have been well observed. The earthquake of Cutch in 1819, which provided the earliest clear instance of faulting observed at the surface accompanying an earthquake, was outside the present field of discussion, being marginal to the stable mass of southern India. The great earthquake of June 12, 1897, investigated by Oldham (1899), has interesting structural implications. Faulting and distortion of the surface with both vertical and horizontal displacement, were found over so extended an area and presenting so complicated relations that Oldham explained them as superficial effects of displacement on a large thrust underlying the Assam hills. However, better knowledge of the structural geology (Wadia, in Dunn *et al.*, 1939) indicates that there are no such thrusts in this area, although great thrusts are known along the Himalayan front. In a later paper Oldham (1926a, pp. 118-147) came to the conclusion, based on reported times when aftershocks were felt, that the disturbance originated at a depth of the order of 100 kilometers. In the light of present knowledge of deep shocks this is most unlikely, but shocks at depths ranging to 80 kilometers are now known to occur in the immediate area.

The great shock of 1934 originated in the vicinity of the Himalayan front. No effects of faulting were found at the surface, though there were extensive changes of level in the alluvial surface, attributable to settling. The phenomena are described in a detailed report (Dunn *et al.*, 1939), which includes discussions of other earthquakes of the region and their probable structural relations. Macroseismic data for Afghanistan and the Hindu Kush have been summarized by Stenz (1945).

Considering the Himalayan arc as of the Pacific type, the following description applies: Feature *A*, the foredeep, is represented by the extremely deep alluviated depression of the Ganges valley. Feature *B* is indicated by strong negative gravity anomalies (not shown on Fig. 23) in a belt well outside of the mountain arc, extending with some interruptions across the entire width of India, and along the upper Brahmaputra. The epicenters of the larger shocks appear to be associated with this belt. A limited number of gravity observations show positive anomalies in the mountain arc, suggesting feature *C*.

Feature *D* is indicated by shocks at depths of the order of 100 kilometers, north of the mountain front along almost the entire extent of the arc as far east as longitude 100°.

The Hindu Kush focus of intermediate earthquakes (region 48) lies beneath the angle formed by the Himalayan arc and the Baluchistan structures. About 70 shocks have been located here, the earliest in 1905. Those of 1907, 1909, 1921, 1933, 1937 (Lynch, 1938), 1939, and 1943 were large earthquakes; some

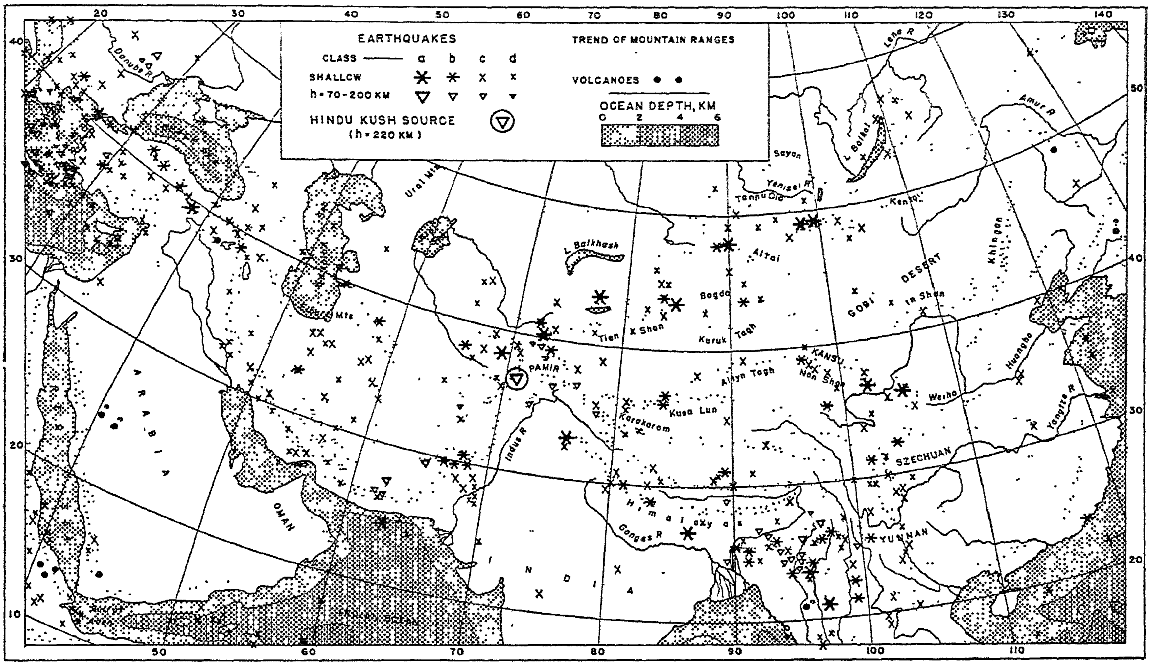

FIGURE 23. Asia.

were destructive. Many smaller intermediate shocks in this region were not recorded well enough for location. Most of the epicenters are at nearly the same point near 36.5°N, 70.5°E. The depths are generally near 230 kilometers. A few shocks at shallower depth have slightly different epicenters.

Shallow shocks north of the Himalaya will be discussed under the subhead "Central and East Asia"; those of southern India are discussed as marginal shocks of a stable mass.

Baluchistan

Region 47, Figure 23. This is an arcuate structure, or a series of such arcs, which fronts southeastward toward the Indian stable mass. Data are available under nearly the same conditions as for the Himalayan arc.

Whether the Indus valley represents a foredeep referable to feature *A* is somewhat questionable. Feature *B* is indicated by a belt of negative gravity anomalies in that region, but there is no corresponding belt of shallow shocks. Large shallow shocks occur farther toward the interior of Baluchistan, in the region of Quetta (West, 1934; 1935; 1936). Rift valleys exist, suggesting strike-slip faulting. In 1892 an earthquake near Old Chaman produced a horizontal offset of a railroad line (Griesbach, 1893; Davison, 1893; McMahon, 1893, p. 402).

The structural relationships of a few shallow shocks in the northern Arabian Sea off the coast of Baluchistan are not quite clear. Some of them lie in line with a possible offshore continuation of the southeastern Baluchistan arc; but they also align with the trend of the structures in Iran. The great shock of November 27, 1945, off the Baluchistan coast is more obviously assigned to the latter alignment. It would be possible to draw an arc convex southward, extending off the coast and turning up the Persian Gulf; the intermediate shocks near 27°N, 62°E would fit this reasonably well as feature *D*.

Iran

Region 29, Figure 23. This is a broadened part of the Alpide belt. The frontal structures are not sharply defined, and there are a wide series of parallel interior structures (de Böckh, Lees and Richardson in Gregory, 1929, pp. 58-176; Clapp, 1940). Published geophysical data are scanty. Location of shocks depends considerably on stations to the north and west—Baku, Tiflis, Ksara, Helwan. These, with the Indian stations, surround the area.

Shocks of class *c* are frequent; their epicenters are scattered over the area. Only the best recorded are catalogued and mapped. Occasionally shocks of class *b* occur; some of these are very destructive because of weak construction.

Description in terms of Pacific arc structure is doubtful. The outer arc fronts against the practically non-seismic depressed areas of Mesopotamia and the Persian Gulf. There is a line southwest of which no epicenters have been found. This extends into the Persian Gulf, and may cross into Oman. Destructive earthquakes have occurred at Muskat.

Caucasus, Crimea

Regions 29 and 30, Figures 23 and 24. The Caucasus and Crimea are on the northern edge of the Alpide belt. Although the southern front is the chief seismic zone, in Iran and westward the belt is broad and there is appreciable seismicity (shallow shocks only) to the north.

Stations have long been established at Baku and Tiflis, and somewhat later at Piatigorsk. Other stations have operated in the area for limited periods. A network of stations was later established in the Caucasus; a report is available for 1933 to March 1938, resumed in 1946. From seismograms Raïko (1930) found a velocity of about 5¾ kilometers per second for longitudinal waves in the uppermost layer. The interval $\bar{P}$-Pn on the seismograms he reproduces suggest a depth of about 50 kilometers for the Mohorovičić discontinuity in the region of the Caucasus. Rozova (1939b) finds about 60 kilometers (depth of the bottom of the granitic layer about 45 km.) from two earthquakes in the northeastern part.

Macroseismic data and their structural relations have been discussed by Vardanjanc (1935).

Gravity stations are numerous (Leushin, 1935). Strong positive anomalies occur in the Caucasus, especially to the south (Skeels, 1940); equally strong negative anomalies occur to the southeast in the general vicinity of Baku. Gravity data near the Crimea are summarized by Tanni (1942). Negative anomalies have been found in the Black Sea, positive on the Crimean Peninsula.

Seismicity near the Crimea received special attention in consequence of a disastrous shock in 1927 (Obruchev *et al.*, 1928). A network of regional stations, with Nikiforov torsion seismometers, issued valuable reports beginning with 1927. Local activity is rather low, mostly concentrated off the coast in the northern part of the Black Sea.

Asia Minor, Levant, Balkans

Region 30, Figure 24. Discussion now reaches the region of Alpine folding, the western portion of the Alpide belt. The structures here have a double front, south and north. The exact interpretation is a well-known subject of controversy. In the present paper the description of the facts favored by Stille (1924) is followed. This does not imply a final preference for his interpretation, but it proves simpler to describe the seismological and geophysical data in his terms.

The eastern portion of the area designated by Stille as *Neo-Europa* has a strongly marked arcuate southern front, with some of the Pacific type characters. For the structure of Asia Minor, Arni (1939) Egeran (1947) and other references have been used. Parejas *et al.* (1941) describe faulting in 1939 (horizontal displacement 3.7 meters, vertical 1 meter). Gravity data are from Cassinis (1941, manuscript of isostatically reduced data from Dr. Heiskanen), and for the vicinity of Cyprus from Mace and Bullard (1939).

Location of shocks in this area depends largely on observations at Ksara and Helwan. The better equipped of the Italian stations are useful, particularly for Balkan shocks. The stations in central Europe are all in the same general direction, so that a shock in this region recorded by numerous stations may still not be well located. Zagreb, being closer, is often more valuable. Observations at Athens, when available, are frequently of critical importance. In 1936 a first-class station was established at Bucharest. To the northeast are Tiflis, Baku, and the Russian stations. The Crimean stations contributed many useful observations for the whole region.

Seismicity is moderately high, comparable with that of other active sectors of the Alpide belt. Beginning with the great earthquake of December 1939, there has been an extended period of high activity in Asia Minor. This appears to be somewhat above the average for that region, though historical records indicate similar episodes in the past. The active area extends westward through the Balkans, but ends abruptly at about 20°E. There is also a fairly definite northern boundary at about 41°N.

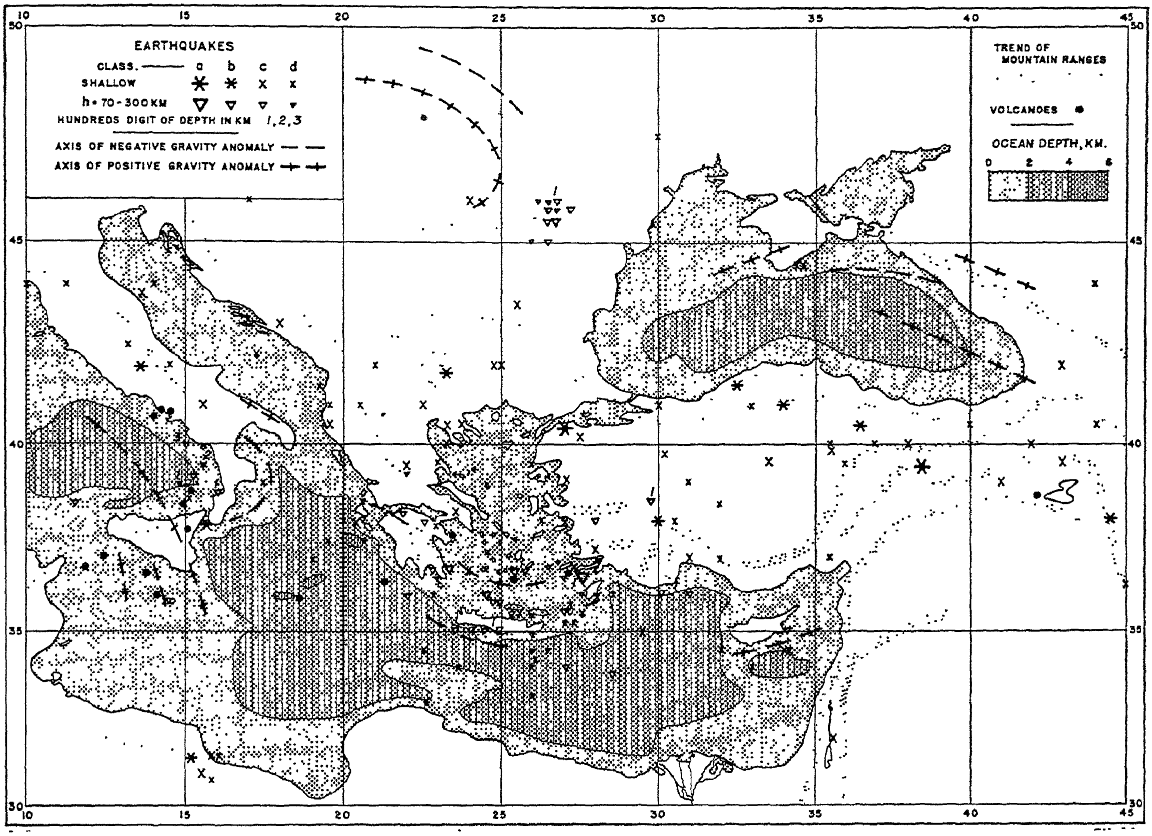

FIGURE 24. Asia Minor and eastern Mediterranean.

Accounts of destructive shocks throughout the region extend far into antiquity, but few of the descriptions are sufficiently detailed to be of use for scientific purposes. Not much use can be made of historical accounts even in the nineteenth century, owing to the sparse population and low state of culture of most of the region. However, certain of the larger earthquakes are so abnormal in their effects that they were noticed and correctly interpreted by Schmidt (1881). He concluded that these shocks must have a focal depth greater than that of ordinary earthquakes, and associated their occurrence in this region with the volcanic activity of Santorin and the Cyclades. Some of these intermediate shocks are the largest earthquakes in Europe. That of August 11, 1903, in southern Greece (Sieberg, 1932b, Fig. 45; seismogram in von dem Borne, 1904) was an intermediate shock of magnitude about 8. A very large shock of this group (magnitude 7.9) occurred in 1926 (Critikos, 1929). It was investigated on the ground by Sieberg, who published a special study of the group (Sieberg, 1932b), which he termed *Levantinische Riesenbeben*. He did not consider the possibility of intermediate focal depth, but attempted an explanation in terms of abnormal conduction of seismic energy along extended hypothetical lines of faulting. Sieberg's figures show the enormous shaken area of some of these shocks, several of which were felt in Egypt, Cyrenaica, Asia Minor, and far up the Adriatic.

Shocks at intermediate depth from 1903 to the present have now been identified. These were previously frequently overlooked, as most of the stations are at such distances that the usual evidences of depth are not available. Investigation of amplitudes of *P*, *S*, and surface waves has discriminated many of these shocks from the shallow earthquakes of the region.

Critikos (1942) has applied seismometric data to analyzing tectonic forces in the region. His map of epicenters shows whether the first motion recorded at Athens is a compression or a dilatation and plainly exhibits the type of effect found in California (Gutenberg, 1941b); shocks in a given area regularly show the same character of first motion. Critikos suggests an interpretation of the observed distribution in terms of known structures. This is complicated both by the occurrence of intermediate shocks and by change of structural trends in the region. Critikos (1946) discusses relationship of deep-focus earthquakes in the Aegean and eastern Greece to volcanoes.

Data on the seismicity of Albania have been published by Mihailovic (1940), Morelli (1942), and Magnini (1946).

The characteristic arc features are incompletely established. Feature *A* may be represented by the depths of the Mediterranean basin. As for feature *B*, negative gravity anomalies have been found south of Rhodes and Crete. Shallow shocks occur here along the structural front, as well as south of Cyprus. Cyprus itself is an area of exceptionally large positive gravity anomalies (Mace and Bullard, 1939). Positive gravity anomalies also occur in the region of feature *D*, which is indicated by intermediate shocks in the region of Santorin and the volcanic arc of the Cyclades. Other intermediate shocks are mapped farther south. Some of these are relatively shallow, and may belong to feature *C*. Others are deeper and suggest some southern active structure under the Mediterranean, but most of these epicenters may be in error by two or three degrees. The shock of 1870, which was certainly one of the deep *Riesenbeben*, attained its greatest violence (on land) in Egypt, and was felt at points far south and east.

Rumania

Region 51, Figure 24. Associated with the northern front of the active belt in Rumania is a remarkable source of intermediate shocks. These occur near the sharp bend in the Carpathian structures, at about 46°N, 26½°E. Eleven of these are tabulated in this paper. Numerous others, all small, have been identified at Bucharest. Historical records include shocks (1790, 1829, etc.) probably from the same focus, reported destructive at Bucharest and perceptible at surprisingly great distances. Detailed accounts of the destructive shocks of 1940 were published by Demetrescu (1941).

These shocks resemble those of the Hindu Kush in location under a very disturbed structure and in frequent repetition from nearly the same focus, which here lies at a depth between 100 and 150 kilometers. Here, also, the other arc features are not well developed. For a discussion of structures and gravity anomalies see Tanni (1942, pp. 94-96).

Italy, Sicily

Region 31, Figures 24 and 25. Stille and other authors trace the Alpine folding from the Balkans through the Dinaric Mountains east of the Adriatic, and connect it by way of the southern Alps with the Apennines; an active arc extends by way of Sicily into Africa. Gravity data are from Coster (1945); see also Meinesz (1947, p. 27). Since there are no seismological stations to the south, listed epicenters and focal depths in this area are less accurate than for the Aegean. Seismicity is decidedly lower than in the Aegean. To the north it decreases so much that discussion has been included under minor seismic areas. The largest shock in the period under investigation was the Messina earthquake of 1908 (31N150) (revised magnitude not over 7½, perhaps slightly less). The Avezzano earthquake of 1915 (31N250) had a magnitude near 7. Smaller shocks have been very destructive locally in Italy; this is due to weak construction (Caloi, 1942).

Feature *A* is indistinctly shown by deep water east of Calabria and Sicily. Negative anomalies occur here, apparently exterior to the belt of shallow earthquakes, which follows the Apennine structures. This belt has been well established from macroseismic data for many years; the historical succession of shocks along the structural line has been noted by many authors especially since the earthquakes of 1783 (Davison, 1936, pp. 29-53). Feature *D* is well established; the volcanoes of western Italy, the Lipari Islands, and Sicily follow an interior arc, and are accompanied by earthquakes at intermediate depth, some of which approach or slightly exceed 300 kilometers, thus being the deepest shocks known outside the Pacific belt. Shocks 31I800 and 900 have been investigated by Di Filippo (1941). Positive gravity anomalies occur here. Interior to the arc, the sea descends to considerable depth. This may be compared to the Weber Deep in the Banda Sea, interior to its active arc.

Western Mediterranean to Azores

Regions 31 and 32, Figures 25 and 27. The structural line continues through northern

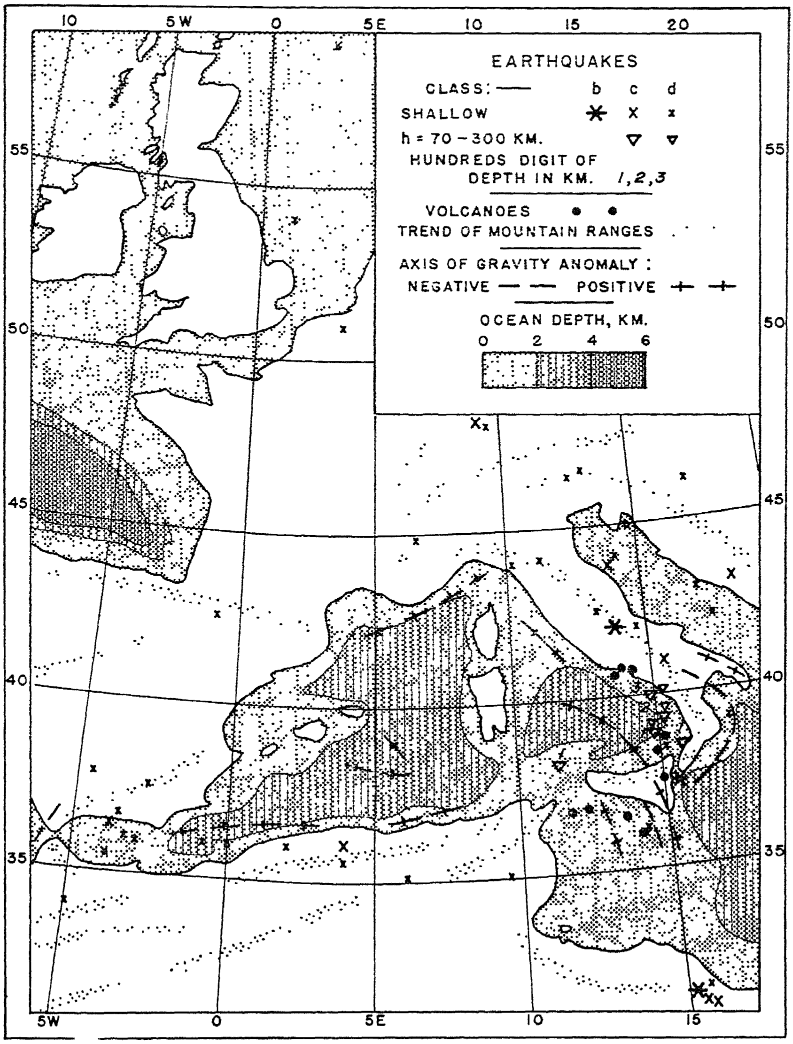

FIGURE 25. Europe.

Africa; it is usually drawn as a loop returning through Spain and France to the Alps. Seismic data support a continuation of the active belt into the Atlantic as far as the Azores, but not farther. There is no justification for extending it to the West Indies, as was done on some early seismic maps of the world. Topography and gravity have been discussed by Meinesz (1942), Cloos (1939), Wüst (1939b). Gravity data are fairly extensive for the western Mediterranean (Coster, 1945), showing prevailing small positive anomalies.

Active volcanism occurs only in the Azores (Agostinho, 1931). No intermediate shocks are known. In the Atlantic some (for example 31N375) seem to be slightly deeper than the average shallow shock. There is no evidence anywhere of Pacific arc features.

In the western Mediterranean quite small shocks can be located accurately, using data of the Spanish stations and Algiers. Only the larger of these have been catalogued here. Many have been discussed in detail in Spanish publications. A catalogue based on macro- and microseismic data was published by Rodriguez (1932, 1940, with extended bibliography).

The westward continuation of the seismic belt is considerably more active than the area of North Africa and the western Mediterranean (which is a minor seismic area only). This is the region of origin of the great earthquake of 1941 (31N420) and the Lisbon earthquake of 1755 (Reid, 1914; Davison, 1936, pp. 1-28), which seems to have had a magnitude of at least 8¾.

Practically all shocks of class *c*, and some of class *d*, can be located in this part of the Atlantic using the European and American stations. Table 17 includes most of those large enough to be recorded on both sides of the Atlantic.

There are macroseismic reports for numerous shocks felt in the Azores, and of others (Rudolph, 1887; 1895) felt as seaquakes on vessels in the major shipping lanes.

NON-ALPIDE ASIA: EASTERN ZONE

General survey

Asia outside the Alpide belt includes at least one great stable mass and a number of minor seismic areas. These are discussed together with other regions of similar geological type and seismic character. The region now considered includes all the remaining major seismicity of the world outside of the circum-Pacific and Alpide belts, accounting for almost all the remaining class *a* shocks, but having no known intermediate or deep shocks.

The area is roughly triangular, with its westward vertex in the vicinity of the Pamir Plateau, and sides extending northeastward and southeastward, including the whole of China, Tibet, eastern Turkestan (Sinkiang), and Mongolia. In addition to the references for the Alpide belt, structural data are from J. S. Lee (1939).

Active volcanism is known only far to the east in Manchuria. Gravity observations are very few, except in the Pamir-Turkestan area.

When the data of all the principal stations are available, location of even class *d* shocks in this region is reliable. No station is located in the interior (excepting perhaps that operated for a short time at Pehpei near Chungking). To the east are the Japanese stations, including those in Korea and Formosa; on the mainland are Zikawei (Shanghai), Chiufeng (Peiping), Nanking, Hong Kong, and Phu-Lien. Many of these were discontinued, and some destroyed, during the war. To the south are the Indian group, while to the north and west are the Soviet stations, including the first-class stations at Vladivostok, Irkutsk, and Tashkent, as well as the network of stations in Ferghana and Turkestan. Because of the generally high seismicity of the region, and its clear relation to the principal structures, minor shocks usually have not been worked out.

The Pamir-Baikal active zone

Regions 28 and 48, Figure 23. A broad and not very sharply defined belt of activity bounds the seismic area of eastern Asia on the north and west, forming the northern face of the triangle whose vertex is in the Pamir region. This boundary belt extends south of the zone of depressions marked by Lakes Balkash and Baikal. The stable area of north central Asia lies beyond it.

There is a gap between the most northeasterly shocks of this zone, in the vicinity of Lake Baikal, and the shocks of the Arctic belt near the mouth of the Lena. To close this gap presumably would call for shocks following the structures eastwardly from Lake Baikal towards Okhotsk and thence northwest along the Verkhojansk Mountains. There would then be a seismic belt completely surrounding the Eurasian mass by way of the Arctic, the North Atlantic, the Azores, the Mediterranean, the Black Sea, and central Asia.

The Pamir-Baikal active zone resembles the Arctic and Atlantic belts in the absence of deep shocks, but differs in higher general seismicity and in the greater magnitude of its largest shocks. The tabulations include seven great shocks with epicenters from the Pamir to Lake Baikal. The alignment of this activity is not along the strike of the more evident surface structures (Fig. 23), which are mostly Palaeozoic or older. Instead, the active belt crosses these structures and follows the region of highlands between the great depressions and the Gobi Desert.

The western terminus of the belt is in the region of the Pamir Plateau and the Ferghana basin. Surface structures in this complicated area have been discussed in many special papers, notably by Mushketov (1929, 1936b,c). The Central Asiatic network of stations facilitates investigation of the deeper crustal structure (Rozova, 1936; 1939a; 1940). The thickness of the granitic layer is about 35 kilometers, the depth of the Mohorovičić discontinuity about 50 kilometers.

Gravity observations are fairly numerous and have been discussed in relation to the structure by Erola (1941), who has reconsidered data given by Oczapowski (1936). Erola compares the great negative anomalies in the Ferghana area with those in the East and West Indies.

Heiskanen (1939a) has compiled gravity observations in Siberia. The majority of these are in the stable area north of the active belt. Some stations in the active belt show large positive anomalies.

The Chinese active area

Between the Pamir-Baikal zone and the Alpide belt is the broad triangular region which includes Sinkiang (Chinese or Eastern Turkestan), Tibet, Mongolia, and China proper. This excludes the coastal area of China and Manchuria which is fairly quiet, with occasional large shocks (not considering the very deep shocks of Manchuria, which belong to the circum-Pacific belt). The Chinese area is traversed by a series of structures with varying trend, all of which show more or less seismicity, while the intervening blocks are relatively undisturbed. The principal stable blocks are those in Sinkiang, Tibet, and the Gobi Desert, and a smaller one lying between the Kuen Lun on the south and the Altyn Tagh and Nan Shan on the north.

Most of the region is remote and sparsely populated, so that macroseismic data are lacking or imperfect; it is fortunate that instrumentally located epicenters for important shocks are usually reliable. For China proper, there are annals extending over many centuries, during which earthquakes were given special notice. These indicate that the most seismic regions of China are to the southwest in Szechuan and Yünnan, and to the northwest in Kansu. Hulin (1946) has reported on large scale block faulting of Basin Range type in the western part of this region, near the meridian of 100°E. North of this, in western Szechuan about 31°N, 101°E, Heim (1934) has described rift features with photographs bearing a striking resemblance to those of the San Andreas fault zone, so as to suggest that strike-slip displacements occur. Heim describes fresh fissures which originated in the earthquake of 1923 (26N195). Dr. S. P. Lee, after discussion with his colleagues at Nanking, has furnished the following information:

"A series of faults has been actually observed. They are almost running in the common direction of NW-SE, along the main valley of the Hsintu river up to Taofu, where the river turns to southwest, but the faults continue in the same direction passing Taining down to Tatsienlu, then turn to N-S direction to the region near Minya Konka and further south. It has been traced from 31°45′N, 100°15′E to 28°30′N, 101°30′E. Earthquakes occurred frequently in and near the fault zone. . . .

"It is no doubt the earthquakes are due to the unsettled faults. A great number of fissures or cracks either parallel or cross cut the fault zone, sometimes very long, were seen by the observers, especially in the area near Taining and between Sharato and Kaladrong. Many have suffered heavy erosion, but they can be definitely taken as caused by the earthquakes ancient and recent. From the relative upheavals it has been interpreted by the observers that the northeast side of the main fault has been tilting up toward north quite a number of times."

In the Nan Shan and eastward, shocks are frequent, and many other epicenters could have been added. The adjacent province of Kansu with two great shocks (1920, 1927) is one of the most frequently shaken parts of China. The history of destructive shocks allows us to extend the seismic belt eastward, at least far enough to include the valley of the Weiho, which enters the Huangho from the west near 34°N, 110°E. This has long been one of the most thickly settled areas in the world, so that merely destructive shocks with considerable loss of life might not prove high local seismicity. However, the reported effects are extreme; the earthquake of 1556 in this region is said to have taken 830,000 lives. If the earthquake history can be trusted, it suggests a deflection to the north rather than an eastward continuation of the active line, but strong shocks have occurred more nearly to the east (26N35 and 27N10 near 35°N, 115°E). A little farther east, destructive shocks have occurred in Shantung (41N100).

OCEANIC ACTIVE BELTS

General survey

Much of the seismicity remaining to be discussed is concentrated along narrow belts which follow oceanic ridges. The best known of these belts passes centrally through the Atlantic Ocean, along the mid-Atlantic Ridge. It extends into the Arctic, and across the polar area to the north coast of Siberia near the mouth of the Lena. A similar belt passes southward from Arabia through the central Indian Ocean to at least 30°S; here there is a branching, and other ridges in the same region appear to be active. The principal branch extends southwest to connect with the Atlantic belt.

Structurally, these active ridges are to be interpreted as young mountain ranges, but there is little evidence of an arcuate structure resembling those of the Pacific belt. The persistence of active volcanoes along these ridges suggests a former condition more like that in the Pacific (or the Alpide) belt, but only shallow earthquakes are associated with them, and the few gravity observations (due to Meinesz) have not revealed any belt of large negative anomalies. It is suggested that these ridges, originally produced by folding, are now being broken up by block faulting consequent on a redistribution of tectonic forces.

Evidence from velocities of surface waves indicates in both Atlantic and Indian Oceans a crustal structure more nearly of continental than of Pacific type. The "continental" crust here has a total thickness less than under the continents, one or more layers probably being absent.

Though no intermediate shocks have been found, a number of shocks in the Atlantic appear to be deeper than the average shallow earthquake. Surface waves from these shocks are abnormally small; and time observations often suggest depths which various authors have occasionally placed as great as 100 kilometers, though this is certainly excessive.

Large shocks are rare; only one class *a* shock is listed, and this is at the lower limit of the class. Large shocks in the Atlantic between Portugal and the Azores, off Puerto Rico, and off the South Sandwich Islands, belong to the Alpide and Pacific belts. Class *c* shocks are relatively frequent.

For these areas nearly every available shock has been studied and mapped, except in the active areas in the northern and equatorial Atlantic and off Madagascar.

Instrumental data were applied to investigation of the seismicity of these regions by Tams (1922; 1927a, b; 1928; 1931). For discussion of bottom contours of the Atlantic and Indian Oceans see Littlehales (1932), Wüst (1934; 1939a, c) and Vaughan *et al.* (1940). Contours for the southern latitudes are based on the chart of Antarctica (Hydrographic Office, 1943). For the Atlantic, Hydrographic Office charts nos. 955, 955a, 956, 956a, 957, 958, and 959 have been used.

Arctic belt

Region 40, Figure 26. The seismicity in the Arctic region north of Europe was first studied by Tams (1922), who recognized this activity as a northward extension of the Atlantic belt into the polar region. He also published a separate discussion (Tams, 1927b) of earthquakes in the region of the Nordenskjöld Sea (near the mouth of the Lena), but refrained from suggesting a direct connection between these and the other Arctic shocks. Such a connection seems first to have been emphasized by Rajko and Linden (1935) and by Mushketov (1935). Their map shows epicenters in the Arctic which clearly fall along a continuous belt. This map has been reproduced by Heck (1938a). In the present volume every adequately reported shock from Spitzbergen to the Lena has been included; between Iceland and Spitzbergen only the better located shocks are given.

Shocks have been reported felt on Spitzbergen and Jan Mayen. Iceland has a long history of destructive earthquakes.

Conditions for accurate location are very uneven. The more westerly shocks are favorably placed with respect to northern European stations, but observations at Pulkovo or other Russian stations are usually needed to fix the longitude. Really good location in this region also requires data for Ottawa or other American stations. The Nordenskjöld Sea shocks call for the Russian stations and some data from Far Eastern stations. The only active stations in the Arctic region itself are Scoresby-Sund, Ivigtut, and Reykjavik. No large shocks are known; shocks of class *c* are fairly frequent.

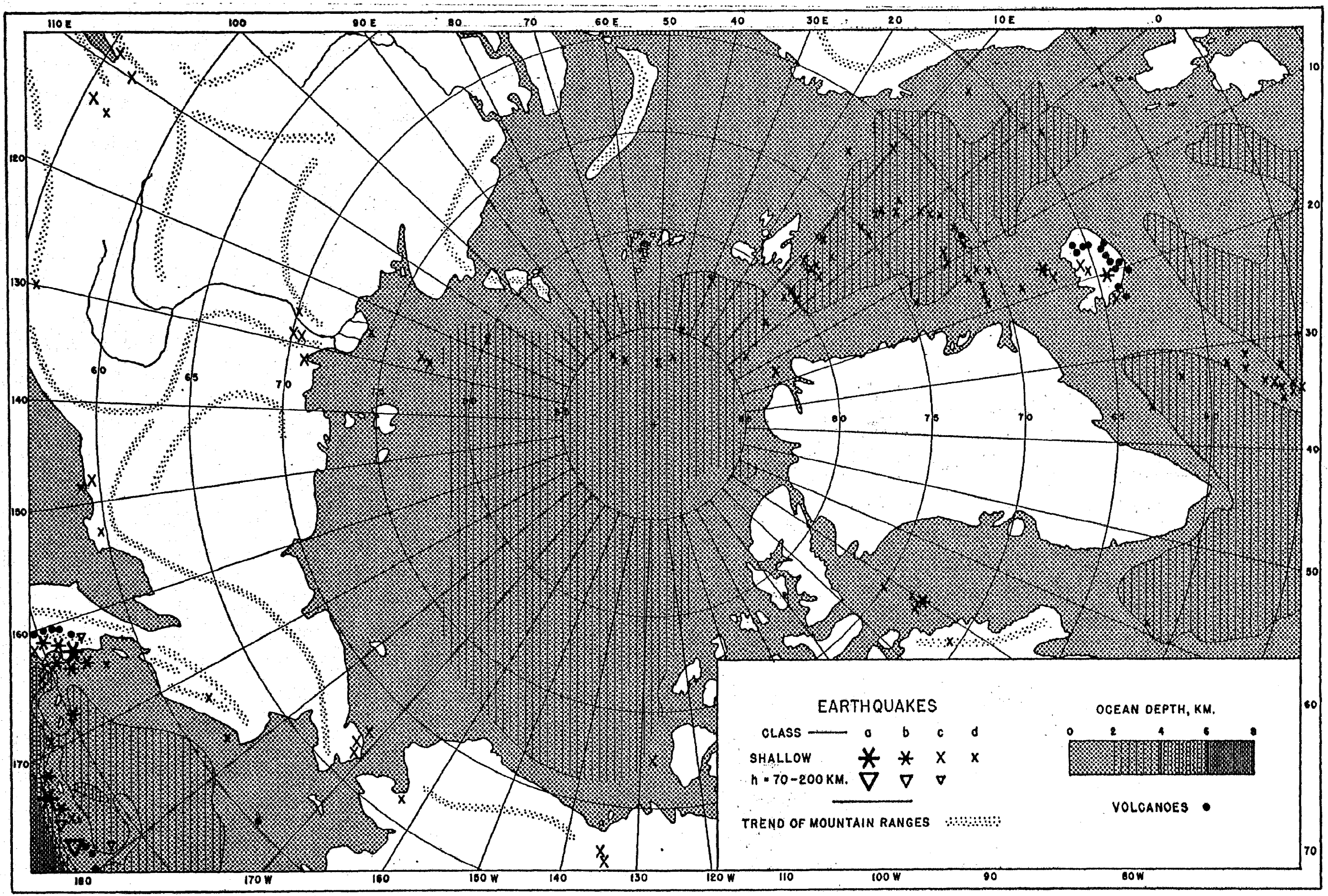

FIGURE 26. Arctic.

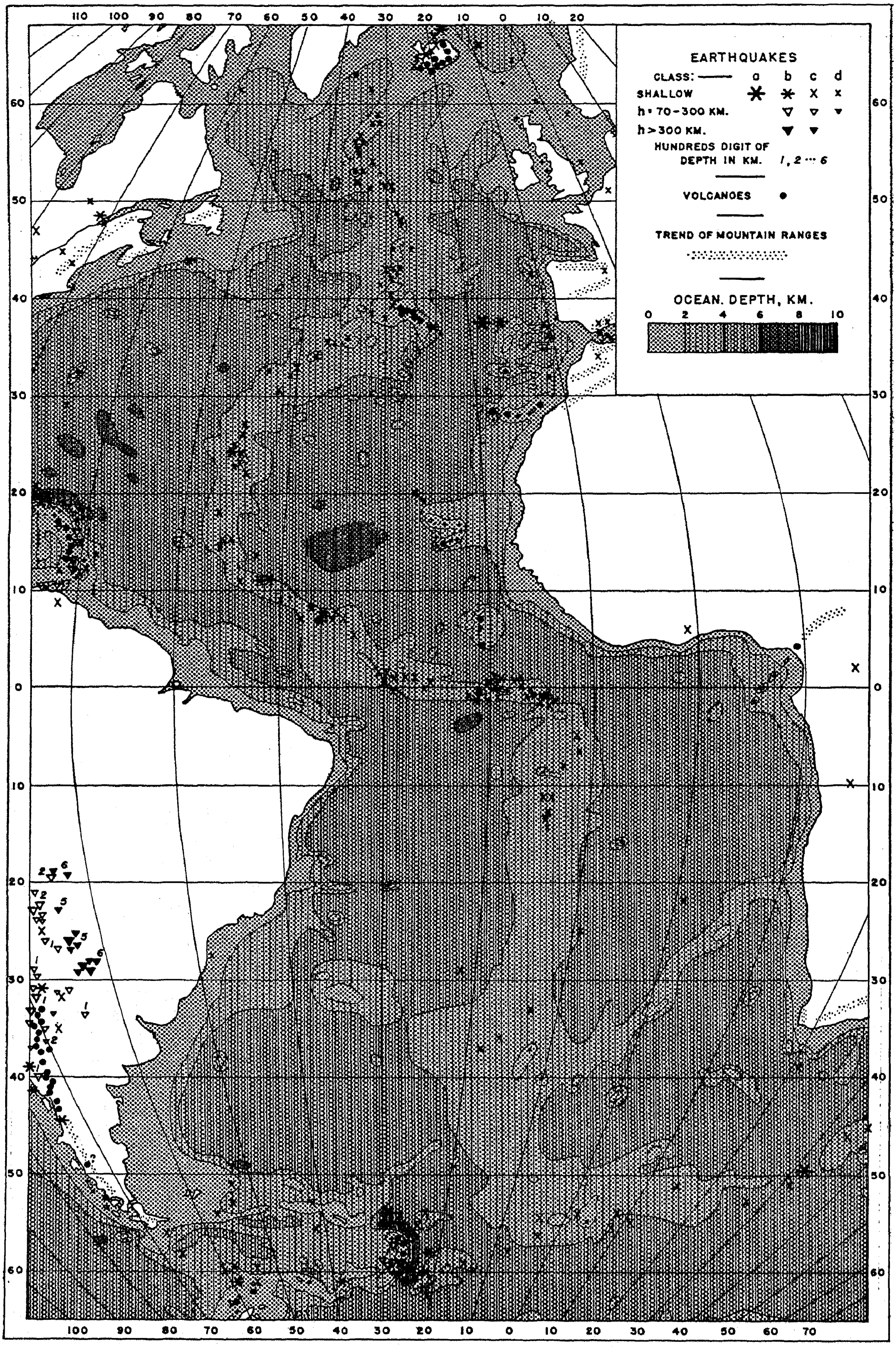

FIGURE 27. Atlantic Ocean, sinusoidal equal-area projection.

Atlantic belt

Region 32, Figure 27. The earliest systematic collection of data on Atlantic shocks is contained in the papers on seaquakes by Rudolph (1887; 1895). Shocks are felt on shipboard in the Atlantic chiefly near the Azores and in the central area near the equator. During the following 20 years it was found that comparatively few of these shocks were recorded by the instruments then in service in Europe and America. This showed that the activity reported by vessels must consist of comparatively small earthquakes, and it was suggested that much of it might be due to submarine volcanism. This is quite certainly false, for with improved instruments epicenters began to be located in the Atlantic, and the energy of the shocks, though moderate, is still larger than that of any ordinary volcanic earthquake. Sieberg and others had pointed out the association of seaquakes with the Mid-Atlantic Ridge; and Tams (1927a; 1928), using revised epicenters from the *International Summary* supplemented by other observations, showed that the Ridge is the chief locus of Atlantic seismicity.

The Mid-Atlantic Ridge is not a mere rise or swell in the ocean bottom, but has a complicated topography (Wüst, 1939a; Pettersson, 1947; Ewing, 1948); it is in fact a submarine mountain range. In the equatorial Atlantic the Ridge has a striking flexure, giving it a long nearly east-west course. This bend parallels the strong curves in the coasts of Africa and South America. From the equator the Ridge trends nearly due south, west of the meridian 10°W; it then turns eastward south of Africa.

North Atlantic shocks are very favorably placed for epicentral determinations using the stations in Europe and North America. Numerous minor shocks could have been added to the catalogue, but only enough have been taken to locate the active belt which follows the Ridge very closely. Adequately recorded shocks which appear to fall out of line have been investigated carefully. In the equatorial region locations are not so reliable, but activity is higher here than anywhere else along the Ridge, and enough shocks of class *c* are available to define the active belt. In southern latitudes there is a decrease in activity along the Ridge. Simultaneously the epicenters become more remote from the majority of good stations, and correspondingly difficult to locate. The tables and maps show every dependable epicenter in this region.

Slightly higher activity in the far south makes it possible, in spite of the unfavorable situation, to trace a nearly continuous belt of epicenters from the South Sandwich Islands to Bouvet Island, and thence along the Atlantic-Indian Swell into the southern Indian Ocean. The class *a* shock of November 10, 1942, is in the eastern part of this belt. No epicenters have been located between Tristan da Cunha and Bouvet Island on the southern part of the Mid-Atlantic Ridge. Shock 10N480 at 60°S, 12½°W originally was assigned a depth of 150 kilometers. This is not consistent with the amplitudes of the surface waves.

Indian Ocean

Region 33, Figure 28. The bottom configuration of the Indian Ocean is very imperfectly known. Wüst (1934; 1939c) has attempted to supplement the data by inferences from temperature distribution.

Location of even large shocks in this area is often difficult. Epicenters depend chiefly on observations at Tananarive, the Indian stations, and Capetown. Listing is as complete as practicable. Near 34°S, 57°E, Figure 28 shows only a few of the listed shocks.

The main seismic belt begins abruptly off the coast of Arabia north of the island group of Socotra and trends roughly southeastward along the Carlsberg Ridge discovered by Schmidt and confirmed by the work of the John Murray Expedition (Farquharson, 1936; review by Hoffmeister, 1938). Near the equator the belt changes direction rather sharply and continues slightly west of south. No large shocks are known here, and seismicity is moderate. The belt passes through a region of recent relatively high activity near 34°S, 57°E, and trends southwestward by way of Prince Edward Island and Bouvet Island into the south Atlantic. The class *a* shock of 1942 lies on this belt beyond Prince Edward Island.

Another belt, possibly a branch, trends southeastward from Amsterdam and St. Paul Islands towards the epicenters on the Indian-Antarctic Swell discussed with the Pacific belt (Fig. 12). However, there are large unfilled gaps, even with the addition of a class *c* shock on December 24, 1947, 05:22.0, near 55°S, 115°E.

There is now adequate evidence of a minor

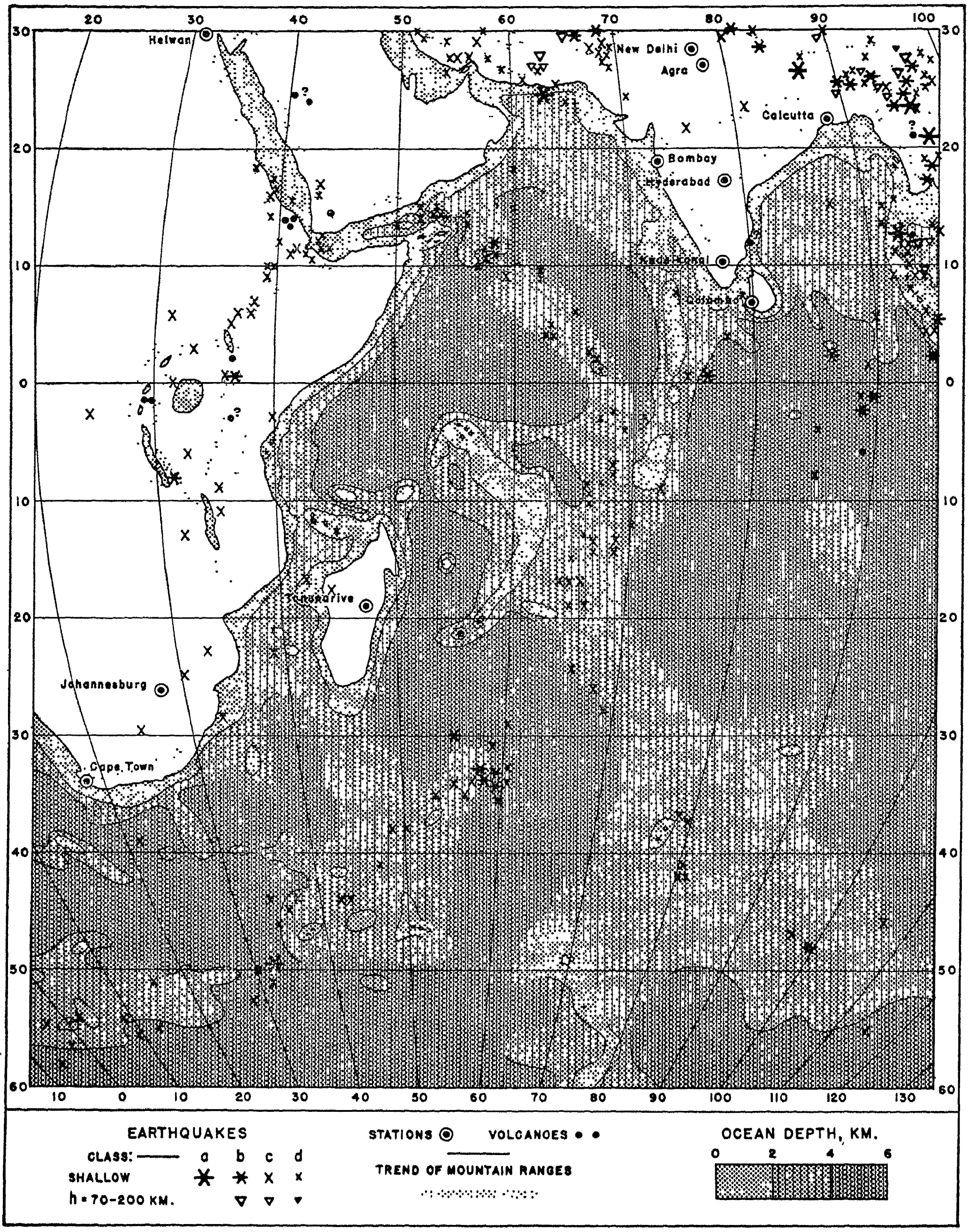

FIGURE 28. Indian Ocean, sinusoidal equal-area projection.

seismic belt trending southwest from Ceylon to join the main belt about 15°S.

A peculiarly isolated group of shocks occurs near 2°S, 89°E. The catalogue now includes a shock in 1918 (33N890) at 8°S, 85°E. (The *International Summary* places this at 5°S, 85°E; it may actually have been there, but not farther north). With other epicenters near 90° E north of the equator, there is suggested a minor seismic belt following imperfectly known rises and ridges roughly north and south.

Shocks west of Australia are discussed with the stable masses.

The activity near 34°S, 57°E calls for special notice. The catalogue shows shocks in this general vicinity in 1909 and 1916, but there was a definite increase in activity about 1925. The improved installation at Tananarive did not become effective until 1926, so that the additional data are not solely responsible for the larger number of shocks located in the area. Many of those listed could have been located without Tananarive, though with less precision. The series continued with interruption to January 1933; since that time the principal activity of the region has been elsewhere. In the *International Summary* practically all these shocks are referred to a single epicenter at 34°S, 57°E, but the data at distant stations establish activity over an extended area, and this is confirmed by the appearance of the seismograms at Tananarive (Poisson, 1939).

RIFT ZONES

General survey

Certain shallow shocks are associated with interior fractures of the stable masses. The most active of these are the East African rift zones, including their possible northerly extension into Palestine. Seismicity at a lower level is associated with the St. Lawrence Valley, which is perhaps rather marginal than interior to the Canadian Shield. The shocks of central Australia are analogously placed. These two groups will be discussed with the associated stable masses.

Hawaiian shocks are included in the present section, since they undoubtedly occur along a fracture system in the interior of the Pacific stable mass. The mechanism of this fracturing, and the forces occasioning tectonic earthquakes, may differ fundamentally between Hawaii and East Africa. There are other fractures in the Pacific mass analogous to that of Hawaii, but their seismicity is comparatively minor, as apparently is the case in Samoa.

Active rifts occur in the Pamir-Baikal active zone, notably Lake Baikal and the Turfan Basin. Rift zones associated with strike-slip faulting occur in many parts of the Pacific belt.

East African rifts

Region 37, Figure 28. The African activity is moderate, even compared with the Atlantic and Indian Ocean belts. It is now possible to include shocks from 1909 to 1914, when there was greater seismicity in East Africa than at any time since. Location is generally difficult, depending on a small number of stations.

Large negative gravity anomalies are found in the rift area from Lake Albert to Lake Tanganyika, as well as north and east of Lake Victoria (Horsfield and Bullard, 1937; Krenkel, 1922). Only positive anomalies are found in the region of southern Egypt and the Red Sea (Bullard, 1937; Heiskanen, 1939a).

The complexity of the known rift structures is reflected in the seismicity, which follows no single line in the equatorial region. A seismic belt runs northwest through Ethiopia to the head of the Gulf of Aden. There is activity along the west coast of the Red Sea, but seismological evidence does not indicate any continuous active zone from central Africa across Suez into the unquestionably active Jordan trough of Palestine. Any such projection of the African rifts must be based on geological and geomorphological evidence (Cloos *et al.*, 1942).

Hawaiian Islands

Region 39, Figure 29 shows the principal volcanic vents known to be active. On the island Hawaii these are Kilauea, Mauna Loa, and Hualalai (which last erupted in 1802). The symbol on Maui indicates the site of an eruption about 1750 (Stearns and Macdonald, 1942, pp. 102-107, 302-303) and not the summit depression of Haleakala.

Gravity observations have been discussed by Duerksen (1943). There is a predominance of positive anomalies (Heiskanen, 1939a, p. 54). Duerksen concludes that the island of Hawaii is an uncompensated load on the earth's crust, while the load of Oahu seems to be partly compensated isostatically.

The principal seismological station is Honolulu, operated by the U.S. Coast and Geodetic Survey. The station was originally at the Ewa Magnetic Observatory, where a Milne instrument was installed in 1903, and replaced by a Milne-Shaw in 1921. The instruments were moved to the University of Hawaii in 1926-1927 and returned to Ewa in October 1946.

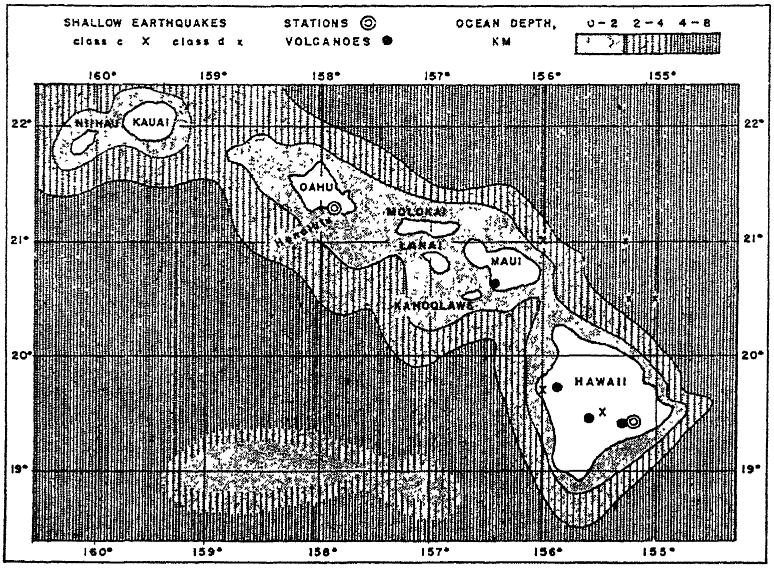

FIGURE 29. Hawaiian Islands.

Honolulu is a highly important station because of its isolated location in the center of the Pacific area. Unfortunately it is subject to heavy microseismic disturbance, which often obscures the first seismic motion.

For the local shocks of Hawaii supplementary data are obtained from the readings at the Hawaiian Volcano Observatory near Kilauea, where Bosch-Omori instruments have been in operation since 1912. Auxiliary stations with small instruments have been operated at various times and locations on Hawaii.

The catalogue includes all shocks recorded at distant stations for which epicenters could be given.

Although this is an active volcanic region, and most small shocks on the island of Hawaii are direct results of volcanic processes comparatively near the surface, there are shocks of tectonic origin. The most noteworthy is the great shock of April 2, 1868 (Wood, 1914; 1933a). Though this was accompanied by eruptive phenomena on Hawaii, it produced fracturing at the surface such as might result from the displacement of large underlying masses of magma, or solid material, or both. Moreover, it presumably originated at the depth usual for great earthquakes, for it was not only violently destructive in the southern part of the island of Hawaii, but was moderately strong at Honolulu, and apparently perceptible on all the islands of the group. It was preceded and followed by many small shocks.

In the middle of September 1929, a swarm of small shocks began in the northwestern part of the island of Hawaii near Hualalai. Larger shocks occurred; that of September 26, at 04h, though of class *d*, was recorded as far as western Europe. The largest (magnitude 6.5) took place on October 6, at 07h. This was violent, with heavy damage in the Kona district, which includes Hualalai. The seismograms are of the usual character for shallow earthquakes. No eruption was associated with these shocks.

SEISMICITY MARGINAL TO STABLE MASSES

General survey

Nearly all the stable masses exhibit marginal fractures which are seismically active. Some of these are rift zones, but appear to be different in character from those discussed under that heading. Such are the St. Lawrence Valley and the shatter zone of Australia. There are no extended seismic belts in this class, and very irregular minor seismicity. The pattern is that of occasional large shocks, sometimes in groups separated by long intervals of quiet. All these shocks are shallow, though some are deeper than average.

Canadian Shield

Regions 34 and 42, Figures 27 and 34. Marginal shocks of the Canadian Shield are known in three groups: to the southeast, in the region of the St. Lawrence River; to the northeast, in Baffin Bay; to the northwest, in the region of the mouth of the Mackenzie River.

The long-established station at Ottawa was later supplemented by auxiliary stations at Seven Falls and Shawinigan Falls, so that the southeastern group of shocks is well observed. These shocks are also recorded at stations in the northeastern United States. Many small shocks have been located in this area by the workers at Ottawa and by the Northeastern Seismological Association. The present catalogue includes only those recorded at more distant stations. A great earthquake in 1663 was violent near Three Rivers (roughly 46½° N, 72½°W; Lefebvre, 1928). The shocks of 1925 and 1935 had depths near 60 kilometers. The epicenter of the latter is well within the margin of the Canadian Shield.

The class *b* shock off Newfoundland (34N-950) is an eastern member of the St. Lawrence group of shocks.

The northeastern marginal shocks, in Davis Strait and Baffin Bay, are more remote from the American stations, but are better recorded in Europe, and within close range of the Greenland stations (Ivigtut and Scoresby-Sund). The shock of 1933 (42N100) is a good instance of a large shock in a region not previously considered active. Small shocks have often been felt on the west coast of Greenland (Tams, 1922) and Tertiary faulting has been found there (Born, 1933, p. 800, following Koch, 1929). The Baffin Bay shocks might have been referred to under the rift zones, if the pre-Cambrian rocks of Greenland are considered as part of the Canadian Shield.

Three shocks (42N500; 550; 600) are referred to the northwestern Mackenzie River group. The station at College (near Fairbanks, Alaska) now makes it more probable that shocks in this remote region will not be overlooked.

Brazilian Shield

Region 35, Figures 27 and 34. Seismicity in this region is low. In spite of many years of recording at Rio de Janeiro and La Plata, only one shock (35N700) can be listed; this was felt on the coast of Brazil. Branner (1912; 1920) gives a history of small shocks. To the west and northwest the stable shield abuts directly on the active Andean zone of the Pacific belt; to the south against its eastern branch in the Mendoza region which is an area of Mesozoic folding.

Africa

Regions 32, 33, and 37, Figures 24, 27, 28, and 34. Strong shocks reported infrequently from the Canary and Cape Verde Islands are in part volcanic; presumably tectonic shocks large enough to record at distant stations are known from both. The destructive Gold Coast shock (37N810) of 1939 is the largest of a series (Junner *et al.*, 1941). That previously best known occurred on November 20, 1906, but was not reported by any distant station. Shock 37N840 was reported strong in Cameroon in the region of Yokaduma. Shock 37N870 is located in Angola on instrumental data alone.

Shock 37N780 south of the Cape of Good Hope was felt in Capetown. The shocks of South Africa occur in a region of Palaeozoic and Mesozoic folding, and are discussed with those of other minor seismic areas. Shocks 37N720 and 37N725 in the Mozambique Channel may be considered as marginal, or as representative of an internal rift zone, Madagascar being related to the African mass analogously to the situation of Greenland with respect to the Canadian Shield. The local shocks of Madagascar have been reported by Poisson (1939, 1941, 1942, 1947a). He finds that in this region the granitic layer is about 15 kilometers thick, the second layer 20 to 50 kilometers, and that the Mohorovičić discontinuity is at a depth of 55 to 60 kilometers (1947b, and personal communication).

Arabia

Regions 30, 33, and 37, Figures 23 and 34. The Arabian mass may be considered as an outlying part of the African stable mass, separated from it by the active zones of the Red Sea and the Gulf of Aden, the former of which has already been mentioned with rift zones. See Cloos *et al.* (1942). Two true marginal shocks in 1941 (37N60; 120) are well located on the east coast of the Red Sea. The Palestine earthquake of 1927 (30N950) is the only shock in Table 17 representing the long seismic history of the Jordan Valley. This shock may be considered as marginal to the Arabian mass, or as in the northern extension of the African rift activity (Sieberg, 1932a, pp. 796-803; 1932b; Willis 1928; correction, 1933).

India

Regions 26, 33, and 47, Figures 23 and 34. The shocks of northern and northwestern India have been discussed with the Alpide belt. Shocks off southern India and Ceylon represent a minor active belt in the Indian Ocean rather than marginal activity of the stable mass. The earthquakes of central India, immediately north of the stable oldland, are true marginal shocks. Several are listed. Shock 26N940 has been investigated by Mukherjee (1942). Shock 47N30 is in the region of the great earthquake of Cutch in 1819 (Oldham, 1926a, pp. 71-117; Davison, 1936, pp. 68-76) which was the first established case of eyewitness observation of fault displacement during an earthquake. The active margin here follows a structural trend slightly north of east from central India. The shocks of Assam are in line with it.

Shock 33N805 in the Bay of Bengal may be in the epicentral region of the great earthquake of December 31, 1881, which was strong on all the coasts of the Bay (Doyle, 1882; Oldham, 1884).

Australia

Region 38, Figures 30, 33, and 34. The old stable mass of western Australia has marginal shocks in several directions. A class *d* shock (38N100) is off the northwest coast. This and a few other small shocks suggest activity between Australia and the Sunda arc. The large shock 38N150 of 1906 is now placed with some doubt at 22°S, 109°E. It was felt along almost the whole west coast. Shocks in south and central Australia occurred and are listed in 1938, 1939, and 1941. The last of these (38N400) ranks as the largest Australian earthquake in at least forty years. These shocks occur in a well-known fracture zone, called the "shatter zone" in its southern portion, which separates the stable mass of Western Australia from the folded structures east of it.

The epicenter inland in Western Australia is that of shock 38N200, felt at Perth and throughout the Southwestern Division of Western Australia. It appears to indicate an active fracture within the margin of the stable mass. Shock 38N250 is off the coast southwest of Perth.

Other marginal shocks

Of the areas usually named as continental shields there remains only that in eastern China. This is smaller than most of the others; it abuts against a very active region to the west, and has marginal shocks near the east coast. One of the latter (21N975) was destructive at Swatow.

Borneo is part of a stable mass, separated from Celebes by the active fracture of the Strait of Macassar. The epicenter 22N920 at 7°N, 114°E may be marginal or internal to the principal mass. Shocks inland from the coast are clearly marginal. Macroseismic data are reported by Sieberg (1932a, p. 833).

Other important stable masses either show no identified marginal activity (Antarctica) or are immediately surrounded by active belts (Philippine Basin) or exhibit marginally an alternation of these conditions (Eurasian stable mass).

MINOR SEISMIC AREAS

General survey

Significant seismicity is not restricted to the principal active belts, the rifts, and the interior or marginal fractures of the stable masses. Two large areas and several smaller ones show fairly frequent minor shocks and occasional larger ones. These areas necessarily fall between the stable masses and the active belts (Fig. 34). The eastern Asiatic active area may belong in this class, since it lies between the Alpide active structures and the stable mass of northern Asia, but its seismicity is much higher than that of the regions now to be discussed.

Regions like the Rocky Mountains and the Alps, which belong structurally with the Pacific and Alpide belts, are included in the present section on account of their relatively low seismicity.

The geological structures are generally of the same type, but show great difference in extent and in activity. The clearest example is

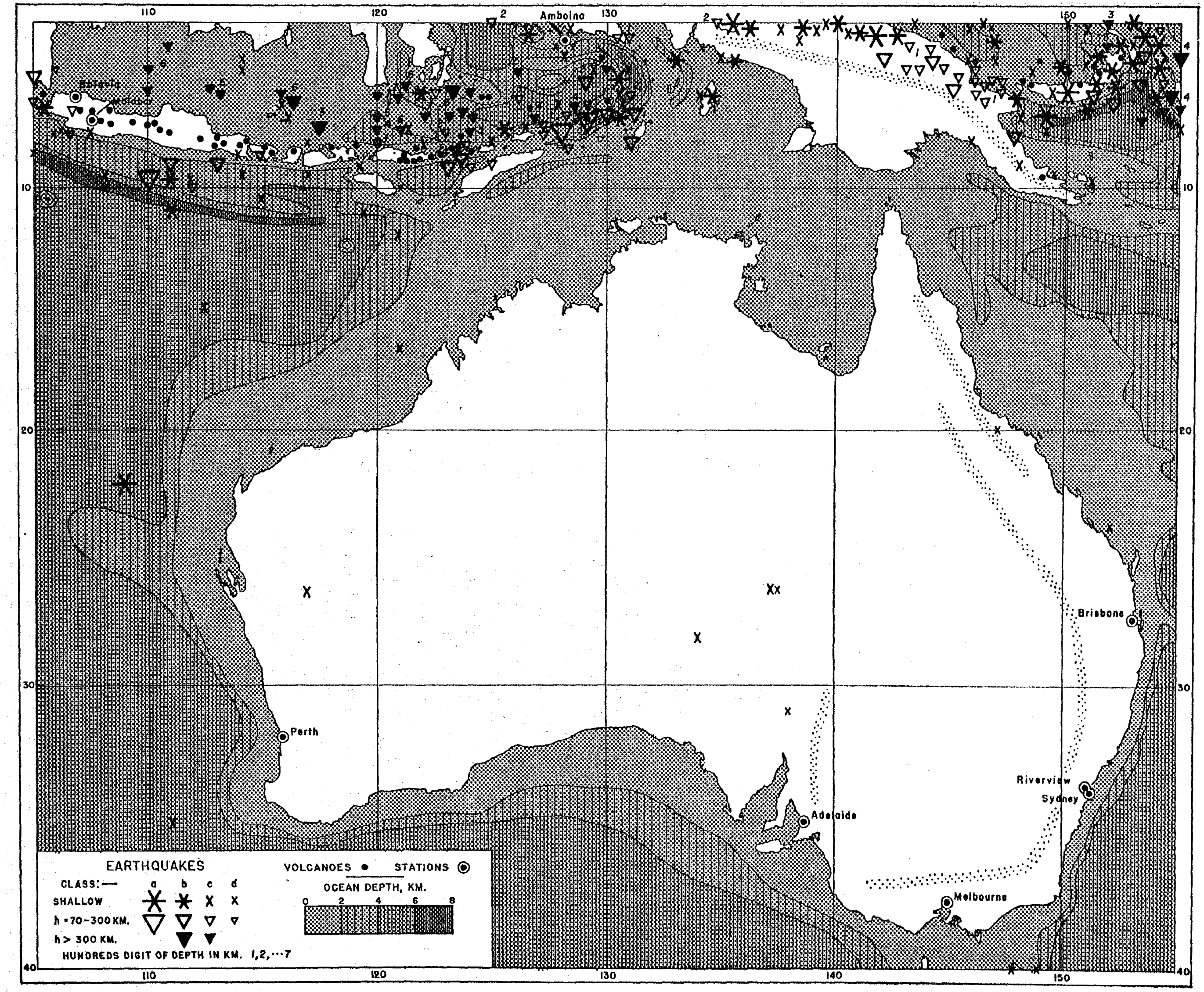

FIGURE 30. Australia.

that of eastern Australia. The West Australian pre-Cambrian Shield is bounded on the east by the active fractures of the marginal "shatter zone." East of these is the area of the Palaeozoic mountains of Australia, with minor activity. Beyond this is an extremely stable oceanic area, bounded on the east by the highly active circum-Pacific belt including the Solomon Islands and New Zealand, and marking the edge of the Australasian continental area.

It frequently happens that in one or several directions the stable mass abuts almost directly on one of the principal active belts, and the intervening area of minor seismicity is narrow or lacking.

In minor seismic areas shocks of class *d* have usually been catalogued whenever the data were adequate. Even when well-recorded, smaller shocks (class *e*) have been omitted. This explains the omission of numerous epicenters in Europe and North America.

North America

Region 34, Figures 8, 27, and 34. The North American active area is surrounded by the circum-Pacific and Arctic-Atlantic belts. The stable mass of the Canadian Shield is eccentrically placed to the northeast. South of the marginal fractures of the St. Lawrence region is the Palaeozoic Appalachian mountain structure. To the west the Rocky Mountains are the eastern and older edge of the Pacific belt.

The crustal structure of this broad region probably varies greatly, and differs from that in the California area. At St. Louis, Chicago, and other stations in the central United States the first seismic waves from distant shocks may arrive as much as 4 seconds early (A. W. Lee, 1937; Gutenberg and Richter, 1938b). The phenomenon suggests unusual structure of the deeper crustal layers and unusually high average wave velocities.

From recorded explosions off the coast of Maryland, Tuve *et al.* (1948) report a thickness of about 12 kilometers for the granitic layer, a second boundary at a depth of 24 kilometers, and the Mohorovičić discontinuity at 42 kilometers.

C. Tsuboi (unpublished, personal communication) has calculated the thickness of the isostatically uncompensated part of the crust in the United States separately for each of nine regional divisions as follows (thickness in km.):

	West	Central	East
North	70	39	108
Central	35	64	38
South	39	54	89
General mean		59	

Shocks east of the Rocky Mountains frequently show a wider area of perceptibility for given epicentral intensity than those of the Pacific coast. This indicates greater depth of focus. On plausible assumptions macroseismic data can be made to yield a rough estimate of this depth which probably differs from the true depth, since it must be affected by local structure and ground (Gutenberg and Richter, 1942). For some shocks this estimate exceeds 60 kilometers. Extreme instances are the Charleston (South Carolina) earthquake of August 31, 1886, rediscussed by Wood (1945), and the Charleston (Missouri) earthquake of October 31, 1895 (Heinrich, 1941, p. 197). The former is the better known; but the latter was even more remarkable, since it occasioned only moderate damage near its epicenter and yet was felt from the District of Columbia to New Mexico and from Canada to Louisiana.

Marginal shocks of the Canadian Shield show a similar distribution of intensity suggesting relatively large depth, which is confirmed by instrumental observations for some of them.

Gravity data for over 1000 stations have been issued in various forms by the U.S. Coast and Geodetic Survey. A gravity profile across the United States has been discussed in relation to geological structure by Woollard (1943). Maps showing gravity data are given by Woollard (1936; 1937; 1939); Woollard, Ewing and Johnson (1938); Longwell (1943).

Seismological stations are most numerous in the coastal regions. Shocks in the central Mississippi Valley are well observed at St. Louis and its auxiliary stations (Florissant, Little Rock, Cape Girardeau), but there are many large areas of the United States where shocks of magnitude 5 to 5½ are still difficult to locate. For earlier years, with fewer stations and less sensitive instruments, information is very incomplete. Macroseismic data are also imperfect; what is known has been summarized by Heck (1938b) and in the serial *United States Earthquakes* (Bodle, Heck, Neumann).

The principal activity of the region is in the eastern Cordilleran belt. Structurally this belongs to the Pacific belt; the Rocky Mountains and related structures are of the same age as others which have been included in the discussion of the circum-Pacific activity. However, their seismicity is lower. Probably the largest known shock of this group was destructive at Bavispe, in Sonora (Mexico), May 3, 1887. It is described as accompanied by surface faulting (Dutton, 1904, p. 54; Montessus de Ballore, 1924, p. 81, quoting Aguilera, 1889). The largest of these shocks in Table 17 is the Montana earthquake of 1925 (Willson, 1926; Byerly, 1926). The table also includes the shocks in Texas (Byerly, 1934) and Utah (Neumann, 1936b; Adams, 1938) in 1931 and 1934, the Helena (Montana) shocks of 1935 (Ulrich, 1936; Gutenberg and Richter, 1938b), and a few smaller earthquakes.

The Helena earthquakes of 1935 are of interest for their succession in time. A small earthquake on October 4 was followed by a series of minor perceptible shocks, until on October 12 a shock occurred strong enough to cause some damage. On October 18 (October 19, G.C.T.) the first destructive shock (34N50) followed. The second destructive shock, 34N60, on October 31, was of nearly the same magnitude. This is one of many exceptions to the commonly stated rule that danger is largely over after the first destructive shock.

The Appalachian belt is a region of fairly continuous minor activity. The northeastern part of it is shaken by the marginal shocks of the Canadian Shield, but moderate earthquakes originate within the Appalachian area. Table 17 gives one example, the New Hampshire earthquake of 1940 (34N580). Shocks are probably more frequent in the southern Appalachians, but even the largest of these is not recorded widely enough for instrumental location, and they are of class *e*, although sometimes felt to distances of several hundred kilometers.

Near the Atlantic coast is the epicenter of the Charleston earthquake of 1886 (Wood, 1945). Small shocks are fairly frequent in the same area.

The earthquakes of 1811 and 1812 in the Mississippi Valley, originating near New Madrid (Missouri), rank as the greatest shocks in the history of the United States, considering the enormous area disturbed and the violent effects (Fuller, 1912). The magnitudes of the large shocks must have been at least 8.

Northeastern Asia

Regions 41 and 42, Figures 7, 18, and 34. A minor seismic area includes northeastern Asia and the extreme northwestern part of North America. This region, like the preceding, lies between the Canadian Shield and the active belts, which are here the Aleutian arc, Kamchatka, and the (non-seismic) eastern boundary of the Angara Shield. Between Lake Baikal and Kamchatka there is no bounding active belt, so that eastern Asia south to Sumatra and Borneo might logically be included, but this larger region is of different seismic and structural type, including several important minor stable masses.

Between Siberia and Alaska this region is transgressed by the Bering Sea, the coasts of which are probably of structural significance, since practically all the known shocks of the region are close to them.

There are no stations in the region. On its margins are Vladivostok, one of the first-class Soviet stations, with reports available since 1930 with interruptions; College (Alaska), in operation since 1935; and Ootomari, one of the older Japanese stations, on the southern part of Sakhalin.

Shock 41N500 was reported destructive at Suihwa, north of Harbin, Manchuria. This is the only shock at normal depth instrumentally located in the interior of this region. Shock 41N600 was destructive on Sakhalin. Shocks 41N800 and 41N900 east of Okhotsk are well located from instrumental data. Four shocks, 42N700 to 42N850, near 67°N, 172°W (northwest of Bering Strait), occurred within a few weeks in 1928.

Purely coastal or marginal activity of this type is characteristic of stable masses, as well as of some minor seismic areas. No structural conclusions should be drawn from seismological data, which cover only the larger shocks of the area, although every shock for which data were adequate has been investigated.

Northeastern Asia is almost uninhabited, so that no macroseismic data are available. Seismicity comparable with that of most of northern Europe could not possibly be detected here. The region is probably analogous, both in structure and in seismicity, to others in the present main section.

Central and Western Europe

Regions 31 and 36, Figures 25 and 27. The exceptional circumstances of information on the seismicity of Europe call for special treatment. In a previous paper (Gutenberg and Richter, 1941, p. 95) a figure was given on which all epicenters in the *International Summary* for a limited period were mapped, regardless of the magnitude of the shocks. This is undesirable for comparison with other maps; it overemphasizes very small shocks, such as occur in all parts of the world, unrelated to the principal active structures. Moreover, it includes only those shocks of that class which are near several good stations; and it maps imperfectly recorded shocks for which epicenters may be seriously in error. The listed shocks of class *d* and over are now sufficient for seismic mapping.

Reference has been made to Stille's structural subdivision of Europe. His *Neo-Europa* includes the entire Alpide belt. The relatively high activity of the southern front has been discussed. The northern front, including the Alps, Pyrenees, and Betic Mountains, remains to be considered.

Seismicity differs somewhat between *Meso-Europa,* the region of Variscan or Hercynian folding, *Palaeo-Europa,* the region affected only by the Caledonian folding, and the stable Baltic Shield, which is the eastern part of Stille's *Ur-Europa.*

With the occurrence of more of the rare stronger shocks of central Europe, some increase in the number of stations and the observations of the Helgoland explosion on April 18, 1947, crustal structure in Europe is now better worked out. The depth of the Mohorovičić discontinuity is at the relatively shallow level of about 30 to 40 kilometers in northwestern Europe. It has a maximum under the Alps at about 70 kilometers and decreases in northern Italy to about 50 kilometers under the Etruscan Apennines and to about 40 kilometers in Yugoslavia. The thickness of the granitic layer is about 20 to 30 kilometers in northwestern Europe and about 40 to 45 kilometers in the general area of the Alps (Gutenberg, 1943b; Caloi, 1942, 1943). Gravity data for the eastern Alps are discussed by Holopainen (1947).

Hiller (1935) has investigated instrumental and macroseismic data for shocks in the northern foreland of the Alps in southern Germany. The larger shocks are all at depths of 30 to 40 kilometers, near the bottom of the granitic layer, but some of the smaller shocks (all definitely class *e*) are at depths of only a few kilometers. This is confirmed by Caloi (1943). Macroseismic data are in agreement with these results (Gutenberg and Richter, 1942). On the other hand, macroseismic data (Oldham, 1923) indicate that the shock of August 7, 1895, in northern Italy had an unusual focal depth, although probably less than 100 kilometers.

The European area is exceptionally well provided with good stations, many of them with excellent time-keeping, and some with short-period instruments for registering local shocks. There are many observations for these shocks, so that European earthquakes are disproportionally represented in the *International Summary.* This gives a misleading impression of high seismicity in that region if all the listed epicenters are mapped without regard to magnitude—especially in the Alpine area, as a result of the excellent Swiss stations, Stuttgart with auxiliary stations, Strasbourg, and Trieste.

Macroseismic data are plentiful. There are innumerable papers discussing the seismicity of particular small areas, often including only a few hundred square kilometers, and many others reporting on particular shocks. More inclusive studies will be referred to in order.

Shocks in the Alps are generally smaller and less frequent than those of Italy (Wanner, 1934; Rothé, 1941). The largest known shock of the region is that at Basel in 1356. A moderately strong shock occurred near Visp in 1855 (Montandon, 1942/43, reviewed by Tillotson, 1946). Probably somewhat less strong is the class *c* shock of January 25, 1946, with epicenter near Sion at 46.4°N, 7.5°E, according to Zürich. This earthquake was felt in all directions to points beyond the Swiss border.

The Basel earthquake is more properly included with the notable minor activity of the northern and northeastern foreland of the Alps, particularly of the region known in Germany as the Schwäbische Alb; the misleading translation as the "Swabian Alps" has unfortunately become accepted in English. This is the area of the earthquake 36N500 of 1911 (Gutenberg, 1915; Sieberg and Lais, 1925).

Seismic activity along the northern front of the Alpide zone is otherwise small. Occasional shocks are destructive on the Riviera and in the Pyrenees. Seismicity increases along the southeastern coast of Spain; a number of offshore shocks are shown on the maps.

The principal mass of *Meso-Europa* is nearly quiescent, except for shocks such as occasionally occur even in the interior of the great stable masses. It is transected by the Rhine structures, which are associated with a notable heightening of minor activity, although practically all the shocks are too small to be included in this study. For discussion of the Rhine structures as rifts see Cloos (1939, pp. 445-462). The macroseismic history of Germany has been catalogued by Sieberg (1940a,b).

Swarms of small shocks in the Vogtland, Saxony, have been described by Etzold (1919). Small locally damaging shocks have occurred about the coasts of France, notably near Nantes and in the Channel Islands. Similar shocks are known from the coast of Portugal, although some of the destructive shocks affecting that region originated far to the west in the Atlantic continuation of the Alpide zone.

The northern boundary of *Meso-Europa* is associated with a number of comparatively large shocks of class *d*. Such are the Belgian earthquake of 1938 (36N600), and that at Colchester in 1884.

The northern region of Caledonian folding (Stille's *Palaeo-Europa*) shows notable minor seismicity. In view of the complete quiescence of much younger structures, it is highly improbable that these shocks represent any persistence of the Caledonian orogeny to the present time. Stresses of more recent origin have produced fractures in the Caledonian mass, or have rejuvenated old faults of Caledonian age. In Scandinavia these stresses are generally attributed to the uplift of the land after removal of the Pleistocene ice load. (See Gutenberg, 1941a.) For a summary, see Renquist (1930).

The history of Norwegian earthquakes was summarized by Kolderup (1913), in a paper which has been followed by a series of annual reports. The available history is comparatively short, Kolderup's earliest shock being dated 1612. Few, if any, of these shocks were larger than class *d*. Instrumental data for the largest (October 23, 1904) are not sufficient to locate it precisely. This was a shock of perhaps magnitude 6 in the Skagerrak near 58½°N, 10½° E. On March 9, 1866, there was a somewhat smaller shock on the northwest coast near Trondhjem and Kristiansund. Earthquakes in Finland have been discussed by Renquist (1930).

The compilation for Great Britain by Davison (1924) is the most extended critical history available for a region of such low activity. Davison lists the earliest authentic British earthquake as of date 974. His list suggests nearly uniform seismicity in the time covered, as the frequency of listed shocks does not greatly vary until the beginning of scientific investigation in the seventeenth century. The low level of activity is apparent from the fact that from 974 to 1924 Davison lists only 1191 shocks, of all sizes down to the smallest; and over 600 of these are accounted for by swarms of minor shocks at Comrie and Menstrie in Scotland. As Davison points out, the activity in Scotland differs from that in England and Wales; more small shocks are known in Scotland, and the stronger shocks there constitute a large fraction of the total for Great Britain. The Scottish shocks are more plainly associated with known structures than the others; thus many important shocks have occurred along the Great Glen Fault (Kennedy, 1946), at Inverness and southwest of it. This and analogous structures of Scotland and elsewhere in Britain have been discussed by E. M. Anderson (1942).

The largest British shock listed by Davison (1924) was destructive at Colchester, in the southeast of England, in 1884. The North Sea shock 36N700 of 1931 was still larger, and thus ranks as the largest known shock in the British region for a thousand years (magnitude about 5½). Other shocks have occurred still farther out in the North Sea, such as shock 36N800.

Australia

Region 38, Figure 30. A general discussion is given by de Jersey (1946), who finds a crustal thickness of about 40 kilometers. The shocks of South Australia and central Australia have been noted as marginal to the stable mass of West Australia. East and southeast of these lies an area of very minor seismicity. Shocks are occasionally reported felt in Queensland. One of these (38N650) is mapped. A smaller shock, on April 12, 1935, was responsible for the establishment of the station at Brisbane (Bryan and Whitehouse, 1938). This is not included in Table 17, not being large enough for class *d*. Table 17 and Figure 30 show shock 38N750 near the Queensland coast. Shocks in that area are rare; Bryan (1944, p. 50) states: "I have watched particularly for disturbances, even small ones, from the edge of the Great Barrier Reef, which especially might be expected to yield evidence of mobility, but although our station is in an excellent position for receiving such shocks, not one has been recorded." Shocks are not infrequent about the fracture of Bass Strait, such as shock 38N-850 and a class *c* shock on September 14, 1946, with nearly the same epicenter.

South Africa

Region 37, Figure 28. The Cape region of South Africa is an area of Palaeozoic and Mesozoic folding. Only a few shocks have been large enough to include. These are marginal to the folded area; either externally, near the coast, or internally, between the folded area and the interior stable mass. The older data were discussed by H. E. Wood (1913); several recent shocks have been discussed in special papers (Krige and Venter, 1933; Gane *et al.*, 1946).

MINOR SEISMICITY

Minor earthquakes occur almost anywhere. Practically all existing seismological stations have recorded local earthquakes in their immediate vicinity. However, seismographs with long-period characteristics, such as are suitable for recording distant earthquakes, often fail to write legible records of nearer shocks, even when these are perceptible at or close to the station. Short-period instruments, which are sensitive to small local shocks, have mostly been installed in active areas. Comparatively few are in regions of minor seismicity.

There are few regions where we have both historical and instrumental data on minor activity. Europe is the only area of low seismicity for which both are available, and even in Europe many of the instruments are ill-suited for the study of minor local shocks.

The somewhat different problem of minor activity in a region of marked seismicity may be studied with the aid of the results in southern California, where a local group of eight stations is in operation, with supplementary data available from temporary installations and stations outside the area.

Figure 31 shows all epicenters for shocks of magnitude 3 or more in the area 33°-35°N, 116°-119°W during the years 1934-1940 inclusive. Each epicenter is given a symbol indicating the magnitude of the largest shock associated with it in that period. The numerous smaller shocks from identical epicenters are not indicated.

The structural cross-section in Figure 32 passes north of the area shown in Figure 31.

The principal known faults are indicated in

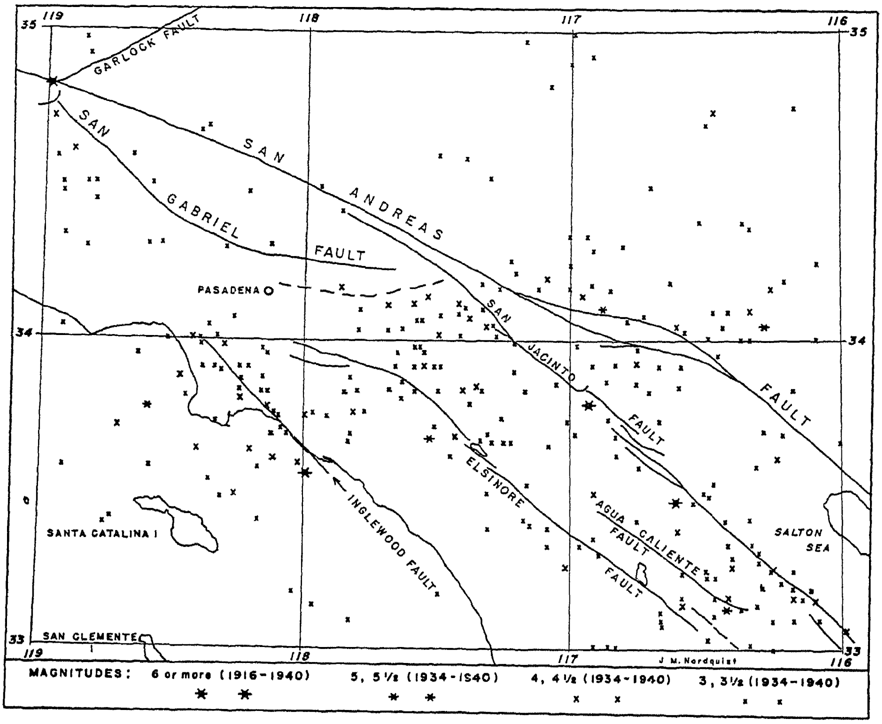

Figure 31. Map of epicenters and faults, southern California.

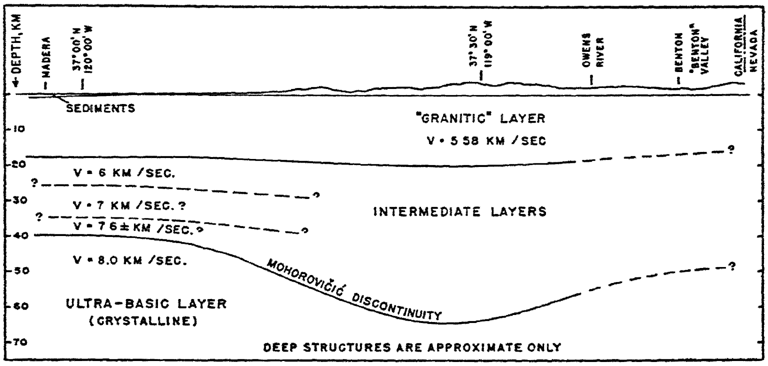

FIGURE 32. Structural cross-section, southern California, horizontal and vertical scales equal.

the figure; the "foothill fault zone," consisting of a series of disconnected traces along the front of the San Gabriel range, is shown as a dashed line. The general lack of clear association between minor shocks and important faults should be noted. Most of the many small shocks are located close to one or another of the numerous minor faults which are common throughout the region. Only the larger shocks show definite association with the larger fractures. It should be added that the only major earthquake known to have occurred in this area, that of January 9, 1857, originated on the San Andreas Fault. There was probably displacement along all that part of the fault shown on the western half of our map, extending northwest far beyond its limits. In recent years most of this part of the fault has been almost completely quiescent (note the absence of epicenters for small shocks). The same applies to most of that segment of the same fault zone along which displacement took place in the major earthquake of 1906, farther north.

Since the larger earthquakes represent a dominant fraction of the seismic energy released, it is apparent that in southern California, as elsewhere, most of this energy is released along the major structures.

The more recent maps showing minor activity in New Zealand (Hayes, 1941a) show a similar irregular distribution of the smaller earthquakes.

STABLE MASSES

General survey

The present section takes up certain large areas which are nearly free from shocks. Only the larger and more important masses of this type have been selected for detailed discussion; stable areas of all sizes exist, their number increasing as one proceeds to smaller dimensions. Even in the interiors of the most active belts it is possible to find minor crustal blocks which are internally unfractured, and are disturbed only by earthquakes external to them. The trans-Asiatic zone includes many such blocks, some of which are hundreds of miles wide.

Of the principal stable masses that of the Pacific basin differs structurally from all the others. The remainder are principally continental nuclei, continental shields, or oldlands, which remain as nearly undisturbed at present as they have been through most of their geological history. A few smaller blocks of similar type will be mentioned, owing to their significance in connection with the general pattern of world seismicity.

Pacific Basin

Region 39, Figure 33. The structure and extent of the Pacific basin have been discussed in the section on the structure of the earth. Except for the single internal zone of the Hawaiian Islands, and for possibly volcanic shocks in some other island groups, the principal Pacific basin is an area of complete seismic calm. A few shocks on the east fall outside the usual belts of activity; noteworthy are shocks 39N950 and 5N10, far off the Mexican coast, and shock 44N220 far west of the Galápagos group. These epicenters correlate with

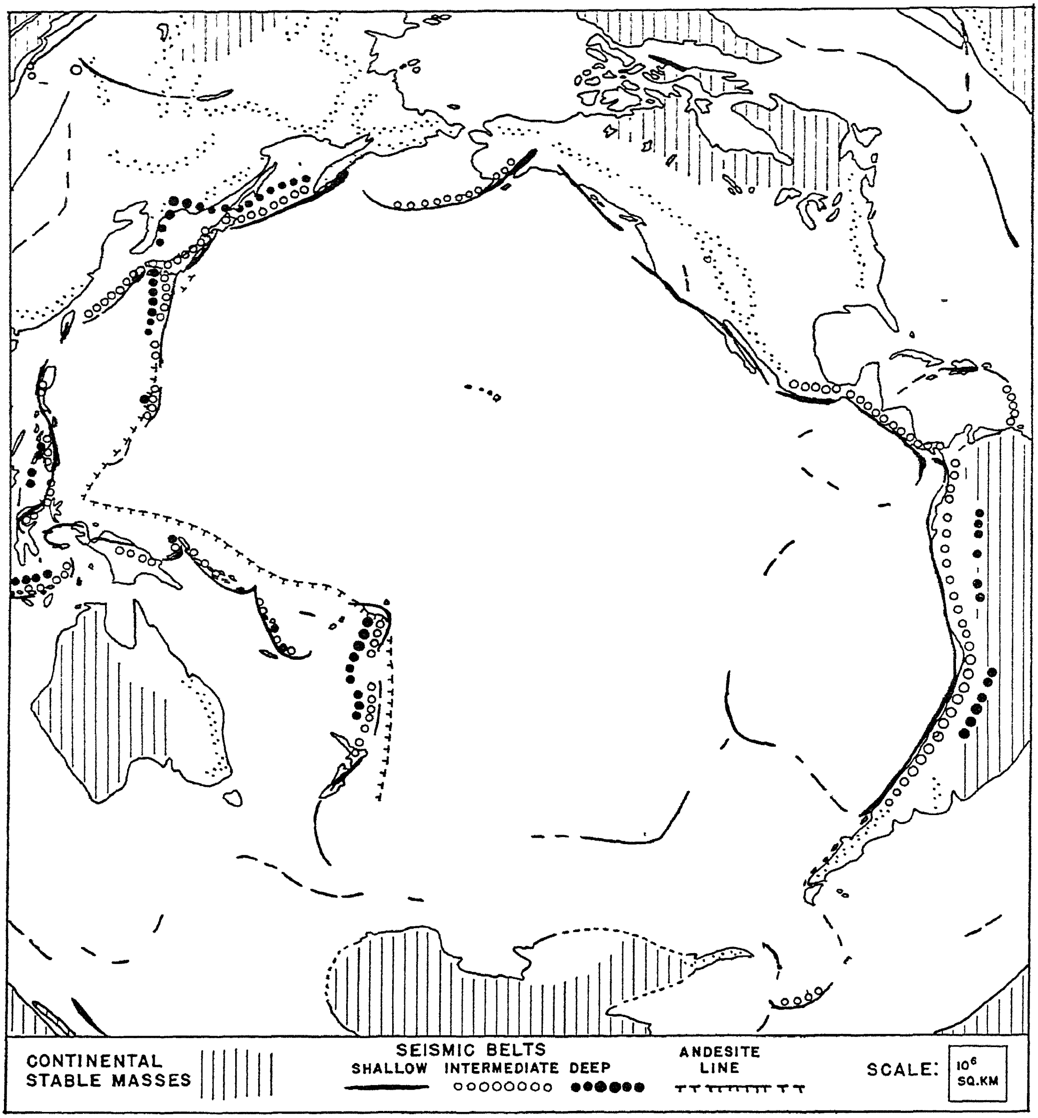

FIGURE 33. Pacific stable mass, azimuthal equal-area projection.

the vagueness in delimitation of the Pacific boundary on the American side.

Sieberg (1932a, p. 919) refers to a shock on April 11, 1911, which was strong on Ponape in the eastern Carolines but was not instrumentally recorded. Montessus de Ballore (1906, p. 174) refers to shocks felt on Tahiti and in the Society Islands. It does not appear that the station at Papeete, during the short period for which reports are available, recorded any local earthquakes. The seismic waves from distant shocks were at first reported as local shocks in the station bulletins, a misinterpretation originating in the surprisingly short periods with which these waves recorded at Papeete, probably due to some local crustal peculiarity (Ravet, 1940).

Seismological maps sometimes show epicenters at scattered points interior to the Pacific basin. Especially in its earlier years, the *International Summary* contains epicenters for poorly recorded shocks which were located, often with expressed doubt, in the stable area. All these epicenters have been subjected to close critical examination. It can now be stated positively that not one of these is well established; many of them are seriously in error.

In the previous paper (Gutenberg and Richter, 1941, p. 83f.) these shocks were discussed in detail, excluding epicenters near the margin of the stable area which, assuming moderate error, might well belong to the adjacent active belts. Of shocks given in the *Summary* as interior to the stable area, some are deep-focus earthquakes, located erroneously on the supposition of shallow depth. Others are inadequately recorded, or too much weight has been placed on the data of one or two stations with inferior instruments and timing.

The data of eighteen shocks were examined; all but one of the indicated epicenters were rejected. The exception was the earthquake of May 16, 1925, 10h, given in the *Summary* as in the Caroline Islands. Re-examination now makes it probable that this shock originated in northern New Guinea.

None of these supposedly interior Pacific epicenters are found in the *International Summary* for 1931-1935, except for shock 12D520 (20°S, 179°W, h=600 km.) which is erroneously given in the *Summary* as a normal shock at 8.6°S, 179.8°E.

Canadian Shield

Region 34, Figures 27 and 34. This is that large part of Canada and a small area in the United States, over most of which pre-Cambrian rocks are exposed at the surface. The interior of the Canadian Shield, thus defined, appears to be almost completely aseismic. Because of the proximity of good stations, only minor shocks can have escaped notice. The earthquake 34N680 of 1935 appears exceptional, with an epicenter in the pre-Cambrian area though near its edge. It is of interest that this shock, like others farther south, appears to have had more than the average depth of shallow shocks. These shocks have been discussed in the section on marginal fractures.

Brazilian Shield

Region 35, Figures 27 and 34. Branner (1912; 1920) has summarized the seismicity of Brazil, as well as the regional geology (Branner, 1919). The earthquakes reported are all small. The Brazilian Shield includes the Archaean masses of Brazil and Guiana; the stable area also includes later rocks consolidated with these by Palaeozoic folding, and thus takes in all of South America east of the Andes and north of the Plata (except the active district of Mendoza). No shock of any consequence has been located within this area from instrumental data.

Seismological evidence fails to distinguish between the Brazilian Shield and the adjacent area, with no known shocks, between the coast and the Mid-Atlantic Ridge.

Eurasian stable mass

Region 49, Figures 25, 26, and 34. Seismic maps of Eurasia show a great blank including the Baltic Shield of Europe, the Angara Shield of Asia, and the intervening Ural mountain system. Throughout this vast area there is apparently no report of felt earthquakes, except that near its boundaries shocks of adjacent active zones are noticed, and that minor local shocks have occurred in the southern Urals. (See Mushketov, 1936a; Weiss-Xenofontova and Popoff, 1940.) There is not a single good instrumental epicenter, although a chain of first-class stations at Moscow, Baku, Sverdlovsk (formerly Ekaterinburg), Tashkent, Irkutsk, and Vladivostok was established under the imperial Russian government, and has been maintained by the Soviet government with the addition of important local networks in Crimea, the Caucasus, and central Asia. The few epicenters in this area given by the *International Summary* are as questionable as those in the Pacific, or worse.

On the south and southeast the stable mass is bounded by the active belt of the central Asiatic highlands. In the northeast is the active area near the mouth of the Lena, which is at the end of the known extent of the Arctic active belt. Between these, the border of the Angara Shield has shown no verifiable recent activity.

On seismological evidence alone, the stable area might be made to include extreme northeastern Asia, which has been considered among the minor seismic areas.

Africa

Region 37, Figures 27, 28, and 34. Most of the shocks associated with the African stable mass have already been disposed of as associated with the rift system or as marginal continental shocks. A few shocks appear in the *International Summary* with epicenters interior to the stable mass. These have been examined carefully; only shock 37N950 near the upper Congo can be retained. Rather numerous shocks are felt in that region (Sieberg, 1932a, pp. 879-881). These are the only seis-

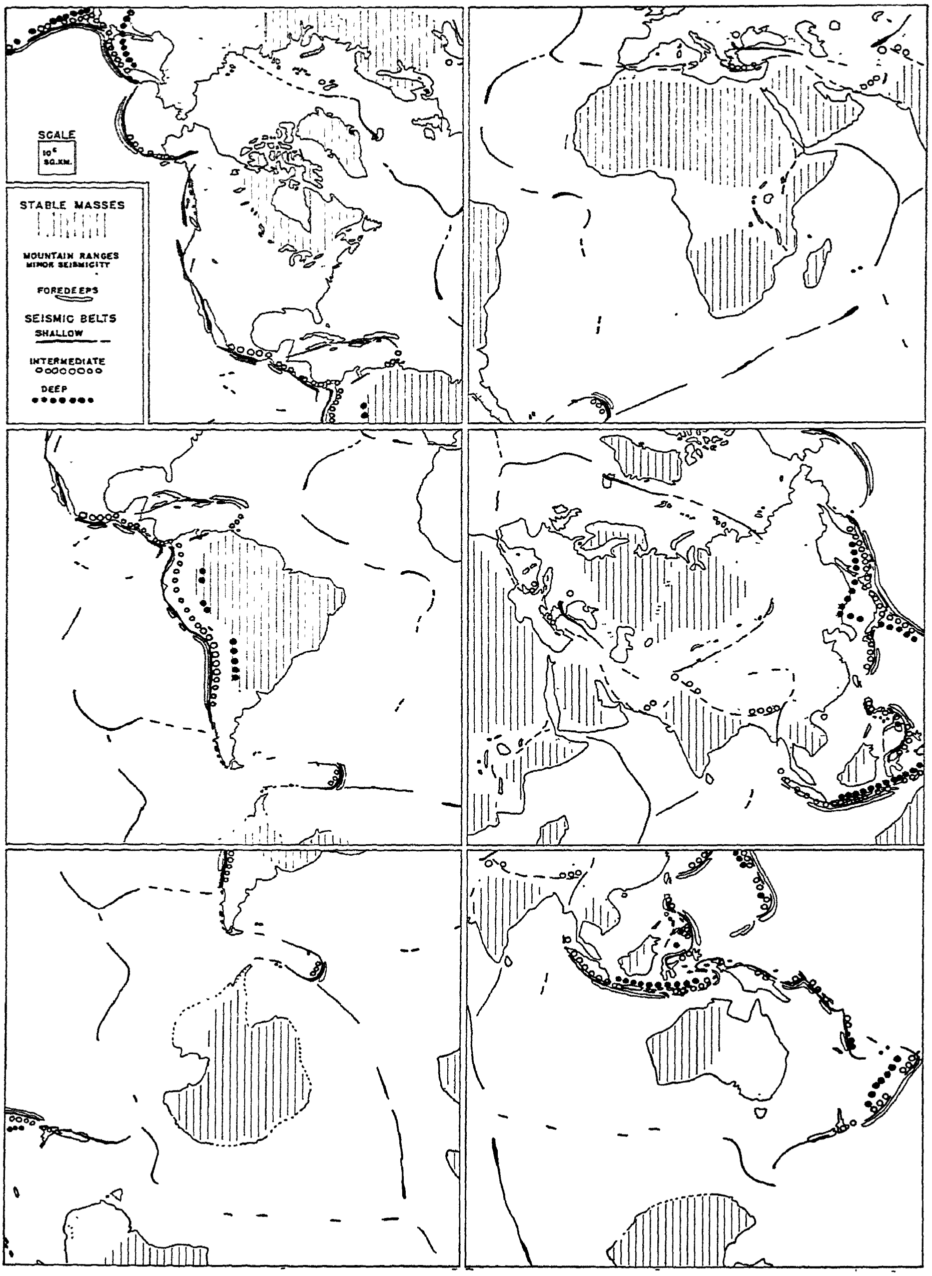

FIGURE 34. Continental stable masses, azimuthal equal-area projections, uniform scale.

mological evidence of the separation between the main units of the African mass.

The long history of Egypt includes a few strong shocks which appear to have originated on the continent west of the rift structures. (Sieberg, 1932a, p. 873; 1932b.) The clearest instances are those of 1303 and 1847, apparently centering in the Fayum west of Cairo. The great shock of 1870 was probably an intermediate earthquake under the Mediterranean. Smaller recent shocks of the same group have been repeatedly reported felt at Cairo.

Antarctica

Region 50, Figures 12 and 34. Teleseismic observation indicates that the whole of Antarctica is stable. There is no present seismological evidence to confirm the supposed structural connection from the South Antillean arc across Antarctica to the vicinity of Macquarie Island. The existence of at least one active volcano, Mt. Erebus, suggests that occasional minor seismicity is to be expected. Permanent seismological stations are all distant, so that detection of minor shocks is usually impossible.

Temporary seismological installations have occasionally been set up on the Antarctic continent. The results of the Scott expedition are published in a summary report by Milne (1905). Instruments were installed near 77° 51'S, 166°45'E, and operated for several months in 1902-1903. One hundred thirty-six shocks were recorded, none of which were felt. Twenty-seven were identified as originating in distant parts of the world; 73 others were located between the station and New Zealand, by using records at Wellington, Christchurch, and Perth. Locations for the remainder are not mentioned; but considering the characteristics of the instruments then in use, it is not likely that trustworthy conclusions could be drawn from these seismograms. It is quite possible that no truly Antarctic shocks were recorded and that the most southerly of those noted belong to the group south of Macquarie Island, region 45.

The Byrd expedition of the U.S. Antarctic Service operated instruments (with cooperation of the U.S. Coast and Geodetic Survey) at Rockefeller Mountain, 78°08'S, 155°25'W, through parts of November and December 1940. Only distant earthquakes were recorded. Readings are given in the reports of the U.S. Coast and Geodetic Survey for those months. The Ronne Antarctic expedition operated a station near Marguerite Bay in 1947-1948.

The *International Summary* and its predecessor reports assign only 11 shocks from 1913 to 1930 and none since then to latitudes from 65°S southward. These data have been reviewed with close attention. None of these epicenters are trustworthy (details in Gutenberg and Richter, 1941, p. 89f.). Locations depend principally on times at La Paz; other data are mostly doubtful. Most of these shocks might be in any of the active regions of southern latitudes.

No great shock (class *a*) can have occurred in the extreme south since 1904. Since about 1918 the *International Summary* provides assurance that a shock of class *b* could hardly have been overlooked or grossly misplaced. By definition, earthquakes of class *c* are well recorded up to 90°; such a shock at the South Pole would be well recorded at all stations in the Southern Hemisphere. However, these stations are not numerous, and a combination of errors and accidents might result in the loss of such an epicenter. It might be possible to detect a shock of class *d* and identify it roughly as occurring in the south polar area.

Thus, Antarctica seems to be a stable mass comparable with those named above. It is not likely that an Antarctic seismological station would provide data that would modify this conclusion, since additional shocks most probably would fall into the minor classes, which are not characteristic of major structures in other parts of the world. However, minor shocks in the Antarctic may prove to be better indicators of major structures and fractures than they are elsewhere.

Seismological evidence for the stability of the Antarctic continent has occasionally been obscured by vague references to shocks in "the Antarctic" which were actually in the Southern Antilles or the Macquarie Island active region. In both, verifiable activity extends south of the 60th parallel, but not beyond the Antarctic Circle.

Australia, Arabia, India

The pre-Cambrian continental nuclei of western Australia, Arabia, and southern India are practically aseismic. Shocks a short distance within their borders have been mentioned in the section on marginal fractures.

Other and minor stable masses

Of areas usually named as continental stable shields there remains only that in eastern China. This is smaller than most of the others; it is the largest of several such blocks in the Chinese active area, of which the next most important is that of the Gobi Desert. Another such area includes Borneo, the Malay Peninsula, most of Indo-China, and the intervening China Sea. Patagonia may be considered here. Greenland and Madagascar may be interpreted either as detached portions of the Canadian Shield and the African stable mass, or as minor independent stable masses.

To these may now be added a group of important non-seismic areas of continental character, most of them covered by ocean. The larger of these are:

1. The area in the Atlantic lying between the American continents on the west and the Mid-Atlantic Ridge on the east. There is no seismological evidence of a connection between the seismic areas of the West Indies and the Mediterranean.
2. The area in the southeastern Pacific south of the Galápagos Islands, between the Easter Island Ridge and the coast of South America.
3. A narrow area in the Arctic and Atlantic Oceans, between the coast of Europe and the active region. This probably has an analogue in the South Atlantic.
4. The Philippine Basin or Philippine Sea, between the active regions of the Philippines and the Marianas.
5. Somaliland and the area of the Indian Ocean east of it and west of the Carlsberg Ridge.
6. The region east of Australia, between the coast and the Pacific active belt. Here de Jersey (1946) finds a total crustal thickness of the order of 25 kilometers. Bryan (1944) has referred to this as forming an essential part of the Australian stable mass. In terms of present activity this is practically correct, if we do not consider the shocks of the fracture system in the interior of Australia, and the minor shocks associated with the ancient mountains of the east. This would correspond in Europe to bringing together Stille's *Ur-Europa* and *Palaeo-Europa* into a single stable mass.
7. The region west and southwest of Australia, between those epicenters considered as marginal to the Australian stable mass and those of the active belts of the Indian Ocean. This is one of a number of rather ill-defined areas of this type in the southern hemisphere, for which we have no data adequate for comparison with such well-observed regions as northern Europe. Such are the oceanic areas immediately surrounding Antarctica.

This list probably should include the Gulf of Mexico. It has not included the area in the Arctic Ocean north of Alaska, which is clearly non-seismic, but for which evidence from reflected seismic waves indicates a structure of Pacific rather than continental character. A much smaller but probably similar area of suspected Pacific crustal structure is the interior of the Caribbean loop.

TSUNAMIS (SEISMIC SEA WAVES)

THE present discussion includes earthquake effects only when they bear either on causative mechanism or on geographical distribution. The phenomena of seismic sea waves bear on both points.

It is necessary to distinguish carefully between (1) seaquakes, (2) seiches, and (3) tsunamis.

The term seaquake is restricted to actual shaking, usually felt on vessels, due to the arrival of elastic (acoustic) waves through water. Seaquakes are not ordinarily felt to great distances from the earthquake epicenter, and reports from remote seas are of interest in geographical discussion. The only full account is that of Rudolph (1887, 1895).

Seiches are free oscillations of closed or partly closed bodies of water (lakes, harbors), which may be occasioned by wind or currents as well as by the arrival of earthquake waves. The latter are usually the large long-period surface waves from a distant source; seiches of this sort usually begin within an hour of the origin time of the earthquake. However, seiches may be started by the arrival of a tsunami, which at very distant points may be more than a day after the occurrence of the earthquake.

Tsunamis or seismic sea waves, popularly but incorrectly termed "tidal waves," are large water waves, often rising to great heights on exposed coasts and propagated across the oceans with the velocity of waves on the surface of deep water. Most of them follow large shallow earthquakes. Waves of the same type have been produced by volcanic phenomena, notably by the explosion of Krakatoa in 1883. Others are due to great storms or to submarine landslides not connected with earthquakes. Such waves without apparent cause are not infrequent on the coasts of Peru and Mexico, but sometimes high swell or storm waves are reported erroneously as tsunamis.

Tsunamis are often attributed to block motion of the ocean floor in consequence of vertical faulting. This interpretation may be correct in some instances, but cannot be generally applicable, since some of these waves have followed earthquakes with epicenters on land. Submarine landslides set off by earthquakes may be a frequent cause. For discussion refer to Gutenberg (1939a). In conversation with the writers, Dr. Benioff has suggested that tsunamis may be generated directly by the large seismic surface waves within about 100 kilometers of the epicenter.

Tsunamis are frequently recorded on mareograms written by tide gages. A number of these are reproduced by Rudolph (1887) and by Imamura and Moriya (1939). Individual records are published in many scattered papers.

Periods of oscillation (T) in tsunamis range roughly from 20 minutes to 1 hour. Wave lengths ($L=vT$) are very large since the velocity v of waves over deep water is given by $\sqrt{gh}$, where g is the acceleration of gravity and h is the depth (Table 12).

In the open ocean the height of these waves is relatively small; together with the great wave length this results in such waves escaping direct observation. Large waves seen by vessels far from land over deep water must be due to other causes. Since the velocity decreases in shallow water, the waves rise rapidly on approaching a coast. Heights of 60 feet and over have been observed. Many of these have been in confined inlets and harbors, but some occurred on exposed low coasts, notably on Hawaii in April 1868 (Wood, 1914, pp. 196ff.). The destructive waves of 1946 in the Hawaiian Islands surged locally to heights of 55 feet (Shepard, 1946; Macdonald *et al.*, 1947).

Rudolph (1887) gave a map showing the coasts affected by tsunamis, which has been reproduced by other authors. He assumed erroneously that all tsunamis originate in volcanic disturbances. An extended discussion was given by Montessus de Ballore (1907, pp. 182ff.). For a list of tsunamis see Heck (1934; 1947). Jaggar (1931) has discussed tsunamis destructive in Hawaii.

There is no thorough synthetic study of these phenomena. Great tsunamis are relatively rare; descriptions of a few of the largest, such as those of 1755, 1868, and 1877, have been repeated in many textbooks.

The majority of tsunamis originate and are effective in the Pacific area. Three at least have been great enough to send large waves across the Pacific Ocean; those following the Arica earthquake of 1868, the Iquique earthquake of 1877, and the Aleutian earthquake of 1946. Many more have risen to destructive heights on coasts near the origin of the earthquake. Local coast and bottom configurations bring about great differences in wave height between adjacent localities. Many tsunamis are reported only locally.

The following geographical account is not meant to be inclusive, but names a few outstanding instances in each region.

The history for tsunamis originating in the Aleutian arc is necessarily short, since in most cases instrumental data are required to locate the corresponding earthquake. That of November 10, 1938, produced only a comparatively small wave, observed at Hilo, Hawaii, and recorded elsewhere on tide gages; but the smaller shock of April 1, 1946, gave rise to a great wave which was destructive at Hilo and rose to observable heights on distant coasts, as in California and Peru (Green, 1946, with mareograms).

The Yakutat Bay earthquake of 1899, with the largest known vertical fault displacement (47 feet) produced only a locally destructive wave.

On the Pacific coast of the United States,

TABLE 12

Approximate calculated velocities and wave lengths for waves on the surface of deep water.

Ocean depth in		Velocity		Wave length for period of 30 minutes	
km.	feet	meters/sec.	miles/hour	km.	miles
0.5	1640	70	160	135	80
1	3280	100	225	180	110
4	13120	200	450	360	220
9	29530	300	670	540	335

only small tsunamis have been known to originate. Some confusion has been caused by reports of small tsunami waves from distant earthquakes, or even of tide-gage registrations of such waves. The earthquake of December 21, 1812, is reported to have caused such a wave in Refugio Harbor west of Santa Barbara; this shock was destructive at several of the missions in that part of California. There is a report of a wave 60 feet high at San Pedro (California) following the Peruvian shock of 1868; this is probably either an exaggeration or a geographical mistake. The shock of November 4, 1927, off Point Arguello caused a small wave on the west coast of Santa Barbara County (Byerly, 1930) which recorded on a tide gage at Hilo, Hawaii (Jaggar, 1931).

Notable tsunamis on the west coast of Mexico occurred in 1787, 1907, and 1932. This is of particular interest because the epicenters of most of the better located and larger shocks are inland. The class *a* shock of June 3, 1932, produced a damaging tidal wave which was recorded strongly at Hilo, Hawaii. Some of the aftershocks, notably the *b* shock of June 22, produced smaller but locally destructive tsunamis.

The Pacific coast of South America is notoriously subject to destructive seismic sea waves. That at Tumaco, Colombia, following the great earthquake of January 31, 1906, is described by Rudolph and Szirtes (1912, pp. 181-189). The propagation across the ocean of the great waves following the Arica earthquake of 1868 and the Iquique earthquake of 1877 was studied by Hochstetter (1868, 1869) and by Geinitz (1878). Their results are summarized by Montessus de Ballore (1907, p. 201). The latter wave is particularly well known for having been very destructive on the Chatham Islands on the other side of the Pacific, and on Hawaii. The epicenter of the earthquake which produced it was probably on land.

Descriptions of the tsunami following the Atacama earthquake of 1922 can be found in Willis (1929). The epicenter is fixed on land by the instrumental data. Waves seem to have started from at least two points (Sieberg, in Sieberg and Gutenberg, 1924). Gutenberg (1939a) has given a rediscussion.

A list of twelve seismic sea waves (maremotos) on the coast of Chile from 1562 to 1932, with descriptive notes, has been given by Bobillier (1933b). The dates are 1562, 1570, 1575, 1604, 1657, 1730, 1751, 1819, 1835, 1868, 1877, 1922; which shows how infrequent the larger phenomena of this sort are. To this list should probably be added the waves on November 7, 1837, which caused damage at Hawaii (Jaggar, 1931; Davison, 1936, p. 94).

Many tsunamis originate in the southwest Pacific. A shock on March 25, 1947, off the North Island, New Zealand, was followed by a tsunami at Poverty Bay. For the shocks of May 1, 1917, and April 30, 1919, Angenheister (1923) reports tide-gage readings from Honolulu and California, also from Apia for the latter shock, and for that of June 26, 1917. These originated in the Tonga salient. He also gives an Apia observation from a wave following the shock of September 20, 1920, in the New Hebrides. Imamura and Moriya (1939, p. 128) reproduce mareograms doubtfully attributed to the great intermediate shock of January 1, 1919, in the Tonga salient. These waves arrived rather late for a tsunami and are possibly large seiches.

Gutenberg and Richter (1936a, pp. 126-127) have reported briefly on the tide-gage recordings at Honolulu and Santa Barbara (California) of the tsunami produced by the earthquake in the Solomon Islands on October 3, 1931.

A seismic sea wave accompanied the shock in eastern New Guinea (Papua) on September 14, 1906 (Sieberg, 1910; summarized, 1932a, p. 911).

In the Philippines, at least one clear instance is the wave at Cotobato following the earthquake of August 15, 1918 (Masó, 1918; mareograms in Imamura and Moriya, 1939, p. 126).

Many destructive seismic sea waves are known from the region of Japan, where the name "tsunami" originated. The best documented is that following the earthquake off the Sanriku coast on March 2, 1933 (March 3, Japanese time; Ishimoto *et al.*, 1934). Imamura (1937, pp. 145-146), in listing severe earthquakes in Japan since 1596, notes 15 tsunamis of which at least eight were large and destructive. Several, including those of 1854 and 1707, were destructive in the region of Osaka, which, as Imamura points out, is especially exposed to these waves. Unpublished manuscripts from the Central Meteorological Observatory describe recent instances. The shock of November 18, 1941, was followed by a tsunami about one meter high on the coasts of eastern Kiushiu and southwestern Shikoku. That following the Tonankai earthquake of December 7, 1944, was very destructive on the east coast of the Kii Peninsula and on the neighboring coasts, reaching a maximum height of 5 to 6 meters at the heads of bays on the west coast of Wakayama prefecture (Kii Peninsula) and on the east and south coasts of Shikoku. The tsunami in the same vicinity on December 20, 1946, should now be added. The former was recorded on tide gages on Attu and in California. The great waves of 1896 and 1933 were destructive on the eastern (Sanriku) coast. Mareograms for several Japanese tsunamis are reproduced by Imamura and Moriya (1939). A tsunami occurred on the west coast of Hokkaido on August 1, 1940 (Miyabe, 1941).

The shock of September 7, 1918, produced a tsunami destructive on Urup in the Kuriles. Angenheister (1923) reproduced a mareogram written at Apia.

The large shocks of the Kamchatka coast occasionally produce tsunamis. That of June 25, 1904, stranded boats at Petropavlovsk. That of February 3, 1923, is notable for having been destructive at Hilo, Hawaii.

Seismic waves have often been reported from the coasts of the East Indies. Montessus de Ballore (1907, p. 220) quotes the opinion of Verbeek (1900) that the Ceram earthquake of September 30, 1899, which was followed by a disastrous wave, had its epicenter on land. This depends on scanty macroseismic observations. Instrumental records (Rudolph, 1904) are inadequate.

The wave following the volcanic explosion of Krakatoa in 1883 is described by Symons (1888) and others.

The earthquake on the west coast of Sumatra on January 4, 1907, was followed by a tsunami.

In the Indian Ocean a wave of moderate size followed the great earthquake of December 31, 1881 (mareograms in Dutton, 1904, p. 284). A spectacular tsunami was produced by the shock off Baluchistan on November 27, 1945 (Anonymous, 1945).

Tsunamis are relatively infrequent in the Atlantic. A comparatively small one following the shock of November 18, 1929 (Keith, 1930) rose to destructive heights in the narrow Burin inlet on the south coast of Newfoundland. The Lisbon earthquake of 1755 produced great waves which contributed heavily to the destruction on the coast of Portugal, were destructive at Madeira, and noticeable in the West Indies. These waves entered the English Channel and North Sea with sufficient amplitude to be noticed in various harbors, many hours after the seiches produced by the seismic surface waves of the earthquake. (Reid, 1914; Davison, 1936.)

Destructive waves some of which were true tsunamis have occasionally followed earthquakes in the Caribbean region. Among the best known are those on May 7, 1842 (Scherer, 1912), and August 4, 1946, on the north coast of Hispaniola; October 11, 1918 on Puerto Rico (Reid and Taber, 1919); January 14, 1907, and other dates on Jamaica (Taber, 1920).

Minor tsunamis on the coasts of the Mediterranean have accompanied earthquakes and volcanic eruptions throughout the historical period. An instance is that following the Messina earthquake of 1908.

MECHANISM

To this point care has been taken to present facts of observation, with only the minimum of hypothesis requisite to organize them into intelligible form. The following interpretative discussion necessarily involves an increased proportion of hypothetical conclusions. The purpose is not to undertake the vast labor of synthesizing the seismological data with those of geology and of other branches of geophysics, but to point out certain features of such a synthesis as they present themselves most naturally, and to forestall the most likely misinterpretations by students unfamiliar with the techniques of seismology.

Seismicity must have changed greatly in the course of geologic time. Contemporary earthquakes indicate only contemporary stresses, displacements, and fracturing. These may well differ, and in some cases they certainly differ markedly, from those associated with the formation of even late Pleistocene structures. A few tens of thousands of years is ample time for extensive and significant changes in the local distribution of stress. The fact that much of the present seismicity of Europe is mechanically unconnected with the Alpine folding has been emphasized by Sieberg (1932a), who attributes contemporary shocks to fractures produced in the rigid Alpine mass after the conclusion of folding. However, his ingenious localization of these fractures on the basis of the very limited earthquake data is open to question.

Stresses now producing earthquakes in northern Europe have been attributed to unloading of the Pleistocene ice burden (see Renquist, 1930); this may apply to some of the Canadian shocks. The progress of this unloading is visible in the evidence of post-glacial uplift.

Few definite changes in seismicity have occurred during historical time. Chronologically long histories for Japan, China, the Near East, and Italy indicate activity of about the same character as at present, with shocks in the same range of magnitude occurring in the same areas, apart from a few individually exceptional events. For less active areas, the best available history is that of Great Britain, extending over about a thousand years with no sign of secular change.

Comparatively quiet regions may have short periods of unusual seismicity. Such appears to have been the case in Korea about three centuries ago (Kunitomi, 1937). Recent instances are the long series of strong shocks in the Indian Ocean near 34°S, 57°E from 1925 to 1933, and the repeated earthquake catastrophes in Anatolia since the great shock of 1939. Examples of individual shocks or brief groups of large shocks from unusual epicenters are the Mississippi Valley shocks of 1811-1812, the Charleston earthquake of 1886, the Baffin Bay shocks of 1933-1934, the west Cuban earthquake of 1880, and the destructive shock at Basel in 1356.

Rather delicate adjustment of crustal blocks to stress conditions is indicated by the occurrence of swarms of small earthquakes, with a few ranging up to magnitude 5, in the vicinity of Boulder Dam subsequent to the filling of Lake Mead, although the area had not previously been considered as active (Carder, 1945).

Most of the earth's surface is partitioned among a number of comparatively stable blocks, separated by active belts. Undoubtedly these blocks have not always had exactly their present size and shape, and they may have greatly changed their relative positions. In particular, the continental blocks may have encroached on the Pacific.

The active zones between the stable blocks frequently coincide with the "orogens" of Kober (1933). As he points out, these zones are chiefly mountainous in character; the oceanic ridges included are submarine mountain chains. The agreement is not necessarily a confirmation of Kober's further interpretations, since it applies chiefly to the larger lines, and frequently diverges widely in detail. Moreover, Kober does not discriminate the Pacific stable area from the structurally different continental blocks, and he draws one orogen across the central Pacific which conflicts with the conclusions of this volume.

The mechanism of stresses in the active zones is of two chief types expressed in folds and in block structures respectively. The former may be seen in the arcuate structures of Pacific type which are well-defined regions of folding and thrust faulting. Their general relation to the central stable mass of the Pacific Basin is evident, but they are frequently separated from it by wide areas of continental character. The arcs are thus not directly correlated with the boundary of the Pacific Basin, nor with the discontinuity in structure and material there. Rather, they arise in a wide disturbed zone extending from the Pacific Basin far into the surrounding continental areas. These latter may originally have been part of the Pacific Basin, subsequently covered by continental masses. Systematic interpretation of the occurrence and tectonic significance of peridotites and other ultrabasic rocks was undertaken by Benson (1927). Peridotites are being used by H. H. Hess and others to infer the location of former active arcs.

The typical arc features, including earthquakes, active volcanism, gravity anomalies, and such forms as foredeeps, can be maintained only by continuing processes, which must have a non-symmetrical character to account for the unilateral order of the features. This order must be determined by a direction associated with these processes, and not by the direction toward the center of the Pacific Basin; for, although most of the structural arcs front toward the Basin with their convex sides and foredeeps, some of them, like that of the New Hebrides, front in the opposite direction, and others front on non-Pacific areas. The Basin itself is completely passive in the development of these structures. In nearly every case the foredeep forms a definite outer boundary on the convex side of the active structure; outside it there are usually no signs of crustal disturbance.

Where foredeeps persist, the relative movement of surface rocks must be outward and downward. This may be due either to forces applied to the continental crustal layers, pushing the rocks down toward the foredeep, with compensating sub-crustal movements (theories of continental spreading), or to forces originating at depth, causing a drawing down of the sub-crustal material and a compensating movement at the surface (theories of sub-crustal convection). In either case deep-focus earthquakes should be expected to originate not at the level of maximum flow, but rather at that of maximum stress associated with the flow or at a minimum of breaking strength. The foci of deep shocks seem to be restricted to the vicinity of a nearly plane surface (Fig. 6) which is probably related to a thrust surface between two different structures, usually dipping towards the continent, but exceptionally vertical or with the opposite dip (as in the New Hebrides and Solomon Islands).

Many authors have correlated deep and shallow earthquakes too closely with oceanic troughs and deeps. The association appears clearly on small-scale maps, but requires modification in detail. Epicenters of shallow shocks usually fall not in the troughs, but on their inner marginal slopes or along the crests of adjacent submarine ridges. Frequently, as south of Sumatra and Java, the ridge adjacent to the deep is not seismically active but becomes so in another part of its course where the adjacent depths are less marked. These ridges are very young anticlines.

All arcs of the Pacific belt do not front toward the Pacific stable mass. The Caribbean and South Antillean arcs front toward the Atlantic. The Sunda arc fronts toward Australia and the Indian Ocean, and the reversal in the region of the New Hebrides also results in a front southwestward toward the Australian mass.

With this may be compared the grouping about the Indian stable mass of the three arcs of Burma, the Himalayas, and Baluchistan. The remaining arcs of the Alpide system front toward the stable masses of Arabia, Africa, and northern Europe. The whole belt is less active than the Pacific belt; it appears as in a later stage of activity, in which the arc features, once perhaps as clearly defined as those of the Pacific, have begun to lose their definiteness and disappear.

A different mechanism not necessarily connected with the stress system producing the active arcs must be postulated for the regions of block and shear faulting, including long sectors of the circum-Pacific belt. The California region is typical of this group. Especially towards the coast, there are young folds associated with active faults; but in general the stresses which produced the Coast Range mountains are either no longer in action or have shifted, and the region is broken up into blocks along fractures which usually cross the older structural trends at a low angle. In southern California much of the faulting can be described in terms of a north-south compression, which will account both for the thrust faulting of the east-west Transverse Ranges, and for the strike-slip faults trending roughly northwest-southeast (San Andreas Fault and parallel fault systems) or northeast-southwest (Garlock Fault). These latter have approximately the right orientation for shear fractures under the north-south compression, and the directions of relative displacement in the strike-slip faulting are consistent with it.

Displacements in this area on the principal fault systems correspond to southward displacement of the continent relative to the oceanic area. The same apparently applies on the opposite side of the Pacific, where there is evidence that the continental (western) sides of the principal faults are being displaced southward (Tsuboi, 1939; Willis, 1940). Unfortunately such information is scarce, in spite of its fundamental importance. Descriptions of strike-slip faulting frequently fail to specify the direction of throw.

The nature of the first motion, compression or dilatation, recorded even at distant stations gives some information as to the character of displacements producing the earthquake (general historical discussion by Kawasumi, 1937; see also Gutenberg, 1941b). Many authors have described the distribution of compressions and dilatations for individual earthquakes. Gherzi (1923; 1925) and Somville (1925) have observed that at Zikawei and Uccle compressions and dilatations are consistently recorded from shocks in particular regions. Similar observations have been made at Pasadena (Gutenberg and Richter, 1935, p. 290; 1938a, p. 283). Vesanen (1942; 1946; 1947) has initiated a very promising investigation of seismograms, especially at Helsinki and Upsala, with reference not only to compressions and dilatations, but to the entire recorded wave form for *P*, *S*, and other phases. He finds remarkable correlations regionally as well as in depth.

All the microseismic evidence strongly indicates the persistence of displacements in the same sense in each individual region. In many areas, as in California, such consistent displacements can be traced into the geological past. On the other hand, Cotton (1947) finds in New Zealand clear evidence of reversals.

The mechanism associated with the seismicity of the oceanic ridges is best considered with reference to the only well-observed example, the Mid-Atlantic Ridge. Its parallelism with the continental coasts is so close that it practically demonstrates a mechanical connection with them. However, it is still possible to consider the Ridge either as a remnant left over from a former connection between America and the Old World, or as a young structure originating at the contact between rigid blocks. (For a summary with references, see Du Toit, 1937, Chap. x.) It can hardly be a young structure in the sense in which the very active zone of the East Indies and other similar regions are young, for it lacks many of the associated phenomena found in such regions, which have been taken as evidence for the contemporary occurrence of sub-crustal flow. Thus there are no parallel deep troughs, and no belts of negative gravity anomalies; the gravity anomalies over the Mid-Atlantic Ridge are slightly positive (Meinesz, 1939). Intermediate and deep shocks are absent, which indicates that there are no large stresses at great depth. Present seismicity and volcanism do not necessarily imply that the processes which created the Ridge are now in action. The Ridge may represent an orogeny of Tertiary age, in which the folding has at least temporarily ceased, and the now practically rigid structures are being broken up by diastrophic processes, along faults which are either of recent origin or recently rejuvenated. For a discussion from the geological point of view see Bucher (1940).

The Carlsberg Ridge in the northern Indian Ocean is almost certainly a structure of this same character. The other active belts in the Indian Ocean and elsewhere are imperfectly known.

The group of active rifts, of which those of East Africa are the best known and best developed, are presumably of different mechanical type. They occur chiefly where it appears that formerly contiguous masses have been separated, either by relative displacement or by foundering of formerly connecting structures. This may be due to any of several causes. The active rift of the Hawaiian volcanic arc may be different in mechanism.

The association of earthquakes with volcanoes requires mechanical interpretation. Shocks in volcanic regions are classifiable into at least three distinct types: (1) very shallow shocks, usually directly associated with explosive and eruptive phenomena; (2) shocks at the normal depth for shallow tectonic earthquakes; (3) shocks at intermediate depths (100 to 200 kilometers) below the volcanic lines. The first group includes shocks associated with eruptions in preparation or abortive, as has been supposed for the destructive earthquakes on Ischia in 1881 and 1883, and for those near Hualalai (Hawaii) in 1929. Most of these shocks come in swarms of which the individuals are very small; even the largest of them are not recorded at great distances.

Although the principal active faults are usually at some distance from volcanic lines, true tectonic earthquakes, some of considerable magnitude, occasionally occur under volcanic areas. Not infrequently such shocks accompany or follow notable eruptions. Examples are those associated with eruptions of Mauna Loa in 1868, and Sakurajima in 1914. Those associated with Katmai in 1912 and Paricutin in 1943 did not originate close to the volcanoes, but at approximately the nearest points of the Pacific active belt, adjacent to the Aleutian Trench and the Acapulco Deep respectively.

The occurrence of earthquakes at depths of 100-150 kilometers under active volcanoes suggests a common cause, but hardly a direct relation of cause and effect. Probably a single system of stresses is responsible for both shocks and eruptions. There are conspicuous exceptions to the correlation; thus, intermediate shocks are lacking in association with the volcanoes of the Mid-Atlantic Ridge, Iceland, and Jan Mayen, while in northern Peru epicenters of intermediate shocks follow the structural belt in a sector where there is no present volcanic activity. In regions where both phenomena occur, they are invariably closely associated.

A similar group of phenomena of greater age seems to be indicated by the presence in certain arcs of a second interior row of older volcanoes under which shocks occur at depths of the order of 200 kilometers. These volcanoes are especially well represented in Kamchatka and South America. In some other arcs they are absent or rare; very deep shocks are then usually missing. These volcanoes do not appear on the maps, which show only active vents.

The mechanism of deep shocks is not completely understood, although it must be similar to that of shallow earthquakes. There is no explanation of the circumstance that activity ceases rather abruptly at a depth slightly exceeding 700 kilometers. Moreover, some of the deepest shocks are decidedly large. The 700-kilometer level is not distinguished by any known change in the physical properties, which show only gradual alterations between the crust and a depth of about 1000 kilometers. However, our information on the material even in the earth's crust and on the properties of rocks under high pressure and temperature is rather limited. (Adams and Williamson, 1923; Anderson, 1938; Birch, 1938; 1939; 1943; Birch and Dow, 1936; Birch *et al.*, 1942; Bridgman, 1936; 1942; Buddington, 1943; Bullard, 1945; Daly, 1940; 1943; 1946; Fujiwhara, 1927; Griggs, 1936; 1939; Gutenberg, 1939b; Holmes, 1933; Jeffreys, 1929; Kennedy and Anderson, 1938.)

Calculations based on the rate of post-glacial uplift lead to a viscosity of the earth's crust of approximately 10^{22} poises (gm./cm. sec.). It requires several thousand years for the strains due to removal of the ice load to be reduced to half (Gutenberg, 1941a). Consequently, if stresses accumulate in the interior of the earth rapidly enough to reach a fracture point in times as short as a few centuries, these processes are practically unaffected by plastic flow. Hence the occurrence of earthquakes at levels down to 450 miles below the surface in no way excludes the possibility of slow equalization of stresses by plastic flow at those levels. This removes any supposed discrepancy between isostasy and the occurrence of deep shocks. The fact that the maximum energy released in deep shocks is less than in shallow shocks may represent a lowered value of breaking strength at great depths. To account for the post-glacial uplift, the strength resisting plastic flow at great depths must be relatively small.

Deep-focus earthquakes cannot be of the nature of detonations due to rapid local changes of state. The distribution of initial compressional or dilatational motion as recorded at distant stations (Honda, 1932; 1934), and the existence of large elastic shear waves radiated directly from the source, leave no doubt that deep shocks are mechanically similar in origin to tectonic shallow shocks. When both shallow and deep shocks occur in the same region it is often observed that the direction of initial displacement indicated by the seismograms is the same for both.

Theoretical investigations by Timoshenko (1934) and Haskell (1935, 1936) show that a shearing strain originating near the surface may extend and be effective to great depth; for discussion see Daly (1939, p. 393).

A number of general problems remain, among them the lower seismicity of the southern hemisphere. The frequency relation between large and small shocks, deep as well as shallow, which results in concentration of the release of energy in the higher magnitudes, not merely justifies the geographical methods of the present study, but disposes of a number of inveterate misconceptions. In general the occurrence of small shocks does not appreciably affect that of the larger earthquakes, which are essentially independent events. In most active regions there is little "safety valve" effect of small shocks. Great shocks occur only on major structures, and then only in certain parts of them. This means that major faults are zones of weakness within large structures which are strong, that is, competent to support the accumulation of large stresses. Structures where the crust is weaker or much fractured by minor and shallow faults may be expected to show smaller shocks. On the other hand, great shocks are relatively frequent only in the active zones where tectonic processes are sufficiently rapid to develop large strains in a relatively short time.

Dr. Hugo Benioff is applying the magnitudes given in this book to investigate the mechanism of sequences of earthquakes. This includes aftershocks and also the general seismicity of limited regions, and applies to deep as well as to shallow shocks. Preliminary results (Benioff, 1948) suggest that each sequence forms a dynamically connected series, which may be either of elastic creep or flow character, or may be analyzed as a superposition of the two.

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SUMMARY

Previous results (Gutenberg and Richter, 1941; 1945) are revised and extended. Numerical magnitudes have been assigned to all shocks, both shallow and deep, included in the study, when the magnitude is 6 or over. The maps showing epicenters, active volcanoes, gravity anomalies, and ocean depths have been redrawn. A checklist of active volcanoes is given. Tsunamis are discussed.

All shocks prior to 1946 which have been located are included in regional tabulations. Of great shallow shocks, 98 have been identified for 1904-1947; 361 major shallow earthquakes of less magnitude have been identified for 1918-1946. These are given in separate chronological lists, which are believed to be practically exhaustive. Over 2000 shallow shocks, and about 1000 deep-focus shocks, 266 with magnitude ≥ 7, have been selected for study because of magnitude or geographical location.

The geographical discussion is based largely on instrumental results, supplemented by historical records.

The earth's surface consists of relatively inactive blocks separated by active zones of four groups:

(1) The circum-Pacific zone includes about 80 per cent of shallow shocks, 90 per cent of intermediate shocks, and all deep shocks. Shallow seismicity is highest in Japan, western Mexico, Melanesia, and the Philippines; South America has an exceptionally high proportion of great shocks. From Japan southward the zone divides into two branches, which again approach closely between Celebes and Halmahera, and then diverge through Polynesia and the Sunda Arc respectively. The Polynesian branch follows the andesite line, which is the boundary of the Pacific structure. Southward from Mexico there is a division into two main branches, one of which follows the Andean structures, while the other passes along the Easter Island Ridge. The area between these is probably chiefly of continental character. The outlying Caribbean loop and the similar loop in the South Atlantic include areas of Pacific type.

(2) The Mediterranean and trans-Asiatic zone includes nearly all remaining intermediate and large shallow shocks. Epicenters are aligned along mountain chains.

(3) Narrow belts of shallow shocks follow the principal ridges in the Atlantic, Arctic, and Indian oceans.

(4) Moderate activity is associated with rift structures such as those of East Africa and the Hawaiian Islands.

The Pacific basin (except the Hawaiian Islands) and the continental nuclear shields are nearly inactive. Between the stable shields and the active belts are areas of minor to moderate activity, with occasional large shocks. Small shocks apparently occur everywhere.

The largest identified shocks in each depth range are as follows:

Shallow shocks, magnitudes near 8½

Jan. 31, 1906	Colombia
Aug. 17, 1906	Chile
Jan. 3, 1911	Tien Shan
Dec. 16, 1920	Kansu
Mar. 2, 1933	Japan

Intermediate shocks, magnitudes near 8

June 16, 1910	Loyalty Is.	$h = 100$ km.
June 15, 1911	Ryukyu	$h = 160$ km.
Nov. 24, 1914	Marianas	$h = 110$ km.
June 26, 1926	Rhodes	$h = 100$ km.
Dec. 21, 1939	Celebes	$h = 150$ km.

Deep shocks, magnitudes 7¾ to 8

Jan. 21, 1906	Japan	$h = 340$ km.
May 26, 1932	Tonga	$h = 600$ km.
Apr. 16, 1937	Tonga	$h = 400$ km.

These few shocks account for much of the energy released in earthquakes over the period studied, of the order of 10^{27} ergs per year or roughly 10^{9} kilowatts. The annual average includes about 2 great shallow shocks, and 17 other major earthquakes of which about 5 are intermediate and one is deep. The annual number of true earthquakes is of the order of one million. Fluctuations are large; in the year 1906 about 6 times the average energy was released.

Structural arcs of the Pacific region typically exhibit the following features in order, beginning at the convex side: *A*, foredeeps; *B*, shallow earthquakes and negative gravity anomalies following anticlines; *C*, positive gravity anomalies and slightly deeper shocks; *D*, the principal mountain arc (Tertiary or older) with active volcanoes and shocks about 100 kilometers deep; *E*, an older structural arc with volcanism in a late stage or extinct, and shocks about 200-300 kilometers deep; *F*, a belt of deep shocks (below 300 km.). In some arcs only a few of these features can be identified; this is true of the similar structural arcs along the southern Alpide front of the trans-Asiatic zone. In parts of the Pacific belt structural arcs and the accompanying features are absent. In many such sectors there is strong evidence of block faulting in place of the folding characteristic of the arcs.

The structural arcs may be interpreted as due to forces either pushing or drawing subcrustal material downward toward the foredeeps, with compensating movements elsewhere.

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TABLES

TABLE 13

Class a, Shallow Shocks

(M = magnitude; R = serial number of region)

Date	Time	Location	M	R	References
1904, Jan. 20	14:52.1	7 N 79 W	7 3/4	6	
June 25	14:45.6	52 N 159 E	8.0	19	Rosenthal (1906,1907)
June 25	21:00.5	52 N 159 E	8.1	19	
June 27	00:09.0	52 N 159 E	7.9	19	
Aug. 24	20:59.9	30 N 130 E	7 3/4	20	
Aug. 27	21:56.1	64 N 151 W	7 3/4	1	
Dec. 20	05:44.3	8 1/2 N 83 W	7 3/4	6	
1905, Feb. 14	08:46.6	53 N 178 W	7 3/4	1	
April 4	00:50.0	33 N 76 E	8	26	Middlemiss (1910), Omori (1907a)
July 6	16:21.0	39 1/2 N 142 1/2 E	7 3/4	19	
July 9	09:40.4	49 N 99 E	8 1/4	28	Sieberg (1932a, p.789)
July 23	02:46.2	49 N 98 E	8 1/4	28	
1906, Jan. 31	15:36.0	1 N 81 1/2 W	8.6	8	Rudolph and Szirtes (1912)
April 18	13:12.0	38 N 123 W	8 1/4	3	Lawson et al. (1908)
Aug. 17	00:10.7	51 N 179 E	8.0	1	Rudolph and Tams (1907)
Aug. 17	00:40.0	33 S 72 W	8.4	8	
Sept. 14	16:04.3	7 S 149 E	8.1	16	Sieberg (1910)
Nov. 19	07:18.3	22 S 109 E	7 3/4	38	
Dec. 22	18:21.0	43 1/2 N 85 E	7.9	28	
1907, April 15	06:08.1	17 N 100 W	8.1	5	Boese et al.(1908)
Sept. 2	16:01.5	52 N 173 E	7 3/4	1	
Oct. 21	04:23.6	38 N 69 E	8.0	48	
1909, July 30	10:51.9	17 N 100 1/2 W	7 3/4	5	
1911, Jan. 3	23:25:45	43 1/2 N 77 1/2 E	8.4	28	Galitzin (1911)
Feb. 18	18:41:03	40 N 73 E	7 3/4	48	Jeffreys (1923)
June 7	11:02.7	17 1/2 N 102 1/2 W	7 3/4	5	
July 12	04:07.6	9 N 126 E	7 3/4	22	
Aug. 16	22:41.3	7 N 137 E	7.9	17	Sieberg (1932a, p. 914)
1912, May 23	02:24.1	21 N 97 E	8.0	25	
Aug. 9	01:29.0	40 1/2 N 27 E	7 3/4	30	Montessus (1924) (p.128)
1913, Mar. 14	08:45:00	4 1/2 N 126 1/2 E	7.9	23	

TABLE 13 (continued)

Date	Time*	Location	M	R	References
1913, Aug. 6	22:14.4	17 S 74 W	7 3/4	8	
1914, May 26	14:22.7	2 S 137 E	7.9	16	
1915. May 1	05:00.0	47 N 155 E	7.9	19	
July 31	01:31.4	54 N 162 E	7 3/4	19	
Oct. 3	06:52.8	40 1/2 N 117 1/2 W	7 3/4	3	Jones (1915) Page (1935)
1916, Jan. 1	13:20.6	4 S 154 E	7 3/4	15	
Jan. 13	08:20.8	3 S 135 1/2 E	7.8	16	
1917, Jan. 30	02:45.6	56 1/2 N 163 E	7 3/4	19	
May 1	18:26.5	29 S 177 W	8	12	
June 26	05:49.7	15 1/2 S 173 W	8.3	12	Gutenberg (1925) Sieberg, (1932a, p. 758)
1918, Aug. 15	12:18.2	5 1/2 N 123 E	8 1/4	22	Masó (1918)
Sept. 7	17:16:13	45 1/2 N 151 1/2 E	8 1/4	19	
Nov. 8	04:38.0	44 1/2 N 151 1/2 E	7 3/4	19	
Dec. 4	11:47.8	26 S 71 W	7 3/4	8	
1919, April 30	07:17:05	19 S 172 1/2 W	8.3	12	
May 6	19:41:12	5 S 154 E	7.9	15	
1920, June 5	04:21:28	23 1/2 N 122 E	8	21	
Sept. 20	14:39:00	20 S 168 E	8	14	
Dec. 16	12:05:48	36 N 105 E	8 1/2	27	Close et al. (1922) Dammann (1924)
1922, Nov. 11	04:32.6	28 1/2 S 70 W	8.3	8	Willis (1929) Sieberg et al. (1924)
1923, Feb. 3	16:01:41	54 N 161 E	8.3	19	
Sept. 1	02:58:36	35 1/4 N 139 1/2E	8.2	19	Davison (1931) with references
1924, April 14	16:20:23	6 1/2 N 126 1/2 E	8.3	22	Masó (1924)
June 26	01:37:34	56 S 157 1/2 E	7.8	11	Macelwane (1930)
1927, March 7	09:27:36	35 3/4 N 134 3/4E	7 3/4	20	Davison (1936) with references
May 22	22:32:42	36 3/4 N 102 E	8.0	27	
1928, June 17	03:19:27	16 1/4 N 98 W	7.8	5	
Dec. 1	04:06:10	35 S 72 W	8.0	8	
1929, March 7	01:34:39	51 N 170 W	8.1	1	
June 27	12:47:05	54 S 29 1/2 W	7.8	10	Tams (1930a,b)
1931, Jan. 15	01:50:41	16 N 96 3/4 W	7.8	5	Ordoñez (1931)
Feb. 2	22:46:42	39 1/2 S 177 E	7 3/4	11	Adams et al.(1933) Davison (1936)
Aug. 10	21:18:40	47 N 90 E	8.0	28	S. P. Lee (1933)

Date	Time	Location	M	R	References
1931, Oct. 3	19:13:13	10 1/2 S 161 3/4 E	7.9	15	Gutenberg and Richter (1934c)
1932, May 14	13:11:00	1/2 N 126 E	8.0	23	
June 3	10:36:50	19 1/2 N 104 1/4 W	8.1	5	
June 18	10:12:10	19 1/2 N 103 1/2 W	7.8	5	
1933, March 2	17:30:54	39 1/4 N 144 1/2 E	8.5	19	Matuzawa(1935,1936)
1934, Jan. 15	08:43:18	26 1/2 N 86 1/2 E	8.3	26	Dunn et al. (1939), Nasu (1935)
July 18	19:40:15	11 3/4 S 166 1/2 E	8.2	14	
1935, Sept. 20	01:46:33	3 1/2 S 141 3/4 E	7.9	16	
Dec. 28	02:35:22	0 98 1/4 E	7.9	24	
1938, Feb. 1	19:04:18	5 1/4 S 103 1/2 E	8.2	24	
Nov. 10	20:18:43	55 1/2 N 158 W	8.3	1	Mukherjee et al. (1941)
1939, Jan. 25	03:32:14	36 1/4 S 72 1/4 W	7 3/4	8	
Jan. 30	02:18:27	6 1/2 S 155 1/2 E	7.8	15	
April 30	02:55:30	10 1/2 S 158 1/2 E	8.0	15	
Dec. 26	23:57:21	39 1/2 N 38 1/2 E	8.0	30	Pamir and Ketin (1941), Parejas et al. (1941)
1940, May 24	16:33:57	10 1/2 S 77 W	8	8	
1941, June 26	11:52:03	12 1/2 N 92 1/2 E	8.1	24	
Nov. 18	16:46:22	32 N 132 E	7.8	20	
Nov. 25	18:03:55	37 1/2 N 18 1/2 W	8.3	31	
1942, May 14	02:13:18	3/4 S 81 1/2 W	7.9	8	
Aug. 6	23:36:59	14 N 91W	7.9	5	
Aug. 24	22:50:27	15 S 76 W	8.1	8	
Nov. 10	11:41:27	49 1/2 S 32 E	7.9	33	
1943, April 6	16:07:15	30 3/4 S 72 W	7.9	8	
May 25	23:07:36	7 1/2 N 128 E	7.9	22	
July 29	03:02:16	19 1/4 N 67 1/2 W	7 3/4	7	
Sept. 6	03:41:30	53 S 159 E	7.8	11	
1944, Dec. 7	04:35:42	33 3/4 N 136 E	8.0	18	
1945, Nov. 27	21:56:50	24 1/2 N 63 E	8 1/4	29	Anonymous (1945)
Dec. 28	17:48:45	6 S 150 E	7.8	15	
1946, Aug. 4	17:51:05	19 1/4 N 69 W	8.1	7	
Sept. 12	15:20:20	23 1/2 N 96 E	7 3/4	25	
Sept. 29	03:01:55	4 1/2 S 153 1/2 E	7 3/4	15	
Dec. 20	19:19:05	32 1/2 N 134 1/2 E	8.2	20	

TABLE 14

Class b shallow shocks

(M = magnitude; R = serial number of region)

Date	Time	Location	M	R	Remarks (Depth h in km)
1918, Feb. 13	06:07:13	24 N 117 E	7.3	21	
May 20	14:36.0	7 1/2 N 36 W	7.4	32	
May 25	19:29:20	30 1/2 S 92 1/2 W	7	43	h = 60±
July 3	06:52:05	3 1/2 S 142 1/2 E	7.5	16	
July 8	10:22:07	24 1/2 N 91 E	7.6	25	
Aug. 15	17:30:11	5 1/2 N 126 E	7.0	22	
Oct. 11	14:14:30	18 1/2 N 67 1/2 W	7.5	7	Reid and Taber (1919a,b)
Oct. 27	17:06:40	2 S 148 E	7.4	16	h = 50
Dec. 6	08:41:05	49 3/4 N 126 1/2 W	7.0	2	
1919, Jan. 1	01:33.7	8 N 126 E	7.4	22	
March 2	03:26:50	41 S 73 1/2 W	7.2	9	h = 40 ±
March 2	11:45:17	41 S 73 1/2 W	7.3	9	h = 40±
April 17	11:22:05	29 1/2 S 178 W	7.0	12	
April 17	20:53:03	14 1/2 N 91 3/4 W	7.0	5	
May 3	00:52:00	40 1/2 N 145 1/2 E	7.6	19	
Aug. 29	05:43:54	2 1/2 S 127 E	7	23	
Dec. 20	20:37:27	22 N 122 E	7.0	21	
1920, Feb. 2	11:22:18	4 S 152 1/2 E	7.7	15	
March 20	18:31:25	35 S 110 W	7.0	43	
Oct. 18	08:11:35	45 N 150 1/2 E	7.2	19	h = 50±
Dec. 10	04:25:40	39 S 73 W	7.4	9	
1921, Feb. 27	18:23:34	18 1/2 S 173 W	7.2	12	
March 28	07:49:22	12 1/2 N 87 1/2 W	7.3	6	
Sept. 11	04:01:38	11 S 111 E	7.5	24	
Sept. 13	02:36:54	55 S 29 W	7.2	10	
Oct. 15	04:58:12	13 1/2 S 166 E	7.0	14	h = 40±
Nov. 11	18:36:08	8 N 127 E	7.5	22	
1922, Jan. 6	14:11:02	16 1/2 S 73 W	7.2	8	
Jan. 9	05:09:34	24 N 46 W	7.1	32	
Jan. 31	13:17:22	41 N 125 1/2 W	7.3	3	Macelwane (1923)
Sept. 1	19:16:06	24 1/2 N 122 E	7.6	21	Omori (1923)
Sept. 14	19:31:39	24 1/2 N 121 1/2 E	7.2	21	

TABLE 14 (continued)

Date	Time	Location	M	R	Remarks
1922, Oct. 11	14:49:50	16 S 72 1/2 W	7.4	8	h = 50
Nov. 7	23:00:09	28 S 72 W	7.0	8	Foreshock of Nov. 11, 4^h
Dec. 31	07:19:59	45 1/2 N 151 1/4 E	7.0	19	
1923, Jan. 22	09:04:18	40 1/2 N 124 1/2 W	7.2	3	Townley and Allen (1939)
Feb. 1	19:24:58	21 S 169 1/2 E	7±	14	h = 50±
Feb. 2	05:07:38	53 1/2 N 162 E	7.2	19	Foreshock of Feb. 3, 16^h
Feb. 24	07:34:36	56 N 162 1/2 E	7.4	19	Aftershock of Feb.3
Mar. 2	16:48:52	6 1/2 N 124 E	7.2	22	
Mar. 16	22:01:38	6 N 127 E	7.0	22	
March 24	12:40:06	31 1/2 N 101 E	7.3	26	Heim (1934)
April 13	15:31:02	56 1/2 N 162 1/2 E	7.2	19	Aftershock of Feb. 3
April 19	03:09:08	2 1/2 N 117 1/2 E	7.0	23	
May 4	16:26:39	55 1/2 N 156 1/2 W	7.1	1	
May 4	22:26:45	28 3/4 S 71 3/4 W	7±	8	h = 60±
June 1	17:24:42	35 3/4 N 141 3/4 E	7.2	19	
June 22	06:44:33	22 3/4 N 98 3/4 E	7.3	25	
July 13	11:13:34	31 N 130 1/2 E	7.2	20	
Sept. 2	02:46:40	35 N 139 1/2 E	7.7	19	Aftershock of Sept. 1, 2^h
Sept. 9	22:03:43	25 1/4 N 91 E	7.1	26	
Oct. 7	03:29:34	1 3/4 S 128 3/4 E	7.5	23	
Nov. 2	21:08:06	4 1/2 S 151 1/2 E	7.2±	15	h = 50±
Nov. 4	00:04:30	5 S 152 E	7.2	15	
Nov. 5	21:27:53	29 1/4 N 130 E	7.2	21	
1924, March 4	10:07:42	9 3/4 N 84 W	7.0	6	
March 15	10:31:22	49 N 142 1/2 E	7.0	41	
July 3	04:40:06	36 N 84 E	7.2	27	
July 11	19:44:40	36 1/2 N 84 E	7.2	27	
July 24	04:55:17	49 1/2 S 159 E	7.5	11	h = 50±
Aug. 14	18:02:37	36 N 142 E	7.0	19	
Aug. 30	03:04:57	8 1/2 N 126 1/2 E	7.3	22	
Dec. 28	22:54:56	43 1/4 N 147 E	7.0	19	
1925, Jan. 18	12:05:54	47 1/2 N 153 1/2 E	7.3	19	
March 1	02:19:18	48 1/4 N 70 3/4 W	7.0	34	Hodgson (1925)
March 16	14:42:12	25 1/2 N 100 1/4 E	7.1	26	
March 22	08:41:55	18 1/2 S 168 1/2 E	7.6	14	h = 50±
March 29	21:12:37	8 N 78 W	7.1	6	h = 60±

TABLE 14 (continued)

Date	Time	Location	M	R	Remarks
1925, April 11	10:42:02	34S 59 E	7.0	33	
April 16	19:52:35	22 N 121 E	7.1	21	
May 3	17:21:45	1 1/2 N 127 E	7.1	23	
May 3	22:59:04	34 S 58 E	7.0	33	
May 15	11:56:57	26 S 71 1/2 W	7.1	8	h = 50±
June 3	04:33:55	1 1/2 N 126 1/2 E	7.1	23	
June 9	13:40:41	3 S 140 E	7.0	16	
Aug. 19	12:07:27	55 1/4 N 168 E	7.2	1	
Oct. 13	17:40:34	11 N 42 W	7.5	32	
Nov. 10	13:50:36	1 S 129 1/2 E	7.4	23	
Nov. 13	12:14:45	13 N 125 E	7.3	22	Lehmann and Plett (1932)
Nov. 16	11:54:54	18 N 107 W	7.0	5	
1926, Jan. 25	00:36:18	9 S 158 E	7.4	15	
Feb. 8	15:17:49	13 N 89 W	7.1	6	
March 21	14:19:12	61 S 25 W	7.1	10	
March 27	10:48:30	9 S 157 E	7.2	15	
April 12	08:32:28	10 S 161 E	7.5	15	
June 3	04:46:56	15 S 168 1/2 E	7.1	14	h = 60±
July 10	10:51:10	1 N 126 E	7.0	23	h = 40±
Aug. 25	05:44:40	23 S 172 E	7.0	14	h = 50±
Sept. 2	01:21:52	33 1/2 S 59 E	7.0	33	
Sept. 16	17:59:12	11 1/2 S 160 E	7.1	15	h = 50±
Oct. 3	19:38:01	49 S 161 E	7.5	11	h = 50
Oct. 13	19:08:07	52 N 176 W	7.1	1	
Oct. 26	03:44:41	3 1/4 S 138 1/2 E	7.7	16	
1927, Jan. 24	01:05:43	16 1/2 S 167 1/2 E	7.1	14	
Feb. 16	01:35:20	47 N 153 1/2 E	7.0	19	
March 3	01:05:09	6 S 122 E	7.0	24	
Aug. 5	21:12:55	37 1/2 N 142 1/2 E	7.1	19	
Aug. 10	11:36:15	1 S 131 E	7.1	16	
Aug. 20	23:54:25	5 N 82 1/2 W	7.0	8	
Oct. 24	15:59:55	57 1/2 N 137 W	7.1	2	Sommer (1931
Nov. 4	13:50:43	34 1/2 N 121 1/2 W	7.3	3	Byerly (1930)
Nov. 16	21:10:09	6 1/2 N 126 E	7.0	22	h = 50
Nov. 21	23:12:25	44 1/2 S 73 W	7.1	9	

Date	Time	Location	M	R	Remarks
1927, Dec. 28	18:20:23	55 N 161 E	7.3	19	
1928, Jan. 6	19:31:58	1/2 N 36 1/2 E	7.0	37	Tillotson (1937)
March 9	18:05:27	2 1/2 S 88 1/2 E	7.7	33	
March 16	05:01:02	22 S 170 1/2 E	7.5	14	
March 22	04:17:00	16 N 96 W	7.5	5	
May 14	22:14:46	5 S 78 W	7.3	8	
May 27	09:50:26	40 N 142 1/2 E	7.0	19	
June 15	06:12:36	12 1/2 N 121 1/2 E	7.0	22	
June 21	16:27:13	60 N 146 1/2 W	7.0	1	
June 29	22:49:38	15 S 170 1/2 E	7.1	14	
July 18	19:05:00	5 1/2 S 79 W	7.0	8	Lehmann and Plett (1932)
Aug. 4	18:26:16	16 N 97 W	7.4	5	
Oct. 9	03:01:08	16 N 97 W	7.6	5	
Nov. 20	20:35:07	22 1/2 S 70 1/2 W	7.1	8	
Dec. 19	11:37:10	7 N 124 E	7.3	22	
1929, Feb. 2	00:00:19	1 1/2 S 21 W	7.1	32	
Feb. 22	20:41:46	11 N 42 W	7.2	32	
May 1	15:37:30	38 N 58 E	7.1	29	
May 26	22:39:54	51 N 131 W	7.0	2	
June 13	09:24:34	8 1/2 N 127 E	7.2	22	
June 16	22:47:32	41 3/4 S 172 1/4 E	7.6	11	Lehmann (1930); Bastings (1933); Henderson (1937)
July 5	14:19:02	51 N 178 W	7.0	1	
July 7	21:23:12	52 N 178 W	7.3	1	
Nov. 15	18:50:33	7 1/2 N 142 1/2 E	7.2	17	Hodgson et al. (1930), Keith (1930)
Nov. 18	20:31:58	44 N 56 W	7.2	34	
Dec. 17	10:58:30	52 1/2 N 171 1/2 E	7.6	1	
1930, March 26	07:12:05	7 1/2 S 125 1/2 E	7.2	24	h = 40
May 5	13:45:57	17 N 96 1/2 E	7.3	25	Visser (1934)
May 6	22:34:23	38 N 44 1/2 E	7.2	30	
June 11	00:49:35	5 1/2 S 150 E	7.1	15	
July 2	21:03:42	25 1/2 N 90 E	7.1	26	Gee (1934)
Aug. 18	09:53:41	55 S 27 W	7.1	10	h = 50±
Oct. 24	20:15:11	18 1/2 N 147 E	7.1	18	Lehmann and Plett (1932)

TABLE 14 (continued)

Date	Time	Location	M	R	Remarks
1930, Nov. 25	19:02:47	35 N 139 E	7.1	19	Davison (1936 p.246) Imamura (1931) Kunitomi (1931)
Dec. 3	18:51:44	18 N 96 1/2 E	7.3	25	Brown et al.(1933)
1931, Jan. 27	20:09:13	25.6 N 96.8 E	7.6	26	
Jan. 28	21:24:03	11 N 144 3/4 E	7.2	17	
Feb. 10	06:34:25	5 1/4 S 102 1/2 E	7.1	24	Gutenberg and Richter (1934c)
Feb. 13	01:27:16	39 1/2 S 177 E	7.1	11	
Mar. 9	03:48:50	40 1/2 N 142 1/2 E	7.7?	19	
Mar. 18	08:02:23	32 1/2 S 72 W	7.1	8	Bobillier (1933)
Mar. 18	20:13:34	5 3/4 N 126 1/4 E	7.0	22	h = 50 ±
May 20	02:22:49	37 1/2 N 16 W	7.1	31	
Aug. 7	02:11:30	4 S 142 E	7.1	16	
Aug. 18	14:21:00	47 N 90 E	7.2	28	Aftershock of Aug. 10
Aug. 24	21:35:22	30 1/4 N 67 3/4 E	7.0	47	West (1934)
Aug. 27	15:27:17	29 3/4 N 67 1/4 E	7.4	47	
Sept. 25	05:59:44	5 S 102 3/4 E	7.4	24	Gutenberg and Richter (1934c)
Oct. 3	21:55:10	11 S 163 E	7.0±	15	Aftershocks of Oct. 3, 19^h Gutenberg and Richter (1934c)
Oct. 3	22:47:40	11 S 161 1/2 E	7.3	15	
Oct. 10	00:19:53	10 S 161 E	7.7	15	
Nov. 2	10:02:59	32 N 131 1/2 E	7.5	20	
1932, Jan. 29	13:41:10	6 S 155 E	7.0	15	
Dec. 4	08:11:12	2 1/2 N 121 E	7.1	23	
Dec. 21	06:10:05	38 3/4 N 118 W	7.2	3	Byerly (1935), Gianella and Callaghan (1934)
Dec. 25	02:04:24	39 1/4 N 96 1/2 E	7.6	27	
1933, Jan. 21	19:21:10	33 S 57 1/2 E	7.0	33	
Feb. 23	08:09:12	20 S 71 W	7.6	8	h = 40 ±
April 27	02:36:04	61 1/4 N 150 3/4 W	7.0	1	
June 18	21:37:29	38 1/2 N 143 E	7.3	19	
June 24	21:54:46	5 1/2 S 104 3/4 E	7.5	24	
Aug. 25	07:50:25	31 3/4 N 103 1/2 E	7.4	26	
Aug. 28	22:19:40	59 1/2 S 25 W	7.4	10	
Nov. 20	23:21:32	73 N 70 3/4 W	7.3	42	Lee (1937) Rajko et al. (1935)
1934, Feb. 14	03:59:34	17 1/2 N 119 E	7.6	22	
Feb. 24	06:23:40	22 1/2 N 144 E	7.3	18	
Feb. 28	14:21:42	5 S 150 E	7.2	15	

TABLE 14 (continued)

Date	Time	Location	M	R	Remarks
1934, Mar. 5	11:46:15	40 1/2 S 175 1/2 E	7.5	11	Bullen (1938)
Mar. 24	12:04:26	10 S 161 1/2 E	7.1	15	
April 15	22:15:13	7 3/4 N 127 E	7.3	22	
July 18	01:36:24	8 N 82 1/2 W	7.7	6	
July 19	01:27:26	1/2 S 133 1/4 E	7.0	16	
July 21	06:18:18	11 S 165 3/4 E	7.3	14	
Nov. 30	02:05:10	18 1/2 N 105 1/2 W	7.0	5	
Dec. 15	01:57:37	31 1/4 N 89 1/4 E	7.1	26	
Dec. 31	18:45:45	32 N 114 3/4 W	7.0	3	
1935, April 19	15:23:22	31 1/2 N 15 1/4 E	7.1	31	
April 20	22:01:54	24 1/4 N 120 3/4 E	7.1	21	Miyabe et al. (1936), Nishimura (1937)
May 30	21:32:46	29 1/2 N 66 3/4 E	7.5	29	West (1935, 1936), Ramanathan (1938)
Aug. 3	01:10:01	4 1/2 N 96 1/4 E	7.0	24	
Sept. 4	01:37:41	22 1/4 N 121 1/4 E	7.2	21	
Sept. 9	06:17:30	6 N 141 E	7.0	17	
Sept. 11	14:04:02	43 N 146 1/2 E	7.6	19	h = 60
Sept. 20	05:23:01	3 1/4 S 142 1/2 E	7.0	16	Aftershock of 1^{h}
Oct. 12	16:45:22	40 1/4 N 143 1/4 E	7.1	19	
Oct. 18	00:11:56	40 1/2 N 143 3/4 E	7.2	19	
Oct. 18	11:05:23	12 1/2 N 141 1/2 E	7.1	17	h = 50
Dec. 14	22:05:17	14 3/4 N 92 1/2 W	7.3	5	
Dec. 15	07:07:48	9 3/4 S 161 E	7.6	15	
Dec. 17	19:17:35	22 1/2 N 125 1/2 E	7.2	21	
1936, Jan. 2	22:34:30	0 N 99 1/2 E	7.0	24	h = 60
Jan. 14	05:36:30	60 S 22 W	7.2	10	h = 50
Feb. 15	12:46:57	4 1/2 S 133 E	7.3	16	
Feb. 22	15:31:54	49 1/2 S 164 E	7.2	11	
April 1	02:09:15.	4 1/2 N 126 1/2 E	7.7	23	
April 19	05:07:17	7 1/2 S 156 E	7.4	15	h=40±
May 27	06:19:19	28 1/2 N 83 1/2 E	7.0	26	
June 30	15:06:38	50 1/2 N 160 E	7.4	19	
July 5	18:55:13	6 1/4 N 126 3/4 E	7.3	22	h=60±
July 13	11:12:15	24 1/2 S 70 W	7.3	8	h = 60 ±
Aug. 22	06:51:35	22 1/4 N 120 3/4 E	7.2	21	

TABLE 14 (continued)

Date	Time	Location	M	R	Remarks
1936, Aug. 23	21:12:13	5 N 95 E	7.3	24	h = 40 ±
Sept. 19	01:01:47	3 3/4 N 97 1/2 E	7.2	24	
Oct. 5	09:44:24	1 1/2 N 126 3/4 E	7.1	23	
Nov. 2	20:45:50	38 1/4 N 142 1/4 E	7.3	19	
Nov. 13	12:31:27	55 1/2 N 163 E	7.2	19	
1937, Jan. 7	13:20:35	35 1/2 N 98 E	7.6	27	
Jan. 23	10:55:51	4 1/2 S 153 E	7.0	15	
Jan. 25	06:34:00	10 S 163 E	7.1	15	
Feb. 21	07:02:35	44 1/2 N 149 1/2 E	7.4	19	
July 22	17:09:29	64 3/4 N 146 3/4 W	7.3	1	Bramhall (1938), Adkins (1940)
Aug. 20	11:59:16	14 1/2 N 121 1/2 E	7.5	22	
Sept. 23	13:06:00	6 S 154 E	7.4	15	h = 60
Sept. 27	08:55:10	9 1/2 S 111 E	7.2	24	
Dec. 8	08:32:09	23 N 121 1/2 E	7.0	21	
Dec. 23	13:17:56	16 3/4 N 98 1/2 W	7.5	5	
1938, Jan. 24	10:31:44	61 S 38 W	7.1	10	
May 12	15:38:57	6 S 147 3/4 E	7.5	16	
May 19	17:08:21	1 S 120 E	7.6	23	
May 23	07:18:28	36 1/2 N 141 E	7.4	19	
June 9	19:15:11	3 1/2 S 126 1/2 E	7.2	23	h = 60 ±
June 10	09:53:39	25 1/2 N 125 E	7.7	21	
June 16	02:15:15	27 1/2 N 129 1/2 E	7.4	20	
Aug. 16	04:27:50	23 1/2 N 94 1/4 E	7.2	25	
Sept. 7	04:03:18	23 3/4 N 121 1/2 E	7.0	21	
Oct. 10	20:48:05	2 1/4 N 126 3/4 E	7.3	23	
Nov. 5	08:43:21	36 3/4 N 141 3/4 E	7.7	19	h = 60 ±
Nov. 5	10:50:15	37 1/4 N 141 3/4 E	7.7	19	h = 60 ±
Nov. 6	08:53:53	37 1/4 N 142 1/4 E	7.6	19	h = 60 ±
Nov. 6	21:38:47	36 1/2 N 142 E	7.1	19	h = 60±
Nov. 13	22:31:30	37 N 142 1/2 E	7.0	19	h = 50±
Nov. 17	03:54:34	55 1/2 N 158 1/2 W	7.2	1	Aftershock of Nov. 10, 20 h
Nov. 30	02:29:50	37 1/4 N 141 E	7.0	19	h = 50
Dec. 6	23:00:53	22 3/4 N 120 3/4 E	7.0	21	
Dec. 16	17:21:25	45 S 167 E	7.0	11	h = 60 ±
1939, Feb. 3	05:26:20	10 1/2 S 159 E	7.1	15	
March 21	01:11:09	1 1/2 S 89 1/2 E	7.2	33	

TABLE 14 (continued)

Date	Time	Location	M	R	Remarks
1939, May 1	05:58:33	40 N 139 3/4 E	7.0	20	Hagiwara (1940)
May 8	01:46:50	37 N 24 1/2 W	7.1	32	
June 2	03:33:15	5 N 127 E	7.0	22	h = 60 ±
Oct. 10	18:31:59	38 1/2 N 143 E	7.4	19	
Dec. 21	20:54:48	10 N 85 W	7.3	6	
1940, April 16	06:07:43	52 N 173 1/2 E	7.1	1	
April 16	06:43:07	52 N 173 1/2 E	7.2	1	
Aug. 1	15:08:21	44 1/2 N 139 E	7.7	19	Miyabe (1941)
Aug. 22	03:27:18	53 N 165 1/2 W	7.1	1	
Sept. 12	13:17:10	4 1/2 S 153 E	7.0	15	h = 40 ±
Oct. 11	18:41:13	41 1/2 S 74 1/2 W	7.0	9	
Nov. 19	15:01:40	39 N 141 3/4 E	7.1	19	h = 50 ±
1941, Jan. 5	18:47:05	2 N 122 E	7.0	23	h = 50 ±
Jan. 13	16:27:38	4 1/2 S 152 1/2 E	7.0	15	Fisher (1944)
April 7	23:29:17	17 3/4 N 78 1/2 W	7.1	7	
April 15	19:09:56	18 N 103 W	7.7	5	
May 17	02:24:50	10 S 166 1/4 E	7.4	14	
Aug. 2	11:41:26	28 1/2 S 178 W	7.1	12	
Sept. 12	07:02:04	1/2 S 132 1/2 E	7.0	16	
Sept. 16	21:39:05	28 3/4 S 177 1/2 W	7.0	12	
Nov. 8	23:37:22	1/2 N 122 E	7.3	23	
Nov. 18	10:14:36	61 S 58 W	7.0	10	
Dec. 5	20:46:58	8 1/2 N 83 W	7.5	6	
Dec. 16	19:19:39	21 1/2 N 120 1/2 E	7.1	21	
Dec. 26	14:48:04	21 1/2 N 99 E	7.0	25	
1942, Jan. 27	13:29:08	4 1/2 S 135 E	7.1	16	
Feb. 21	07:07:43	38 N 142 E	7.1	19	h = 60 ±
April 8	15:40:24	13 1/2 N 121 E	7.7	22	
June 18	09:30:57	9 N 140 1/2 E	7.1	17	
June 24	11:16:29	41 S 175 1/2 E	7.1	11	Ongley (1943b)
July 29	22:49:15	2 S 128 1/2 E	7.0	23	
Aug. 1	12:34:03	41 S 175 3/4 E	7.1	11	h = 50 ±
Aug. 1	14:30:05	48 S 99 E	7.0	33	
Aug. 23	06:35:21	53 N 162 1/2 E	7.0	19	h = 60 ±

TABLE 14 (continued)

Date	Time	Location	M	R	Remarks
1942, Oct. 20	23:21:44	8 1/2 N 122 1/2 E	7.3	22	
Oct. 26	21:09:13	45 1/2 N 151 1/2 E	7.2	19	h = 60 ±
Nov. 15	17:12:00	37 N 141 1/2 E	7.0	19	
Nov. 28	10:38:45	7 1/2 N 36 W	7.1	32	
Dec. 19	23:10:40	31 1/2 N 142 1/2 E	7.0	18	
Dec. 20	14:03:08	40 1/2 N 36 1/2 E	7.3	30	
1943, Feb. 22	09:20:45	17 3/4 N 101 1/2 W	7.5	5	
March 9	09:48:55	60 S 27 W	7.3	10	
March 14	17:11:00	22 S 169 1/2 E	7.1	14	
March 21	20:35:43	5 3/4 S 152 1/4 E	7.3	15	
March 25	18:27:15	60 S 27 W	7.3	10	
April 1	14:18:08	6 1/2 S 105 1/2 E	7.0	24	
May 2	17:18:09	6 1/2 N 80 W	7.1	6	
May 3	01:59:12	12 1/2 N 125 1/2 E	7.4	22	
June 8	20:42:46	1 S 101 E	7.4	24	h = 50
June 9	03:06:22	1 S 101 E	7.6	24	h = 50 ±
June 13	05:11:49	42 3/4 N 143 1/4 E	7.4	19	h = 60
Sept. 10	08:36:53	35 1/4 N 134 E	7.4	20	
Sept. 14	02:01:12	22 S 171 E	7.5	14	
Sept. 14	03:47:15	22 S 170 E	7.3	14	
Sept. 14	07:18:08	30 S 177 W	7.6	12	h = 60
Oct. 21	23:08:13	15 S 177 1/2 W	7.0	12	
Oct. 23	17:23:16	26 N 93 E	7.2	26	
Oct. 24	16:04:36	22 S 174 W	7.0	12	
Nov. 2	18:08:22	57 S 26 W	7.2	10	
Nov. 3	14:32:17	61 3/4 N 151 W	7.3	1	
Nov. 6	08:31:37	6 S 134 1/2 E	7.6	16	
Nov. 13	18:43:57	19 S 170 E	7.2	14	
Nov. 26	22:20:36	41 N 34 E	7.6	30	
Dec. 23	19:00:10	5 1/2 S 153 1/2 E	7.3	15	h = 50
1944, Jan. 5	21:12:43	3 1/2 S 102 E	7.0	24	h = 60
Jan. 15	23:49:30	31 1/4 S 68 3/4 W	7.4	8	h = 50± Castellanos (1945)
Feb. 1	03:22:36	41 1/2 N 32 1/2 E	7.4	30	
Feb. 29	16:28:07	1/2 N 76 E	7.2	33	
March 9	22:12:58	44 N 84 E	7.2	28	

Date	Time				arks
1944, March 31	02:51:43	7 S 130 1/2 E	7.0	24	h = 60 ±
April 26	01:54:15	1 S 134 E	7.2	16	h = 50 ±
April 27	14:38:09	1/2 S 133 1/2 E	7.4	16	h = 50 ±
May 19	00:19:19	2 1/2 S 152 3/4 E	7.2	15	h = 50 ±
May 25	12:58:05	2 1/2 S 152 3/4 E	7.5	15	
June 21	10:58:20	22 S 169 E	7.2	14	h = 50 ±
June 28	07:58:54	15 N 92 1/2 W	7.0	5	
Sept. 3	19:11:29	57 S 122 W	7	43	
Sept. 11	09:45:22	1 1/2 N 127 E	7.2	23	h = 40 ±
Sept. 23	12:13:20	54 N 160 E	7.4	19	h = 40 ±
Sept. 27	16:25:02	39 N 73 1/2 E	7.0	48	h = 40 ±
Nov. 15	20:47:01	4 1/2 N 127 1/2 E	7.2	23	
Nov. 16	12:10:58	12 1/2 S 167 E	7.3	14	
Dec. 10	16:24:58	18 S 168 E	7.3	14	h = 50 ±
Dec. 12	04:17:10	51 1/2 N 179 1/2 E	7.0	1	
1945, Jan. 12	18:38:26	34 3/4 N 136 3/4 E	7.1	19	
Feb. 1	10:35:51	22 S 170 E	7	14	h = 60 ±
Feb. 1	12:13:40	22S 170 E	7 1/4	14	h = 60 ±
Feb. 10	04:57:56	41 1/4 N 142 1/2 E	7.3	19	h = 50
Feb. 18	10:08:07	42 N 143 E	7.0	19	h = 50 ±
Feb. 26	22:14:27	26 N 143 1/2 E	7.1	18	h = 50
March 11	21:37:50	37 N 142 E	7.2±	19	h = 50 ±
March 23	23:14:13	62 S 153 E	7.1±	45	
April 15	02:35:22	57 N 164 E	7.0	19	
April 19	13:03:58	21 S 169 1/2 E	7.0	14	h = 40 ±
June 27	13:08:20	27 N 111 W	7.0	4	
Aug. 29	10:22:40	15 S 168 E	7.2	14	h = 50 ±
Sept. 1	22:44:10	46 1/2 S 165 1/2 E	7.2	11	
Sept. 5	21:48:45	5 S 153 1/2 E	7.1	15	h = 50 ±
Sept. 9	04:03:54	17 S 167 E	7.0	14	h = 60 ±
Sept. 22	09:10:05	4 S 147 E	7.0	16	h = 50 ±
Oct. 16	16:02:58	1/4 S 125 E	7.1	23	h = 50 ±
Dec. 8	01:04:02	6 1/2 S 151 E	7.1	15	
Dec. 27	04:41:05	6 S 151 E	7.0	15	h = 40 ±

TABLE 14 (continued)

Date	Time	Location	M	R	Remarks
1946, Jan. 5	19:57:20	16 S 167 E	7.3	14	h = 50
Jan. 12	20:25:37	59 1/4 N 147 1/4 W	7.2	1	h = 50
Jan. 20	16:54:21	17 1/2 S 167 1/2 E	7.0	14	
April 1	12:28:54	52 3/4 N 163 1/2 W	7.4	1	
April 11	01:52:20	1 S 14 1/2 W	7.2	32	
May 3	22:23:40	5 S 153 E	7.4	15	
May 8	05:20:22	0 99 1/2 E	7.1	24	
May 21	09:16:42	14 1/2 N 60 1/2 W	7	7	
June 23	17:13:22	49 3/4 N 124 1/2 W	7.3	2	
Aug. 2	19:18:48	26 1/2 S 70 1/2 W	7 1/2	8	h = 50
Aug. 8	13:28:28	19 1/2 N 69 1/2 W	7.6	7	
Sept. 12	15:17:15	23 1/2 N 96 E	7 1/2	25	
Oct. 4	14:45:26	18 3/4 N 68 1/2 W	7	7	h = 50
Nov. 1	11:14:24	51 1/2 N 174 1/2 W	7.0	1	h = 40
Nov. 2	18:28:25	41 1/2 N 72 1/2 E	7.6	48	
Nov. 4	21:47:47	39 3/4 N 54 1/2 E	7.5	29	
Nov. 10	17:42:53	8 1/2 S 77 1/2 W	7 1/4	8	
Nov. 12	17:28:41	20 S 173 1/2 W	7 1/2	12	
Dec. 21	10:18:49	44 N 149 E	7.2	19	

TABLE 15 (continued)

Date	Time	Depth	Location	M	Region
1910, Sept. 7	07:11.3	80	6 S 151 E	7 1/4	15
Oct. 4	23:00.1	120	22 S 69 W	7 1/4	8
Nov. 9	06:02.0	70±	16 S 166 E	7 3/4	14
Nov. 10	12:19.9	90±	14 S 166 1/2 E	7.2	14
1911, April 4	15:43.9	140	36 1/2 N 25 1/2 E	7	30
April 10	18:42.4	100	9 N 74 W	7.2	7
May 4	23:36.9	240	51 N 157 E	7.6	19
June 15	14:26.0	160±	29 N 129 E	8.2	20
July 4	13:33:26	190	36 N 70 1/2 E	7.6	48
Oct. 20	17:44.0	160	12 1/2 S 166 E	7.1	14
Nov. 22	23:05.4	200	15 S 169 E	7 1/4	14
1912, Jan.31	20:11.8	80	61 N 147 1/2 W	7 1/4	1
March 25	04:49.5	240	18 S 169 E	7	14
Aug. 6	21:11.3	260	14 S 167 E	7.2	14
Oct. 26	09:00.6	130	14 N 146 E	7	18
Nov. 7	07:40.4	90	57 1/2 N 155 W	7 1/2	1
Nov. 19	13:55.0	80±	19 N 100 W	7	5
Dec. 5	12:27.6	90	57 1/2 N 154 W	7	1
1913, Jan. 19	23:47:55	150	46 N 152 E	7±	19
March 23	20:47.3	80±	24 N 142 E	7.0	18
May 8	18:35.4	200	17 S 174 1/2 W	7.0	12
Aug. 13	04:25.7	75	5 1/2 S 105 E	7.2	24
Oct. 14	08:08.8	230	19 1/2 S 169 E	7 3/4	14
Nov. 10	21:12.5	80	18 S 169 E	7 1/2 ?	14
Nov. 15	05:27.1	150	23 S 171 E	7±	14
1914, Feb. 6	11:42.3	100±	29 1/2 N 65 E	7	29
Feb. 26	04:58.2	130	18 S 67 W	7.2	8
March 30	00:41.3	150	17 N 92 W	7 1/2	5
May 28	03:23.9	70	9 N 78 W	7.2	6
July 4	23:38.9	200	5 1/2 S 129 E	7	23
Oct. 3	17:22.2	100	16 N 61 W	7.4	7
Oct. 11	16:17.1	80	12 N 94 E	7.2	24
Nov. 22	08:14.3	100±	39 S 176 E	7±	11
Nov. 24	11:53:30	110±	22 N 143 E	8.1	18
1915, Jan. 5	14:33:15	200	15 S 168 E	7 1/4	14

TABLE 15 (continued)

Date	Time	Depth	Location	M	Region
1915, Jan. 5	23:26.7	160	25 N 123 E	7 1/4	21
March 17	18:45:00	100	42 N 142 E	7 1/4±	19
June 6	21:29:37	160	18 1/2 S 68 1/2 W	7.6	8
Sept. 7	01:20.8	80	14 N 89 W	7 3/4	6
Oct. 8	15:36:03	170	33 1/2 N 138 E	7	18
1916, April 18	04:01.8	170	53 1/4 N 170 W	7.5	1
April 24	04:26.7	80	18 1/2 N 68 W	7.2	7
June 2	13:59.4	150±	17 1/2 N 95 W	7.1	5
July 27	11:52.7	100	4 N 96 1/2 E	7	24
Aug. 25	09:44.7	180	21 S 68 W	7 1/2 ?	8
Sept. 11	06:30.6	100	9 S 113 E	7 1/4	24
Sept. 15	07:01.3	100	34 1/2 N 141 E	7 1/4	19
1917, April 21	00:49:49	220	37 N 70 1/2 E	7.0	48
Aug. 30	04:07:15	100±	7 1/2 S 128 E	7 3/4	24
1918, Feb. 7	05:20:30	120±	6 1/2 N 126 1/2 E	7 1/2±	22
May 20	17:55:10	80±	28 1/2 S 71 1/2 W	7.5	8
Oct. 14	12:00.5	130±	19 S 174 W	7 ±	12
Nov. 18	18:41:55	190	7 S 129 E	7.8	24
Nov. 23	22:57:55	190	7 S 129 E	7 1/4	24
1919, Jan. 1	02:59:57	180	19 1/2 S 176 1/2 W	7 3/4-8	12
June 1	06:51:20	200	26 1/2 N 125 E	7 ±	21
Aug. 31	17:20:46	180	16 S 169 E	7 1/4	14
Nov. 20	14:11:43	210	13 S 167 E	7	14
1921, Feb. 4	08:22:44	120	15 N 91 W	7.5	5
July 4	14:18:20	200?	25 1/2 N 141 1/2 E	7.2	18
Oct. 20	06:03:24	120	18 1/2 S 68 W	7 ±	8
Nov. 15	20:36:38	215	36.5 N 70.5 E	7 3/4	48
1922, March 4	13:07:38	220	52 1/2 N 157 E	7.0	19
March 28	03:57:54	90	21 S 68 W	7.2±	8
Oct. 24	21:21:06	80	47 N 151 1/2 E	7.4	19
Dec. 6	13:55:36	230	36 1/2 N 70 1/2 E	7.5±	48
1923, Sept. 2	22:38:12	150	16 S 68 1/2 W	7.0	8
1924, June 30	15:44:25	120	45 N 147 1/2 E	7.3	19
Oct. 13	16:17:45	220	36 N 70 1/2 E	7.3	48
Dec. 27	11:22:05	150	45 N 146 E	7.3	19

TABLE 15 (continued)

Date	Time	Depth	Location	M	Region
1926, April 28	11:13:50	180	24 S 69 W	7.0	8
June 26	19:46:34	100	36 1/2 N 27 1/2 E	7.9	30
June 29	14:27:06	130	27 N 127 E	7.5	20
Aug. 30	11:38:12	100	36 3/4 N 23 1/4 E	7.0	30
Sept. 10	10:34:29	80	9 S 111 E	7.0	24
Nov. 5	07:55:38	135	12.3 N 85.8 W	7.0	6
1927, April 14	06:23:34	110	32 S 69 1/2 W	7.1	8
June 3	07:12:11	150	7 S 131 E	7.4	24
1928, March 13	18:31:52	100	5 1/2 S 153 E	7.0	15
Aug. 24	21:43:30	220	15 S 168 E	7.0	14
1929, Jan. 13	00:03:12	140	49 3/4 N 154 3/4 E	7.7	19
Feb. 1	17:14:26	220	36.5 N 70.5 E	7.1	48
Oct. 19	10:12:52	100	23 S 69 W	7.5	8
1930, July 22	19:25:53	140	44 3/4 N 147 1/2 E	7.1	19
1931, March 2	02:18:34	110	22 S 172 E	7.1	14
March 28	12:38:37	80	7 S 129 1/2 E	7.3	24
July 21	03:36:22	140	21 S 170 E	7.0	14
Sept. 9	20:38:26	180	19 N 145 1/2 E	7.1	18
1932, Aug. 14	04:39:32	120	26 N 95 1/2 E	7.0	26
1933, Jan. 1	08:48:39	140	14 3/4 S 168 E	7.0	14
Oct. 25	23:28:16	220	23.0 S 66.7 W	7.0	8
1934, March 1	21:45:25	120	40 S 72 1/2 W	7.1[1]	9
May 1	07:04:56	145	3 1/2 N 97 1/2 E	7.0	24
May 4	04:36:07	80	61 1/4 N 147 1/2 W	7.2	1
June 13	22:10:28	80	27 1/2 N 62 1/2 E	7.0	29
1935, Jan. 1	13:21:00	300	17 1/2 S 174 1/2 W	7.1	12
May 14	23:23:10	155	59 S 26 1/2 W	7.0	10
June 24	23:23:14	140	15 3/4 S 167 3/4 E	7.1	14
Aug. 17	01:44:42	120	22 1/2 S 171 E	7.2	14
Oct. 2	05:33:00	70 ±	43 1/2 N 146 1/2 E	7.0	19
1936, Jan. 20	16:56:19	80	6 N 127 E	7.1	22
Dec. 29	14:47:56	100	4 1/2 S 153 1/2 E	7.0	15
1937, July 19	19:35:24	190	1 1/2 S 76 1/2 W	7.1	8

[1] Diameter of macroseismic area 1500 km.

TABLE 15 (continued)

Date	Time	Depth	Location	M	Region
1937, July 26	03:47:11	100	18.4 N 95.8 W	7.3	5
July 26	19:56:37	90 ±	38 1/2 N 141 1/2 E	7.1	19
Sept. 1	08:38:59	120	32 S 180	7.0	12
Sept. 3	18:48:12	80	52 1/2 N 177 1/2 W	7.3	1
Sept. 8	00:40:01	130±	57 S 27 W	7.2	10
Sept. 15	12:27:32	80 ±	10 1/2 S 161 1/2 E	7.3	15
Nov. 14	10:58:12	240	36 1/2 N 70 1/2 E	7.2	48
1938, Feb. 5	02:23:34	160	4 1/2 N 76 1/4 W	7.0	8
May 23	08:21:53	80	18 N 119 1/2 E	7.0	22
May 30	14:29:50	70±	20 1/2 S 169 1/2 E	7.0	14
Oct. 20	02:19:27	90	9 S 123 E	7.3	24
1939, April 5	16:42:40	70	19 1/2 S 168 E	7.1	14
April 18	06:22:45	100	27 S 70 1/2 W	7.4	8
June 8	20:46:53	100	15 1/2 S 174 W	7.2	12
Aug. 12	02:07:27	180	16 1/4 S 168 1/2 E	7.2	14
Oct. 17	06:22:06	120	14 S 167 3/4 E	7.4	14
Dec. 16	10:46:32	75	43 3/4 N 147 3/4 E	7.1	19
Dec. 21	21:00:40±	150 ±	0 123 E	8.0	23
1940, Jan. 6	14:03:24	90	22 S 171 E	7.2	14
Jan. 17	01:15:00	80	17 N 148 E	7.3	18
Feb. 7	17:16:02	70	51 1/2 N 175 E	7	1
Feb. 20	02:18:20	200 ±	13 1/2 S 167 E	7.0	14
July 14	05:52:53	80	51 3/4 N 177 1/2 E	7 3/4	1
Sept. 19	18:19:48	80	24 S 171 E	7.0	14
Oct. 4	07:54:42	75	22 S 71 W	7.3	8
Oct. 7	06:43:04	100	5 N 126 E	7.0	22
Nov. 10	01:39:09	150 ±	45 3/4 N 26 1/2 E	7.4	51
Dec. 22	18:59:46	230 ±	15 1/2 S 68 1/2 W	7.1	8
Dec. 28	16:37:44	80	18 N 147 1/2 E	7.3	18
1941, April 3	15:21:39	260	22 1/2 S 66 W	7.2	8
Sept. 4	10:21:44	90	4 3/4 S 154 E	7.1	15
Sept. 17	06:47:57	190	1/2 S 121 1/2 E	7.1	23
Sept. 18	13:14:09	100	13 3/4 S 72 1/4 W	7.0	8
Sept. 24	01:01:24	75	51 N 158 E	7.0	19
Nov. 15	04:19:54	80	59 S 27 1/2 W	7.0	10

TABLE 15 (continued)

Date	Time	Depth	Location	M	Region
1941, Nov. 24	21:46:23	80	28 S 177 1/2 W	7.3	12
1942, Jan. 29	09:23:44	130	19 S 169 E	7.1	14
May 28	01:01:48	120	0 124 E	7.5	23
June 14	03:09:45	80	15 N 145 E	7.0	18
July 8	06:55:45	140	24 S 70 W	7.0	8
Sept. 9	01:25:26	80	53 N 164 1/2 W	7.0	1
Sept. 14	11:31:01	130	22 S 171 1/2 E	7.0	14
Nov. 26	14:27:28	110	45 1/2 N 150 E	7.4	19
1943, Feb. 16	07:28:35	190	15 S 72 W	7 ±	8
Feb. 28	12:54:33	210	36 1/2 N 70 1/2 E	7.0	48
March 14	18:37:56	150	20 S 69 1/2 W	7.2	8
April 9	08:48:59	170	19 N 146 E	7.0	18
July 11	02:10:25	180	32 1/2 S 178 1/2 W	7.0	12
July 23	14:53:09	90	9 1/2 S 110 E	7 3/4	24
Aug. 1	16:18:41	230	20 S 170 E	7.0	14
Sept. 27	22:03:44	90	30 S 178 W	7.1	12
Nov. 26	21:25:22	130	2 1/2 S 100 E	7.1	24
Dec. 1	06:04:55	120	4 3/4 S 144 E	7.2	16
Dec. 1	10:34:46	80	19 1/2 S 69 3/4 W	7 ±	8
1944, Jan. 7	02:49:20	120	4 1/2 S 143 1/2 E	7.1	16
Feb. 29	03:41:53	200	14 1/2 S 70 1/2 W	7 ±	8
March 22	00:43:18	220	8 1/2 S 123 1/2 E	7.5	24
July 27	00:04:23	70	54 N 165 1/2 W	7.1	1
Oct. 2	20:29:51	75	42 1/2 N 142 1/2 E	7.0	19
Oct. 5	17:28:27	120	22 1/2 S 172 E	7 1/2	14
Nov. 24	04:49:03	170	19 S 169 E	7.5	14
Nov. 29	18:51:21	170	19 S 169 E	7.0	14
Dec. 27	15:25:49	90	5 1/2 S 152 E	7.0	15
1945, June 22	09:18:40	120	44 N 146 E	7.0	19
July 15	05:35:13	120	17 1/2 N 146 1/2 E	7.1	18
Sept. 13	11:17:11	100	33 1/4 S 70 1/2 W	7.1±	8
Oct. 9	14:36:33	80	43 1/2 N 147 1/2 E	7.0	19
1946, Jan. 17	09:39:35	100	7 1/2 S 147 1/2 E	7.2	16
June 7	04:13:20	150	16 1/2 N 94 W	7.1	5
July 9	13:13:50	170	19 S 169 E	7	14

TABLE 15 (continued)

Date	Time	Depth	Location	M	Region
1946, July 11	04:46:42	130	17 N 94 1/2 W	7	5
Aug. 21	18:00:18	100	24 S 177 W	7	12
Sept. 23	23:30:00	100 ?	6 S 145 E	7.2	16
Sept. 30	00:59:40	70	13 S 76 W	7	8

TABLE 16

Large Deep Shocks

Date	Time	Depth	Location	M	Region
1904, June 7	08:17.9	350±	40 N 134 E	7 1/2	19
1905, July 11	15:37.5	450	22 N 143 E	7 1/4	18
1906, Jan. 21	13:49:35	340	34 N 138 E	8.0	19
1907, March 29	20:46.5	500	3 N 122 E	7 1/4	23
March 31	22:00.6	400	18 S 177 W	7 1/4	12
May 25	14:02:08	600	51 1/2 N 147 E	7.4	46
1909, Feb. 22	09:21.7	550	18 S 179 W	7.5	12
1910, Feb. 12	18:10.1	350	32 1/2 N 138 E	7.4	18
April 20	22:22.0	330	20 S 177 W	7	12
Aug. 21	05:38.6	600	17 S 179 W	7 1/4	12
Dec. 14	20:46.2	600	21 S 178 W	7	12
1911, April 28	09:52.9	600±	0 71 W	7.1	8
July 5	18:40.1	370	7 1/2 S 117 1/2 E	7	24
Aug. 21	16:28:55	300	21 S 176 W	7.3	12
Sept. 6	00:54.3	350	46 N 143 E	7.3	46
1912, Sept. 1	04:10.0	430	4 1/2 S 155 E	7	15
Dec. 7	22:46:50	620	29 S 62 1/2 W	7 1/2	8
1914, Aug. 6	04:10.7	600±	6 S 123 E	7 ±	24
1915, Feb. 25	20:36.2	600	20 S 180	7 1/4	12
April 23	15:29.3	650	8 S 68 W	7 1/4	8
1916, June 21	21:32:30	600	28 1/2 S 63 W	7.5	8
July 8	09:34.5	600	18 S 180	7	12
1917, July 31	03:23:10	460	42 1/2 N 131 E	7.5	46
1918, Jan. 30	21:18:33	330	45 1/2 N 135 E	7.7	46
April 10	02:03:54	570	43 1/2 N 130 1/2 E	7.2	46
May 22	06:31:27	380	17 S 177 1/2 W	7 ±	12
1919, Aug. 18	16:55:25	300	20 1/2 S 178 1/2 W	7.2±	12
1920, Feb. 22	17:35:50	340	47 1/2 N 146 E	7	46
1921, Dec. 18	15:29:35	650	2 1/2 S 71 W	7.6	8
1922, Jan. 17	03:50:33	650	2 1/2 S 71 W	7.6	8
1924, Jan. 16	21:38:00	350	21 S 176 W	7.0±	12
Jan. 21	01:52:54	340	55 N 156 1/2 E	7.0	46

TABLE 16 (continued)

Date	Time	Depth	Location	M	Region
1924, May 4	16:51:43	560	21 S 178 W	7.3	12
May 28	09:51:59	500	48 N 146 E	7.0	46
1927, April 1	19:06:09	400	20 S 177 1/2 W	7.1	12
1928, March 29	05:06:03	410	31.7 N 138.2 E	7.1	18
1929, June 2	21:38:34	360	34 1/2 N 137 1/4 E	7.1	19
June 4	15:15:58	380	6 1/2 N 124 1/2 E	7.0	22
1931, Feb. 20	05:33:24	350	44.3 N 135.5 E	7.4	46
1932, Jan. 9	10:21:42	380	6.2 S 154.5 E	7.3	15
May 26	16:09:40	600	25 1/2 S 179 1/4 E	7 3/4	12
Nov. 13	04:47:00	320	43 3/4 N 137 E	7.0	46
1933, Sept. 6	22:08:29	600	21 1/2 S 179 3/4 W	7.1	12
1934, Oct. 10	15:42:06	540	23 1/2 S 180	7.3	12
1935, July 29	07:38:53	510	20 3/4 S 178 W	7.2	12
1937, April 16	03:01:37	400	21 1/2 S 177 W	7 3/4	12
Aug. 11	00:55:54	610	6 1/4 S 116 1/2 E	7.2	24
1939, April 21	04:29:04	520	47 1/2 N 139 3/4 E	7.0	46
July 20	02:23:00±	650	22 S 179 1/2 W	7.0	12
1940, July 10	05:49:55±	580	44 N 131 ± E	7.3	46
1943, Nov. 17	14:57:17	300±	33 1/2 N 138 E	7.0	18
1944, May 25	01:06:37	640	21 1/2 S 179 1/2 W	7.2	12
1945, Nov. 26	05:13:10	600	21 S 180	7.0	12
1946, Jan. 11	01:33:29	580	44 N 129 1/2 E	7.2	46
Aug. 28	22:28:15	580	26 S 63 W	7.2	8
Sept. 26	10:53:15	600	25 S 179 E	7	12

TABLE 17

Regional List of Shallow Shocks

Region 1 (Aleutian Islands, Alaska)

No.	Date	Time	Location	M	Remarks
20	1925, Aug. 19	12:07:27	55 1/4 N 168 E	7.2	
30	1939, July 14	08:31:40	53 3/4 N 169 E	6 1/2	h = 60
40	1929, Dec. 17	10:58:30	52 1/2 N 171 1/2 E	7.6	
50	1907, Sept. 2	16:01.5	52 N 173 E	7 3/4	
60	1940, April 16	06:07:43	52 N 173 1/2 E	7.1	
61	1940, April 16	06:43:07	52 N 173 1/2 E	7.2	
80	1935, Feb. 22	17:05:54	52 1/4 N 175 E	6.9	
100	1906, Aug. 17	00:10.7	51 N 179 E	8	
105	1936, April 23	23:14:21	50 1/4 N 179 E	6 1/4	
110	1944, Dec. 12	04:17:10	51 1/2 N 179 1/2 E	7.0	
120	1913, March 31	03:41.1	51 N 179 W	6.9	h = 60
130	1912, Jan. 4	15:46.9	52 N 179 W	7.0	
140	1932, Jan. 13	16:17:27	52 N 179 W	6	
150	1929, July 5	14:19:02	51 N 178 W	7.0	
160	1932, March 8	04:29:30	51 1/2 N 178 W	6	
161	1932, April 29	18:18:23	51 1/2 N 178 W	6 1/4	
170	1929, July 7	21:23:12	52 N 178 W	7.3	
180	1905, Feb. 14	08:46.6	53 N 178 W	7 3/4	
190	1910, Sept. 9	01:13.3	51 1/2 N 176 W	7.1	
200	1926, Oct. 13	19:08:07	52 N 176 W	7.1	
210	1933, Nov. 2	12:26:54	52 N 176 W	6 1/2	
220	1934, Nov. 5	23:02:20	52 N 175 W	6 1/2	
230	1933, July 19	10:45:29	51 3/4 N 174 W	6	
231	1933, July 19	10:53:53	51 3/4 N 174 W	6	
232	1933, July 19	13:32:21	51 3/4 N 174 W	6 1/4	
233	1933, July 19	14:59:52	51 3/4 N 174 W	6 1/4	
270	1933, May 1	18:49:47	51 3/4 N 173 W	6 1/2	
280	1934, July 20	02:10:44	52 N 173 W	6	
290	1929, March 7	01:34:39	51 N 170 W	8.1	h=50
300	1931, March 29	17:24:58	51 N 170 W	6	
310	1935, Jan. 23	07:24:00	52 1/4 N 169 1/2 W	6 3/4	

TABLE 17 (cont.), REGION 1

No.	Date	Time	Location	M	Remarks
320	1933, July 22	20:55:13	53 N 169 1/2 W	6 3/4	
330	1932, Aug. 12	03:23:57	52 1/4 N 169 W	6 3/4	
340	1931, Aug. 14	16:12:03	52 1/2 N 168 W	6	
350	1933, April 27	11:55:38	52 1/2 N 167 W	6	
360	1938, July 24	13:12:13	53 1/2 N 167 W	6 1/4	h=50
370	1940, Aug. 22	03:27:18	53 N 165 1/2 W	7.1	
380	1933, June 28	23:34:58	53 1/2 N 165 W	6	
390	1933, Oct. 14	22:19:01	53 3/4 N 164 W	6 1/4	
400	1940, Feb. 12	09:17:46	55 N 161 1/2 W	6 3/4	
410	1932, Oct. 16	12:08:01	54 1/4 N 160 W	6 3/4	h=50
420	1932, Oct. 30	20:46:56	55 N 159 3/4 W	6 3/4	
430	1938, Nov. 17	03:54:34	55 1/2 N 158 1/2 W	7.2	
440	1938, Nov. 10	20:18:43	55 1/2 N 158 W	8.3	
450	1934, July 28	21:36:57	55 1/2 N 156 3/4 W	6 3/4	
460	1923, May 4	16:26:39	55 1/2 N 156 1/2 W	7.1	
470	1912, June 7	09:55.9	59 N 153 W	6.4	Follows Katmai eruption
471	1912, June 10	16:06.1	59 N 153 W	7.0	
480	1932, March 25	23:54:51	62 1/2 N 153 W	6	
481	1932, June 8	07:52:39	62 1/2 N 153 W	6	
500	1932, March 25	23:58:31	62 1/2 N 152 1/2 W	6.9	
510	1934, May 14	22:12:46	57 3/4 N 152 1/4 W	6 1/2	h=60
515	1936, Jan. 18	01:20:00	62 N 152 W	d	
520	1940, Oct. 11	07:53:10	59 1/2 N 152 W	6	
530	1945, Nov. 3	22:09:03	58 1/2 N 151 W	6 3/4	h=50
540	1933, June 13	22:19:47	61 N 151 W	6 1/4	
550	1943, Nov. 3	14:32:17	61 3/4 N 151 W.	7.3	
555	1935, Sept. 4	01:27:39	63 3/4 N 152 1/2 W	6 1/4	
560	1904, Aug. 27	21:56.1	64 N 151 W	7 3/4	
570	1933, April 27	02:36:04	61 1/4 N 150 3/4 W	7.0	
580	1933, June 19	18:47:43	61 1/4 N 150 1/2 W	6	
590	1933, June 12	15:23:38	61 1/2 N 150 1/2 W	d	
600	1933, March 28	04:20:26	58 1/4 N 149 W	d	
610	1911, Sept. 22	05:01.4	60 1/2 N 149 W	6.9	h=60
620	1931, Jan. 27	14:29:03	60 3/4 N 149 W	d	
630	1929, July 3	00:53:00	62 1/2 N 149 W	6 1/4	

TABLE 17 (cont.), REGION 1

No.	Date	Time	Location	M	Remarks
640	1931, May 29	05:16:32	63 N 149 W	d	
650	1932, Sept. 14	08:43:23	61 N 148 W	6 1/4	h=50
651	1933, Jan. 4	03:59:28	61 N 148 W	6 1/4	
670	1929, Jan. 21	10:30:53	64 N 148 W	6 1/4	
671	1929, July 4	04:28:35	64 N 148 W	6 1/2	
690	1934, Aug. 2	07:13:08	61 1/2 N 147 1/2 W	6	
700	1934, June 2	16:45:29	61 1/4 N 147 W	6 1/4	
710	1923, July 17	01:02:11	63 N 147 W	d	
720	1931, Oct. 17	12:34:50	63 N 147 W	d	
730	1933, July 26	04:57:26	63 N 147 W	d	
740	1912, July 7	07:57.6	64 N 147 W	7.4	
750	1937, July 22	17:09:29	64 3/4 N 146 3/4 W	7.3	
760	1928, June 21	16:27:13	60 N 146 1/2 W	7.0	

REGION 2 (Eastern Alaska, British Columbia)

No.	Date	Time	Location	M	Remarks
20	1940, Jan. 28	08:27:57	61 3/4 N 137 1/2 W	5 1/4	
40	1920, July 7	18:41:29	61 N 140 W	6	
60	1942, June 12	02:01:32	61 N 138 W	5 3/4	
80	1944, Feb. 3	12:14:59	60 1/2 N 137 1/2 W	6 1/2	
100	1933, Sept. 19	23:39:32	60 N 138 W	d	
120	1933, Aug. 31	02:51:40	59 1/4 N 137 1/2 W	5 1/4	
140	1941, Aug. 10	05:05:17	59 1/4 N 137 1/2 W	5 1/4	
160	1908, May 15	08:31.6	59 N 141 W	7.0	
180	1923, April 25	19:31:53	59 N 138 W	5 3/4	
200	1938, Oct. 14	15:52:16	58 1/2 N 136 W	5	
220	1945, Nov. 16	18:02:22	58 N 136 1/2 W	d	
240	1927, Oct. 24	15:59:55	57 1/2 N 137 W	7.1	
260	1921, April 10	13:40:16	54 N 134 W	6 1/2	
280	1945, Aug. 2	20:44:45	54 N 133 W	6 1/4	
300	1930, July 1	01:09:15	52 1/2 N 132 1/2 W	5.7	
320	1936, Dec. 21	19:03:13	52 1/2 N 131 1/2 W	6.0	
340	1938, March 22	15:22:14	52 1/4 N 132 W	6.3	
341	1938, March 22	22:27:46	52 1/4 N 132 W	5 1/4	
380	1929, March 1	07:31:13	51 1/2 N 130 3/4 W	6.1	
400	1944, Aug. 10	01:52:50	51 1/4 N 131 W	6 1/4	

TABLE 17 (cont.), REGION 2

No.	Date	Time	Location	M	Remarks
420	1912, March 11	10:17.5	51 N 131 W	6 1/2	
440	1929, May 26	22:39:54	51 N 131 W	7.0	
441	1929, Sept. 17	19:17:34	51 N 131 W	6.3	
480	1920, March 29	05:07:53	51 N 129 W	6.4	
500	1942, Jan. 31	06:49:07	51 N 124 W	5 1/2	Felt, Vancouver
520	1942, March 19	11:59:19	50 1/2 N 131 W	6	
540	1924, March 30	00:08:56	50 N 130 1/4 W	6.0	
560	1938, April 22	04:15:49	49 3/4 N 129 3/4 W	5 1/2	
580	1918, Dec. 6	08:41:05	49 3/4 N 126 1/2 W	7.0	
600	1930, April 16	14:30:40	49 1/2 N 130 W	5 1/2	
605	1935, Sept. 24	22:12:15	49 1/2 N 130 W	6.2	
620	1942, June 9	11:06:48	49 1/2 N 129 W	5 3/4	
640	1937, Sept. 29	11:30:19	49 1/4 N 129 1/2 W	5 1/2	
660	1914, July 21	22:31.3	49 N 130 W	6 1/2	
680	1939, July 18	03:26:38	49 N 129 1/4 W	6 1/2	
700	1932, Aug. 18	20:22:49	49N 129 W	d	
705	1933, May 5	04:14:11	49 N 129 W	5.5	
740	1926, Nov. 1	01:39:18	48 3/4 N 128 1/2 W	6.6	
780	1926, Oct. 30	19:41:55	48 1/2 N 129 W	6.1	
800	1930, May 31	10:21:53	48 1/2 N 129 W	5.4	
820	1945, April 29	20:16:17	47 3/4 N 121 3/4 W	5 1/2	
840	1939, Nov. 13	07:45:54	47 1/2 N 122 1/2 W	5 3/4	
860	1926, May 12	14:53:33	46 1/2 N 131 W	d	
880	1936, July 16	07:07:48	46 N 118 1/2 W	5 3/4	

REGION 3 (California)

No.	Date	Time	Location	M	Remarks
10	1944, July 12	19:30:23	44 1/2 N 115 1/2 W	6.1	
15	1944, March 6	20:09:08	44 1/2 N 129 W	5 3/4	
16	1944, March 6	23:16:30	44 1/2 N 129 W	5 3/4	
20	1914, Aug. 22	05:28.3	44 N 129 W	6 3/4	
25	1917, June 10	04:32.4	44 N 129 W	6 1/2	
30	1936, April 30	10:55:38	44 N 128 1/2 W	5 1/2±	
40	1924, Feb. 24	05:45:10	44 N 127 W	5 3/4	
45	1944, Dec. 30	22:03:02	43 3/4 N 126 3/4 W	5 3/4±	

TABLE 17 (cont.), REGION 3

No.	Date	Time	Location	M	Remarks
50	1928, Sept. 11	12:36:19	43 1/2 N 130 1/4 W	6.3	
60	1933, March 26	19:05:53	43 1/2 N 129 W	5 1/2	
70	1929, Aug. 14	19:03:30	43 N 130 W	5 1/4	
80	1941, Oct. 31	12:41:00	43 N 128 1/2 W	5 1/2	
90	1926, June 5	19:50:24	43 N 127 1/2 W	6	
100	1932, June 20	09:26:27	43 N 127 1/2 W	5.5	
110	1938, Aug. 3	13:32:30	43 N 127 1/2 W	d	
120	1933, July 19	05:06:36	43 N 127 1/4 W	5 1/4	
130	1938, May 28	10:14:01	42 3/4 N 126 W	6	
140	1941, June 9	06:17:26	42 3/4 N 126 W	5 1/4	
141	1941, June 9	08:43:45	42 3/4 N 126 W	5	
150	1936, Sept. 25	12:53:35	42 1/2 N 128 W	6.2	
160	1910, Aug. 5	01:31.6	42 N 127 W	6.8	
170	1945, Sept. 28	22:24:10	42 N 126 W	6.0	
180	1925, June 4	12:02:52	41 1/2 N 125 W	6	
190	1934, July 6	22:48:52	41 1/4 N 125 3/4 W	6.5	
200	1939, Dec. 4	23:54:54	41 N 128 1/2 W	5 1/4	
210	1915, Dec. 31	12:20.0	41 N 126 W	6 1/2	
220	1922, Jan. 26	09:31:20	41 N 126 W	6	Foreshock of Jan. 31
230	1922, Jan. 31	13:17:22	41 N 125 1/2 W	7.3	
240	1918, July 15	00:23:00	41 N 125 W	6 1/2	
250	1923, April 29	02:31:29	41 N 125 W	d	
260	1926, Dec. 10	08:38:53	40 3/4 N 126 W	6.0	
270	1941, Oct. 3	16:13:08	40 3/4 N 125 W	6.4	
280	1932, June 6	08:44:22	40 3/4 N 124 1/2 W	6.4	
290	1937, Feb. 7	04:41:34	40 1/2 N 125 1/4 W	5 3/4	
300	1941, Feb. 9	09:44:04	40 1/2 N 125 1/4 W	6.6	
310	1923, Jan. 22	09:04:18	40 1/2 N 124 1/2 W	7.2	
320	1931, Sept. 9	13:40:40	40 1/2 N 124 W	5.8	
330	1915, Oct. 3	06:52.8	40 1/2 N 117 1/2 W	7 3/4	
340	1945, May 19	15:07:04	40 1/4 N 126 1/2 W	6.2	
350	1935, Jan. 2	22:40:58	40 1/4 N 125 1/4 W	5 3/4	
360	1938, Sept. 12	06:10:43	40 1/4 N 125 W	5 1/2	
370	1941, May 13	16:01:45	40 N 126 W	6	

TABLE 17 (cont.), REGION 3

No.	Date	Time	Location	M	Remarks
380	1936, June 3	09:15:13	40 N 125 1/2 W	5.9	
390	1931, Aug. 23	18:01:46	40 N 125 W	5.3	
400	1931, March 10	03:28:53	40 N 125 W	d	
410	1930, Aug. 5	00:11:06	39 3/4 N 127 1/4 W	5.3	
420	1940, Dec. 20	23:40:54	39 3/4 N 124 1/2 W	5 1/2	
430	1940, Feb. 8	08:05:59	39 3/4 N 121 1/4 W	6	h=35
440	1915, May 6	12:09.0	39 1/2 N 126 1/2 W	6 3/4	
450	1933, June 25	20:45:27	39 1/4 N 119 W	6.1	
460	1932, Dec. 21	06:10:05	38 3/4 N 118 W	7.2	
470	1933, Jan. 5	06:50:20	38 3/4 N 118 W	5.7	
480	1939, May 11	18:04:42	38 1/2 N 117 3/4 W	5 1/2	
490	1906, April 18	13:12.0	38 N 123 W	8 1/4	
500	1934, Jan. 30	20:16:31	38 N 118 1/2 W	6.3	
510	1941, Sept. 14	16:43:32	37.6 N 118.7 W	5.8	
511	1941, Sept. 14	18:39:12	37.6 N 118.7 W	6.0	
512	1941, Dec. 31	06:48:44	37.6 N 118.7 W	5.4	
530	1927, Sept. 18	02:07:07	37 1/2 N 118 3/4 W	6	
540	1911, July 1	22:00.0	37 1/4 N 121 3/4 W	6.6	
550	1926, Oct. 22	12:35:11	36 3/4 N 122 W	6.1	
551	1926, Oct. 22	13:35:27	36 3/4 N 122 W	6.1	
570	1934, June 8	04:47:45	36 N 120 1/2 W	6.0	
580	1922, March 10	11:21:20	35 3/4 N 120 1/4 W	6 1/2	
590	1916, Oct. 23	02:44	34.9 N 118.9 W	5 1/2±	
600	1927, Nov. 4	13:50:43	34 1/2 N 121 1/2 W	7.3	
610	1941, July 1	07:50:55	34.4 N 119.6 W	5.9	
620	1925, June 29	14:42:16	34.3 N 119.8 W	6 1/4	
630	1930, Jan. 16	00:24:34	34.2 N 116.9 W	5 1/4	
640	1935, Oct. 24	14:48:08	34.1 N 116.8 W	5 1/4	
650	1940, May 18	05:03:59	34.1 N 116.3 W	5.4	
660	1923, July 23	07:30:26	34 N 117 1/4 W	6 1/4	
670	1930, Aug. 31	00:40:36	33.9 N 118.6 W	5 1/4	
680	1933, Oct. 2	09:10:18	33.8 N 118.1 W	5.4	
690	1918, April 21	22:32:25	33 3/4 N 117 W	6.8	
700	1933, March 11	01:54:08	33.6 N 118.0 W	6 1/4	

TABLE 17 (cont.), REGION 3

No.	Date	Time	Location	M	Remarks
710	1937, March 25	16:49:03	33.5 N 116.5 W	6.0	
720	1942, Oct. 22	01:50:38	33.3 N 115.7 W	5 3/4	
730	1942 Oct. 21	16:22:14	33.0 N 116.0 W	6 1/2	
740	1940, May 19	04:36:41	32.7 N 115.5 W	6.7	
750	1927, Jan. 1	08:16:45	32 1/2 N 115 1/2 W	5 3/4	
751	1927, Jan. 1	09:13:30	32 1/2 N 115 1/2 W	5 1/2	
770	1935, Feb. 24	01:45:10	32 1/2 N 115 W	5 1/4	
780	1934, Dec. 30	13:52:14	32 1/4 N 115 1/2 W	6.5	
790	1939, June 24	16:27:27	32 N 117 1/2 W	5 1/4	
800	1915, Nov. 21	00:13.7	32 N 115 W	7.1	
810	1934, Dec. 31	18:45:45	32 N 114 3/4 W	7.0	

REGION 4 (Gulf of California)

No.	Date	Time	Location	M	Remarks
20	1939, Sept. 21	21:27:35	31 N 114 W	5 3/4	
40	1940, Dec. 7	22:16:21	30 3/4 N 115 1/4 W	5 3/4	
80	1941, April 9	17:08:36	30 1/2 N 114 W	5 1/4	
120	1931, Oct. 1	11:45:38	30 N 114 1/2 W	6	
140	1939, May 2	13:14:47	29 1/2 N 113 1/2 W	6 3/4	
160	1939, Dec. 22	06:59:18	29 N 114 W	5 3/4	
180	1932, July 7	16:15:51	29 N 113 W	6 3/4	
220	1941, March 15	05:46:23	28 1/2 N 113 1/4 W	6	
260	1907, Oct. 16	14:57.3	28 N 112 1/2 W	7.5	
300	1934, May 14	13:14:50	27 N 115 W	5 1/2	
340	1918, May 23	11:57:30	27 N 111 W	6.8	
360	1945, June 27	13:08:20	27 N 111 W	7.0	
400	1931, Jan. 17	02:50:14	26 3/4 N 111 W	6 1/2	
440	1932, July 12	19:24:10	26 1/2 N 110 W	6 3/4	
480	1929, Sept. 27	23:16:03	25 N 110 1/2 W	6	
520	1936, July 31	17:41:15	24 3/4 N 109 3/4 W	5 3/4	
560	1932, April 24	06:10:48	24 1/2 N 112 W	5 3/4	
600	1932, Oct. 11	19:08:05	24 N 110 W	d	
640	1922, June 12	04:47:44	24 N 108 1/2 W	6 3/4	
680	1931, May 9	10:34:33	23 1/2 N 109 1/4 W	5 3/4	
720	1931, Oct. 26	04:25:00	22 3/4 N 108 1/2 W	5 3/4	
760	1932, March 14	04:05:55	22 1/2 N 109 W	6	

TABLE 17 (cont.), REGION 4

No.	Date	Time	Location	M	Remarks
800	1934, Aug. 26	01:31:21	22 N 108 W	5 3/4	
840	1931, April 19	02:00:26	21 N 109 W	5 3/4	
880	1937, July 11	17:19:27	20 1/2 N 108 1/2 W	5 3/4	
920	1934, Sept. 15	06:56:46	20 N 105 W	6 1/4	
			REGION 5 (Mexico)		
10	1945, June 30	05:31:18	17 N 115 W	6 3/4	
20	1931, Nov. 14	13:51:28	19 N 110 W	d	
30	1931, June 21	12:23:03	18 N 107 1/2 W	d	
45	1932, Aug. 25	08:05:47	19 1/2 N 107 1/4 W	d	
60	1931, Jan. 2	09:49:02	19 N 107 W	6 3/4	
75	1925, Nov. 16	11:54:54	18 N 107 W	7.0	
90	1943, May 26	10:31:30	18 1/4 N 106 W	6 1/2	
105	1934, Nov. 30	02:05:10	18 1/2 N 105 1/2 W	7.0	
120	1932, June 5	09:04:37	19 1/2 N 105 W	6 1/4	
135	1933, April 9	03:58:17	19 1/2 N 105 W	6 1/2	
150	1933, July 9	05:34:20	18 N 105 W	6	
165	1932, June 22	12:59:24	19 N 104 1/2 W	6.9	
180	1932, June 3	10:36:50	19 1/2 N 104 1/4 W	8.1	
181	1932, June 3	17:40:04	19 1/2 N 104 1/4 W	6	Aftershock
195	1933, Dec. 13	21:23:45	19 1/4 N 104 1/4 W	6 1/2	
210	1932, Sept. 8	01:41:13	19 N 104 W	6 1/4	
225	1932, Dec. 7	16:22:09	19 N 104 W	6 1/2	
240	1932, Nov. 17	06:02:58	19 1/2 N 103 3/4 W	6 1/4	
255	1932, July 25	09:12:47	19 N 103 3/4 W	6 3/4	
270	1932, June 18	10:12:10	19 1/2 N 103 1/2 W	7.8	
285	1933, July 10	03:22:04	19 N 103 1/2 W	6 1/4	
300	1935, June 29	06:48:54	19 N 103 1/2 W	6.9	
315	1933, Dec. 14	07:16:29	18 3/4 N 103 1/2 W	6	
330	1941, April 15	19:09:56	18 N 103 W	7.7	
345	1943, Feb. 22	09:20:45	17 3/4 N 101 1/2 W	7.5	
360	1911, June 7	11:02.7	17 1/2 N 102 1/2 W	7 3/4	
375	1933, May 8	10:33:40	17 1/2 N 101 W	6 3/4	
390	1944, Jan. 10	20:09:52	17 N 101 W	6.8	
405	1909, July 30	10:51.9	17 N 100 1/2 W	7 3/4	

TABLE 17 (cont.), REGION 5

No.	Date	Time	Location	M	Remarks
410	1911, Dec. 16	19:14.3	17 N 100 1/2 W	7.5	h = 50
420	1907, April 15	06:08.1	17 N 100 W	8.1	
435	1934, Jan. 28	19:10:03	17 N 100 W	6 3/4	
450	1937, Dec. 23	13:17:56	16 3/4 N 98 1/2 W	7.5	
465	1928, June 17	03:19:27	16 1/4 N 98 W	7.8	
480	1931, July 17	09:13:44	16 1/4 N 97 1/4 W	6 1/4	
495	1931, May 16	20:47:30	16 1/2 N 97 W	6 1/4	
510	1928, Aug. 4	18:26:16	16 N 97 W	7.4	
511	1928, Oct. 9	03:01:08	16 N 97 W	7.6	
525	1931, Nov. 2	00:32:03	16 N 97 W	6 3/4	
540	1931, Jan. 15	01:50:41	16 N 96 3/4 W	7.8	
555	1932, June 21	04:33:45	16 N 96 1/2 W	6	
570	1942, Oct. 28	10:44:39	15 1/4 N 96 1/2 W	6 1/4	
585	1931, Jan. 16	19:19:53	16 1/2 N 96 1/4 W	6 1/2	
600	1928, March 22	04:17:00	16 N 96 W	7.5	
615	1934, June 12	09:32:20	14 3/4 N 96 W	6	
630	1931, July 7	03:54:12	14 N 96 W	6 1/4	
645	1943, Dec. 7	01:07:23	16 N 94 W	6	h = 60
660	1935, April 24	18:51:40	15 1/4 N 93 W	6 1/4	h = 50
675	1934, July 27	02:25:45	16 N 92 1/2 W	6 1/4	h = 50
690	1935, Dec. 14	22:05:17	14 3/4 N 92 1/2 W	7.3	
705	1944, June 28	07:58:54	15 N 92 1/2 W	7.0	
720	1932, Dec. 19	06:28:45	14 N 92 1/2 W	d	
735	1931, Sept. 26	19:50:30	15 N 92 W	6	h = 60
750	1919, April 17	20:53:03	14 1/2 N 91 3/4 W	7.0	
765	1932, Aug. 17	08:46:53	15 1/2 N 91 1/2 W	d	h = 40
780	1931, Sept. 26	20:03:07	14 1/2 N 91 1/2 W	6 1/4	
795	1939, Dec. 5	08:30:07	14 1/2 N 91 1/2 W	6 3/4	
810	1942, Aug. 8	22:36:34	14 1/4 N 91 1/2 W	6 1/2	
825	1942, Aug. 6	23:36:59	14 N 91 W	7.9	
900	1931, Jan. 25	12:34:24	15 N 105 W	6	
920	1926, Oct. 1	09:07:55	11 N 104 W	6	
940	1936, May 28	18:49:00	10 1/2 N 103 1/2 W	6 3/4	
960	1911, Oct. 29	18:09.0	11 N 101 W	6 3/4	
980	1933, Aug. 7	03:02:43	12 1/2 N 98 W	6	

REGION 6 (Central America)

No.	Date	Time	Location	M	Remarks
10	1916, Feb. 27	20:20.8	12 N 90 W	7.5	
20	1931, Aug. 25	22:20:42	12 1/2 N 89 1/2 W	d	
40	1926, Feb. 15	02:59:48	11 3/4 N 89 1/2 W	6.9	
60	1945, Oct. 7	13:23:27	12 1/4 N 89 1/4 W	6 3/4	
80	1926, Feb. 8	15:17:49	13 N 89 W	7.1	
100	1934, Dec. 3	02:38:29	15 N 88 3/4 W	6 1/4	
120	1934, March 7	22:41:47	13 1/4 N 87 3/4 W	6 1/4	
140	1921, March 28	07:49:22	12 1/2 N 87 1/2 W	7.3	
160	1934, Dec. 22	14:29:31	11 1/2 N 87 W	6 1/2	
180	1933, Jan. 12	01:17:42	11 N 87 W	d	
200	1920, July 16	17:14:15	10 N 87 W	6	
220	1932, Oct. 2	02:59:08	11 1/2 N 86 1/2 W	6 3/4	
240	1931, March 31	16:02:21	13 1/4 N 85 3/4 W	d	
260	1916, April 24	08:02.2	11 N 85 W	7.3	
280	1916, April 26	02:21.5	10 N 85 W	7.3	
300	1939, Dec. 21	20:54:48	10 N 85 W	7.3	
310	1936, March 20	18:46:28	11 N 84 W	d	
320	1939, Dec. 22	04:44:00	10 N 84 1/2 W	6 3/4	
340	1940, Oct. 27	05:35:37	9 3/4 N 84 1/2 W	6 3/4	
360	1940, Oct. 5	14:38:43	9 1/2 N 84 1/4 W	6 1/4	
380	1924, March 4	10:07:42	9 3/4 N 84 W	7.0	
400	1941, Dec. 6	21:24:40	8 1/2 N 84 W	6.9	
420	1904, Dec. 20	05:44.3	8 1/2 N 83 W	7 3/4	
440	1941, Dec. 5	20:46:58	8 1/2 N 83 W	7.5	
460	1933, May 30	11:43:36	8 N 83 W	d	
470	1933, Nov. 21	23:48:38	8 N 83 W	6	
471	1933, Nov. 23	18:57:44	8 N 83 W	6	
475	1933, Nov. 29	05:03:20	8 N 83 W	6	
490	1934, July 18	04:00:35	8 N 83 W	6 1/2	
520	1939, Oct. 20	20:06:02	8 N 83 W	6	
540	1934, July 18	06:35:32	8 1/4 N 82 1/2 W	6	
560	1934, July 21	10:39:06	8 1/4 N 82 1/2 W	6 3/4	
580	1934, July 18	01:36:24	8 N 82 1/2 W	7.7	

No.	Date	Time	Location	M	Remarks
600	1931, Oct. 12	03:57:24	7 1/2 N 82 1/2 W	6	
620	1934, July 18	16:09:49	8 N 82 1/4 W	6	
640	1934, July 18	16:59:38	7 3/4 N 82 1/4 W	6.9	
660	1941, March 10	04:05:42	7 1/2 N 80 3/4 W	d	
680	1943, May 2	17:18:09	6 1/2 N 80 W	7.1	
700	1904, Jan. 20	14:52.1	7 N 79 W	7 3/4	
720	1924, July 6	14:18:41	7 N 78 W	6 3/4	
740	1932, June 29	22:20:12	7 N 77 1/2 W	d	
800	1926, March 17	11:53:36	12 1/2 N 82 1/2 W	6.9	h=50
820	1913, July 25	12:38.1	13 N 83 W	6.3	
840	1929, Jan. 19	03:17:54	10 N 81 1/2 W	6	
860	1935, Nov. 30	03:39:47	10 N 79 1/4 W	6 1/4	
900	1930, March 8	03:45:30	9 3/4 N 78 3/4 W	6 1/4	
920	1925, March 29	21:12:37	8 N 78 W	7.1	h=60
980	1942, Dec. 26	12:31:40	8 1/2 N 75 1/2 W	6 1/2	

REGION 7 (Caribbean)

No.	Date	Time	Location	M	Remarks
10	1912, June 12	12:43.7	17 N 89 W	6.8	
15	1936, April 27	06:31:01	17 N 87 W	d	
20	1942, Feb. 27	08:22:55	18 N 87 W	d	h=60
30	1933, March 12	04:25:52	16 1/2 N 86 1/2 W	d	
40	1933, June 10	11:26:59	17 1/4 N 86 1/4 W	d	
50	1933, Feb. 18	19:45:43	16 1/2 N 86 W	d	h=60
60	1933, March 18	23:32:50	17 N 86 W	d	
70	1931, July 27	07:16:15	17 1/2 N 85 1/2 W	d	
80	1931, Jan. 16	16:52:03	15 3/4 N 85 W	d	
90	1910, Jan. 1	11:02.0	16 1/2 N 84 W	7.1	h=60
100	1940, Nov. 10	20:40:27	17 N 84 W	d	
110	1935, March 26	21:32:18	17 1/2 N 84 W	d	
120	1941, March 23	09:00:27	17 N 83 3/4 W	d	
140	1943, April 19	01:19:15	17 N 81 1/2 W	d	
150	1934, July 10	01:02:01	19 N 80 1/2 W	d	
160	1941, April 27	05:34:28	17 3/4 N 79 1/2 W	d	
170	1941, April 7	23:29:17	17 3/4 N 78 1/2 W	7.1	
180	1917, Feb. 20	19:29.8	19 1/2 N 78 1/2 W	7.4	

No.	Date	Time	Location	M	Remarks
190	1941, April 24	01:04:17	17 1/2 N 78 W	d	
200	1924, Jan. 30	20:54:48	20 N 77 1/2 W	d	
210	1914, Aug. 3	11:25.5	18 1/2 N 76 1/2 W	6	
220	1932, June 6	11:49:55	19 1/2 N 76 1/2 W	6	
230	1932, Feb. 3	06:15:55	19 1/2 N 75 1/2 W	6 3/4	
240	1940, July 30	16:05:26	19 1/4 N 75 1/4 W	d	
250	1932, July 6	15:07:04	19 N 74 W	d	
260	1938, Nov. 10	15:23:30	20 3/4 N 74 W	d	
270	1923, Nov. 3	08:37:46	19 1/2 N 73 1/2 W	6	
280	1942, March 9	10:19:46	19 1/2 N 73 W	d	
290	1939, Nov. 7	15:43:57	18 N 72 1/2 W	d	
310	1911, Oct. 6	10:16.2	19 N 70 1/2 W	7.0	
320	1945, Jan. 22	07:47:53	19 1/2 N 70 1/2 W	6	
330	1942, July 5	23:16:10	19 1/2 N 70 W	d	h= 50
340	1916, Nov. 30	13:18.0	20 N 70 W	6 3/4	
350	1926, March 24	05:41:21	19 1/2 N 69 1/2 W	d	
370	1943, Aug. 15	00:13:15	19 N 68 1/4 W	d	
375	1943, Aug. 8	00:38:43	19 N 68 W	d	
380	1939, Dec. 24	18:53:57	18 N 68 W	d	
390	1923, March 15	06:03:12	20 N 68 W	d	
395	1943, July 30	01:02:30	19 1/4 N 67 3/4 W	6 1/2	
400	1920, Feb. 10	22:07:15	18 N 67 1/2 W	6 1/2	
410	1918, Oct. 11	14:14:30	18 1/2 N 67 1/2 W	7.5	
420	1917, July 27	01:01.3	19 N 67 1/2 W	7.0	h=50
430	1943, July 29	03:02:16	19 1/4 N 67 1/2 W	7 3/4	
440	1939, March 7	11:20:49	18 N 67 W	d	
441	1939, March 7	22:10:33	18 N 67 W	d	
450	1915, Oct. 11	19:33.2	19 N 67 W	6 3/4	
455	1944, Aug. 9	04:15:30	18 1/2 N 67 W	d	h= 60
460	1922, Dec. 18	12:35:03	19 N 67 W	6 1/4	
470	1939, June 12	04:05:09	20 1/2 N 66 W	6 1/4	
475	1935, Sept. 15	04:01:35	19 N 65 W	d	
480	1919, Sept. 6	09:29:49	19 1/2 N 64 1/2 W	6 1/4	
490	1927, Aug. 2	00:51:46	19 N 64 1/2 W	6 1/2	
500	1930, June 25	12:06:20	19 N 64 W	6 1/4	

TABLE 17 (cont.), REGION 7

No.	Date	Time	Location	M	Remarks
510	1941, Jan. 17	12:35:44	18 1/2 N 63 1/2 W	d	
520	1918, June 11	12:30:30	19 N 62 1/2 W	5 3/4	
525	1944, June 3	07:12:15	20 N 63 W	5 3/4	
530	1925, Sept. 29	17:33:50	18 1/2 N 62 W	6 1/2	
535	1936, March 20	17:48:34	18 1/2 N 62 W	d	h=50
540	1925, July 7	15:05:21	18 1/2 N 61 W	6 1/2	h=60
541	1925, July 7	17:43:45	18 1/2 N 61 W	6 3/4	h=60
550	1933, April 4	12:09:38	17 1/2 N 60 1/2 W	d	
560	1941, March 12	02:53:28	17 N 61 W	d	
570	1919, Nov. 6	07:13:12	13 1/2 N 58 W	5 3/4	
580	1922, May 11	06:45:35	12 N 59 1/2 W	6	
590	1928, Sept. 27	00:44:05	12 N 60 W	6 1/2	
600	1938, April 13	13:53:13	12 N 60 1/2 W	d	
610	1918, Feb. 24	23:00:20	12 N 62 W	6 1/4	
620	1940, Feb. 27	12:12:47	8 1/2 N 62 W	6	
630	1939, Oct. 14	06:02:18	10 1/2 N 64 W	d	
640	1929, Jan. 17	11:45:39	10 1/2 N 64 1/2 W	6.9	
650	1942, May 6	22:50:13	10 N 65 W	6	
660	1940, June 23	18:59:33	10 N 68 W	d	
670	1931, May 1	22:36:52	8 1/4 N 69 3/4 W	6 1/4	
680	1921, Nov. 13	08:40:45	10 1/2 N 71 W	6 1/4	
690	1943, Dec. 22	12:53:00	12 N 71 W	6 1/2	
700	1943, Dec. 21	13:46:21	13 N 71 W	6 1/2	
702	1943, Dec. 23	15:56:05	13 N 71 W	6 1/2	
703	1943, Dec. 24	01:00:14	13 N 71 W	6 1/4	
705	1944, Jan. 5	10:59:12	13 N 71 W	6 1/4	
740	1932, March 14	22:42:48	8 1/4 N 71 3/4 W	6 3/4	
750	1919, July 11	00:30:38	8 N 72 W	6 1/4	
760	1933, Nov. 4	08:41:17	8 1/2 N 72 W	6	
770	1932, Feb. 17	16:06:57	12 N 73 1/2 W	d	
900	1939, Aug. 15	03:52:35	22 1/2 N 79 1/4 W	d	
950	1939, March 5	15:11:52	23 N 70 W	d	

TABLE 17 (cont.)

REGION 8 (South America)

No.	Date	Time	Location	M	Remarks
10	1920, Sept. 24	21:55:00	6 N 83 W	6 1/2	
20	1942, Oct. 8	03:02:39	6 N 82 3/4 W	6	
30	1941, Feb. 2	23:38:32	6 N 77 1/2 W	d	
40	1933, May 6	20:30:29	5 3/4 N 82 3/4 W	6	
50	1933, May 6	05:33:30	5 1/2 N 83 W	6 1/2	
60	1924, June 22	22:29:08	5 1/2 N 78 1/2 W	6 1/2	h=60
70	1943, March 5	00:31:40	5 1/4 N 82 1/2 W	6 3/4	
80	1929, Aug. 15	19:56:21	5 N 83 1/2 W	6 1/2	
90	1927, Aug. 20	23:54:25	5 N 82 1/2 W	7.0	
100	1941, July 11	01:16:29	5 N 82 1/2 W	6 1/4	
110	1931, Sept. 12	15:41:32	5 N 77 1/2 W	6 1/4	
120	1934, April 3	07:36:27	4 N 78 W	6	
130	1917, Aug. 31	11:36.4	4 N 74 W	7.3	
140	1934, Aug. 6	12:07:08	3 1/4 N 77 3/4 W	6	
150	1937, July 8	12:51:05	3 N 84 W	6	
155	1935, Dec. 24	12:24:05	3 N 79 W	6 3/4	
160	1920, Jan. 30	18:26:45	3 N 77 1/2 W	6	
170	1924, Oct. 18	23:05:27	2 1/2 N 80 W	6 3/4	
180	1906, Jan. 31	15:36.0	1 N 81 1/2 W	8.6	
190	1944, Oct. 23	23:40:01	1/2 N 80 1/2 W	6.9	
200	1933, May 18	04:28:35	1/2 N 78 1/2 W	d	h=60
210	1942, May 14	02:13:18	3/4 S 81 1/2 W	7.9	
220	1933, Oct. 3	10:21:20	1 3/4 S 80 3/4 W	6 1/4	
221	1933, Oct. 3	14:21:49	1 3/4 S 80 3/4 W	6	
230	1933, Oct. 2	15:29:21	2 S 81 W	6.9	
240	1924, March 11	22:44:23	4 S 82 W	6 3/4	h=60
250	1928, May 14	22:14:46	5 S 78 W	7.3	
260	1928, July 18	19:05:00	5 1/2 S 79 W	7.0	
270	1927, March 13	05:32:26	6 S 81 1/2 W	6	
280	1932, Sept. 5	06:23:50	6 S 81 W	6	h=50
290	1940, May 4	16:44:30	6 1/2 S 81 W	d	
300	1940, May 5	02:03:42	7 S 80 W	6	
310	1937, June 21	15:13:04	8 1/2 S 80 W	6 3/4	h=60

No.	Date	Time	Location	M	Remarks
320	1931, April 3	01:56:11	9 1/4 S 79 W	6 1/4	
330	1940, May 24	16:33:57	10 1/2 S 77 W	8	h=60
340	1937, Dec. 24	06:20:40	10 1/2 S 76 1/2 W	6 1/4	
350	1940, Jan. 30	11:56:55	11 1/2 S 77 W	d	h=50
360	1939, Sept. 20	06:53:12	11 1/2 S 75 1/2 W	6	h=60
370	1933, Aug. 20	22:59:16	13 S 80 W	d	
371	1933, Aug. 22	09:49:58	13 S 80 W	d	
390	1928, April 9	17:34:15	13 S 69 1/2 W	6.9	h=30
391	1928, April 27	20:34:58	13 S 69 1/2 W	6 3/4	
400	1931, June 15	11:19:55	14 1/2 S 75 1/2 W	6	
420	1942, Aug. 24	22:50:27	15 S 76 W	8.1	h=60
430	1939, Nov. 18	07:42:15	15 S 75 1/2 W	d	
440	1943, July 5	21:07:54	16 S 74 W	6 3/4	
450	1922, Oct. 11	14:49:50	16 S 72 1/2 W	7.4	h=50
460	1922, Jan. 6	14:11:02	16 1/2 S 73 W	7.2	
470	1913, July 28	05:39.3	17 S 74 W	7.0	
471	1913, Aug. 6	22:14.4	17 S 74 W	7 3/4	
480	1940, March 31	16:52:30	19 S 70 1/2 W	6	h=50
490	1938, April 17	14:39:38	19 S 69 1/2 W	6 1/2	h=60
500	1934, May 11	17:13:08	19 1/2 S 71 W	d	
510	1911, Sept. 15	13:10.0	20 S 72 W	7.3	
520	1933, Feb. 23	08:09:12	20 S 71 W	7.6	h=40
530	1940, Oct. 6	15:38:20	22 S 71 W	6 3/4	h=60
540	1928, Nov. 20	20:35:07	22 1/2 S 70 1/2 W	7.1	
550	1926, Aug. 12	22:17:48	23 S 70 W	6 3/4	
560	1936, July 26	07:36:53	24 S 70 W	6 3/4	h=40
570	1936, July 13	11:12:15	24 1/2 S 70 W	7.3	h=60
580	1937, March 14	11:55:48	24 1/2 S 69 1/2 W	6 1/2	h=60
590	1937, Dec. 12	14:03:45	25 S 70 W	6	h=60
600	1930, Dec. 24	06:02:47	25 S 66 W	6	
610	1925, May 15	11:56:57	26 S 71 1/2 W	7.1	h=50
620	1918, Dec. 4	11:47.8	26 S 71 W	7 3/4	
630	1909, June 8	05:46.5	26 1/2 S 70 1/2 W	7.6	
640	1931, May 20	21:53:54	27 1/2 S 71 1/2 W	6 1/4	

No.	Date	Time	Location	M	Remarks
650	1920, Aug. 3	19:57:12	27 1/2 S 70 W	6 3/4	
655	1936, Feb. 16	03:09:07	28 S 71 1/2 W	d	
660	1922, Nov. 7	23:00:09	28 S 72 W	7.0	
670	1934, March 31	03:13:00	28 1/2 S 72 W	5 1/2	h=60
680	1922, Nov. 11	04:32.6	28 1/2 S 70 W	8.3	
690	1923, May 4	22:26:45	28 3/4 S 71 3/4 W	7	h=60
700	1931, June 29	20:24:04	29 1/2 S 71 W	6	
720	1934, Jan. 1	08:05:14	29 1/2 S 71 W	d	
730	1917, Feb. 15	00:48.4	30 S 73 W	7	
740	1933, Dec. 10	07:49:02	30 S 71 W	d	
750	1927, Nov. 14	07:19:25	30 1/2 S 71 1/2 W	6 3/4	
760	1943, April 6	16:07:15	30 3/4 S 72 W	7.9	
762	1943, May 22	09:01:57	30 3/4 S 72 W	6 3/4	
780	1934, July 28	17:25:30	31 S 71 1/2 W	d	
790	1928, July 28	19:50:15	31 S 71 W	6 1/2	h=50
800	1917, July 27	02:51.8	31 S 70 W	7.0	h=60
810	1944, Jan. 15	23:49:30	31 1/4 S 68 3/4 W	7.4	
820	1941, July 3	07:11:46	31 1/2 S 69 1/2 W	6 1/4	
830	1936, May 22	00:15:58	32 S 66 W	6	
840	1931, March 18	08:02:23	32 1/2 S 72 W	7.1	
850	1906, Aug. 17	00:40.0	33 S 72 W	8.4	
860	1940, April 8	08:49:15	33 1/2 S 71 1/2 W	6	
870	1935, June 28	02:00:35	34 S 73 W	6	
880	1914, Jan. 30	03:36.0	35 S 73 W	7.6	
885	1935, Aug. 5	23:50:10	35 S 72 W	6	
890	1928, Dec. 1	04:06.2	35 S 72 W	8.0	
900	1929, May 30	09:43:24	35 S 68 W	6 3/4	Lunkenheimer, 1930
910	1939, Jan. 25	03:32:14	36 1/4 S 72 1/4 W	7 3/4	

REGION 9 (South America 37°–50° S)

100	1923, Nov. 6	17:15:17	38 S 73 1/2 W	6 1/4	
200	1920, Dec. 10	04:25:40	39 S 73 W	7.4	
300	1919, March 2	03:26:50	41 S 73 1/2 W	7.2	h=40
301	1919, March 2	11:45:17	41 S 73 1/2 W	7.3	h=40
400	1940, Oct. 11	18:41:13	41 1/2 S 74 1/2 W	7.0	

TABLE 17 (cont.), REGION 9

No.	Date	Time	Location	M	Remarks
500	1942, Sept. 27	13:12:21	42 S 81 W	6 1/4	
600	1930, June 22	18:24:40	44 S 81 W	6	
700	1926, Sept. 10	08:26:53	44 S 80 W	d	
800	1927, Nov. 21	23:12:25	44 1/2 S 73 W	7.1	
900	1932, Dec. 3	17:25:51	45 S 80 W	d	

REGION 10 (Southern Antilles)

No.	Date	Time	Location	M	Remarks
20	1930, July 13	01:12:22	56 S 67 W	6 1/4	
40	1941, Dec. 1	19:56:20	54 S 56 W	6 1/4	
60	1928, Oct. 17	15:19:35	53 S 54 W	6 1/2	
80	1933, Dec. 2	20:05:12	51 S 53 W	6 1/2	
120	1941, Jan. 19	03:13:28	53 S 41 W	6 1/2	
140	1934, July 4	01:42:34	55 1/2 S 41 W	6 1/4	
160	1929, Dec. 6	20:21:09	54 1/2 S 30 W	6 3/4	
180	1929, June 27	12:47:05	54 S 29 1/2 W	7.8	
200	1929, Dec. 6	16:46:43	53 1/2 S 29 W	6 3/4	
220	1921, Sept. 13	02:36:54	55 S 29 W	7.2	
240	1930, March 30	08:26:10	54 1/2 S 27 1/2 W	6 3/4	
260	1929, March 28	20:17:57	55 S 27 1/2 W	6 1/2	
280	1930, Aug. 18	09:53:41	55 S 27 W	7.1	h=50
300	1933, July 21	20:06:45	56 1/2 S 26 1/2 W	6 1/2	
320	1930, April 21	11:50:56	56 1/2 S 26 W	6 3/4	h=60
340	1925, Jan. 21	18:11:10	56 S 25 W	6 3/4	h=60
360	1937, Sept. 17	09:30:41	56 1/2 S 25 W	6 1/2	
380	1923, May 1	10:36:18	55 S 24 W	6 3/4	h=50
400	1929, April 13	21:05:59	55 S 24 W	6	
420	1928, May 15	05:43:45	54 S 23 W	6	
460	1933, March 18	03:05:22	59 S 15 W	6 1/2	
480	1932, Feb. 23	00:13:50	60 S 12 1/2 W	6.9	h=60±
520	1910, Nov. 15	14:21.8	58 S 22 W	7 1/4	h=60
540	1936, Jan. 14	05:36:30	60 S 22 W	7.2	
550	1935, Aug. 10	17:31:55	62 1/2 S 21 W	6 1/2	h=60
560	1943, Nov. 2	18:08:22	57 S 26 W	7.2	
561	1943, Nov. 4	06:45:44	57 S 26 1/2 W	6 1/2	
580	1933, Aug. 28	22:19:40	59 1/2 S 25 W	7.4	
600	1930, Feb. 18	01:52:48	60 S 25 W	6 1/2	

TABLE 17 (cont.), REGION 10

No.	Date	Time	Location	M	Remarks
620	1926, March 21	14:19:12	61 S 25 W	7.1	
640	1935, July 17	10:46:14	60 1/2 S 24 W	6 3/4	h=60
660	1929, Oct. 21	10:33:38	59 S 26 W	6	
680	1943, March 9	09:48:55	60 S 27 W	7.3	
685	1943, March 25	18:27:15	60 S 27 W	7.3	
720	1938, Jan. 24	10:31:44	61 S 38 W	7.1	
760	1937, Oct. 7	07:51:45	59 1/2 S 53 W	6 1/4	
780	1928, Dec. 27	04:46:10	61 S 55 W	6 1/4	
800	1938, April 2	06:02:00	59 1/2 S 58 W	6 1/4	
820	1941, Nov. 18	10:14:36	61 S 58 W	7.0	
860	1933, Oct. 26	12:07:02	60 S 60 W	6 3/4	
990	1944, Nov. 21	10:02:20	58 S 66 W	6 1/2	h=50±
			REGION 11 (New Zealand)		
30	1924, June 26	01:37:34	56 S 157 1/2 E	7.8	
60	1929, Dec. 16	00:45:31	55 S 156 E	d	
80	1935, Dec. 9	07:23:30	55 S 162 E	6 1/4	
90	1934, Oct. 25	10:23:17	54 S 160 E	d	
120	1943, Sept. 6	03:41:30	53 S 159 E	7.8	
150	1939, Nov. 10	16:49:40	53 S 160 E	6	
180	1933, Dec. 2	05:17:18	52 S 161 E	6	
210	1932, Aug. 13	20:56:01	51 S 164 E	6 1/4	
225	1939, Sept. 17	19:20:14	50 1/2 S 164 E	d	
240	1936, Feb. 22	19:22:40	50 S 164 E	6 3/4	
245	1939, Sept. 20	07:28:20	50 S 164 E	d	
300	1924, July 24	04:55:17	49 1/2 S 159 E	7.5	h=50
330	1936, Feb. 22	15:31:54	49 1/2 S 164 E	7.2	
360	1926, Oct. 3	19:38:01	49 S 161 E	7.5	h=50
390	1918, Nov. 3	11:14:00	47 S 165 E	6 3/4	h=50 ?
420	1945, Sept. 1	22:44:10	46 1/2 S 165 1/2 E	7.2	
450	1939, April 20	22:06:35	46 1/2 S 167 1/2 E	6	
480	1931, Sept. 15	21:08:47	45 S 168 E	d	
510	1938, Dec. 16	17:21:25	45 S 167 E	7.0	h=60
520	1943, Aug. 2	00:46:35	45 S 167 E	6 3/4	
570	1922, Dec. 25	03:33:10	43 S 173 E	6 1/4	

No.	Date	Time	Location	M	Remarks
600	1929, March 9	10:50:35	42 1/2 S 172 E	6.9	
630	1929, June 16	22:47:32	41 3/4 S 172 1/4 E	7.6	
660	1942, Aug. 1	12:34:03	41 S 175 3/4 E	7.1	h=50
690	1942, June 24	11:16:29	41 S 175 1/2 E	7.1	
720	1934, March 5	11:46:15	40 1/2 S 175 1/2 E	7.5	
750	1914, Oct. 28	00:16.3	40 S 178 E	6 1/2	
780	1932, July 20	04:52:27	40 S 174 E	d	h=60
810	1934, March 15	10:46:35	40 S 176 E	6 1/4	
840	1931, Feb. 2	22:46:42	39 1/2 S 177 E	7 3/4	
841	1931, Feb. 8	01:43:47	39 1/2 S 177 E	6 1/2	
845	1931, Feb. 13	01:27:16	39 1/2 S 177 E	7.1	
900	1932, May 5	08:23:57	39 1/2 S 177 1/2 E	d	
910	1932, Sept. 15	13:54:54	39 S 177 1/2 E	6.8	
940	1927, Feb. 25	15:41:23	38 S 178 E	6 3/4	h=60
970	1914, Oct. 6	19:15.8	38 S 178 1/2 E	6 1/2	
990	1932, March 5	01:40:54	36 1/2 S 178 E	d	

REGION 12 (Kermadec and Tonga Islands)

No.	Date	Time	Location	M	Remarks
20	1930, Sept. 22	01:31:19	35 1/2 S 179 1/2 W	6 1/2	
40	1943, Sept. 22	23:18:08	35 1/2 S 178 1/2 W	6 3/4	
60	1924, April 30	05:07:38	34 S 176 W	6	
61	1924, April 30	03:59:20	34 S 175 W	5 3/4	
80	1933, April 16	06:00:03	33 S 178 W	d	
100	1943, Dec. 30	07:36:07	32 1/2 S 177 W	6 1/4	
120	1934, May 5	14:32:16	32 S 179 W	6 1/4	
140	1943, Dec. 27	03:55:13	32 S 178 1/2 W	6 1/4	
160	1910, June 29	10:45.0	32 S 176 W	7.0	
180	1932, April 3	20:38:53	30 3/4 S 177 1/2 W	6 1/4	
200	1924, Aug. 10	06:12:00	30 S 178 W	6 3/4	h=50
220	1943, Sept. 14	07:18:08	30 S 177 W	7.6	
240	1919, April 17	11:22:05	29 1/2 S 178 W	7.0	
260	1931, Aug. 13	22:09:11	29 S 178 W	6 1/4	
280	1917, Nov. 16	03:19.5	29 S 177 1/2 W	7.5	
290	1935, March 29	12:24:18	29 S 177 1/2 W	6 1/4	
300	1917, May 1	18:26.5	29 S 177 W	8	

No.	Date	Time	Location	M	Remarks
320	1941, Aug. 2	11:41:26	28 1/2 S 178 W	7.1	
322	1941, Sept. 16	21:39:05	28 3/4 S 177 1/2 W	7.0	
340	1940, Sept. 30	11:13:06	27 S 177 W	d	
341	1940, Sept. 30	14:10:30	27 S 177 W	d	
360	1931, June 9	15:58:36	24 1/2 S 176 W	6 1/4	
380	1939, Feb. 3	20:13:15	22 1/2 S 175 1/2 W	6 1/4	
400	1935, April 5	02:55:00	22 S 175 W	6	
420	1943, Oct. 24	16:04:36	22 S 174 W	7.0	
430	1936, Sept. 6	17:39:28	21 1/2 S 174 W	6	
440	1930, Feb. 14	20:41:10	21 S 175 W	6 1/2	h=50
460	1917, June 24	19:48.6	21 S 174 W	7 1/4	h=60±
480	1933, May 20	04:38:24	20 S 174 1/2 W	6	
500	1913, June 26	04:57.2	20 S 174 W	7.6	
510	1931, Nov. 18	03:32:05	20 S 174 W	6	
520	1932, May 22	11:29:18	20 S 174 W	6 1/4	
530	1933, March 15	04:58:19	20 S 174 W	6	
540	1935, Feb. 4	17:24:27	20 S 174 W	6 1/4	
600	1941, Aug. 28	20:27:03	19 1/2 S 173 1/2 W	d	
620	1942, Nov. 2	23:59:36	19 S 173 W	6.9	
640	1919, April 30	07:17:05	19 S 172 1/2 W	8.3	
660	1932, March 8	18:01:04	18 1/2 S 179 E	6 1/4	
680	1921, Feb. 27	18:23:34	18 1/2 S 173 W	7.2	
700	1929, Aug. 3	12:49:28	17 S 172 1/2 W	6 1/2	
720	1942, Dec. 22	04:14:40	16 3/4 S 174 W	6 3/4	h=50
730	1926, March 16	17:37:20	16 1/2 S 171 W	6	
740	1933, July 24	18:55:30	16 S 173 1/2 W	6 3/4	
745	1934, Jan. 31	10:06:30	16 S 173 1/2 W	6 1/4	
760	1943, June 3	20:48:03	16 S 173 W	6 1/2	
780	1933, Jan. 27	22:36:35	16 S 172 W	6 3/4	h=50
800	1930, Jan. 14	22:01:19	16 S 171 W	6 1/4	h=30
820	1917, June 26	05:49.7	15 1/2 S 173 W	8.3	
840	1940, July 20	01:53:53	15 1/2 S 173 W	6	
860	1940, Aug. 24	13:31:07	15 1/2 S 173 W	6	
880	1940, Aug. 11	16:46:44	15 1/2 S 172 W	6	

TABLE 17 (cont.), REGION 12

No.	Date	Time	Location	M	Remarks
900	1943, Sept. 11	19:34:00	15 S 174 W	6.9	
920	1927, July 3	10:37:49	15 S 172 1/2 W	6 1/4	
930	1932, Dec. 3	06:19:52	15 S 172 1/2 W	5 3/4	h=60
940	1933, June 18	03:53:58	15 S 172 W	6	
950	1941, Oct. 5	10:11:12	14 1/2 S 173 3/4 W	6 1/2	
955	1936, March 20	23:53:03	14 1/2 S 173 1/2 W	6 1/4	
960	1940, May 31	00:41:05	14 1/2 S 173 W	d	
980	1931, June 9	13:52:12	14 S 174 W	6 1/2	
990	1934, April 24	17:36:20	14 S 174 W	6 1/4	

REGION 13 (Fiji)

No.	Date	Time	Location	M	Remarks
25	1936, June 16	00:33:31	15 S 175 W	6	
50	1940, July 2	19:08:53	15 S 175 1/2 W	6	
100	1943, Oct. 21	23:08:13	15 S 177 1/2 W	7.0	
150	1940, Dec. 22	12:31:44	14 S 178 W	6 1/2	
200	1938, March 25	15:49:26	14 1/2 S 179 W	6	
250	1935, Dec. 5	17:50:42	16 S 178 W	6 1/2	
300	1939, Nov. 24	23:21:37	16 S 179 1/2 W	d	
400	1923, July 12	03:15:40	14 1/2 S 180	6 1/2	h=50
500	1932, Feb. 16	13:48:50	15 S 180	6 1/2	
600	1934, Aug. 14	08:49:14	18 1/2 S 176 E	6	
650	1936, Sept. 21	16:29:19	17 S 176 1/2 E	d	
700	1939, Nov. 18	00:13:28	16 1/2 S 175 E	d	
800	1933, Sept. 22	11:37:36	16 1/2 S 174 1/2 E	6	
850	1943, March 20	04:50:33	16 S 174 1/2 E	6 1/2	
900	1930, June 5	11:42:43	17 S 174 E	6 1/2	

REGION 14 (New Hebrides)

No.	Date	Time	Location	M	Remarks
20	1938, April 20	06:27:05	22 S 175 E	6 1/2	
25	1941, Sept. 29	17:08:23	22 S 175 E	6 1/2	h=60
40	1934, Nov. 4	01:53:40	22 S 174 1/2 E	6 1/4	
60	1934, Nov. 4	03:14:16	22 S 174 E	6 1/2	
80	1930, May 8	13:35:00	22 S 173 E	6 1/4	
100	1926, Aug. 25	05:44:40	23 S 172 E	7.0	h=50
120	1934, April 26	07:56:52	22 1/2 S 172 E	6	
130	1934, Sept. 4	16:34:25	22 1/2 S 172 E	6 1/4	
160	1934, April 26	05:31:53	23 S 171 1/2 E	6 1/4	
180	1934, April 27	20:46:55	22 3/4 S 171 1/4 E	6 1/2	

No.	Date	Time	Location	M	Remarks
200	1943, Sept. 14	02:01:12	22 S 171 E	7.5	
220	1928, March 16	05:01:02	22 S 170 1/2 E	7.5	
240	1943, Sept. 14	03:47:15	22 S 170 E	7.3	
242	1945, Feb. 1	10:35:51	22 S 170 E	7	h=60
243	1945, Feb. 1	12:13:40	22 S 170 E	7 1/4	h=60
260	1943, March 14	17:11:00	22 S 169 1/2 E	7.1	
261	1943, March 15	02:24:29	22 S 169 1/2 E	6.9	
280	1944, June 21	10:58:20	22 S 169 E	7.2	h=50
300	1931, April 12	02:00:43	24 S 169 E	6 1/4	
320	1923, Feb. 1	19:24:58	21 S 169 1/2 E	7	h=50
325	1945, April 19	13:03:58	21 S 169 1/2 E	7.0	h=40
340	1935, Jan. 17	02:08:11	20 1/4 S 169 1/2 E	6 1/2	
360	1920, Sept. 20	14:39:00	20 S 168 E	8	
380	1943, Nov. 13	18:43:57	19 S 170 E	7.2	
400	1925, March 22	08:41:55	18 1/2 S 168 1/2 E	7.6	h=50
420	1939, Aug. 18	22:16:02	18 1/2 S 168 1/4 E	6.9	h=50
440	1944, Dec. 10	16:24:58	18 S 168 E	7.3	h=50
460	1944, Aug. 30	01:14:09	17 1/2 S 167 1/2 E	6 3/4	h=60
480	1932, Jan. 24	03:44:19	17 1/4 S 167 3/4 E	6 1/2	
490	1945, Sept. 9	04:03:54	17 S 167 E	7.0	h=60
500	1934, March 4	05:55:01	16 3/4 S 167 3/4 E	6 1/4	
520	1927, Jan 24	01:05:43	16 1/2 S 167 1/2 E	7.1	
540	1933, Oct. 30	06:59:51	16 1/2 S 167 1/2 E	6	
542	1933, Nov. 19	03:11:20	16 1/2 S 167 1/2 E	6 1/4	
560	1928, June 29	22:49:38	15 S 170 1/2 E	7.1	
580	1926, June 3	04:46:56	15 S 168 1/2 E	7.1	h=60
600	1939, Dec. 18	06:26:18	15 S 168 E	6	
620	1945, Aug. 29	10:22:40	15 S 168 E	7.2	h=50
640	1940, April 27	09:35:18	15 S 167 E	6 1/2	
641	1940, April 27	18:04:40	15 S 167 E	6 1/2	
660	1930, Oct. 8	10:19:18	14 S 168 1/2 E	6.9	
680	1910, Nov. 26	04:41.3	14 S 167 E	7.4	h=50
700	1934, Aug. 23	23:48:42	14 S 167 E	6 1/4	
720	1934, April 26	21:00:18	14 S 166 E	6 1/2	

No.	Date	Time	Location	M	Remarks
740	1921, Oct. 15	04:58:12	13 1/2 S 166 E	7.0	h=40
760	1932, Nov. 29	01:47:34	13 S 167 E	6	
780	1934, July 19	05:45:21	13 S 166 1/2 E	6 1/2	
800	1934, July 19	07:36:55	13 S 166 E	6.9	
820	1944, Nov. 16	12:10:58	12 1/2 S 167 E	7.3	
840	1934, Aug. 7	03:40:04	12 3/4 S 166 3/4 E	6.9	
860	1928, Sept. 22	07:31:28	12 1/2 S 166 1/2 E	6.9	h=60
880	1934, June 28	00:56:03	12 1/2 S 165 E	6	
900	1914, June 20	07:20.5	12 S 166 E	7 1/4	h=50
910	1934, July 19	00:06:43	12 S 166 E	6 3/4	
911	1935, Jan. 31	17:45:45	12 S 166 E	6 1/4	
920	1934, July 18	19:40:15	11 3/4 S 166 1/2 E	8.2	
940	1934, July 22	02:57:49	11 1/2 S 165 E	6 1/4	
960	1934, July 21	06:18:18	11 S 165 3/4 E	7.3	
980	1934, Oct. 18	07:48:22	10 3/4 S 165 E	6 1/2	
985	1941, May 17	02:24:50	10 S 166 1/4 E	7.4	
990	1933, Oct. 2	13:59:06	10 S 166 E	6	

REGION 15 (Solomon Islands to New Britain)

No.	Date	Time	Location	M	Remarks
10	1932, June 23	02:19:13	11 S 164 E	d	
20	1934, March 13	13:11:51	11 S 164 E	6 3/4	
30	1914, April 11	16:30.4	12 S 163 E	7 1/4	h=50
40	1931, Oct. 3	21:55:10	11 S 163 E	7.0±	
50	1933, Feb. 19	08:34:39	11 S 163 E	6 1/2	h=60
60	1937, Jan. 25	06:34:00	10 S 163 E	7.1	
70	1931, Oct. 13	04:34:36	9 S 163 E	d	
80	1910, Dec. 10	09:26.7	11 S 162 1/2 E	7.5	h=50
90	1932, Feb. 23	20:11:30	10 S 162 E	6 1/2	h=60
100	1931, Oct. 3	19:13:13	10 1/2 S 161 3/4 E	7.9	
110	1931, Nov. 20	14:16:26	10 1/2 S 161 3/4 E	6 3/4	
120	1931, Oct. 3	21:18:15	11 S 161 1/2 E	6 3/4±	
121	1931, Oct. 3	22:47:40	11 S 161 1/2 E	7.3	
140	1934, March 24	12:04:26	10 S 161 1/2 E	7.1	
150	1935, June 19	22:14:54	10 1/2 S 161 E	6	
160	1926, April 12	08:32:28	10 S 161 E	7.5	
170	1931, Oct. 10	00:19:53	10 S 161 E	7.7	

TABLE 17 (cont.), REGION 15

No.	Date	Time	Location	M	Remarks
171	1931, Oct. 10	01:08:20	10 S 161 E	6 3/4	
172	1931, Oct. 10	01:30:48	10 S 161 E	6 3/4	
173	1931, Oct. 10	02:16:47	10 S 161 E	6 3/4	
200	1935, Dec. 15	07:07:48	9 3/4 S 161 E	7.6	
210	1926, Sept. 16	17:59:12	11 1/2 S 160 E	7.1	h=50
220	1939, Feb. 3	05:26:20	10 1/2 S 159 E	7.1	
230	1931, Oct. 23	20:06:34	9 S 159 E	6 1/4	
240	1939, April 30	02:55:30	10 1/2 S 158 1/2 E	8.0	h=50
250	1926, Jan. 25	00:36:18	9 S 158 E	7.4	
260	1931, April 16	21:35:00	8 S 158 E	d	
270	1933, Aug. 5	00:44:13	9 S 157 1/2 E	6 1/4	
275	1936, March 22	12:16:05	8 1/4 S 157 1/2 E	6.9	h=60
280	1926, July 28	08:52:28	8 S 157 1/2 E	6 1/2	h=50
290	1926, March 27	10:48:30	9 S 157 E	7.2	
300	1933, June 7	05:49:52	8 S 156 3/4 E	d	
310	1935, March 20	22:57:21	7 3/4 S 156 E	6 1/2	
320	1936, April 19	05:07:17	7 1/2 S 156 E	7.4	h=40
330	1927, Feb. 1	17:56:37	6 1/2 S 155 1/2 E	6.9	h=60
340	1939, Jan. 30	02:18:27	6 1/2 S 155 1/2 E	7.8	
350	1932, Jan. 30	03:04:46	7 1/2 S 155 E	6 1/4	
360	1931, April 6	06:49:37	7 S 155 E	6 3/4	
370	1931, April 24	17:22:11	6 1/2 S 155 E	6.9	
380	1932, Jan. 29	15:39:06	6 1/2 S 155 E	6 1/2	
390	1932, Jan. 29	13:41:10	6 S 155 E	7.0	
400	1932, Jan. 31	16:01:05	6 S 155 E	6	
410	1939, March 8	21:58:18	6 S 155 E	6 3/4	
420	1933, Nov. 18	03:54:00	7 S 154 1/2 E	6 1/4	h=60
430	1932, March 30	15:01:32	6 1/2 S 154 1/2 E	6	h=50
440	1937, Sept. 23	13:06:00	6 S 154 E	7.4	h=60
450	1919, May 6	19:41:12	5 S 154 E	7.9	
460	1916, Jan. 1	13:20.6	4 S 154 E	7 3/4	
470	1943, Dec. 23	19:00:10	5 1/2 S 153 1/2 E	7.3	h=50
480	1945, Sept. 5	21:48:45	5 S 153 1/2 E	7.1	h=50
490	1937, Jan. 23	10:55:51	4 1/2 S 153 E	7.0	

No.	Date	Time	Location	M	Remarks
500	1940, Sept. 12	13:17:10	4 1/2 S 153 E	7.0	h=40
510	1934, Nov. 18	22:40:07	4 S 153 E	6 1/2	
520	1941, Feb. 9	19:19:28	4 S 153 E	6 1/2	
529	1944, May 19	00:19:19	2 1/2 S 152 3/4 E	7.2	h=50
530	1944, May 25	12:58:05	2 1/2 S 152 3/4 E	7.5	
540	1933, Dec. 12	14:11:10	4 1/2 S 152 1/2 E	6 3/4	
550	1941, Jan. 13	16:27:38	4 1/2 S 152 1/2 E	7.0	
555	1935, Nov. 14	19:56:43	4 1/4 S 152 1/2 E	6 3/4	h=60
560	1920, Feb. 2	11:22:18	4 S 152 1/2 E	7.7	
570	1934, April 28	15:07:54	4 S 152 1/2 E	6	
580	1943, March 21	20:35:43	5 3/4 S 152 1/4 E	7.3	
590	1923, Nov. 4	00:04:30	5 S 152 E	7.2	
600	1931, June 1	11:54:23	4 1/2 S 152 E	6 1/4	
610	1934, Feb. 3	14:33:07	5 3/4 S 151 1/2 E	6 3/4	
620	1934, Aug. 11	11:57:39	5 1/2 S 151 1/2 E	6 1/4	
630	1923, Nov. 2	21:08:06	4 1/2 S 151 1/2 E	7.2	h=50
640	1934, Feb. 9	09:28:47	4 S 151 1/2 E	6 1/2	
650	1945, Dec. 8	01:04:02	6 1/2 S 151 E	7.1	
660	1933, Nov. 22	12:42:15	6 S 151 E	6 3/4	
665	1945, Dec. 27	04:41:05	6 S 151 E	7.0	h=40
670	1933, Sept. 27	21:41:30	4 3/4 S 151 E	6	
680	1940, Nov. 27	14:41:22	3 1/4 S 151 E	6 3/4	
685	1936, April 2	06:16:51	3 S 151 E	6 1/2	
690	1945, Dec. 28	17:48:45	6 S 150 E	7.8	
700	1930, June 11	00:49:35	5 1/2 S 150 E	7.1	
710	1934, Feb. 28	14:21:42	5 S 150 E	7.2	
800	1918, May 20	18:03.7	1 S 153 E	6.7	
810	1938, Feb. 7	01:19:04	1 S 152 E	d	
820	1931, Aug. 6	15:21:08	0 151 E	d	
830	1934, June 22	17:55:34	3 S 150 E	6	
840	1913, June 4	09:57.3	1 1/2 S 150 E	7	
850	1933, Dec. 24	10:45:55	1 S 150 E	6	
900	1940, June 7	07:17:15	9 3/4 S 151 1/4 E	6 1/4	

REGION 16 (New Guinea)

No.	Date	Time	Location	M	Remarks
10	1944, Dec. 28	01:05:35	6 S 149 1/2 E	6 3/4	h=60
20	1939, Jan. 22	13:31:43	7 1/2 S 149 E	6 1/4	
30	1906, Sept. 14	16:04.3	7 S 149 E	8.1	
40	1940, April 24	10:22:06	5 S 148 1/2 E	6	
45	1936, May 5	19:43:09	3 1/4 S 148 1/2 E	6 1/4	
50	1934, March 1	19:41:09	7 S 148 E	6 1/2	
60	1934, June 15	02:51:57	6 1/2 S 148 E	6	
70	1934, March 20	02:38:22	5 1/2 S 148 E	6 1/2	
80	1938, May 12	15:38:57	6 S 147 3/4 E	7.5	
90	1935, June 16	06:18:34	4 1/2 S 147 E	6	
95	1945, Sept. 22	09:10:05	4 S 147 E	7.0	h=50
100	1930, Sept. 30	21:20:45	4 1/2 S 146 E	6 3/4	
105	1936, May 25	03:02:35	3 1/2 S 146 1/2 E	d	
110	1931, Jan. 15	22:42:59	3 S 143 1/2 E	6 1/2	
120	1927, May 13	23:09:13	2 1/2 S 143 1/2 E	6 1/4	h=50
130	1911, Dec. 31	06:07.1	2 S 143 1/2 E	7.0	
140	1918, July 3	06:52:05	3 1/2 S 142 1/2 E	7.5	
150	1935, Sept. 20	05:23:01	3 1/4 S 142 1/2 E	7.0	
160	1931, Aug. 7	02:11:30	4 S 142 E	7.1	
170	1935, Sept. 20	01:46:33	3 1/2 S 141 3/4 E	7.9	
180	1940, Feb. 24	12:00:06	3 S 141 1/2 E	6 3/4	
190	1934, June 3	21:01:34	2 1/2 S 141 1/2 E	d	
200	1917, July 29	21:52.4	3 1/2 S 141 E	7.6	
210	1939, May 22	01:34:48	3 S 141 E	6 1/4	
220	1939, May 26	17:50:23	3 1/2 S 140 1/2 E	6 1/2	
230	1925, June 9	13:40:41	3 S 140 E	7.0	
240	1933, April 16	19:16:27	3 S 139 1/2 E	6 1/4	
250	1940, April 1	11:18:57	3 1/4 S 139 E	6.9	
260	1940, May 28	09:40:41	2 1/2 S 139 E	6.9	
270	1921, Feb. 19	18:14:35	2 S 139 E	6 3/4	
280	1935, Jan. 22	14:56:43	2 3/4 S 138 3/4 E	6 1/4	
290	1939, July 12	22:58:25	3 1/2 S 138 1/2 E	6 3/4	h=60
300	1926, Oct. 26	03:44:41	3 1/4 S 138 1/2 E	7.7	
310	1940, Dec. 17	14:42:07	3/4 S 138 1/2 E	6 1/2	

No.	Date	Time	Location	M	Remarks
320	1931, April 8	19:03:15	2 S 138 E	6	
330	1933, Sept. 30	14:21:03	2 S 138 E	6 1/4	
340	1932, July 21	12:39:49	3 1/4 S 137 1/2 E	6 1/2	
350	1932, June 20	19:09:00	2 1/2 S 137 1/2 E	d	
360	1914, May 26	14:22.7	2 S 137 E	7.9	
370	1916, Jan. 13	06:18.5	3 S 136 E	7.5	
380	1916, Jan. 13	08:20.8	3 S 135 1/2 E	7.8	
390	1944, April 27	14:38:09	1/2 S 133 1/2 E	7.4	h=50
400	1932, April 14	16:58:42	1 S 134 E	d	
410	1933, June 2	12:20:56	1 S 134 E	d	
420	1944, April 26	01:54:15	1 S 134 E	7.2	h=50
430	1934, July 19	01:27:26	1/2 S 133 1/4 E	7.0	
440	1941, Sept. 12	07:02:04	1/2 S 132 1/2 E	7.0	
450	1930, Nov. 9	19:08:38	1/2 S 132 E	6.9	
460	1927, Aug. 10	11:36:15	1 S 131 E	7.1	
700	1942, Jan. 27	13:29:08	4 1/2 S 135 E	7.1	
710	1934, Feb. 2	15:05:16	4 1/2 S 135 E	6 1/4	
720	1943, Nov. 6	08:31:37	6 S 134 1/2 E	7.6	
730	1933, July 10	10:33:12	6 S 134 E	6 1/4	
735	1941, May 24	05:12:30	5 1/2 S 134 E	6	
740	1937, Nov. 5	09:28:30	4 S 134 E	d	
750	1936, Feb. 15	12:46:57	4 1/2 S 133 E	7.3	
800	1934, Dec. 17	15:52:38	2 1/4 S 148 1/2 E	6 1/2	
810	1918, Oct. 27	17:06:40	2 S 148 E	7.4	h=50
820	1934, Aug. 4	13:08:06	3 S 146 1/2 E	6	
830	1940, Sept. 19	23:59:55	2 1/2 S 146 E	d	
840	1932, Dec. 24	06:30:32	3 1/4 S 145 3/4 E	6 1/2	
900	1940, July 31	11:39:16	9 1/2 S 149 1/2 E	d	
920	1939, Nov. 10	20:20:48	9 S 148 E	6 1/4	
940	1931, Nov. 2	17:02:56	8 S 146 E	6 1/2	

TABLE 17 (cont.)

REGION 17 (Caroline Islands)

No.	Date	Time	Location	M	Remarks
30	1930, Oct. 3	18:09:04	1/2 N 135 E	6	
60	1928, Nov. 15	02:32:18	2 N 135 E	d	
90	1931, Sept. 19	07:40:38	8 N 136 E	6	
120	1911, Aug. 16	22:41.3	7 N 137 E	7.9	
150	1936, April 12	20:51:00	8 N 137 1/2 E	6 3/4	
180	1912, Sept. 29	20:51.5	7 N 138 E	7.5	h=50
210	1912, Oct. 31	17:24.1	7 N 138 E	7.0	
240	1930, March 30	00:26:45	11 N 139 E	d	
270	1933, July 18	19:05:22	11 N 139 E	6	
300	1940, June 2	12:09:34	11 1/2 N 139 E	d	
330	1935, Sept. 9	06:17:30	6 N 141 E	7.0	
360	1928, Feb. 13	05:33:37	11 N 141 E	6	
390	1929, Dec. 31	01:03:57	11 N 141 E	6 1/4	
420	1927, July 17	08:48:33	13 N 141 E	6	
450	1925, July 17	03:13:53	12 N 141 1/2 E	6 1/4	
460	1935, Oct. 18	11:05:23	12 1/2 N 141 1/2 E	7.1	h=50
480	1942, June 18	09:30:57	9 N 140 1/2 E	7.1	h=50
510	1943, March 15	04:47:56	9 1/2 N 142 E	6 3/4	
540	1931, Aug. 31	06:34:40	12 N 142 E	d	
570	1929, Nov. 15	18:50:33	7 1/2 N 142 1/2 E	7.2	
600	1941, June 4	16:31:03	12 N 143 1/2 E	d	
630	1933, March 2	08:10:03	12 1/2 N 143 1/2 E	d	
660	1929, Jan. 17	22:28:42	12 N 144 E	6 1/4	
690	1939, Jan. 16	02:13:38	12 N 144 E	d	
720	1924, Jan. 30	04:47:43	13 N 144 E	6 1/4	
740	1932, March 15	04:32:14	11 N 144 1/2 E	6 1/4	
780	1909, Dec. 9	23:28.8	12 N 144 1/2 E	7.4	h=50
810	1931, Jan. 28	21:24:03	11 N 144 3/4 E	7.2	
840	1928, Oct. 10	20:36:30	13 N 146 E	d	

REGION 18 (Marianne Islands)

No.	Date	Time	Location	M	Remarks
15	1932, June 11	17:00:00	13 1/2 N 145 1/2 E	6	h=60
30	1939, Feb. 23	10:07:04	13 1/2 N 146 E	d	
35	1936, Oct. 29	18:38:52	13 3/4 N 144 1/2 E	6 3/4	h=60

No.	Date	Time	Location	M	Remarks
45	1925, July 17	22:31:04	14 N 142 E	6	
60	1931, Oct. 30	08:39:09	14 N 145 1/2 E	d	
75	1929, May 1	07:38:41	14 N 147 E	6 1/4	
80	1944, Dec. 4	20:34:34	14 1/2 N 146 1/2 E	6 3/4	h=60
90	1941, July 10	03:22:06	15 N 146 E	d	
91	1941, July 10	10:16:43	15 N 146 E	d	
105	1941, July 26	20:11:19	15 1/2 N 146 E	6 1/4	
120	1932, March 19	10:59:36	15 1/2 N 147 3/4 E	6 3/4	
135	1941, June 21	00:35:50	18 N 147 E	d	h=40
150	1921, Feb. 10	23:53:45	18 N 148 E	6 1/4	
165	1930, Oct. 24	20:15:11	18 1/2 N 147 E	7.1	
180	1934, Dec. 25	06:27:20	18 1/2 N 147 E	6	
195	1941, Aug. 30	13:06:52	18 1/2 N 147 E	6 3/4	
200	1941, Aug. 30	09:36:18	18 1/2 N 147 1/2 E	6 1/2	
215	1930, Oct. 29	12:29:36	19 N 148 E	d	
230	1940, March 15	05:27:58	22 N 144 1/2 E	d	
245	1931, Aug. 20	00:03:26	22 N 146 E	d	
260	1934, Feb. 24	06:23:40	22 1/2 N 144 E	7.3	
275	1939, May 17	18:30:34	22 3/4 N 143 1/4 E	6.9	
290	1931, March 11	12:26:39	23 N 143 1/2 E	6 3/4	
305	1926, April 22	23:47:52	23 N 145 E	6	
320	1920, Jan. 12	13:39:58	23 1/2 N 144 E	6	
335	1929, March 9	02:11:51	24 1/2 N 142 1/2 E	6 1/4	
350	1945, Feb. 26	22:14:27	26 N 143 1/2 E	7.1	h=50
365	1933, Jan. 4	01:25:01	26 N 144 E	6 1/2	h=60
380	1933, June 6	06:44:50	27 N 143 1/2 E	5 1/2	h=60
395	1924, April 25	18:04:59	27 1/2 N 142 E	6	
410	1934, May 3	01:31:11	27 3/4 N 142 1/2 E	6	
425	1929, March 14	18:37:16	28 N 139 1/2 E	d	
440	1927, Feb. 22	19:54:16	28 N 144 E	6 1/4	h=50
455	1934, April 3	22:32:00	28 1/2 N 140 1/2 E	6	
470	1927, Oct. 31	13:25:10	29 N 142 E	d	
485	1928, Sept. 19	08:15:48	29 N 142 E	6	
500	1932, Nov. 27	03:37:28	29 N 142 E	6	h=60

TABLE 17 (cont.) REGION 18

No.	Date	Time	Location	M	Remarks
515	1928, Jan. 26	18:50:39	29 N 143 E	6	
530	1933, Aug. 15	02:57:59	29 N 143 1/2 E	6 1/4	h=60
545	1927, May 16	12:01:05	30 N 142 E	6 1/4	
560	1926, June 21	08:48:52	30 N 142 1/2 E	6	
575	1925, May 22	09:40:10	30 1/2 N 142 E	6 1/4	
580	1927, April 27	19:16:17	30 1/2 N 142 E	6 1/2	h=50
585	1927, May 18	09:25:10	30 1/2 N 142 E	d	
586	1927, May 20	22:09:18	30 1/2 N 142 E	d	
595	1925, May 20	11:04:48	30 1/2 N 142 1/2 E	6	
610	1924, June 22	13:23:53	31 N 143 E	5 3/4	
615	1936, Sept. 4	08:09:38	31 N 141 1/2 E	6 1/2	h=50±
616	1936, Sept. 18	18:38:30	31 N 142 E	6 1/4	h=50±
625	1926, May 7	06:11:28	31 1/2 N 141 E	6 1/4	
640	1942, Dec. 19	23:10:40	31 1/2 N 142 1/2 E	7.0	
655	1939, Feb, 7	04:09:31	32 N 142 E	d	
670	1933, Dec. 21	23:08:54	32 N 142 1/2 E	d	
685	1916, April 21	11:31.8	33 N 141 E	7.0	
700	1927, Oct. 24	19:05:32	33 N 143 E	6	
715	1921, Sept. 3	08:58:00	33 1/2 N 143 E	6	
730	1927, Oct. 28	15:22:56	33 1/2 N 143 E	d	
900	1944, Dec. 7	04:35:42	33 3/4 N 136 E	8.0	

REGION 19 (Japan to Kamchatka)

5	1933, July 11	05:59:33	34 N 142 1/2 E	d	
10	1927, Oct. 8	12:26:10	34 N 143 E	6	
15	1933, July 11	06:49:56	34 1/2 N 141 1/2 E	d	
20	1933, Oct. 21	02:44:21	34 1/2 N 141 3/4 E	d	
25	1933, Oct. 1	14:35:00	35 N 142 E	d	
30	1935, Feb. 19	20:10:19	35 1/2 N 140 1/2 E	6	
35	1931, June 17	12:09:37	35 3/4 N 139 1/2 E	6	
40	1923, June 1	17:24:42	35 3/4 N 141 3/4 E	7.2	
45	1932, June 22	00:36:03	36 N 140 1/2 E	6	[illegible]40
50	1931, June 23	06:14:55	36 N 141 E	6 1/4	
55	1931, June 9	05:07:39	36 N 141 1/2 E	6	
60	1924, Aug. 14	18:02:37	36 N 142 E	7.0	

No.	Date	Time	Location	M	Remarks
65	1938, Sept. 21	18:52:00	36 1/4 N 141 E	6.9	h=60
68	1938, May 23	07:18:28	36 1/2 N 141 E	7.4	
70	1931, Aug. 18	05:40:14	36 1/2 N 141 1/4 E	d	
75	1931, Sept. 8	19:08:58	36 1/2 N 141 1/2 E	6 1/4	
80	1938, Nov. 6	21:38:47	36 1/2 N 142 E	7.1	h=60
85	1938, Nov. 5	08:43:21	36 3/4 N 141 3/4 E	7.7	h=60
90	1938, Nov. 13	22:31:30	37 N 142 1/2 E	7.0	h=50
95	1942, Nov. 15	17:12:00	37 N 141 1/2 E	7.0	
100	1945, March 11	21:37:50	37 N 142 E	7.2	h=50
105	1938, Nov. 30	02:29:50	37 1/4 N 141 E	7.0	h=50
110	1938, Nov. 5	10:50:15	37 1/4 N 141 3/4 E	7.7	h=60
115	1938, Nov. 6	08:53:53	37 1/4 N 142 1/4 E	7.6	h=60
120	1935, March 30	21:19:43	37 1/2 N 141 1/4 E	6 1/2	h=50
125	1927, Aug. 5	21:12:55	37 1/2 N 142 1/2 E	7.1	
130	1934, Jan. 29	12:34:43	37 1/2 N 144 1/4 E	d	
135	1942, Feb. 21	07:07:43	38 N 142 E	7.1	h=60
140	1936, Nov. 2	20:45:56	38 1/4 N 142 1/4 E	7.3	h=40
145	1932, June 3	00:18:53	38 1/2 N 142 E	d	
150	1933, June 18	21:37:29	38 1/2 N 143 E	7.3	
155	1933, Sept. 21	09:47:56	38 1/2 N 143 E	6 1/4	
160	1939, Oct. 10	18:31:59	38 1/2 N 143 E	7.4	
165	1929, March 18	23:21:02	38 1/2 N 143 1/2 E	6	
170	1934, July 12	09:51:43	38 3/4 N 144 E	6	
175	1940, Nov. 19	15:01:40	39 N 141 3/4 E	7.1	h=50
180	1915, Nov. 1	07:24.0	39 N 142 1/2 E	7.7	
185	1933, April 23	07:13:41	39 N 143 E	6 1/4	
190	1934, May 20	07:01:54	39 N 143 1/2 E	d	h=60
195	1933, July 10	00:21:31	39 N 144 3/4 E	6 1/4	
200	1933, March 3	09:12:52	39 1/4 N 143 E	6 1/2	
205	1933, April 9	02:46:35	39 1/4 N 143 3/4 E	6 3/4	
210	1933, March 2	17:30:54	39 1/4 N 144 1/2 E	8.5	
215	1931, Nov. 3	16:19:56	39 1/2 N 141 3/4 E	6	
220	1905, July 6	16:21.0	39 1/2 N 142 1/2 E	7 3/4	
225	1933, March 2	20:42:52	39 1/2 N 143 E	6 1/2	

No.	Date	Time	Location	M	Remarks
230	1933, March 3	15:07:14	39 1/2 N 143 1/2 E	6	
235	1933, April 1	15:58:58	39 1/2 N 143 1/2 E	6	
240	1932, July 10	07:45:10	39 1/2 N 145 E	6	
245	1928, May 27	09:50:26	40 N 142 1/2 E	7.0	
250	1933, March 8	01:35:42	40 N 143 E	6	
255	1933, June 8	18:10:39	40 N 144 1/2 E	6 1/4	
260	1929, March 14	14:14:55	40 N 146 E	d	
265	1935, Oct. 12	16:45:22	40 1/4 N 143 1/4 E	7.1	
270	1931, March 9	03:48:50	40 1/2 N 142 1/2 E	7.7	About 7 1/4 from P, S; 7 1/2 to 8 from maxima.
275	1933, Jan. 7	04:06:37	40 1/2 N 143 E	6 1/2	
280	1931, March 15	16:33:27	40 1/2 N 143 1/4 E	d	
285	1933, Jan. 8	06:28:51	40 1/2 N 143 1/4 E	6	
290	1935, Oct. 18	00:11:56	40 1/2 N 143 3/4 E	7.2	
300	1933, Jan. 3	15:26:55	40 1/2 N 144 E	6 1/4	
305	1919, May 3	00:52:00	40 1/2 N 145 1/2 E	7.6	
310	1932, June 4	02:00:43	41 N 143 E	d	
315	1933, June 13	20:33:36	41 N 143 E	6 1/4	
320	1945, Feb. 10	04:57:56	41 1/4 N 142 1/2 E	7.3	h=50
325	1932, Sept. 3	11:58:54	41 1/4 N 143 1/4 E	6 3/4	h=50
330	1934, Oct. 5	20:25:52	41 3/4 N 143 1/2 E	6 1/4	
335	1932, Nov. 26	04:23:53	42 N 142 1/2 E	6 3/4	
340	1945, Feb. 18	10:08:07	42 N 143 E	7.0	h=50
345	1931, Feb. 16	18:48:35	42 1/4 N 142 1/2 E	6 1/2	
350	1933, March 11	14:22:01	42 1/2 N 147 E	6 1/4	
355	1943, June 13	05:11:49	42 3/4 N 143 1/4 E	7.4	h=60
360	1935, Sept. 11	14:04:02	43 N 146 1/2 E	7.6	h=60
365	1924, Dec. 28	22:54:56	43 1/4 N 147 E	7.0	
368	1938, May 28	16:42:03	43 1/2 N 144 3/4 E	6 1/2	
370	1931, April 9	23:01:13	43 1/2 N 146 E	6 1/4	
375	1934, June 6	06:23:51	43 1/2 N 146 1/2 E	d	
380	1930, Aug. 21	15:05:20	44 N 148 E	d	
385	1933, July 9	01:29:58	44 1/2 N 149 1/2 E	6 1/2	
390	1937, Feb. 21	07:02:35	44 1/2 N 149 1/2 E	7.4	
395	1933, July 9	09:27:57	44 1/2 N 150 E	6 1/4	
396	1933, July 9	12:30:36	44 1/2 N 150 E	6 3/4	

TABLE 17 (cont.), REGION 19

No.	Date	Time	Location	M	Remarks
400	1918, Nov. 8	04:38.0	44 1/2 N 151 1/2 E	7 3/4	
405	1933, May 1	19:51:07	44 3/4 N 149 E	6 1/2	
410	1925, Jan. 31	17:00:40	45 N 149 E	d	
415	1933, May 1	18:30:05	45 N 149 E	6	
418	1908, Nov. 6	07:09.5	45 N 150 E	7 1/4	
420	1933, July 9	11:21:33	45 N 150 E	6	
421	1933, July 9	16:07:02	45 N 150 E	6 1/4	
422	1933, July 9	22:14:51	45 N 150 E	6	
430	1920, Oct. 18	08:11:35	45 N 150 1/2 E	7.2	h=50
435	1921, Jan. 2	07:06:40	45 1/2 N 150 E	6 1/4	
440	1939, Aug. 12	09:50:00	45 1/2 N 151 E	6 1/4	h=60
445	1922, Dec. 31	07:19:59	45 1/2 N 151 1/4 E	7.0	
450	1918, Sept. 7	17:16:13	45 1/2 N 151 1/2 E	8 1/4	
455	1942, Oct. 26	21:09:13	45 1/2 N 151 1/2 E	7.2	h=60
460	1933, July 9	09:48:20	46 N 148 E	6 1/4	
461	1933, July 9	17:51:41	46 N 148 E	6	
465	1935, June 25	12:33:37	46 N 150 E	6 1/4	
470	1932, June 26	19:19:09	46 N 152 E	6 1/4	
475	1932, Sept. 29	17:46:27	46 N 153 E	6 1/2	
480	1922, May 5	00:18:45	47 N 151 E	5 3/4	
485	1927, Feb. 16	01:35:20	47 N 153 1/2 E	7.0	
490	1915, May 1	05:00.0	47 N 155 E	7.9	
495	1925, Jan. 18	12:05:54	47 1/2 N 153 1/2 E	7.3	
500	1934, May 9	16:13:34	47 1/2 N 154 1/2 E	6	
505	1936, Nov. 2	14:57:50	47 1/2 N 154 1/2 E	6 3/4	
508	1935, Dec. 23	14:43:19	48 1/2 N 154 1/2 E	6	h=60
510	1931, Nov. 4	17:53:34	49 1/4 N 155 1/2 E	6	
515	1931, June 9	12:14:11	50 1/2 N 159 E	6	
520	1936, June 30	15:06:38	50 1/2 N 160 E	7.4	
525	1933, Oct. 22	11:53:39	51 N 156 E	d	
530	1931, May 12	01:37:03	52 N 158 E	6 1/2	h=50
535	1904, June 25	14:45.6	52 N 159 E	8.0	
540	1904, June 25	21:00.5	52 N 159 E	8.1	
545	1904, June 27	00:09.0	52 N 159 E	7.9	

TABLE 17 (cont.) REGION 19

No.	Date	Time	Location	M	Remarks
550	1904, July 24	10:44.6	52 N 159 E	7 1/2	
555	1931, April 26	04:22:07	53 1/2 N 162 E	6 1/4	h=50
560	1931, May 28	18:34:10	52 1/2 N 160 E	6	
565	1942, Aug. 23	06:35:21	53 N 162 1/2 E	7.0	h=60
570	1923, Feb. 2	05:07:38	53 1/2 N 162 E	7.2	
575	1944, Sept. 23	12:13:20	54 N 160 E	7.4	h=40
580	1934, Nov. 18	09:18:31	54 N 160 1/2 E	6	
585	1923, Feb. 3	16:01:41	54 N 161 E	8.3	
590	1931, June 20	01:16:21	54 N 161 E	d	
595	1931, July 18	11:23:44	54 N 161 E	6 3/4	
600	1933, May 17	23:55:24	54 N 161 E	6 1/4	
605	1915, July 31	01:31.4	54 N 162 E	7 3/4	
610	1931, June 28	16:26:56	54 N 164 E	6	
615	1933, March 17	15:55:23	54 1/2 N 161 1/2 E	6.9	
620	1931, Dec. 14	19:17:50	54 1/2 N 163 E	6	
625	1933, Feb. 20	11:01:19	54 1/2 N 163 E	d	
630	1927, Dec. 28	18:20:23	55 N 161 E	7.3	
635	1931, Jan. 12	20:34:03	55 1/4 N 163 E	6 1/2	
640	1936, Nov. 13	12:31:27	55 1/2 N 163 E	7.2	
645	1923, Feb. 24	07:34:36	56 N 162 1/2 E	7.4	
650	1934, March 4	11:17:30	56 N 164 E	6 1/4	
655	1931, Sept. 12	01:45:00	56 1/2 N 161 E	6	
660	1923, April 13	15:31:02	56 1/2 N 162 1/2 E	7.2	
665	1917, Jan. 30	02:45.6	56 1/2 N 163 E	7 3/4	
670	1945, April 15	02:35:22	57 N 164 E	7.0	
671	1945, April 15	03:41:28	57 N 164 E	6 3/4	
680	1937, Sept. 21	21:02:42	58 N 165 E	d	
800	1935, April 9	08:18:45	34 1/2 N 138 E	d	
805	1931, Aug. 10	14:34:00	35 N 138 E	d	
810	1930, Nov. 25	19:02:47	35 N 139 E	7.1	
820	1923, Sept. 2	02:46:40	35 N 139 1/2 E	7.7	
830	1923, Sept. 1	02:58:36	35 1/4 N 139 1/2 E	8.2	
840	1931, Sept. 16	12:43:05	35 1/2 N 138 3/4 E	6	
850	1929, July 26	22:48:16	35 1/2 N 139 E	6 1/2	h=60

No.	Date	Time	Location	M	Remarks
860	1931, Sept. 21	02:19:56	36 N 139 1/4 E	6 3/4	
870	1941, July 15	14:45:26	36 3/4 N 138 1/4 E	6	
880	1943, Oct. 13	05:43:03	36 3/4 N 138 1/4 E	6	
900	1945, Jan. 12	18:38:26	34 3/4 N 136 3/4 E	7.1	
910	1909, Aug. 14	06:31.0	35 1/2 N 136 E	7.0	Destructive east of Lake Biwa
920	1933, Sept. 21	03:14:26	37 1/4 N 137 1/4 E	6 1/4	h=50
930	1933, Oct. 3	18:38:51	37 1/4 N 139 E	5	
940	1934, Nov. 8	03:25:46	37 1/2 N 138 E	d	
950	1934, Sept. 23	21:40:58	39 1/2 N 139 1/2 E	d	
960	1935, March 7	10:26:43	40 N 139 1/4 E	d	
970	1939, May 1	05:58:33	40 N 139 3/4 E	7.0	
980	1919, Oct. 11	13:17:30	40 N 140 E	6 1/4	
990	1940, Aug. 1	15:08:21	44 1/2 N 139 E	7.7	

REGION 20 (Riukiu Islands)

20	1923, April 23	03:16:50	26 1/2 N 126 1/2 E	6 3/4	
40	1923, Aug. 12	10:06:08	26 1/2 N 128 E	6 3/4	
60	1940, Jan. 26	17:04:19	26 3/4 N 132 E	6 3/4	
70	1945, Aug. 14	12:10:53	27 N 129 1/2 E	6 3/4	h=60
80	1931, Aug. 17	17:48:46	27 1/2 N 128 E	6	
100	1931, May 13	23:03:47	27 1/2 N 128 1/2 E	d	
120	1938, June 16	02:15:15	27 1/2 N 129 1/2 E	7.4	
140	1934, Sept. 12	17:42:20	28 N 130 E	d	
160	1933, Aug. 26	01:30:29	28 N 131 E	d	
180	1933, Sept. 15	16:19:46	28 N 131 1/2 E	d	
200	1932, May 28	02:21:19	28 N 132 E	6 1/2	h=60
220	1933, June 3	17:09:11	28 1/4 N 128 3/4 E	6 1/4	
240	1931, Jan. 15	21:01:35	28 1/2 N 127 1/4 E	5 3/4	
260	1929, Feb. 14	14:39:26	28 1/2 N 128 1/2 E	6	
280	1933, Aug. 18	08:19:34	28 1/2 N 131 E	d	
290	1935, Dec. 1	23:45:03	29 N 128 E	6 1/4	
291	1935, Dec. 2	16:42:42	28 3/4 N 128 E	6	
300	1934, Oct. 26	17:11:06	29 N 131 1/4 E	6 3/4	
320	1923, Nov. 5	21:27:53	29 1/4 N 130 E	7.2	
340	1904, Aug. 24	20:59.9	30 N 130 E	7 3/4	

No.	Date	Time	Location	M	Remarks
360	1939, Jan. 22	11:10:15	30 N 132 E	d	h=50
380	1923, July 13	11:13:34	31 N 130 1/2 E	7.2	
400	1933, June 2	07:38:45	31 N 131 1/2 E	6 1/4	
420	1914, Jan. 12	09:28.1	31 1/2 N 131 E	7	h=50
440	1932, May 2	23:29:12	31 1/2 N 131 E	d	
460	1913, April 13	06:40.3	31 1/2 N 132 E	6.8	
480	1932, June 8	06:13:58	31 1/2 N 132 E	d	
500	1932, June 8	10:54:00	31 1/2 N 132 E	d	
520	1931, Nov. 2	10:02:59	32 N 131 1/2 E	7.5	
540	1941, Nov. 18	16:46:22	32 N 132 E	7.8	
560	1931, Nov. 1	18:53:12	32 1/2 N 132 E	6 1/2	
580	1924, Aug. 28	23:50:36	33 1/2 N 131 E	6	
600	1934, Jan. 8	23:07:03	34 N 134 E	d	
620	1940, May 28	14:23:24	34 1/2 N 134 1/2 E	d	
640	1943, Sept. 10	08:36:53	35 1/4 N 134 E	7.4	
650	1943, March 4	10:13:46	35 1/2 N 134 1/4 E	5 3/4	
651	1943, March 4	20:50:08	35 1/2 N 134 1/4 E	5 3/4	
660	1925, May 23	02:09:45	35 3/4 N 134 3/4 E	6 3/4	
680	1927, March 7	09:27:36	35 3/4 N 134 3/4 E	7 3/4	
700	1940, Aug. 13	15:36:40	36 N 132 E	6 3/4	
900	1938, Jan. 11	15:11:58	33 1/2 N 135 1/2 E	6 1/2	h=50
910	1936, Feb. 21	01:07:58	34 1/2 N 135 3/4 E	6	

REGION 21 (Formosa)

No.	Date	Time	Location	M	Remarks
25	1932, Dec. 15	19:33:38	21 N 121 E	6	
50	1941, Dec. 16	19:19:39	21 1/2 N 120 1/2 E	7.1	
75	1934, April 16	13:40:18	21 1/2 N 121 1/2 E	6	
100	1930, May 19	15:03:48	21 1/2 N 122 E	6 1/2	h=50
125	1925, April 16	19:52:35	22 N 121 E	7.1	
150	1919, Dec. 20	20:37:27	22 N 122 E	7.0	
175	1935, Dec. 17	19:17:35	22 1/2 N 125 1/2 E	7.2	
200	1936, Aug. 22	06:51:35	22 1/4 N 120 3/4 E	7.2	
225	1935, Sept. 4	01:37:41	22 1/4 N 121 1/4 E	7.2	
250	1943 Nov. 24	13:17:13	22 1/2 N 122 E	6.9	
275	1938, Dec. 6	23:00:53	22 3/4 N 120 3/4 E	7.0	
300	1927, Aug. 24	18:09:00	23 N 120 1/2 E	6 3/4	h=60
325	1937, Dec. 8	08:32:09	23 N 121 1/2 E	7.0	

No.	Date	Time	Location	M	Remarks
350	1934, Oct. 28	23:36:08	23 1/4 N 123 1/2 E	d	
375	1920, June 5	04:21:28	23 1/2 N 122 E	8	
400	1931, Jan. 1	23:52:22	23 1/2 N 122 E	6 1/4	
425	1938, Sept. 7	04:03:18	23 3/4 N 121 1/2 E	7.0	
450	1914, July 6	06:37.5	24 N 122 E	6 3/4	h=60
475	1929, Aug. 19	02:43:05	24 N 122 E	6 3/4	
500	1937, Nov. 26	10:45:14	24 N 123 E	6	h=50
525	1935, April 20	22:01:54	24 1/4 N 120 3/4 E	7.1	
550	1935, May 4	23:02:24	24 1/4 N 121 1/4 E	6	
575	1933, April 19	06:44:36	24 1/4 N 121 1/2 E	6 1/2	
600	1922, Sept. 14	19:31:39	24 1/2 N 121 1/2 E	7.2	
625	1932, Aug. 21	04:15:35	24 1/2 N 121 1/2 E	6 1/2	
650	1935, Feb. 9	19:19:37	24 1/2 N 121 3/4 E	6 1/4	
675	1922, Sept. 1	19:16:06	24 1/2 N 122 E	7.6	
700	1932, Oct. 23	21:27:48	24 1/2 N 122 1/4 E	6 1/4	
725	1931, Oct. 24	12:36:39	24 1/2 N 123 E	d	
750	1934, Aug. 11	08:18:21	24 3/4 N 121 1/2 E	6 1/2	
775	1935, April 20	22:26:26	25 N 120 1/2 E	6	
800	1931, Feb. 13	00:40:45	25 1/2 N 122 E	6	
825	1934, Jan. 20	22:52:23	25 1/2 N 122 E	d	
850	1938, June 10	09:53:39	25 1/2 N 125 E	7.7	
950	1929, Oct. 24	06:34:13	22 N 118 E	6 1/2	
975	1918, Feb. 13	06:07:13	24 N 117 E	7.3	

REGION 22 (Philippine Islands)

No.	Date	Time	Location	M	Remarks
20	1939, June 2	03:33:15	5 N 127 E	7.0	h=60
30	1918, Aug. 15	12:18.2	5 1/2 N 123 E	8 1/4	
40	1933, Feb. 22	03:48:10	5 1/2 N 125 E	d	
50	1918, Aug. 15	17:30:11	5 1/2 N 126 E	7.0	
60	1935, May 7	05:55:20	5 3/4 N 126 E	6	h=50
70	1931, March 18	20:13:34	5 3/4 N 126 1/4 E	7.0	h=50
80	1934, Jan. 16	18:39:42	6 N 124 3/4 E	6 1/4	
90	1933, Sept. 25	13:45:45	6 N 126 E	6	
95	1923, March 16	22:01:38	6 N 127 E	7.0	
100	1933, April 1	08:07:35	6 N 127 E	d	
102	1936, July 5	18:55:13	6 1/4 N 126 3/4 E	7.3	h=60±

No.	Date	Time	Location	M	Remarks
105	1923, March 2	16:48:52	6 1/2 N 124 E	7.2	
110	1927, Nov. 16	21:10:09	6 1/2 N 126 E	7.0	h=50
120	1924, April 14	16:20:23	6 1/2 N 126 1/2 E	8.3	
131	1933, March 17	19:32:25	6 1/2 N 127 E	6 3/4	
140	1928, Dec. 19	11:37:10	7 N 124 E	7.3	
150	1932, April 29	17:30:40	7 N 127 E	d	
160	1932, Dec. 16	07:14:22	7 N 127 E	d	
170	1928, Dec. 28	14:19:35	7 1/2 N 123 E	6.9	
180	1922, June 2	20:11:47	7 1/2 N 127 1/2 E	6 3/4	h=50
190	1943, May 25	23:07:36	7 1/2 N 128 E	7.9	
200	1934, April 15	22:15:13	7 3/4 N 127 E	7.3	
210	1919, Jan. 1	01:33.7	8 N 126 E	7.4	
220	1931, Oct. 26	11:57:29	8 N 126 E	d	
230	1921, Nov. 11	18:36:08	8 N 127 E	7.5	
240	1934, April 16	03:59:15	8 N 127 1/4 E	6	
250	1942, Oct. 20	23:21:44	8 1/2 N 122 1/2 E	7.3	
260	1924, Aug. 30	03:04:57	8 1/2 N 126 1/2 E	7.3	
270	1934, Aug. 12	23:49:17	8 1/2 N 126 3/4 E	6.9	
280	1929, June 13	09:24:34	8 1/2 N 127 E	7.2	
285	1936, Aug. 13	20:02:41	9 N 126 1/2 E	6 3/4	h=60
290	1911, July 12	04:07.6	9 N 126 E	7 3/4	h=50
300	1925, May 5	10:06:06	9 1/2 N 123 E	6 3/4	
310	1913, April 25	17:56.5	9 1/2 N 127 E	7.2	
320	1931, May 24	00:13:00	10 N 125 1/2 E	6 1/4	
330	1931, Jan. 24	13:41:04	10 N 126 E	6 1/4	
340	1919, April 27	00:22:05	11 N 123 E	6.4	
350	1926, Jan. 23	03:11:52	11 N 126 E	d	
360	1928, June 15	17:16:17	11 1/2 N 121 1/2 E	6 3/4	
370	1935, May 26	22:03:47	11 3/4 N 125 1/2 E	6 1/4	
380	1931, July 12	16:45:23	12 N 123 E	6 1/2	
390	1915, March 12	14:48.5	12 N 124 E	7	h=40
400	1935, May 24	05:36:31	12 N 125 E	6 3/4	
410	1935, May 25	00:07:55	12 N 125 1/2 E	6 1/4	
420	1928, June 15	06:12:36	12 1/2 N 121 1/2 E	7.0	
430	1925, May 25	03:43:06	12 1/2 N 122 1/2 E	6 1/4	

No.	Date	Time	Location	M	Remarks
440	1941, Nov. 5	17:38:47	12 1/2 N 123 E	6.9	
450	1932, July 11	08:21:31	12 1/2 N 124 1/2 E	d	
460	1935, June 18	22:27:41	12 1/2 N 125 1/2 E	6 1/4	
470	1943, May 3	01:59:12	12 1/2 N 125 1/2 E	7.4	
480	1919, March 21	01:02:23	13 N 123 E	6 1/2	h=50
490	1925, Nov. 13	12:14:45	13 N 125 E	7.3	
500	1931, Oct. 26	14:42:08	13 1/4 N 126 1/4 E	d	
510	1942, April 8	15:40:24	13 1/2 N 121 E	7.7	
520	1935, Feb. 7	17:29:02	13 1/2 N 122 3/4 E	6	
530	1907, April 18	23:52.4	13 1/2 N 123 E	7.4	
540	1933, Aug. 20	11:45:05	13 1/2 N 125 E	6 1/2	
550	1933, June 6	02:28:22	14 N 120 E	6 1/4	
560	1934, Nov. 26	12:09:08	14 N 120 E	6 1/4	
570	1907, April 18	20:59.8	14 N 123 E	7.6	
580	1941, May 9	05:32:37	14 N 123 E	6 3/4	
590	1937, Aug. 20	11:59:16	14 1/2 N 121 1/2 E	7.5	
600	1929, July 21	13:15:59	14 1/2 N 124 E	d	
610	1934, July 31	05:58:34	15 N 119 3/4 E	d	
620	1928, Aug. 5	14:41:56	16 N 119 1/2 E	6 1/4	
630	1932, Aug. 24	12:10:32	16 1/2 N 120 1/2 E	6 1/4	
640	1934, Feb. 14	03:59:34	17 1/2 N 119 E	7.6	
650	1931, Oct. 28	05:35:03	17 1/2 N 121 1/2 E	6 1/4	
660	1932, June 13	20:57:32	18 N 119 1/4 E	6 1/4	
670	1932, June 14	11:20:12	18 N 120 E	6	h=40
680	1931, March 19	06:25:00	18 N 120 1/2 E	6.9	
685	1936, Aug. 4	14:09:41	19 N 121 E	d	
690	1932, Jan. 18	20:26:47	19 1/2 N 121 E	d	
700	1934, April 12	03:20:42	19 3/4 N 120 1/4 E	d	
810	1932, Sept. 15	11:13:15	6 N 120 3/4 E	6 1/4	
840	1940, Dec. 19	15:48:30	9 N 118 E	d	
920	1930, July 21	14:06:02	7 N 114 E	6	

REGION 23 (Celebes)

No.	Date	Time	Location	M	Remarks
15	1923, Aug. 11	00:54:25	4 1/2 N 119 1/2 E	6 1/2	
30	1910, Dec. 16	14:45.0	4 1/2 N 126 1/2 E	7.5	
45	1913, March 14	08:45:00	4 1/2 N 126 1/2 E	7.9	h=40

No.	Date	Time	Location	M	Remarks
50	1936, April 1	02:09:15	4 1/2 N 126 1/2 E	7.7	
60	1944, Nov. 15	20:47:01	4 1/2 N 127 1/2 E	7.2	
65	1941, Feb. 27	09:44:12	4 1/4 N 127 E	6 3/4	h=50
75	1933, June 24	13:55:00	4 N 126 E	d	
90	1935, May 20	05:21:29	4 N 126 1/2 E	6	
105	1912, Aug. 17	19:11.8	4 N 127 E	7.5	
120	1921, Feb. 14	01:00:47	3 1/2 N 126 E	6 1/4	
130	1941, Feb. 5	23:04:36	3 N 128 E	5 3/4	h=50
135	1933, Sept. 3	03:45:59	3 N 126 E	d	
150	1935, Feb. 27	09:09:21	3 N 126 E	6	
165	1923, April 19	03:09:08	2 1/2 N 117 1/2 E	7.0	
180	1932, Dec. 4	08:11:12	2 1/2 N 121 E	7.1	
195	1940, July 21	15:38:25	2 1/2 N 121 E	6 1/4	
210	1933, Feb. 16	09:08:08	2 1/2 N 126 E	d	
225	1932, Dec. 4	10:32:57	2 1/4 N 121 E	6 1/4	
240	1938, Oct. 10	20:48:05	2 1/4 N 126 3/4 E	7.3	
255	1934, June 14	19:08:36	2 N 121 E	d	
270	1941, Jan. 5	18:47:05	2 N 122 E	7.0	h=50
285	1931, Feb. 27	09:37:35	2 N 127 E	6 3/4	
300	1934, Nov. 27	06:14:06	2 N 127 1/2 E	6 3/4	
315	1913, Jan. 11	13:16.9	1 1/2 N 122 E	7.1	
330	1925, June 3	04:33:55	1 1/2 N 126 1/2 E	7.1	
345	1931, Sept. 29	05:14:32	1 1/2 N 126 1/2 E	6	
360	1936, Oct. 5	09:44:24	1 1/2 N 126 3/4 E	7.1	h=40
375	1925, May 3	17:21:45	1 1/2 N 127 E	7.1	
390	1944, Sept. 11	09:45:22	1 1/2 N 127 E	7.2	h=40
391	1944, Oct. 14	20:16:08	1 1/2 N 127 E	6 3/4	
400	1941, Jan. 12	00:18:38	1 3/4 N 122 E	6 1/4	h=60
405	1941, Feb. 8	18:46:08	1 N 120 E	6 1/2	
420	1934, April 26	13:39:35	1 N 123 E	6 1/4	
425	1926, July 10	10:51:10	1 N 126 E	7.0	
435	1924, April 13	13:48:00	1/2 N 117 1/2 E	6 1/4	
450	1941, Nov. 8	23:37:22	1/2 N 122 E	7.3	
465	1932, May 14	13:11:00	1/2 N 126 E	8.0	
495	1912, Dec. 23	23:56.2	0 N 123 E	7	h=[illegible]

No.	Date	Time	Location	M	Remarks
510	1923, Feb. 23	05:51:54	0 N 124 E	6 3/4	
525	1934, April 2	04:57:45	0 N 125 E	6	h=50
530	1945, Oct. 16	16:02:58	1/4 S 125 E	7.1	h=50
540	1941, June 18	10:15:01	1/2 S 125 E	6 1/2	
555	1941, June 18	19:58:56	1/2 S 125 E	6 1/4	
570	1925, April 22	23:10:42	1/2 S 129 E	6	
585	1938, May 19	17:08:21	1 S 120 E	7.6	
600	1932, July 30	12:13:36	1 S 121 E	d	
615	1936, July 6	18:21:01	1 S 126 1/2 E	d	
630	1933, March 5	08:19:51	1 S 128 E	d	
645	1925, Nov. 10	13:50:36	1 S 129 1/2 E	7.4	
655	1941, June 23	09:28:45	1 S 119 1/2 E	6 1/4	
660	1925, Dec. 29	16:04:11	1 1/2 S 120 1/2 E	6 1/2	
675	1932, Sept. 9	06:46:25	1 1/2 S 128 1/2 E	d	
690	1927, June 11	02:32:09	1 1/2 S 130 E	6 1/2	h=60
705	1933, May 16	16:41:19	1 3/4 S 121 E	d	
720	1923, Oct. 7	03:29:34	1 3/4 S 128 3/4 E	7.5	
735	1936, Nov. 30	23:45:48	2 S 126 E	6 1/4	
750	1936, Oct. 19	12:04:17	2 S 127 E	6 3/4	
765	1942, July 29	22:49:15	2 S 128 1/2 E	7.0	
780	1915, Aug. 12	07:36.6	2 1/2 S 119 1/2 E	6 3/4	h=60
795	1924, July 29	05:18:45	2 1/2 S 120 E	6 3/4	
810	1924, Feb. 13	22:50:13	2 1/2 S 122 E	6 1/2	
825	1926, Aug. 3	10:32:04	2 1/2 S 126 1/2 E	6 3/4	
840	1919, Aug. 29	05:43:54	2 1/2 S 127 E	7	
855	1932, July 2	02:11:17	2 1/2 S 132 E	6	
860	1941, Dec. 9	02:43:13	3 S 121 1/2 E	6 1/4	
870	1938, June 9	19:15:11	3 1/2 S 126 1/2 E	7.2	h=60
885	1932, Sept. 9	13:39:04	3 1/2 S 128 1/2 E	6 1/4	
900	1935, Dec. 29	23:37:20	3 1/2 S 128 1/2 E	6 1/2	
915	1932, April 13	03:59:02	4 S 128 E	d	
930	1935, March 16	07:50:13	4 S 128 E	d	
945	1938, Aug. 30	17:08:42	4 S 128 1/2 E	d	
960	1932, March 26	09:52:18	4 1/2 S 128 1/4 E	6 3/4	

TABLE 17 (cont.)

REGION 24 (Sunda arc)

No.	Date	Time	Location	M	Remarks
10	1940, Dec. 4	13:05:42	5 S 131 E	6 1/2	
20	1921, March 23	22:44:40	6 1/2 S 131 E	6	h=50
30	1931, March 11	05:58:47	7 S 131 E	6	
40	1938, Feb. 1	19:04:18	5 1/4 S 130 1/2 E	8.2	
50	1934, April 24	01:59:10	6 S 130 1/2 E	6	
60	1944, March 31	02:51:43	7 S 130 1/2 E	7.0	h=60
70	1932, July 27	21:19:30	6 1/2 S 130 E	6 1/4	h=60
80	1934, Feb. 4	22:01:11	5 S 129 1/2 E	6 1/4	
90	1939, Oct. 7	20:43:01	6 1/2 S 128 E	6 1/2	
100	1931, Jan. 19	12:24:06	7 1/2 S 126 1/2 E	6	
110	1930, March 26	07:12:05	7 1/2 S 125 1/2 E	7.2	h=40
120	1940, June 11	08:42:13	8 S 125 E	6 1/4	
130	1927, March 3	01:05:09	6 S 122 E	7.0	
135	1941, Jan. 4	03:12:55	5 3/4 S 122 E	6±	h=50
140	1934, Jan. 1	06:16:45	8 S 122 E	6 1/2	h=60
150	1928, Nov. 28	10:43:10	7 1/2 S 121 1/2 E	6.9	
160	1931, July 28	03:37:53	10 S 121 E	d	
170	1926, Dec. 14	17:10:32	12 S 121 E	6 1/4	
180	1935, June 22	15:48:28	6 S 120 E	6 1/4	
190	1925, March 15	13:46:45	11 S 119 1/2 E	6	h=50
191	1925, March 15	15:41:30	11 S 119 1/2 E	6 1/4	h=50
195	1936, Jan. 2	17:26:42	9 1/4 S 119 1/4 E	6 3/4	
200	1930, May 8	12:47:16	8 S 117 E	d	h=60
210	1931, Feb. 24	17:28:24	9 1/2 S 117 E	d	
220	1934, April 11	21:56:02	7 S 116 1/4 E	6	
230	1934, April 10	10:22:58	6 1/2 S 116 E	6 3/4	
240	1925, Oct. 23	01:47:35	10 1/2 S 115 E	6	
250	1935, April 21	07:25:54	4 1/2 S 114 E	6	
255	1936, Feb. 28	16:15:24	5 S 114 E	6 1/2	
260	1929, June 20	18:22:33	8 1/2 S 114 E	6 1/4	h=60
270	1939, May 11	17:30:50	9 1/2 S 112 E	d	
280	1937, Sept. 27	08:55:10	9 1/2 S 111 E	7.2	
290	1921, Sept. 11	04:01:38	11 S 111 E	7.5	

No.	Date	Time	Location	M	Remarks
300	1931, Jan. 20	23:44:01	7 1/4 S 108 1/2 E	d	
305	1944, Sept. 14	06:38:56	8 1/2 S 108 1/2 E	6 3/4	
310	1940, May 10	18:59:32	9 1/2 S 108 E	6	h=50
320	1940, March 21	13:52:52	10 S 108 E	6 3/4	
330	1927, Sept. 8	23:22:48	7 1/2 S 107 1/2 E	6 1/4	h=50
340	1939, July 25	07:17:24	7 1/2 S 106 1/2 E	d	h=60
350	1934, Dec. 9	11:18:59	7 1/2 S 106 E	d	
360	1943, April 1	14:18:08	6 1/2 S 105 1/2 E	7.0	
370	1933, Aug. 10	04:42:01	8 1/2 S 105 E	d	
380	1933, June 24	21:54:46	5 1/2 S 104 3/4 E	7.5	
385	1941, April 18	12:25:40	5 S 103 1/2 E	6 1/4	
390	1931, Sept. 25	05:59:44	5 S 102 3/4 E	7.4	
400	1914, June 25	19:07.3	4 1/2 S 102 1/2 E	7.6	
410	1931, Sept. 25	21:31:38	5 S 102 1/2 E	6	
420	1931, Feb. 10	06:34:25	5 1/4 S 102 1/2 E	7.1	
421	1931, Feb. 12	05:43:57	5 1/4 S 102 1/2 E	6 1/2	
422	1931, Feb. 14	13:58:45	5 1/4 S 102 1/2 E	6 1/2	
426	1935, Aug. 23	13:57:44	4 1/4 S 102 E	6 1/2	
430	1944, Jan. 5	21:12:43	3 1/2 S 102 E	7.0	h=60
440	1931, Dec. 18	09:49:19	5 1/2 S 102 E	6 1/4	
450	1943, June 8	20:42:46	1 S 101 E	7.4	h=50
451	1943, June 9	03:06:22	1 S 101 E	7.6	h=50
460	1909, June 3	18:40.8	2 S 101 E	7.6	
470	1926, July 1	14:08:49	2 1/2 S 101 E	6 3/4	
480	1934, May 23	23:08:38	2 1/2 S 101 E	d	
490	1918, Sept. 22	09:55:03	1 S 100 E	6 3/4	
500	1934, Feb. 19	10:24:43	2 1/2 S 99 3/4 E	6 1/4	
510	1936, Jan. 2	22:34:30	0 99 1/2 E	7.0	h=60
515	1936, June 9	16:36:30	0 99 E	6 3/4	h=60
520	1926, June 28	06:15:41	1 S 99 1/2 E	6 1/2	
530	1926, June 28	03:23:25	1 1/2 S 99 1/2 E	6 3/4	
540	1927, May 10	06:03:44	1 1/2 S 99 1/2 E	6	h=50
550	1939, Feb. 9	11:45:20	0 98 1/2 E	d	
560	1935, Dec. 28	02:35:22	0 98 1/4 E	7.9	
570	1934, Aug. 21	19:26:15	0 98 E	6 1/4	

No.	Date	Time	Location	M	Remarks
572	1936, March 17	19:49:22	0 98 E	d	
580	1926, Aug. 3	19:41:20	1 N 97 1/2 E	6	
590	1907, Jan. 4	05:19.2	2 N 94 1/2 E	7.6	h=50
600	1940, March 29	21:37:24	2 N 96 1/2 E	d	
610	1921, April 1	04:06:44	2 N 98 E	6 3/4	
620	1931, March 5	17:55:01	3 N 96 E	6	
630	1928, Dec. 10	04:33:38	3 N 98 E	6	
640	1934, July 31	11:49:16	3 1/2 N 96 1/4 E	6	
650	1936, Sept. 19	01:01:47	3 3/4 N 97 1/2 E	7.2	
660	1933, June 1	17:19:53	4 N 94 E	d	
670	1934, July 31	10:58:47	4 N 96 E	d	
680	1934, May 12	20:26:30	4 N 96 1/2 E	d	
690	1929, Dec. 9	06:49:54	4 1/2 N 94 1/2 E	6 3/4	
700	1935, Aug. 3	01:10:01	4 1/2 N 96 1/4 E	7.0	
710	1939, Jan. 29	15:25:50	5 N 94 1/2 E	d	
720	1936, Aug. 23	21:12:13	5 N 95 E	7.3	h=40
725	1945, July 23	03:54:55	5 N 96 E	6 3/4	
730	1942, May 24	03:26:30	5 N 96 1/2 E	6 3/4	h=60
740	1935, Nov. 25	10:03:02	6 N 94 E	6 1/2	
750	1933, May 16	01:12:28	7 N 96 1/2 E	6 1/2	
760	1939, July 18	11:24:09	8 N 93 E	d	h=60
770	1932, Sept. 20	15:43:25	8 1/2 N 93 1/2 E	d	
780	1940, Nov. 13	11:35:58	8 1/2 N 93 1/2 E	d	
800	1915, Aug. 12	09:17.1	9 N 92 E	6 1/4	
805	1941, Aug. 19	16:19:30	9 N 93 E	d	
810	1932, Dec. 11	04:25:55	9 N 93 1/2 E	6	
820	1939, Sept. 25	15:31:03	9 N 94 E	d	
830	1931, Aug. 8	04:07:06	9 1/2 N 93 E	d	
840	1929, Aug. 1	05:01:48	10 N 93 E	6 1/2	
850	1936, April 19	09:04:00	10 1/2 N 93 E	6 1/2	
860	1925, May 13	23:54:34	11 N 92 E	6	
865	1945, Aug. 8	09:53:40	11 N 92 1/2 E	6 3/4	h=50
870	1925, June 28	13:41:45	11 N 93 E	6 1/2	h=60
885	1941, July 14	02:02:25	12 N 93 E	6	
890	1941, June 26	11:52:03	12 1/2 N 92 1/2 E	8.1	h=60

No.	Date	Time	Location	M	Remarks
900	1941, Aug. 9	22:17:38	12 1/2 N 93 E	6	
910	1922, Oct. 17	06:37:59	12 1/2 N 96 E	6 1/4	
920	1935, April 11	01:17:55	13 1/4 N 95 1/2 E	6	
930	1928, May 19	03:28:46	13 1/2 N 91 1/2 E	6 1/4	h=60
940	1926, May 29	22:37:32	15 N 92 E	d	
960	1932, March 28	00:35:34	8 S 98 1/2 E	6	
980	1928, Jan. 26	21:51:34	5 S 96 E	6 1/4	
990	1937, Nov. 30	00:40:27	5 1/2 N 90 E	6 1/2	

REGION 25 (Andaman Islands to Burma)

40	1931, Nov. 30	17:01:36	15 1/2 N 92 1/2 E	d
80	1932, June 21	22:59:12	16 1/2 N 112 E	d
120	1930, May 5	13:45:57	17 N 96 1/2 E	7.3
160	1930, Dec. 3	18:51:44	18 N 96 1/2 E	7.3
200	1931, Sept. 6	05:38:07	18 1/2 N 96 E	d
240	1933, July 3	15:09:05	19 N 97 E	d
280	1935, May 13	19:53:33	19 1/2 N 101 E	6 1/2
320	1931, Sept. 21	10:27:17	19 3/4 N 113 E	6 3/4
360	1934, Feb. 12	11:30:50	20 N 101 1/4 E	6
400	1935, Nov. 1	16:22:01	20 1/2 N 103 1/2 E	6 3/4
440	1912, May 23	02:24.1	21 N 97 E	8.0
480	1925, Dec. 22	05:05:30	21 N 101 1/2 E	6 3/4
520	1941, Dec. 26	14:48:04	21 1/2 N 99 E	7.0
560	1923, June 22	06:44:33	22 3/4 N 98 3/4 E	7.3
580	1936, Feb. 21	06:20:40	23 N 96 E	d
600	1939, June 19	21:56:40	23 1/2 N 94 E	d
640	1938, Aug. 16	04:27:50	23 1/2 N 94 1/4 E	7.2
680	1934, Jan. 12	13:31:49	23 3/4 N 102 1/2 E	6
720	1941, May 16	07:14:32	24 N 99 E	6.9
760	1929, March 22	03:04:04	24 N 103 E	d
800	1918, July 8	10:22:07	24 1/2 N 91 E	7.6
840	1932, March 27	08:44:40	24 1/2 N 92 E	d
880	1940, April 6	13:42:52	24 1/2 N 103 E	6

REGION 26 (Szechuan, Southern Tibet)

15	1932, April 6	09:11:14	31 1/2 N 115 E	6
35	1937, July 31	20:35:44	34 1/2 N 115 E	6.9

No.	Date	Time	Location	M	Remarks
50	1940, Nov. 6	16:11:06	29 1/2 N 104 1/2 E	d	
60	1936, May 16	07:05:41	28 1/2 N 103 3/4 E	6 3/4	
70	1933, Aug. 25	07:50:25	31 3/4 N 103 1/2 E	7.4	
80	1935, Dec. 18	07:10:30	28 1/2 N 103 1/2 E	6	
85	1927, March 14	17:37:39	26 N 103 E	d	
90	1936, April 26	23:59:04	29 N 103 1/2 E	6 3/4	
92	1936, May 8	15:24:21	29 N 103 1/2 E	d	
105	1941, June 11	23:13:30	30 N 102 1/2 E	6	
120	1928, July 19	20:13:50	31 1/2 N 102 1/2 E	d	
140	1931, Dec. 6	23:00:57	34 1/2 N 102 E	d	
155	1926, Aug. 11	05:47:35	29 1/2 N 101 1/2 E	d	
175	1927, July 2	20:38:46	29 1/2 N 101 E	d	
195	1923, March 24	12:40:06	31 1/2 N 101 E	7.3	
200	1935, July 26	10:32:18	33 1/4 N 101 E	6	
210	1925, March 16	14:42:12	25 1/2 N 100 1/4 E	7.1	
230	1933, June 7	11:46:06	27 1/4 N 100 1/4 E	6 1/4	
245	1930, Aug. 24	10:51:16	30 N 100 E	d	
260	1932, Jan. 3	07:50:23	25 1/2 N 98 1/2 E	d	
275	1933, Aug. 11	08:54:01	25 1/2 N 98 1/2 E	6 1/2	
290	1931, May 27	00:43:29	27 1/2 N 98 1/2 E	d	
310	1934, Jan. 19	12:33:07	25 1/2 N 98 1/4	6	
325	1933, Nov. 19	09:08:29	25 N 98 E	d	
345	1931, Oct. 18	07:06:40	26 N 98 E	d	
360	1908, Dec. 12	12:54.9	26 1/2 N 97 E	7 1/2	
380	1931, Jan. 27	20:09:13	25.6 N 96.8 E	7.6	
395	1931, Feb. 10	01:22:54	25 1/2 N 96 E	d	
415	1929, March 25	03:47:04	29 N 94 1/2 E	d	
430	1930, Sept. 22	14:19:11	25 N 94 E	6 1/4	
450	1943, Oct. 23	17:23:16	26 N 93 E	7.2	
465	1941, May 22	01:00:32	27 1/2 N 93 E	d	
485	1932, March 6	00:17:56	25 1/2 N 92 1/2 E	d	
500	1934, June 23	05:19:53	33 N 92 1/2 E	6	
520	1932, Nov. 9	18:30:09	26 1/2 N 92 E	d	
535	1940, Sept. 3	14:40:32	31 N 91 1/2 E	d	
555	1923, Sept. 9	22:03:43	25 1/4 N 91 E	7.1	

No.	Date	Time	Location	M	Remarks
570	1933, March 6	13:05:35	26 N 90 1/2 E	d	
590	1932, March 24	16:08:36	25 N 90 E	d	
605	1930, July 2	21:03:42	25 1/2 N 90 E	7.1	
625	1924, Aug. 13	23:57:50	29 1/2 N 90 E	d	
640	1924, Oct. 8	20:32:57	30 N 90 E	6 1/2	
660	1934, Dec. 15	01:57:37	31 1/4 N 89 1/4 E	7.1	
665	1936, Feb. 18	14:30:32	31 N 89 E	d	
675	1935, Jan. 3	01:50:08	30 1/2 N 88 E	6 1/2	
685	1936, Feb. 11	04:48:00	27 1/2 N 87 E	d	h=50
695	1934, Jan. 15	08:43:18	26 1/2 N 86 1/2 E	8.3	
710	1931, June 18	12:58:29	30 1/2 N 84 E	d	
730	1936, May 27	06:19:19	28 1/2 N 83 1/2 E	7.0	
745	1944, Oct. 17	18:36:54	31 1/2 N 83 1/2 E	6 3/4	
760	1944, Oct. 29	00:11:32	31 1/2 N 83 1/2 E	6 3/4	
780	1913, March 6	02:09.0	30 N 83 E	6.2	
785	1913, March 6	11:04.0	30 N 83 E	6.4	
800	1934, Oct. 19	20:58:16	34 N 82 E	d	
820	1927, June 2	16:37:34	23 1/2 N 81 E	6 1/2	
840	1916, Aug. 28	06:39.7	30 N 81 E	7.5	
860	1932, March 4	23:20:48	33 1/2 N 81 E	d	
880	1911, Oct. 14	23:24.0	31 N 80 1/2 E	6 3/4	
900	1935, March 5	22:15:53	29 3/4 N 80 1/4 E	6	
905	1945, June 4	12:09:06	30 N 80 E	6 1/2	h=60
920	1905, April 4	00:50.0	33 N 76 E	8	
925	1945, June 22	18:00:57	32 1/2 N 76 E	6 1/2	h=60
940	1938, March 14	00:48:38	21 1/2 N 75 3/4 E	6 1/4	h=50

REGION 27 (Kansu to Sinkiang)

No.	Date	Time	Location	M	Remarks
3	1945, Sept. 23	15:34:21	39 1/2 N 119 E	6 1/4	
10	1937, Aug. 1	10:41:00	35 N 115 1/2 E	6 3/4	
40	1934, Jan. 20	17:56:07	40 3/4 N 108 1/4 E	6 1/4	
50	1936, April 10	20:00:55	42 N 106 E	d	
60	1936, Aug. 1	06:24:25	34 N 106 E	6	
70	1920, Dec. 16	12:05:48	36 N 105 E	8 1/2	
90	1936 Feb. 7	08:56:25	35 1/2 N 103 1/4 E	6 3/4	
100	1927, May 22	22:32:42	36 3/4 N 102 E	8.0	

No.	Date	Time	Location	M	Remarks
130	1928, March 7	22:43:24	37 1/2 N 102 E	6	
160	1938, Aug. 22	21:37:26	36 3/4 N 99 E	d	
190	1930, July 13	19:27:17	38 N 98 1/2 E	6 1/2	
220	1933, May 19	17:20:45	38 N 98 1/2 E	d	
250	1937, Jan. 7	13:20:35	35 1/2 N 98 E	7.6	
280	1927, March 15	21:48:35	38 1/2 N 97 1/2 E	6	
310	1941, April 19	07:53:42	39 N 97 E	6	
340	1933, Jan. 17	15:59:56	40 N 97 E	d	
370	1932, Dec. 25	02:04:24	39 1/4 N 96 1/2 E	7.6	
400	1922, Oct. 16	16:01:32	39 1/2 N 91 E	6 1/2	
430	1926, June 4	06:50:58	35 N 89 1/2 E	6	
460	1933, Sept. 25	18:51:21	38 N 87 E	6 3/4	
490	1924, July 3	04:40:06	36 N 84 E	7.2	
500	1924, July 11	19:44:40	36 1/2 N 84 E	7.2	
530	1930, Sept. 1	17:43:13	35 1/2 N 81 E	d	
560	1920, Oct. 12	06:54:48	36 N 81 E	6 1/4	
590	1939, March 17	12:12:39	41 1/2 N 81 E	d	
620	1926, Aug. 6	22:45:54	35 1/2 N 78 1/2 E	6 1/4	
650	1927, April 30	13:56:47	38 1/2 N 78 E	6	
680	1934, July 28	02:06:24	41 N 77 1/2 E	d	
710	1925, Dec. 7	08:34:30	37 N 76 1/2 E	6	

REGION 28 (Mongolia)

No.	Date	Time	Location	M	Remarks
30	1917, April 29	11:55.5	55 1/2 N 113 E	6 1/2	
40	1936, March 11	08:40:48	56 1/2 N 112 E	d	
60	1937, Dec. 25	09:55:55	57 N 110 E	6	
90	1931, Aug. 6	18:16:04	55 1/2 N 109 E	6	
120	1939, May 26	09:40:35	53 N 109 E	6	
150	1941, July 1	06:25:50	53 N 106 E	d	
180	1933, March 23	17:38:20	48 N 104 E	6	
210	1932, June 2	19:44:50	47 1/2 N 102 1/2 E	d	
240	1930, June 17	20:07:22	43 1/2 N 102 1/2 E	d	
270	1915, April 30	01:44.9	44 N 101 E	6 1/2	
300	1939, May 19	18:51:31	50 1/2 N 98 E	d	
330	1905, July 9	09:40.4	49 N 99 E	8 1/4	
360	1905, July 23	02:46.2	49 N 98 E	8 1/4	

No.	Date	Time	Location	M	Remarks
390	1923, Sept. 14	12:57:31	48 N 96 E	6 1/4	
420	1935, Jan. 30	00:35:16	49 1/2 N 95 E	d	
450	1932, July 9	11:11:51	49 N 93 E	d	
460	1935, July 12	01:41:23	43 3/4 N 92 3/4 E	d	
470	1936, Jan. 27	19:30:22	45 N 91 1/2 E	d	
480	1914, Aug. 4	22:41.6	43 1/2 N 91 1/2 E	7 1/2	
510	1922, Aug. 25	19:29:40	50 N 91 E	6 1/2	
540	1933, Feb. 13	02:49:12	45 3/4 N 90 1/4 E	6 1/2	
570	1938, Oct. 19	04:13:26	49 N 90 E	6 3/4	
600	1931, Aug. 10	21:18:40	47 N 90 E	8.0	
630	1931, Aug. 18	14:21:00	47 N 90 E	7.2	
660	1931, Nov. 5	12:19:33	47 N 90 E	6 1/4	
690	1927, May 10	19:59:20	52 N 88 1/2 E	d	
720	1934, Aug. 7	11:49:58	43 N 87 1/2 E	d	
750	1906, Dec. 22	18:21.0	43 1/2 N 85 E	7.9	
780	1941, Aug. 14	09:38:42	45 N 84 E	d	
810	1944, March 9	22:12:58	44 N 84 E	7.2	
840	1927, Sept. 23	13:54:20	42 1/2 N 84 E	6 3/4	
870	1932, Sept. 11	14:13:04	45 N 83 1/4 E	6	
900	1941, April 4	22:00:26	46 N 82 1/2 E	d	
930	1939, Feb. 23	15:40:56	43 N 82 E	d	
960	1911, Jan. 3	23:25:45	43 1/2 N 77 1/2 E	8.4	

REGION 29 (Iran - Urals)

No.	Date	Time	Location	M	Remarks
20	1933, July 7	07:30:51	24 N 65 E	d	
40	1932, April 18	11:23:21	25 N 64 E	6	
50	1943, Feb. 6	02:35:58	24 1/2 N 63 E	6 1/4	
60	1932, Feb. 4	21:18:09	26 1/2 N 62 1/4 E	d	
80	1945, Nov. 27	21:56:50	24 1/2 N 63 E	8 1/4	
100	1936, June 30	19:26:06	33 N 60 E	6 1/4	
120	1926, May 19	21:13:55	26 1/2 N 59 E	d	
140	1932, Sept. 8	07:25:32	31 N 58 1/2 E	d	
160	1933, Feb. 21	19:02:59	27 1/2 N 57 1/2 E	d	
180	1934, Jan. 2	20:55:38	30 N 57 1/2 E	d	
200	1923, Sept. 22	20:47:38	29 N 56 1/2 E	6.9	
220	1939, June 10	08:36:41	33 1/2 N 56 1/2 E	d	
240	1927, May 9	10:31:47	27 1/2 N 56 E	6 1/4	

No.	Date	Time	Location	M	Remarks
260	1911, April 18	18:14.6	32 N 56 E	6.7	h=50
280	1933, Nov. 28	11:09:18	32 N 56 E	6 1/4	
300	1930, May 11	22:35:46	27 1/2 N 55 E	6	
320	1923, Sept. 17	07:09:14	35 1/2 N 55 E	6 1/2	
340	1929, Oct. 29	05:53:39	27 1/2 N 54 1/2 E	d	
360	1939, April 6	04:08:00	35 1/2 N 54 1/2 E	d	
380	1931, May 5	06:42:15	26 1/2 N 54 E	d	
400	1930, April 15	09:56:27	29 N 54 E	d	
420	1932, May 20	19:16:11	36 1/2 N 53 1/2 E	d	
440	1935, April 11	23:14:43	36 1/2 N 53 1/2 E	6 3/4	
460	1927, July 22	03:55:10	34 1/2 N 53 1/2 E	6 1/4	
480	1935, March 5	10:26:35	36 1/4 N 53 1/4 E	6	
500	1909, Jan. 23	02:48.3	33 N 53 E	7.4	
520	1931, July 28	17:36:25	29 1/2 N 52 E	d	
540	1934, Feb. 4	13:27:14	30 1/2 N 51 3/4 E	6 1/4	
560	1930, Sept. 2	18:58:48	30 N 51 1/2 E	d	
580	1939, Jan. 25	11:02:22	31 N 50 E	d	
600	1929, July 15	07:44:14	32 N 49 1/2 E	6 1/4	
620	1939, Nov. 4	10:15:24	32 N 49 1/2 E	6	
640	1934, Oct. 29	16:15:43	40 3/4 N 49 E	d	
660	1932, March 15	10:18:06	34 N 48 E	d	
680	1941, June 10	20:38:43	32 N 47 1/2 E	d	
700	1932, Jan. 22	00:48:56	33 N 47 E	d	
720	1927, Nov. 12	14:45:50	32 1/2 N 46 1/2 E	d	
740	1931, April 27	16:50:38	38 3/4 N 46 E	6 1/2	
760	1934, Feb. 22	08:07:13	38 1/2 N 45 E	d	
780	1932, March 15	07:44:34	41 N 45 E	d	
810	1934, April 3	11:26:37	35 1/2 N 65 E	d	
825	1941, Feb. 16	16:39:03	33 3/4 N 59 E	6 1/4	
835	1931, Aug. 8	08:54:16	37 N 58 1/2 E	d	
850	1940, May 4	21:01:54	35 1/4 N 58 1/4 E	6 1/2	
860	1929, May 1	15:37:30	38 N 58 E	7.1	
870	1933, Oct. 5	13:29:45	35 N 57 3/4 E	6	
880	1928, Nov. 6	13:42:35	40 N 53 1/2 E	d	
890	1938, Feb. 14	02:54:16	40 1/2 N 53 1/2 E	6	
930	1933, July 14	04:41:07	43 N 56 1/2 E	d	
960	1931, Oct. 20	15:58:31	43 N 51 E	d	

REGION 30 (Asia Minor - Levant- Balkans)

No.	Date	Time	Location	M	Remarks
10	1932, May 7	14:54:09	36 1/4 N 45 E	d	
20	1930, May 6	22:34:23	38 N 44 1/2 E	7.2	
25	1926, Oct. 22	19:59:26	40 1/2 N 44 E	d	
30	1935, May 1	10:24:35	39 1/2 N 43 E	6	
40	1941, Sept. 10	21:53:55	39 1/2 N 43 E	6	
50	1940, May 7	22:23:43	42 N 43 E	6 1/2	h=50
60	1924, Sept. 13	14:34:05	40 N 42 E	6 3/4	
70	1934, Nov. 12	07:19:16	39 N 41 E	6	
80	1931, July 31	00:25:50	40 1/2 N 40 E	d	
90	1939, Dec. 26	23:57:21	39 1/2 N 38 1/2 E	8.0	
100	1909, Feb. 9	11:24.1	40 N 38 E	6 3/4	h=60
110	1929, May 18	06:37:51	40 N 38 E	6 1/2	
120	1923, April 29	09:34:35	40 N 37 E	d	
130	1942, Dec. 20	14:03:08	40 1/2 N 36 1/2 E	7.3	
135	1940, April 13	06:29:04	39 1/2 N 36 E	d	
140	1928, Aug. 23	06:15:55	36 1/2 N 36 E	d	
150	1936, June 14	17:01:30	37 N 35 1/2 E	d	
160	1940, July 30	00:12:07	39 3/4 N 35 1/2 E	6 1/4	
170	1941, April 27	13:01:32	40 N 35 1/2 E	d	
180	1924, Feb. 18	17:03:56	34 1/2 N 34 E	6	
190	1943, Nov. 26	22:20:36	41 N 34 E	7.6	
200	1938, April 19	10:59:15	39 1/2 N 33 1/2 E	6 3/4	
210	1921, April 20	16:04:20	34 N 33 E	d	
220	1936, Sept. 21	11:41:24	41 N 33 E	d	
230	1944, Feb. 1	03:22:36	41 1/2 N 32 1/2 E	7.4	
240	1930, May 9	07:07:22	34 1/2 N 32 E	d	
250	1924, Sept. 10	11:59:30	37 N 32 E	d	
260	1931, Jan. 12	15:06:09	38 1/2 N 32 E	d	
270	1929, Aug. 4	09:03:53	36 N 31 E	d	
280	1930, Sept. 11	12:36:44	37 N 31 E	6	
290	1934, June 19	18:43:15	39 N 31 E	d	
300	1925, Aug. 7	06:46:37	38 N 30 1/2 E	5 3/4	
305	1939, Sept. 15	23:16:24	39 3/4 N 30 1/4 E	d	
310	1914, Oct. 3	22:07.1	38 N 30 E	7.1	
320	1943, June 20	15:32:53	41 N 30 E	6 1/4	

No.	Date	Time	Location	M	Remarks
330	1926, March 18	14:06:09	35 N 29 1/2 E	6.9	
340	1932, May 14	03:44:53	36 N 28 1/2 E	d	
350	1922, Aug. 13	00:09:53	36 N 28 E	6 3/4	h=40
360	1941, May 23	19:51:53	37 1/4 N 28 E	6	
361	1941, May 23	22:34:12	37 1/4 N 28 E	d	
370	1932, June 29	02:30:01	35 1/2 N 27 1/2 E	d	
380	1935, Jan. 4	14:41:23	40 1/4 N 27 1/2 E	6 1/4	
381	1935, Jan. 4	16:20:00	40 1/4 N 27 1/2 E	6	
400	1932, Oct. 23	13:36:35	35 1/4 N 27 1/4 E	d	
410	1933, April 23	05:57:35	36 3/4 N 27 1/4 E	6 3/4	h=50
420	1933, April 28	22:28:41	35 1/4 N 27 E	d	
430	1928, March 31	00:29:47	38 N 27 E	6 1/4	
440	1939, Sept. 22	00:36:32	39 N 27 E	6 1/2	
450	1912, Aug. 9	01:29.0	40 1/2 N 27 E	7 3/4	
460	1941, July 13	15:39:31	38 N 26 1/4 E	d	
470	1934, March 8	02:56:47	33 1/4 N 26 E	d	
480	1934, Nov. 21	22:26:13	34 N 26 E	d	
482	1936, Aug. 8	04:12:43	34 N 26 E	d	h=60
490	1931, July 12	22:24:22	39 1/2 N 26 E	d	
500	1940, Feb. 29	16:07:42	35 1/2 N 25 1/2 E	6	
510	1937, Jan. 2	14:04:02	35 N 25 E	d	
520	1928, April 14	08:59:53	42 N 25 E	6 3/4	
530	1928, April 18	19:22:46	42 N 24 3/4 E	6 3/4	
540	1913, Sept. 30	07:33.8	35 N 24 E	5 3/4	h=60
550	1933, May 11	19:09:44	40 1/2 N 23 3/4 E	6 1/4	
560	1932, April 27	01:47:46	34 N 23 1/2 E	d	
570	1914, Oct. 17	06:22.5	38 1/4 N 23 1/2 E	o	
580	1932, Sept. 26	19:20:37	40 N 23 1/4 E	6.9	
590	1932, Sept. 29	03:57:19	40 1/2 N 23 1/4 E	6 1/4	
600	1932, Nov. 1	16:19:26	40 1/2 N 23 1/4 E	d	
610	1904, April 4	10:26.0	41 3/4 N 23 1/4 E	7 1/2	
620	1931, Jan. 4	00:00:43	38 N 23 E	d	
630	1941, May 14	08:36:21	39 1/2 N 23 E	d	
640	1932, Sept. 30	06:12:09	36 N 22 3/4 E	d	
650	1936, June 13	00:32:39	32 3/4 N 22 1/2 E	d	
660	1934, Feb. 21	11:37:13	34 1/2 N 22 1/2 E	d	

No.	Date	Time	Location	M	Remarks
670	1931, March 7	00:16:42	41 N 22 1/2 E	6	
680	1931, March 8	01:50:19	41 N 22 1/2 E	6 3/4	
690	1941, March 1	03:52:48	39 1/2 N 22 E	6 1/4	
700	1942, Aug. 27	06:14:11	42 N 21 E	d	
710	1912, Jan. 24	16:23.1	38 N 20 1/2 E	6 3/4	h=60
720	1932, March 9	10:16:48	38 N 20 1/2 E	d	
730	1941, June 24	15:16:10	41 N 20 1/2 E	d	
740	1943, Feb. 14	07:28:22	38 N 20 E	d	h=50
810	1929, Feb. 10	17:20:16	44 N 44 E	d	
820	1927, June 26	11:20:48	44 1/2 N 34 1/2 E	6	
830	1927, Sept. 11	22:15:47	44 1/2 N 34 1/2 E	6 1/2	
840	1928, Nov. 23	04:23:30	47 1/2 N 30 E	d	
850	1913, June 14	09:33.2	43 1/2 N 25 1/2 E	6 3/4	
860	1916, Jan. 26	07:38.0	46 N 24 E	6 1/2	
950	1927, July 11	13:04:07	32 N 35 1/2 E	6 1/4	

REGION 31 (Western Mediterranean)

No.	Date	Time	Location	M	Remarks
15	1912, April 21	02:53.7	37 1/2 N 19 1/2 E	5 3/4	
30	1930, Nov. 21	02:00:25	40 1/2 N 19 1/2 E	6	
45	1939, May 20	09:35:23	41 N 19 1/2 E	d	
60	1934, Feb. 4	09:35:22	41 1/2 N 19 1/4 E	d	
75	1925, Feb. 7	12:14:58	37 N 19 E	d	
90	1927, Feb. 14	03:43:21	43 N 18 E	6 1/4	h=50
105	1932, Jan. 2	23:36:43	39 N 17 1/2 E	d	
120	1938, May 27	21:23:50	42 1/4 N 17 1/4 E	d	
135	1942, Dec. 29	03:42:12	43 N 17 E	d	
150	1908, Dec. 28	04:20.4	38 N 15 1/2 E	7 1/2	
165	1930, July 23	00:08:37	41 N 15 1/2 E	6 1/2	
180	1932, May 22	17:01:48	38 N 15 1/2 E	d	
195	1939, Jan. 27	20:10:15	38 1/2 N 15 E	d	
210	1933, Sept. 26	03:33:22	42 N 14 1/4 E	d	
225	1929, Dec. 13	04:45:27	36 N 14 E	d	
240	1934, Nov. 30	02:58:14	44 N 14 E	d	
250	1915, Jan. 13	06:52.7	42 N 13 1/2 E	7	
255	1930, Oct. 30	07:13:10	43 3/4 N 13 1/2 E	6	

No.	Date	Time	Location	M	Remarks
270	1943, Oct. 3	08:28:25	42 1/2 N 13 1/4 E	d	
285	1929, April 20	01:09:45	44 N 11 1/4 E	d	
300	1920, Sept. 7	05:55:40	44 N 10 E	5 3/4	
315	1935, March 19	07:27:15	44 3/4 N 6 1/2 E	d	
330	1923, July 10	05:31:13	42 1/2 N 3/4 W	d	
345	1932, March 5	02:10:28	37 1/2 N 2 3/4 W	d	
350	1930, July 5	23:11:47	37 3/4 N 4 1/2 W	d	
360	1934, Nov. 12	08:31:57	38 N 8 1/2 W	d	
375	1941, Dec. 27	18:17:27	36 N 10 1/2 W	6 3/4	h=60
390	1915, July 11	11:28.6	37 N 10 1/2 W	6 1/4	h=50
405	1931, May 20	02:22:49	37 1/2 N 16 W	7.1	
420	1941, Nov. 25	18:03:55	37 1/2 N 18 1/2 W	8.3	
430	1942, May 29	05:32:03	38 N 19 W	d	
490	1921, April 22	16:04:02	44 N 17 W	d	
520	1939, Jan. 23	02:22:46	31 1/2 N 16 E	d	
540	1935, April 20	05:10:51	31 N 15 3/4 E	6 1/2	
560	1941, March 4	23:45:10	30 3/4 N 15 3/4 E	d	
580	1935, April 19	20:31:30	31 N 15 1/2 E	6	
600	1935, April 19	15:23:22	31 1/2 N 15 1/4 E	7.1	
620	1920, Feb. 25	17:56:23	35 N 9 1/2 E	d	
640	1924, March 16	10:17:25	35 N 6 E	d	
660	1910, June 24	13:27.0	36 N 4 E	6.4	
680	1924, Nov. 5	18:54:25	36 N 4 E	d	
700	1943, April 16	11:43:05	35 1/2 N 4 E	d	
720	1934, Sept. 7	03:39:10	36 N 2 E	d	
740	1928, Aug. 24	09:44:15	36 N 0	d	
760	1941, June 12	13:55:35	36 N 1 W	d	
780	1926, Oct. 11	06:38:52	36 N 3 W	d	
800	1935, March 14	17:02:14	36 3/4 N 3 3/4 W	d	
820	1927, Sept. 8	08:52:50	36 N 3 1/2 W	d	
840	1910, June 16	04:16.3	36 1/2 N 4 W	6.1	
860	1923, July 9	15:31:16	35 1/2 N 4 W	d	
880	1930, Aug. 9	18:09:26	34 N 5 W	d	
900	1930, March 7	06:41:00	32 N 11 1/2 W	d	
940	1936, June 20	14:03:10	42 1/2 N 11 W	d	

REGION 32 (Atlantic Ocean)

No.	Date	Time	Location	M	Remarks
5	1925, Feb. 16	17:39:18	58 S 7 W	6 3/4	
10	1925, March 7	18:14:16	58 S 7 W	6 1/2	
15	1928, Nov. 22	08:31:01	56 1/2 S 3 W	6.9	
20	1928, July 19	23:38:45	55 1/2 S 9 E	6 1/4	
25	1938, March 1	23:26:58	55 S 12 E	6 1/2	
30	1942, June 2	00:30:31	54 1/2 S 4 W	6 1/4	
35	1927, Nov. 14	15:04:35	54 S 8 E	6 1/4	
40	1920, Sept. 4	14:09:02	54 S 2 E	6 1/2	
50	1931, April 7	07:39:26	51 S 15 E	6	
60	1933, Jan. 18	08:37:32	37 S 18 W	6 1/4	
70	1939, Aug. 2	00:46:22	36 S 16 W	6 1/2	
75	1930, Dec. 25	13:07:19	33 S 13 W	6 1/4	
95	1925, June 13	20:23:10	29 S 22 W	6	
110	1925, Dec. 15	10:31:31	25 S 9 W	d	
115	1933, Jan. 6	19:10:13	22 S 1 E	6	
125	1926, May 17	21:42:17	14 1/2 S 14 W	d	
130	1929, July 25	22:57:17	13 1/2 S 14 W	6 1/4	
135	1934, May 19	01:15:41	13 S 14 W	6	
140	1943, June 20	17:39:35	11 1/2 S 14 W	6	
145	1928, April 3	16:42:45	11 1/2 S 14 1/2 W	6 1/4	
155	1932, Aug. 1	10:46:26	8 S 12 1/2 W	d	
165	1922, Nov. 8	23:33:45	6 1/2 S 11 W	d	
170	1932, April 30	01:06:19	5 S 11 1/2 W	6	
175	1923, July 20	15:02:37	1 1/2 S 13 1/2 W	6 1/2	
180	1920, July 4	00:11:40	2 S 14 W	6	
185	1928, Aug. 3	11:44:42	2 S 14 W	6	
190	1929, June 6	10:50:11	1 S 14 1/2 W	6 1/2	
195	1933, May 19	17:57:59	1 1/2 S 15 W	6 1/2	
200	1929, March 31	03:09:53	1 S 15 W	d	
210	1942, April 13	07:46:18	1 S 16 W	6 1/2	
215	1939, Dec. 21	01:45:50	1/2 S 16 W	d	
225	1920, Dec. 5	10:01:15	0 17 W	6 1/4	
230	1929, Jan. 18	21:27:45	1 N 17 W	d	

No.	Date	Time	Location	M	Remarks
250	1939, April 23	16:23:06	1/2 N 17 1/2 W	6 1/4	
255	1925, Sept. 12	14:14:58	1 S 19 W	d	
260	1928, May 12	20:28:00	1 N 19 W	6	
265	1941, July 21	16:36:10	1/4 S 19 1/2 W	6	
275	1940, April 27	10:33:13	1 N 19 1/2 W	6 3/4	
280	1940, Oct. 30	03:10:08	1 1/2 S 20 W	6 1/4	
285	1928, Sept. 18	17:19:20	0 20 W	6 1/2	
290	1941, Jan. 24	15:35:24	1/2 N 20 W	6 1/4	
300	1929, Aug. 22	19:40:53	3 S 21 W	d	
305	1929, Feb. 2	00:00:19	1 1/2 S 21 W	7.1	
315	1925, Aug. 20	23:04:30	1 S 21 1/2 W	d	
320	1932, May 21	15:43:30	1 S 21 1/2 W	d	
330	1934, Sept. 1	11:39:26	1/2 N 25 1/2 W	6	
340	1924, June 20	16:21:34	0 26 W	d	
345	1934, Oct. 6	12:48:34	1 N 27 W	6	
355	1920, Nov. 12	05:41:58	1 N 28 W	6.5	
360	1935, Jan. 19	12:37:30	1 N 28 W	6 1/4	
361	1935, Jan. 19	12:58:53	1 N 28 W	6	
365	1924, Oct. 12	19:34:10	1/2 S 29 W	6 1/2	
375	1937, Dec. 28	06:19:26	1 N 29 W	6 1/2	
380	1937, Oct. 6	21:48:02	1 1/2 N 29 W	6 1/4	
390	1923, Sept. 26	02:29:20	1 1/2 N 29 1/2 W	6	
395	1923, Aug. 8	12:17:25	1/2 N 30 W	6 1/4	
400	1934, May 22	11:01:40	1 1/4 N 30 1/4 W	6 1/2	
410	1934, Sept. 26	07:27:28	5 1/4 N 33 W	6 1/4	
415	1939, Nov. 5	02:02:05	7 N 34 W	6	
420	1941, March 21	07:57:59	7 N 35 W	6 1/2	
430	1937, Aug. 22	11:31:44	7 N 36 W	6	
435	1932, May 31	08:37:18	7 N 38 W	6	
440	1934, July 23	18:21:26	7 1/4 N 34 1/2 W	6	
445	1945, June 1	22:24:07	7 1/2 N 34 1/2 W	6	
450	1918, May 20	14:36.0	7 1/2 N 36 W	7.4	
455	1942, Nov. 28	10:38:45	7 1/2 N 36 W	7.1	
465	1928, Aug. 31	05:14:34	8 N 37 W	d	

No.	Date	Time	Location	M	Remarks
470	1929, Jan. 27	16:07:12	8 N 37 W	6 1/2	
480	1928, Dec. 10	15:39:00	9 N 39 W	d	
485	1929, July 27	12:53:12	9 N 40 W	d	
490	1925, Oct. 13	17:40:34	11 N 42 W	7.5	
500	1929, Feb. 22	20:41:46	11 N 42 W	7.2	
505	1927, Sept. 3	19:47:45	11 N 44 W	6.9	
510	1925, July 5	07:02:09	13 1/2 N 42 1/2 W	6	h=60
515	1936, June 22	19:27:00	13 1/2 N 45 W	6	
520	1929, July 6	09:46:15	14 1/2 N 46 W	6 1/2	
525	1930, Feb. 28	00:57:56	15 N 46 W	6	
530	1940, March 4	19:59:05	15 1/4 N 45 W	6	
540	1942, Dec. 31	12:03:42	18 N 47 W	6 1/2	
550	1938, Feb. 15	03:27:42	19 N 26 W	6 1/4	
555	1941, Aug. 15	06:09:25	20 N 27 W	6 3/4	
575	1944, May 6	00:13:42	22 N 44 W	6 1/4	
580	1928, Sept. 14	08:02:02	22 1/2 N 45 1/2 W	d	
585	1935, May 23	17:58:59	23 N 45 W	6 1/4	
595	1924, Oct. 14	05:00:19	24 N 45 W	6 1/2	
600	1922, Jan. 9	05:09:34	24 N 46 W	7.1	
605	1925, Aug. 12	06:58:45	24 N 46 W	6 1/2	h=60
615	1920, Aug. 12	06:21:01	25 N 46 W	d	
625	1937, Dec. 13	22:58:47	26 N 45 W	6	
630	1927, March 6	01:33:40	27 N 45 W	6	
640	1931, Aug. 16	08:06:11	29 N 65 W	d	
650	1935, Feb. 6	01:53:53	30 1/2 N 42 W	6	
660	1923, May 31	22:06:03	32 N 41 W	d	
665	1933, July 23	09:37:48	32 1/2 N 40 W	d	
670	1928, Aug. 15	15:38:48	32 1/2 N 43 W	d	
675	1926, Jan. 7	14:31:18	33 N 40 W	6	
680	1929, April 21	12:37:52	34 N 38 W	d	
685	1926, July 31	18:09:53	35 1/2 N 36 W	d	
690	1932, Dec. 4	04:04:00	35 1/2 N 36 1/2 W	6	
700	1939, June 5	23:03:31	36 N 34 1/2 W	d	
710	1930, Oct. 21	19:05:51	36 1/2 N 23 W	d	
715	1939, May 8	01:46:50	37 N 24 1/2 W	7.1	

TABLE 17 (cont.), REGION 32

No.	Date	Time	Location	M	Remarks
730	1933, Aug. 15	00:45:04	38 N 26 1/2 W	d	
735	1926, July 9	15:05:34	38 N 30 W	d	
740	1926, Aug. 31	10:40:08	38 1/2 N 28 W	d	
745	1941, July 19	09:24:15	38 1/2 N 32 W	d	
750	1926, April 5	23:29:19	39 N 29 W	6	h=50
760	1931, July 9	12:00:19	40 1/4 N 29 1/2 W	d	
770	1924, Aug. 27	22:33:57	41 1/2 N 30 1/2 W	d	
775	1923, July 18	01:06:03	42 N 29 1/2 W	d	
780	1939, April 28	00:32:55	43 N 28 1/2 W	d	
785	1940, July 1	21:29:42	43 N 29 W	d	
790	1923, July 18	06:02:19	43 N 29 1/4 W	d	
795	1930, May 21	22:09:07	43 N 30 W	6	
810	1939, Feb. 6	10:39:20	45 N 27 W	d	
815	1926, Sept. 23	15:11:14	45 N 29 W	d	
825	1922, Feb. 16	02:51:15	48 N 28 W	d	
830	1931, April 15	16:58:58	48 N 28 W	6	
835	1934, Jan. 22	10:07:18	48 1/2 N 28 1/2 W	d	
845	1939, Dec. 25	12:52:47	51 1/4 N 32 1/2 W	d	
850	1932, Jan. 27	19:40:54	51 1/2 N 29 1/2 W	6	
855	1933, Feb. 28	22:19:24	51 1/2 N 30 W	d	
860	1941, June 18	11:09:10	52 N 34 1/2 W	6 1/4	
865	1927, July 6	00:03:48	53 N 34 W	d	
870	1933, July 31	11:35:34	53 N 35 W	d	
875	1923, Sept. 30	01:20:50	54 N 32 W	6 1/2	
880	1923, Nov. 28	00:34:23	54 N 37 W	d	
885	1924, March 22	13:08:52	55 N 34 1/2 W	d	
890	1930, April 16	13:44:50	55 N 34 1/2 W	d	
895	1939, Sept. 21	12:43:50	55 1/2 N 34 1/2 W	d	
900	1931, Sept. 6	08:02:16	55 1/2 N 35 W	d	
905	1924, Dec. 12	02:20:57	56 N 33 W	d	
910	1929, July 4	07:14:23	56 N 33 W	d	
915	1934, Nov. 10	15:39:51	56 N 33 1/2 W	d	
925	1929, March 3	16:52:02	56 N 35 W	d	
930	1929, July 4	07:56:42	56 N 35 1/2 W	d	
935	1933, Dec. 15	07:42:06	56 1/2 N 34 W	6	

TABLE 17 (cont.) REGION 32

No.	Date	Time	Location	M	Remarks
940	1921, Aug. 23	05:11:57	57 N 34 W	d	
945	1932, April 14	01:38:22	58 N 31 1/2 W	d	
947	1936, March 25	08:58:49	58 1/4 N 32 W	d	
950	1941, June 16	21:11:47	59 N 32 W	d	
955	1921, June 30	02:10:13	61 1/2 N 33 W	d	
960	1929, Dec. 15	01:33:26	63 N 36 W	d	
965	1912, May 6	19:00.0	64 N 20 W	7.0	
970	1929, July 23	18:43:08	64 N 23 W	6 1/4	
975	1933, June 10	12:06:54	64 N 23 W	6	
980	1934, May 20	19:04:22	64 1/2 N 2 W	d	
985	1924, Sept. 4	16:01:16	64 1/2 N 23 W	d	
990	1927, July 31	20:59:02	65 1/2 N 19 W	d	
995	1934, June 2	13:42:38	66 N 18 1/4 W	6 1/4	
998	1935, July 17	00:04:13	66 N 8 E	d	

REGION 33 (Indian Ocean)

No.	Date	Time	Location	M	Remarks
2	1935, Oct. 20	04:51:30	18 N 60 E	d	
5	1924, April 20	14:27:04	15 N 52 E	6 1/4	
10	1932, June 11	08:32:56	15 N 53 1/2 E	d	
15	1931, June 24	23:47:04	15 N 59 1/2 E	d	
25	1929, April 28	04:58:44	14 1/2 N 53 E	d	
30	1928, March 19	10:02:06	14 1/2 N 53 1/2 E	d	
35	1941, Sept. 24	03:45:57	14 1/2 N 53 1/2 E	d	
40	1935, Jan. 18	02:08:37	14 1/2 N 56 E	d	
50	1928, Sept. 18	19:52:37	14 N 52 E	6.0	
55	1929, March 16	12:30:52	14 N 54 E	d	
65	1923, Dec. 10	23:53:38	13 1/2 N 50 E	d	
70	1932, Aug. 14	12:36:08	13 1/2 N 56 E	d	
85	1904, Oct. 3	03:05.0	12 N 58 E	7	
95	1940, Oct. 31	05:21:55	11 1/2 N 57 1/2 E	d	
105	1926, Jan. 5	10:03:24	11 N 58 E	d	
115	1932, Feb. 12	00:58:09	10 1/2 N 57 1/2 E	6	
125	1928, July 4	17:53:38	10 N 57 E	d	
130	1929, Jan. 1	13:38:18	9 1/2 N 62 E	d	
135	1939, May 23	04:18:45	9 N 59 E	6	
140	1925, Feb. 2	18:44:31	9 N 62 E	d	

No.	Date	Time	Location	M	Remarks
150	1941, March 16	20:54:53	7 1/2 N 73 E	d	
160	1930, Aug. 23	15:07:40	6 N 65 E	d	
165	1927, Aug. 18	01:50:55	5 N 63 E	d	
170	1928, July 6	00:48:05	4 N 62 1/2 E	d	
175	1932, Feb. 21	13:20:57	4 N 63 E	d	
185	1938, Oct. 21	20:24:12	2 1/2 N 66 E	6 1/2	h=60 ?
190	1932, March 26	07:08:50	2 N 66 1/2 E	d	
195	1926, Dec. 2	16:41:47	1 N 67 E	d	
200	1935, April 24	15:52:18	1/2 N 74 1/4 E	6	
210	1922, Sept. 8	14:14:13	2 1/2 S 68 E	d	
215	1936, Aug. 23	20:45:58	3 S 67 E	d	
220	1930, March 9	08:52:26	3 S 71 E	d	
225	1934, June 20	09:14:50	4 S 69 E	d	
235	1932, July 16	21:02:48	7 S 68 E	6	
240	1941, March 4	15:18:00	7 1/2 S 68 E	d	
245	1922, July 3	05:29:22	8 1/2 S 66 E	6	
250	1929, Feb. 17	20:44:17	8 1/2 S 67 E	d	
255	1912, May 11	17:26.4	9 S 72 E	6.8	
260	1934, May 27	13:26:38	9 1/2 S 66 E	d	
270	1939, Feb. 8	10:26:40	10 1/2 S 66 E	d	
280	1939, Feb. 20	16:48:55	12 S 70 E	d	
285	1929, May 5	16:56:43	13 S 66 E	d	
290	1922, Feb. 14	12:45:22	13 1/2 S 67 E	6	
295	1928, Oct. 25	12:36:19	13 1/2 S 68 1/2 E	6 1/2	
297	1944, Dec. 10	19:23:00	14 S 68 1/2 E	6	
300	1925, July 8	04:56:02	14 1/2 S 67 E	d	
310	1939, July 16	12:21:33	15 S 65 E	d	
320	1931, Dec. 31	00:23:34	17 S 64 E	6 1/4	
325	1941, June 30	16:33:56	17 S 65 E	6	
330	1932, March 18	05:16:19	17 S 65 1/2 E	6	
335	1936, March 21	01:52:11	17 S 66 E	6 1/4	
345	1926, Dec. 24	07:01:10	19 S 65 E	d	
350	1932, Feb. 14	23:13:34	19 S 66 1/2 E	6 1/4	
360	1944, Dec. 10	05:11:28	24 1/2 S 65 1/2 E	6 3/4	
365	1937, Aug. 20	06:38:05	26 S 67 1/2 E	6	

No.	Date	Time	Location	M	Remarks
370	1934, March 8	23:02:20	28 S 68 1/2 E	6	
375	1943, June 14	02:59:58	29 S 60 E	6 1/4	
380	1916, April 7	09:26:12	30 S 55 E	7.4	
385	1923, Nov. 26	12:18:37	31 S 58 E	6	
400	1933, Jan. 21	19:21:10	33 S 57 1/2 E	7.0	
405	1927, March 21	15:05:34	33 S 58 E	6 1/2	
410	1928, Jan. 30	03:15:24	33 S 59 E	6 1/2	
415	1930, Jan. 17	11:10:19	33 S 59 E	6	
420	1930, April 27	14:26:22	33 S 59 E	6 1/4	
425	1929, Jan. 8	07:23:27	33 S 60 E	6 1/4	
430	1929, May 3	08:08:37	33 S 60 E	d	
440	1926, May 31	13:35:49	33 1/2 S 57 E	6 1/2	
445	1925, May 19	05:23:45	33 1/2 S 58 E	6 3/4	
450	1929, April 9	03:52:49	33 1/2 S 58 E	6 1/4	
460	1927, April 16	09:11:19	33 1/2 S 58 1/2 E	6 1/4	
465	1926, Sept. 2	01:21:52	33 1/2 S 59 E	7.0	
470	1929, June 6	14:18:53	33 1/2 S 59 E	6 ?	
480	1933, Oct. 23	13:32:33	34 S 55 E	6	
485	1926, Dec. 2	08:13:44	34 S 57 E	6 1/4	
490	1927, Sept. 10	16:28:15	34 S 57 E	6 1/4	h=50
495	1928, Aug. 8	02:15:14	34 S 57 E	6	
500	1933, Aug. 13	09:27:58	34 S 57 E	6 1/4	
505	1925, May 3	22:59:04	34 S 58 E	7.0	
510	1928, Nov. 11	22:40:56	34 S 58 E	6 1/4	
520	1926, March 21	12:05:58	34 S 58 1/2 E	6	
525	1925, April 11	10:42:02	34 S 59 E	7.0	
530	1927, April 11	22:03:50	34 S 59 E	6	
535	1927, Oct. 19	13:48:40	34 S 59 E	6	
540	1933, Jan. 17	18:47:41	34 S 59 E	6	
550	1925, Oct. 12	05:44:40	34 S 60 E	6 1/4	
560	1927, Nov. 8	03:10:28	34 S 60 E	6 1/2	
565	1928, March 27	19:06:48	34 S 60 E	6 1/4	
570	1929, Sept. 10	20:22:40	34 S 60 E	6 1/4	
580	1909, April 29	22:41.2	35 S 53 E	6.8	
590	1925, May 28	05:55:11	35 S 56 E	6 1/2	

No.	Date	Time	Location	M	Remarks
600	1925, July 7	08:14:02	35 1/2 S 59 1/2 E	6	
605	1943, Sept. 26	02:08:17	38 S 50 E	6 1/2	
610	1941, Nov. 24	16:37:37	38 S 48 1/2 E	6 1/2	
630	1927, Oct. 15	10:59:10	41 S 47 E	d	
640	1941, Oct. 5	07:04:45	44 S 34 E	6 1/4	
650	1927, Jan. 29	18:37:37	44 S 37 E	6 1/4	
660	1927, Oct. 16	14:12:08	44 S 42 E	6	
670	1928, March 17	14:22:09	44 S 43 E	6	
680	1924, Aug. 25	02:21:45	45 S 35 1/2 E	6 3/4	
690	1926, May 9	09:47:37	46 S 34 E	6	
710	1923, Aug. 1	04:29:47	49 S 32 E	6	
720	1942, Nov. 10	11:41:27	49 1/2 S 32 E	7.9	
730	1924, Feb. 29	08:38:20	50 S 30 E	6 3/4	h=60
740	1933, Aug. 22	10:57:15	51 S 31 E	6 1/4	
750	1938, April 21	01:15:14	52 1/2 S 27 1/2 E	6 1/4	
805	1927, July 29	00:03:11	15 N 87 E	6 1/2	
815	1938, Sept. 10	22:23:57	7 1/2 N 79 E	d	
825	1939, Aug. 7	23:59:42	4 N 77 1/2 E	d	
835	1913, Jan. 19	17:05.6	2 N 86 E	7.0	
840	1916, May 9	14:33.7	1 1/2 N 89 E	6.3	
850	1944, Feb. 29	16:28:07	1/2 N 76 E	7.2	
860	1923, May 28	01:25:53	1 1/2 S 88 1/2 E	6 1/2	
865	1939, March 21	01:11:09	1 1/2 S 89 1/2 E	7.2	
870	1926, Jan. 18	21:07:23	2 S 89 E	6 3/4	
875	1928, Feb. 7	00:01:43	2 1/2 S 88 1/2 E	6 3/4	
880	1928, March 9	18:05:27	2 1/2 S 88 1/2 E	7.7	
885	1936, Jan. 13	18:10:16	4 S 85 E	d	
890	1918, April 13	00:51:15	8 S 85 E	6 1/2	
920	1929, Oct. 5	02:34:45	37 S 78 E	6	
925	1940, Feb. 20	12:54:40	37 1/2 S 79 E	6 1/2	
935	1924, Dec. 11	17:28:34	41 S 80 E	6 1/4	
940	1928, May 31	23:23:58	41 1/2 S 80 E	6 1/4	
945	1945, April 18	13:04.8	42 S 80 E	6 1/2	
950	1927, Oct. 16	12:21:25	42 S 81 E	d	
960	1932, May 18	18:45:50	46 S 106 E	6	

No.	Date	Time	Location	M	Remarks
965	1936, March 1	10:27:11	47 S 96 E	6 1/2	
970	1938, May 8	13:48:00	48 S 99 E	6 3/4	
975	1942, Aug. 1	14:30:05	48 S 99 E	7.0	

REGION 34 (North America)

50	1935, Oct. 19	04:48:03	46.6 N 112 W	6 1/4	
60	1935, Oct. 31	18:37:49	46 1/2 N 112 W	6	
100	1925, June 28	01:21:06	46 N 111 1/2 W	6 3/4	
150	1934, March 12	18:20:13	41 3/4 N 112 1/2 W	6	
200	1934, May 6	08:09:49	41 3/4 N 113 W	5 1/2	
250	1934, March 12	15:05:40	41 1/2 N 112 1/2 W	6.6	
260	1934, April 14	21:26:32	41 1/2 N 112 1/2 W	5 1/4	
350	1938, Sept. 17	17:20:18	33 1/4 N 108 3/4 W	5 1/2	
400	1931, Aug. 16	11:40:23	30.6 N 104.2 W	6.4	
450	1928, Nov. 1	04:12:49	27 N 105 1/2 W	6.3	
520	1939, Oct. 19	11:53:58	47 3/4 N 70 W	d	h=40
550	1925, March 1	02:19:18	48 1/4 N 70 3/4 W	7.0	h=60
580	1940, Dec. 20	07:27:26	43.7 N 71.5 W	d	
620	1931, Jan. 8	00:13:41	50 N 74 W	d	
650	1944, Sept. 5	04:38:45	44 3/4 N 74 3/4 W	d	
680	1935, Nov. 1	06:03:40	46.8 N 79.1 W	6 1/4	h=60
850	1934, June 15	06:34:25	61 1/2 N 59 W	d	
950	1929, Nov. 18	20:31:58	44 N 56 W	7.2	
990	1945, July 26	10:32:15	34 1/2 N 81 1/2 W	d	

REGION 35 (Brazilian Shield)

700	1939, June 28	11:32:27	27 1/2 S 48 1/2 W	d	

REGION 36 (Central and Western Europe)

100	1938, March 27	11:16:23	46 N 17 E	d	
200	1928, March 27	08:32:30	46 1/2 N 13 E	d	
300	1936, Oct. 18	03:10:07	46.2 N 12.5 E	d	
400	1935, June 27	17:19:30	48.1 N 9.5 E	d	
500	1911, Nov. 16	21:25.8	48.3 N 9.1 E	6 1/4	h=40
600	1938, June 11	10:57:36	50.8 N 3.6 E	d	
700	1931, June 7	00:25:13	54 N 1 1/4 E	d	
800	1927, Jan. 24	05:18:22	59 N 3 E	d	

REGION 37 (Africa)

No.	Date	Time	Location	M	Remarks
20	1938, May 12	21:31:35	18 1/2 N 37 1/2 E	d	
40	1913, Feb. 27	16:22.9	17 1/2 N 39 E	5 3/4	
60	1941, Jan. 11	08:31:56	17 N 43 E	6 1/4	
80	1913, March 27	03:13.0	16 1/2 N 39 E	5 1/2	
100	1915, Sept. 23	08:14.8	16 N 39 E	6 3/4	
120	1941, Feb. 4	09:17:44	16 N 43 E	d	
140	1921, Aug. 14	13:15:28	15 1/2 N 40 1/2 E	d	
160	1921, Sept. 21	11:01:31	14 N 39 E	d	
180	1930, Oct. 27	23:28:41	12 1/2 N 43 1/2 E	d	
200	1941, March 19	01:31:52	12 N 43 1/2 E	d	
210	1942, Nov. 18	12:01:20	12 N 40 E	d	
220	1929, May 18	01:02:12	11 1/2 N 41 1/2 E	6	
240	1929, Jan. 22	14:43:05	11 1/2 N 43 1/2 E	6	
260	1930, Oct. 25	17:41:55	11 1/2 N 44 E	d	
280	1938, Sept. 27	02:31:49	11 N 41 E	6	
290	1945, Oct. 28	00:17:10	11 N 42 1/2 E	d	
300	1926, Oct. 30	01:38:10	11 N 44 E	d	
320	1930, Oct. 24	10:47:21	10 1/2 N 43 E	d	
340	1938, Oct. 23	02:25:14	10 N 39 1/2 E	d	
350	1938, Oct. 20	13:14:58	10 N 39 1/2 E	d	
370	1906, Aug. 25	13:47.6	9 N 39 E	6 3/4	
390	1928, Oct. 4	18:22:58	7 N 38 E	6	
410	1915, May 21	04:18.1	6 N 31 E	6.6	
430	1913, Sept. 16	11:56.7	6 N 36 1/2 E	6.2	
440	1944, Sept. 6	13:27:55	6 N 38 E	6	
450	1937, Nov. 30	12:57:46	5 N 36 E	6 1/4	
470	1912, July 9	08:18.1	3 N 33 E	6 3/4	
490	1928, Jan. 10	02:25:33	1/2 N 36 E	6	
500	1928, Jan. 6	19:31:58	1/2 N 36 1/2 E	7.0	
510	1945, March 18	08:01:26	0 32 E	6	
520	1919, July 8	21:06:25	6 S 32 1/2 E	6 3/4	
540	1910, Dec. 13	11:37.4	8 S 31 E	7.3	
560	1919, May 1	05:05:39	9 S 35 E	6 1/2	

No.	Date	Time	Location	M	Remarks
580	1942, Oct. 9	15:46:14	11 S 35 E	6 3/4	h=60
600	1940, Dec. 18	03:39:33	13 S 32 E	6	
710	1938, July 21	09:10:42	3 S 40 E	6	
720	1938, Oct. 23	15:01:20	17 S 42 E	6	
725	1943, March 29	05:14:06	18 S 44 E	6	
730	1940, May 19	18:16:32	22 3/4 S 32 1/2 E	6 1/4	
740	1915, May 8	13:42.9	23 S 39 E	6 3/4	
750	1919, Oct. 31	15:36:35	25 S 30 E	6 1/2	
760	1932, Dec. 31	06:30:53	28 1/2 S 32 3/4 E	6 3/4	
770	1912, Feb. 20	13:03.0	29 1/2 S 25 E	6.0	
780	1920, Dec. 4	05:51:47	39 S 21 E	6 1/4	
810	1939, June 22	19:19:31	6 N 1 W	6 1/2	
840	1945, Sept. 12	00:51:20	2 N 15 E	6	
870	1914, May 24	15:56.4	10 S 15 E	6	
950	1929, July 26	17:18:50	2 1/2 S 24 1/2 E	d	

REGION 38 (Australia)

No.	Date	Time	Location	M	Remarks
50	1934, July 12	14:24:18	15 S 112 1/2 E	6	
100	1929, Aug. 16	21:28:25	16 1/2 S 121 E	6 1/4	
150	1906, Nov. 19	07:18.3	22 S 109 E	7 3/4	h=60
200	1941, April 29	01:35:43	26 1/2 S 117 E	6 3/4	h=60
250	1920, Feb. 8	05:24:30	35 S 111 E	6 1/4	
350	1941, May 4	22:07:31	26 1/2 S 137 1/2 E	d	
400	1941, June 27	07:55:49	26 1/2 S 137 1/2 E	6 1/2	
450	1938, April 17	08:56:08	28 S 134 E	6	
500	1939, March 26	03:56:08	31 S 138 E	d	
650	1913, Dec. 18	13:54.0	20 S 147 E	d	Felt, Queensland
750	1918, June 5	18:14:24	24 S 152 E	5 3/4	
850	1929, Dec. 28	01:22:53	40 S 149 E	d	

REGION 39 (Pacific Basin)

No.	Date	Time	Location	M	Remarks
50	1940, July 16	03:17:33	20 1/2 N 155 W	d	
150	1935, June 28	19:30:05	19 1/2 N 155 1/4 W	d	
250	1940, June 17	10:26:47	20 1/2 N 155 1/4 W	6	
350	1940, Sept. 2	08:44:42	21 N 155 1/4 W	d	
450	1941, Sept. 25	17:48:38	19 1/2 N 155 1/2 W	6	

TABLE 17 (cont.), REGION 39

No.	Date	Time	Location	M	Remarks
500	1944, Dec. 27	14:11:40	19 1/2 N 155 1/2 W	d	Strong on Hawaii; felt on Oahu
600	1929, Sept. 26	04:50:56	19 3/4 N 156 W	d	
700	1929, Oct. 6	07:51:31	19 3/4 N 156 W	6 1/2	
800	1938, Jan. 23	08:32:43	21 N 156 W	6 3/4	
950	1933, Jan. 4	21:10:46	28 N 126 1/2 W	5 1/2	

REGION 40 (Arctic Belt)

No.	Date	Time	Location	M	Remarks
15	1921, Aug. 23	20:17:28	67 N 18 W	6 1/4	
30	1910, Jan. 22	08:48.5	67 1/2 N 17 W	7.1	
45	1925, Nov. 28	08:14:53	69 N 18 W	d	
60	1934, Feb. 13	09:51:45	70 1/2 N 14 1/2 W	d	
75	1933, April 25	22:37:54	71 N 19 W	d	
90	1927, July 16	01:35:03	71 N 17 W	d	
91	1927, July 16	02:16:03	71 N 17 W	d	
105	1924, Oct. 10	09:21:17	71 N 16 W	d	
120	1930, Oct. 11	03:06:22	71 N 13 W	d	
135	1932, Nov. 29	08:34:38	71 N 8 W	d	
150	1929, June 27	22:39:07	71 N 6 W	d	
165	1941, Sept. 7	00:50:51	71 1/4 N 2 1/2 W	d	
180	1927, Oct. 30	03:09:04	71 1/2 N 14 W	d	
205	1934, May 21	10:07:19	71 3/4 N 1 1/2 W	d	
220	1923, Oct. 10	07:11:18	72 N 10 W	6 1/2	
235	1922, April 8	20:42:21	72 N 8 1/2 W	6 1/4	
250	1929, Aug. 6	01:30:13	72 N 8 W	d	
265	1941, June 6	21:02:24	72 N 1/2 W	d	
280	1924, March 12	13:52:48	73 N 2 1/2 E	d	
290	1936, June 7	04:38:13	72 1/2 N 4 E	d	
295	1924, July 19	02:50:09	73 1/2 N 4 E	d	
310	1927, Aug. 7	23:57:05	74 N 4 E	d	
325	1932, June 20	15:39:16	74 N 4 E	d	
340	1927, Aug. 8	00:25:28	75 N 2 E	d	
355	1926, Dec. 25	05:13:20	75 N 5 E	d	
370	1938, June 25	23:45:08	77 N 9 E	d	
385	1927, Sept. 6	07:16:09	77 N 10 E	d	
400	1935, May 11	19:14:58	77 1/4 N 4 1/2 E	d	

No.	Date	Time	Location	M	Remarks
415	1930, March 15	09:13:30	78 1/2 N 4 E	d	
420	1935, Aug. 25	05:07:49	78 1/4 N 5 E	d	
430	1915, June 1	14:43.9	78 1/2 N 8 E	6 3/4	
445	1941, July 17	22:08:49	78 1/2 N 8 E	d	
460	1939, Jan. 16	00:11:16	80 N 5 E	d	
475	1943, Nov. 8	06:59:19	80 N 5 E	6	
490	1936, Jan. 2	00:37:09	79 3/4 N 2 E	6	
505	1929, Aug. 16	23:29:02	80 1/2 N 5 E	d	
520	1926, April 24	08:56:26	82 N 3 E	d	
535	1908, Oct. 14	14:56.3	82 N 30 E	6.6	
550	1935, Sept. 30	19:00:42	84 N 2 1/2 W	d	
565	1935, Jan. 26	17:41:34	85 N 35 E	d	
580	1933, Dec. 19	05:39:58	86 1/2 N 35 E	d	
595	1916, Dec. 6	22:17.2	87 N 48 E	5 3/4	
610	1931, June 20	15:05:15	86 1/4 N 79 E	d	
625	1926, Aug. 6	05:23:58	86 N 85 E	d	
640	1912, April 13	02:39.7	80 N 100 E	d	
655	1927, Jan. 7	10:43:12	80 N 117 E	d	
670	1909, April 10	18:46.9	77 1/2 N 128 E	6 3/4	
685	1923, May 30	08:30:40	77 N 127 E	6	
686	1923, May 30	17:56:42	77 N 127 E	6	
700	1926, April 9	10:04:50	74 N 125 E	5 3/4	
715	1918, Nov. 30	06:48:40	71 N 132 E	6 1/4	
730	1927, Nov. 14	00:12:05	70 1/2 N 128 E	6 1/2	
732	1927, Nov. 15	21:48:46	70 1/2 N 128 E	6	
745	1928, Feb. 3	13:47:35	70 1/2 N 128 E	6 1/4	
760	1928, Aug. 16	07:36:37	70 N 126 E	d	
775	1927, Nov. 14	04:56:29	70 N 128 E	6 3/4	
820	1940, June 23	06:55:38	74 3/4 N 14 W	d	
850	1945, Nov. 8	09:05:23	83 N 15 W	6	
851	1945, Nov. 8	10:02:37	83 N 15 W	6	
920	1929, June 10	23:03:14	71 N 10 E	6 1/4	
950	1924, July 25	19:36:22	72 1/2 N 16 E	d	

REGION 41 (Eastern Siberia)

No.	Date	Time	Location	M	Remarks
100	1910, Jan. 8	14:49.5	35 N 122 E	6 3/4	
200	1927, Feb. 3	03:53:10	33 1/2 N 121 E	6 1/2	
300	1932, Aug. 22	11:12:37	36 N 121 1/2 E	6 1/4	
350	1944; Dec. 19	14:08:56	39 N 124 E	6 3/4	
400	1940, Aug. 5	09:55:10	40 N 121 1/2 E	d	
500	1941, May 5	15:18:32	46 1/2 N 127 E	6	
600	1924, March 15	10:31:22	49 N 142 1/2 E	7.0	
650	1935, Oct. 25	17:38:13	51 N 142 1/2 E	d	
700	1932, July 10	00:43:22	52 1/2 N 142 E	6	
750	1939, Jan. 22	04:41:08	56 N 130 E	d	
800	1931, July 15	16:26:57	59 N 148 E	6 1/4	
900	1931, Oct. 10	16:37:05	59 1/4 N 147 3/4 E	6 1/2	
950	1936, Nov. 3	04:43:26	59 1/2 N 153 E	d	

REGION 42 (Baffin Bay to Bering Sea)

No.	Date	Time	Location	M	Remarks
50	1945, Jan. 1	01:20:42	73 N 70 W	6 1/2	
100	1933, Nov. 20	23:21:32	73 N 70 3/4 W	7.3	
150	1934, Aug. 31	05:02:45	73 N 71 W	6 1/2	
180	1935, Aug. 22	20:30:52	73 1/4 N 71 1/2 W	d	
200	1934, Feb. 24	00:49:03	73 1/2 N 71 1/2 W	d	
250	1933, Dec. 19	17:48:20	75 N 72 W	d	
300	1935, April 18	22:15:28	70 1/2 N 73 W	d	
500	1920, Nov. 16	08:30:57	72 1/2 N 128 W	6 1/2	h=50
550	1940, May 29	01:57:52	67 N 135 W	6 1/4	
600	1940 June 5	11:01:10	67 1/2 N 136 W	6 1/2	
650	1926, July 14	22:22:25	66 N 163 W	d	
700	1928, Feb. 24	14:10:23	67 N 171 W	6 1/4	
750	1928, Feb. 21	19:49:04	67 N 172 W	6.9	
800	1928, May 1	18:54:41	67 N 172 W	6 1/4	
850	1928, Feb. 26	01:19:10	68 N 172 W	6 1/2	
900	1933, Sept. 7	22:39:18	61 3/4 N 177 1/2 E	d	
950	1934, March 9	14:02:30	62 N 173 E	d	

REGION 43 (Southeastern Pacific)

No.	Date	Time	Location	M	Remarks
20	1932, Nov. 2	11:03:22	22 S 112 W	6 3/4	
40	1933, Sept. 27	22:40:42	24 S 111 W	d	
60	1931, May 10	19:24:45	25 S 116 W	6 1/4	
80	1931, May 27	06:34:14	25 1/2 S 116 1/2 W	6 1/4	
90	1944, April 19	22:32:10	26 S 112 1/2 W	6	
100	1935, Sept. 15	14:09:00	27 S 113 W	6 3/4	
120	1918, May 11	21:23:14	27 S 113 1/2 W	6 1/4	
140	1932, Jan. 5	01:53:56	27 S 114 W	6 1/2	
160	1938, Jan. 13	22:44:25	27 S 116 W	6	
170	1944, Nov. 18	07:53:19	28 S 112 W	6	
180	1943, Sept. 19	04:47:48	28 S 113 W	6 1/4	
190	1944, April 22	03:35:38	28 S 113 1/2 W	6	
200	1912, July 18	21:16.3	28 S 114 W	6 1/2	
220	1926, June 25	03:36:52	28 S 115 W	6 1/4	
240	1940, Jan. 2	11:07:14	28 1/2 S 113 W	6 1/4	
260	1925, Dec. 19	16:09:30	32 S 111 W	6 3/4	
280	1929, May 28	04:49:15	33 S 110 W	6 1/4	
300	1929, July 14	08:58:00	33 S 110 W	6 1/2	
320	1940, March 7	07:08:40	33 S 111 W	6 1/2	
340	1943, July 21	04:13:57	34 S 110 W	6 1/2	
360	1920, March 20	18:31:25	35 S 110 W	7.0	
370	1944, April 4	22:46:00	36 S 101 W	d	
380	1934, Sept. 1	06:57:32	36 S 104 W	6 1/2	
400	1939, Oct. 20	07:13:25	36 S 111 W	d	
420	1939, Aug. 24	14:44:50	37 1/2 S 104 W	d	
440	1927, March 12	18:44:32	41 S 106 W	6 1/2	h=50
450	1944, May 18	19:55:12	44 S 109 W	6	
460	1937, Nov. 23	13:52:50	44 S 116 W	6 1/4	
480	1930, June 15	21:08:11	46 S 116 W	6 1/4	
500	1934, Oct. 27	09:54:55	48 S 116 W	6 1/4	
520	1933, April 19	01:45:47	51 S 116 W	6	
540	1941, Feb. 14	18:55:16	53 1/2 S 131 W	6 1/2	
560	1935, May 16	20:41:30	55 S 123 W	6 1/4	

No.	Date	Time	Location	M	Remarks
570	1943, Nov. 13	16:43:28	55 S 129 W	6 1/2	
580	1930, Jan. 6	23:50:00	55 S 131 W	6	
600	1940, Jan. 20	09:58:00	55 S 133 W	6 3/4	
620	1932, March 10	05:17:47	55 S 135 W	6 1/2	
640	1938, Sept. 5	14:42:32	55 S 152 W	6	
660	1929, Feb. 16	19:23:16	56 S 121 W	6 1/4	
680	1934, June 6	03:18:34	56 S 140 W	6 1/4	
700	1937, Aug. 13	11:47:38	56 1/2 S 130 W	6	
720	1926, Dec. 27	08:42:55	57 S 110 W	6	
740	1926, Dec. 27	09:20:30	57 S 110 W	6 1/4	
760	1930, Aug. 2	16:06:05	57 S 135 W	6 1/2	
770	1944, April 1	09:22:08	57 S 128 W	6±	
780	1944, Sept. 3	19:11:29	57 S 122 W	7	
800	1918, May 25	19:29:20	30 1/2 S 92 1/2 W	7	h=60
820	1934, April 9	15:29:24	35 S 99 W	6 1/2	
840	1942, July 20	13:31:45	35 S 99 W	6	
860	1937, Nov. 9	10:21:40	36 1/2 S 97 W	6	
880	1937, March 23	00:44:26	36 1/2 S 98 W	6 1/2	h=50
900	1942, Sept. 22	00:46:15	37 S 98 W	6 1/4	
920	1932, March 23	12:08:02	37 S 99 W	6	
940	1942, Oct. 9	00:40:50	37 S 100 W	d	
960	1926, Aug. 14	08:36:50	40 S 88 W	6	
980	1937, Oct. 11	21:23:02	42 S 91 W	6	

REGION 44 (Eastern Pacific)

No.	Date	Time	Location	M	Remarks
20	1927, Nov. 19	06:51:00	10 N 101 W	d	
60	1930, Jan. 17	16:54:30	8 N 105 W	d	
80	1944, Dec. 29	22:55:59	8 N 104 W	6	
81	1944, Dec. 29	23:45:19	8 1/2 N 104 W	6 1/4	
100	1939, Feb. 28	01:17:00	7 N 103 W	d	
140	1928, Dec. 26	21:32:52	6 N 99 W	6	
180	1931, Aug. 30	07:34:34	6 N 99 W	d	
220	1938, June 20	14:02:28	6 N 119 W	d	
260	1937, Aug. 24	20:13:23	5 N 89 W	6	
300	1935, June 11	21:55:55	3 1/2 N 83 W	d	

No.	Date	Time	Location	M	Remarks
340	1926, May 5	06:21:33	3 N 91 W	6 1/2	
380	1938, Feb. 4	10:27:21	3 N 91 W	6	
420	1928, Dec. 5	11:04:32	3 N 95 W	d	
460	1937, May 24	00:40:32	3 N 95 W	d	
500	1931, July 27	16:28:54	1 1/2 N 90 1/2 W	d	
520	1940, Aug. 26	05:00:43	1 1/4 N 90 W	d	
530	1944, June 11	19:18:56	1 N 86 W	d	
540	1935, Nov. 23	07:52:30	1/2 N 85 1/2 W	6 1/4	h=60
580	1932, Oct. 3	04:37:40	1 S 91 W	d	
620	1940, May 31	04:56:20	2 1/2 S 103 1/2 W	d	
660	1934, June 24	01:39:55	2 1/2 S 106 1/2 W	6	
700	1931, April 24	02:15:05	3 S 103 W	d	
740	1938, Oct. 10	02:56:23	3 1/2 S 105 1/2 W	d	
780	1934, Feb. 20	03:18:55	4 S 105 W	6	
820	1942, July 25	15:18:55	5 S 104 W	d	
860	1936, Aug. 26	21:19:32	5 S 106 W	d	
900	1941, July 17	07:47:53	5 S 106 W	d	
920	1939, July 23	15:07:24	9 S 109 W	6	
950	1936, March 5	06:05:58	9 1/2 S 108 W	6	
970	1937, Sept. 15	19:30:05	10 S 110 W	d	
990	1944, Aug. 5	00:57:17	13 1/2 S 92 1/2 W	6±	
991	1944, Aug. 5	01:24:08	13 1/2 S 92 1/2 W	6 1/4±	

REGION 45 (Indian-Antarctic Swell)

No.	Date	Time	Location	M	Remarks
25	1931, Dec. 1	03:20:21	63 S 153 E	6 1/4	
50	1938, Oct. 9	16:36:40	62 S 160 E	6	
75	1940, Oct. 1	21:38:20	62 S 160 E	6 1/2	
100	1929, May 22	20:06:15	62 S 155 E	6 1/2	
125	1945, March 23	23:14:13	62 S 153 E	7.1	
150	1931, Jan. 19	15:54:51	61 S 150 E	d	
175	1931, Nov. 26	11:54:42	61 S 150 E	d	
176	1931, Nov. 26	12:30:00	61 S 150 E	d	
200	1939, April 15	20:03:40	61 S 150 E	d	
225	1940, Nov. 17	05:55:47	61 S 148 E	6 1/2	
250	1930, Dec. 13	02:35:32	60 S 150 E	6	

TABLE 17 (cont.), REGION 45

No.	Date	Time	Location	M	Remarks
275	1930, Sept. 14	03:01:05	60 S 148 E	6 1/4	
300	1925, Aug. 14	04:08:38	59 S 151 E	6 1/2	
325	1931, Dec. 7	18:51:57	59 S 148 E	d	
350	1928, Feb. 29	21:57:00	58 1/2 S 148 E	6 1/4	
375	1933, Oct. 7	02:09:35	58 1/2 S 146 E	d	
400	1933, Sept. 6	01:15:46	58 S 146 E	d	
425	1940, Aug. 8	14:08:20	57 1/2 S 147 E	6 1/4	
450	1931, Sept. 25	16:35:02	57 1/2 S 144 E	d	
451	1931, Sept. 25	20:31:27	57 1/2 S 144 E	d	
460	1933, Feb. 27	16:09:57	57 1/2 S 144 E	6	
475	1934, Nov. 24	12:34:03	57 S 146 E	6 1/4	
500	1942, Dec. 17	01:08:20	57 S 146 E	6	
525	1931, Dec. 1	18:10:02	57 S 144 E	6 1/2	
550	1940, March 29	23:20:22	57 S 144 E	6	
575	1934, Sept. 22	23:08:00	56 1/2 S 144 E	d	
600	1929, Dec. 28	11:28:24	56 1/2 S 143 E	d	
625	1927, Sept. 7	19:57:05	56 S 148 E	6 1/4	
650	1925, April 26	08:24:40	56 S 147 E	6 1/4	
675	1940, March 14	18:22:35	56 S 145 E	6 3/4	
700	1942, June 10	13:49:30	55 1/2 S 143 1/2 E	d	
725	1937, Oct. 12	03:10:12	53 S 145 E	6	
750	1931, Dec. 25	03:04:24	52 S 141 E	6	
775	1931, Aug. 10	09:43:57	52 S 137 E	d	
800	1926, July 25	04:52:40	51 S 146 E	d	
825	1921, Jan. 7	02:51:24	51 S 140 E	6 1/4	
850	1927, Dec. 31	23:13:23	51 S 140 E	6	
860	1936, Aug. 24	22:22:00	51 S 140 E	6 1/4	
875	1929, Dec. 31	04:10:20	51 S 138 E	6	
900	1931, Aug. 1	19:14:42	51 S 138 E	d	
925	1927, June 14	17:16:55	50 S 140 E	6 1/2	
950	1940, June 12	11:48:49	50 S 139 E	d	
975	1929, Jan. 21	04:55:35	50 S 136 E	6	

REGION 47 (Baluchistan)

No.	Date	Time	Location	M	Remarks
30	1940, Oct. 31	10:43:56	24 1/2 N 70 1/4 E	d	
100	1934, May 1	03:40:40	27 N 69 E	d	
170	1931, Aug. 26	19:29:20	28 N 69 E	d	
240	1931, Sept. 30	11:14:45	28 1/2 N 69 E	d	
310	1930, Sept. 29	13:29:00	27 1/2 N 68 1/2 E	d	
380	1928, Sept. 1	06:09:00	29 N 68 1/2 E	6 1/4	
450	1935, May 15	02:01:24	28 N 68 E	6	
520	1909, Oct. 20	23:41.2	30 N 68 E	7.2	
590	1931, Aug. 24	21:35:22	30 1/4 N 67 3/4 E	7.0	
660	1928, Oct. 15	14:19:41	28 1/2 N 67 1/2 E	6.8	
730	1931, Aug. 27	15:27:17	29 3/4 N 67 1/4 E	7.4	
800	1933, Oct. 16	04:34:44	33 N 67 E	d	
870	1935, May 30	21:32:46	29 1/2 N 66 3/4 E	7.5	
920	1935, June 2	09:16:25	30 N 66 3/4 E	6	
980	1934, April 19	23:27:00	24 N 65 E	d	

REGION 48 (Hindu Kush and Pamir)

30	1944, Sept. 27	16:25:02	39 N 73 1/2 E	7.0	h=40
60	1924, July 6	18:31:49	40 1/2 N 73 1/2 E	6 1/2	
90	1924, July 12	15:12:34	40 1/2 N 73 1/2 E	6 3/4	
120	1933, March 22	02:22:55	42 1/2 N 73 1/2 E	d	
150	1911, Feb. 18	18:41:03	40 N 73 E	7 3/4	
180	1932, Oct. 29	11:08:49	39 1/2 N 72 E	6	
210	1934, Nov. 15	23:14:42	36 1/2 N 71 E	d	
212	1936, Aug. 20	23:32:33	36 1/2 N 71 E	d	
240	1939, June 19	00:42:40	36 1/2 N 71 E	d	
270	1934, Sept. 8	06:44:56	38 1/2 N 71 E	d	
300	1934, Aug. 31	14:57:41	38 3/4 N 71 E	6 1/2	
330	1939, May 30	10:07:04	39 N 71 E	d	
360	1924, Sept. 16	02:36:00	39 N 70 1/2 E	6 1/4	
390	1941, April 20	17:38:30	39 N 70 1/2 E	6 1/2	
395	1941, April 26	23:11:01	39 N 70 1/2 E	d	
420	1941, May 6	16:55:36	39 N 70 1/2 E	6	h=60
450	1940, March 19	04:35:50	35 3/4 N 70 E	6	h=50

No.	Date	Time	Location	M	Remarks
480	1926, March 22	16:24:10	36 N 70 E	d	
510	1933, Dec. 2	02:15:16	36 1/2 N 69 1/2 E	d	
520	1933, Dec. 9	07:52:10	36 1/2 N 69 1/2 E	d	
540	1907, Oct. 21	04:23.6	38 N 69 E	8.0	
570	1923, Dec. 28	22:24:52	39 1/2 N 68 E	6	
600	1935, July 5	17:53:01	38 N 67 1/2 E	6	
630	1928, Feb. 25	17:23:58	37 1/2 N 67 E	d	
660	1929, June 3	20:29:47	43 N 67 E	6 1/2	
720	1929, Sept. 4	22:24:57	43 N 67 E	d	
750	1911, Jan. 1	10:18.0	38 N 66 E	7.2	h=50
780	1932, Oct. 2	03:22:02	41 1/2 N 66 E	d	
810	1929, June 13	22:15:51	43 N 66 E	d	
			REGION 50 (Antarctic)		
500	1929, Aug. 14	02:16:50	66 S 175 E	6	

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TABLE 18

REGIONAL LIST OF INTERMEDIATE AND DEEP SHOCKS

REGION 1 (Aleutian Islands, Alaska),Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
40	1940, Feb. 7	17:16:02	70 km.	51 1/2 N 175 E	7	AAA
80	1940, July 14	05:52:53	80	51 3/4 N 177 1/2 E	7 3/4	AAA
120	1941, Aug. 4	10:53:09	70	53 1/4 N 179 E	6 3/4	BBB
160	1937, Sept. 3	18:48:12	80	52 1/2 N 177 1/2 W	7.3	AAA
200	1933, Sept. 24	15:19:41	70	51 3/4 N 177 W	6 3/4	AAA
240	1930, Dec. 6	07:03:28	80	53 N 172 W	6 1/2	CCC
280	1916, April 18	04:01.8	170	53 1/4 N 170 W	7.5	BBB
320	1909, Sept. 8	16:49.8	90	52 1/2 N 169 W	7.4	BCB
360	1944, July 27	00:04:23	70	54 N 165 1/2 W	7.1	BBB
400	1939, Feb. 24	14:15:45	70	53 N 164 1/2 W	6 1/4	CCA
420	1942, Sept. 9	01:25:26	80	53 N 164 1/2 W	7.0	BBB
460	1939, Aug. 20	07:17:26	75	54 N 164 W	6 1/4	CCB
500	1941, Aug. 6	06:15:06	150	55 3/4 N 163 W	6 3/4	AAA
540	1941, Sept. 28	05:33:45	100	56 N 162 1/2 W	6 1/2	CCB
580	1907, Aug. 22	22:24.0	120	57 N 161 W	6 1/2	CCB
620	1910, May 13	07:58.1	100	57 N 160 W	6 3/4	CCC
660	1942, Dec. 5	14:28:40	100	59 1/2 N 152 W	6 1/2	BBB
700	1931, Dec. 24	03:40:40	100	60 N 152 W	6 1/4	BBA
720	1936, May 8	17:22:18	170	61 N 153 W	5 3/4±	BBB
740	1912, Nov. 7	07:40.4	90	57 1/2 N 155 W	7 1/2	BBB
780	1944, Aug. 14	11:07:23	100	59 N 155 W	6 1/4	BBB
820	1912, Dec. 5	12:27.6	90	57 1/2 N 154 W	7	CCC
860	1934, June 18	09:13:50	80	60 1/2 N 151 W	6 3/4	AAA
900	1912, Jan. 31	20:11.8	80	61 N 147 1/2 W	7 1/4	BBB
940	1934, May 4	04:36:07	80	61 1/4 N 147 1/2 W	7.2	AAB

REGION 5 (Mexico), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
25	1925, Aug. 7	07:47:48	100	19 N 102 W	6 3/4	BCB
50	1933, Oct. 10	13:34:52	110	19 N 102 W	5 1/2	BBB
75	1942, June 20	10:02:07	100	19 N 101 W	6 3/4	BBB
100	1933, Jan. 24	15:39:09	90	18 3/4 N 101 3/4 W	6 1/4	AAB
125	1939, May 23	02:49:43	90	18 N 101 W	5 1/2	BCB
150	1945, April 21	17:14:28	100	19 N 100 1/2 W	6 1/2	BBA

TABLE 18 (cont.), REGION 5

No.	Date	Time	Depth	Location	M	Quality
175	1912, Nov. 19	13:55.0	80	19 N 100 W	7	BBC
200	1938, June 28	19:17:42	110	18 N 100 W	6 1/2	ABA
225	1941, Feb. 23	11:32:15	120	18 N 100 W	5 3/4	BBB
250	1937, Oct. 6	09:47:18	100	18 1/2 N 99 W	6.9	BAA
275	1938, May 3	02:15:27	100	18 1/2 N 99 W	6 1/2	AAA
300	1908, March 26	23:03.5	80	18 N 99 W	7.8	BCB
325	1945, Oct. 11	16:52:52	90	17 1/2 N 98 1/2 W	6 1/2	CCC
350	1928, Feb. 10	04:38:35	100	19 N 97 1/2 W	6 1/2	BCB
375	1920, April 19	21:06:36	110	19 N 97 W	6 3/4	BBB
400	1932, March 10	23:01:39	150	18 1/2 N 97 W	5 1/2	CCC
425	1910, Sept. 24	03:32.7	80	17 N 96 W	6.9	CCC
450	1911, Aug. 27	10:59.3	100	17 N 96 W	6 3/4	BCB
475	1937, July 26	03:47:11	100	18.4 N 95.8 W	7.3	AAA
500	1943, May 3	10:17:17	150	18 N 95 W	5 3/4	CCC
525	1916, June 2	13:59.4	150	17 1/2 N 95 W	7.1	CCC
550	1942, Nov. 12	04:55:34	90	17 1/4 N 94 1/4 W	6 3/4	BBB
575	1937, May 28	15:35:53	150	17 N 93 W	6 1/2	CBB
600	1941, June 27	17:11:44	220	17 3/4 N 92 1/4 W	6 1/4	BBB
625	1914, March 30	00:41.3	150	17 N 92 W	7 1/2	BBC
650	1937, Jan. 11	13:21:16	110	16 N 94 1/2 W	6	BBA
675	1944, Aug. 24	23:37:54	100	16 N 93 1/2 W	6	BBA
700	1945, Jan. 12	21:59:29	110	16 N 93 W	5 3/4	BBB
725	1937, June 8	22:29:39	200	16 N 93 W	6 1/4	BAA
750	1935, March 17	21:33:18	110	14 1/2 N 92 W	5 3/4	BAA
775	1939, Dec. 12	02:50:12	240	15 1/2 N 91 3/4 W	5 1/2	AAB
785	1939, Sept. 28	14:58:27	110	15 1/2 N 91 1/2 W	6 1/4	BCB
800	1943, Sept. 23	15:00:44	110	15 N 91 1/2 W	6 3/4	AAA
825	1942, April 11	01:25:12	140	14 3/4 N 91 1/2 W	6 1/2	BBB
850	1940, July 27	13:32:30	90	14 1/4 N 91 1/2 W	6 3/4	AAA
875	1943, Aug. 31	16:10:40	80	14 1/4 N 91 1/2 W	6 3/4	BBB
900	1939, Jan. 20	20:40:27	70	13 1/2 N 91 1/2 W	6 1/2	BBB
925	1934, May 19	10:47:37	120	14 3/4 N 91 1/4 W	6 1/4	AAA
935	1945, Oct. 27	11:24:41	200	15 N 91 1/4 W	6 3/4	BBB
950	1921, Feb. 4	08:22:44	120	15 N 91 W	7.5	BBB

No.	Date	Time	Depth	Location	M	Quality
975	1937, Dec. 5	05:42:09	80	14 N 91 W	5 1/2	CCA
999	1932, May 22	22:40:02	80	14 1/4 N 90 W	6	BCB
REGION 6 (Central America), Intermediate Shocks						
50	1944, Oct. 2	17:22:00	160	14 1/2 N 89 3/4 W	6 1/2	AAA
100	1915, Sept. 7	01:20.8	80	14 N 89 W	7 3/4	BBB
150	1939, Dec. 26	11:55:11	75	13 1/4 N 88 1/4 W	6	AAA
200	1931, Feb. 7	03:30:35	100	13 N 87 W	5 3/4	CCC
250	1934, Feb. 24	05:33:30	200	12 3/4 N 86 3/4 W	6	ABB
300	1926, Nov. 5	07:55:38	135	12.3 N 85.8 W	7.2	BBA
330	1944, April 7	13:32:58	200	12 N 85 1/2 W	6	BCC
350	1925, Oct. 5	04:09:07	135	12 1/4 N 85 1/4 W	6 3/4	BBA
400	1931, March 7	00:41:56	80	11 1/2 N 85 1/2 W	6	ACB
450	1919, July 22	22:01:35	150	12 N 85 W	6 1/2	CCC
500	1931, Dec. 20	14:59:42	280	11 N 84 1/2 W	5 3/4	BCC
550	1939, June 18	16:46:05	70	10 N 83 W	6 1/2	BCB
600	1939, Nov. 28	02:09:56	80	8 3/4 N 78 1/2 W	5 3/4	BBB
650	1914, May 28	03:23.9	70	9 N 78 W	7.2	CCB
700	1937, Sept. 24	02:40:07	100	9 N 76 W	5 1/2	CCC
750	1932, June 20	09:01:47	80	12 1/2 N 89 W	6	AAA
800	1939, July 8	21:31:44	90	12 1/2 N 88 W	5 1/2	CCC
850	1932, May 21	10:10:07	90	12 N 87 1/2 W	6.9	AAA
950	1919, June 29	23:14:23	90	13 1/2 N 86 1/2 W	6 3/4	BCC
REGION 7 (Caribbean), Intermediate Shocks						
100	1925, June 14	22:28:16	90	18 N 83 W	6 1/2	CCC
200	1933, July 21	07:29:05	100	19 N 68 1/2 W	5 3/4	BCC
250	1916, April 24	04:26.7	80	18 1/2 N 68 W	7.2	BCC
400	1943, Jan. 23	13:30:10	110	18 N 61 1/2 W	5 3/4	CCB
450	1935, Nov. 10	18:27:46	100	16 1/2 N 62 1/2 W	6 1/4	BBB
500	1914, Oct. 3	17:22.2	100	16 N 61 W	7.4	BBC
550	1906, Dec. 3	22:59.4	100	15 N 61 W	7 1/2	CCC
600	1940, July 6	03:40:18	160	13 N 61 1/4 W	6 1/2	BBA
650	1939, April 20	17:46:14	130	13 N 60 1/2 W	5 1/4	CCC
700	1910, Jan. 23	18:49.7	100	12 N 60 1/2 W	7.2	CCC
750	1935, April 10	22:32:31	100	10 1/2 N 62 W	6 1/2	BCC
800	1945, Dec. 23	08:10:01	100	10 N 62 W	6 1/2	BBB

No.	Date	Time	Depth	Location	M	Quality
850	1923, Aug. 8	12:01:27	110	10 1/2 N 63 1/2 W	6 1/2	BCB
875	1926, Feb. 1	01:17:33	100	10 1/2 N 63 1/2 W	6 1/2	BCB
900	1911, April 10	18:42.4	100	9 N 74 W	7.2	CCC
950	1930, May 29	08:30:54	220	7 N 74 1/2 W	6	CCC

REGION 8 (South America), Intermediate Shocks

5	1935, Sept. 18	04:58:00	80	5 1/2 N 76 W	6 1/4	BBB
10	1942, May 22	10:30:50	130	4 1/2 N 75 W	5 3/4	BCC
15	1938, Feb. 5	02:23:34	160	4 1/2 N 76 1/4 W	7.0	AAA
20	1935, Oct. 27	22:05:05	150	4 N 76 W	5 1/2	BCB
25	1925, June 7	23:41:42	170	3 N 78 W	6 3/4	BBA
28	1944, May 9	14:29:57	100	2 1/2 N 75 1/2 W	6	BCC
30	1945, July 9	16:42:08	100	2 1/2 N 76 1/2 W	6 1/2	CCC
35	1937, May 21	13:12:25	90	2 1/2 N 77 1/2 W	6 1/2	AAA
40	1925, June 23	16:46:58	180	0 77 W	6 3/4	BCB
45	1937, July 19	19:35:24	190	1 1/2 S 76 1/2 W	7.1	AAA
50	1940, Oct. 23	02:23:15	140	2 S 76 W	6	CCA
55	1930, Nov. 24	06:06:48	100	2 S 77 W	6 1/4	CCC
60	1906, Sept. 28	15:24.9	150	2 S 79 W	7 1/2	CCC
65	1935, Nov. 2	21:05:40	130	2 S 79 W	6	CCC
70	1924, July 22	04:04:18	250	2 S 80 W	6 1/2	BBA
75	1943, Jan. 30	05:33:03	100	2 S 80 1/2 W	6.9	BBA
80	1943, Dec. 22	07:01:50	130	2 1/2 S 77 W	6 1/4	BBA
85	1941, Jan. 24	05:44:03	120	3 1/4 S 76 3/4 W	6 1/2	AAA
90	1935, March 8	11:59:14	100	4 S 80 W	6	CCC
95	1934, Oct. 29	23:25:23	110	5 S 78 W	6 1/4	BBB
100	1926, March 7	20:33:38	150	5 S 76 1/2 W	6 1/2	CCC
105	1938, Jan. 16	21:41:47	100	6 S 75 W	6	BCC
110	1942, Nov. 6	13:31:10	130	6 S 77 W	6 3/4	BBA
112	1942, Jan. 8	15:12:33	110	6 S 78 W	5 1/2±	BBB
115	1943, April 5	03:08:58	140	6 1/2 S 76 W	6 1/2	CCC
125	1933, Oct. 1	02:40:42	120	7 S 75 1/4 W	6 1/4	AAA
130	1936, May 6	03:38:55	160	8 S 75 W	6	BBA
135	1931, July 11	05:56:13	120	8 1/2 S 74 1/2 W	6 1/4	ABC
140	1929, May 25	11:59:38	150	8 1/2 S 75 1/2 W	6 3/4	BAA
145	1939, Nov. 26	06:26:18	130	8 1/2 S 77 1/2 W	5 1/2	BCB

No.	Date	Time	Depth	Location	M	Quality
150	1937, June 22	05:34:03	150	9 S 79 W	5 3/4	CCC
155	1945, Aug. 21	16:29:37	120	10 1/2 S 75 W	6 3/4	BBA
160	1933, Aug. 6	02:54:52	100	11 S 75 1/2 W	6 1/2	BCC
165	1940, Aug. 26	02:27:59	110	11 1/2 S 75 W	6	BBA
170	1932, Jan. 20	02:30:50	100	12 S 77 1/2 W	6 3/4	BCC
175	1935, March 9	02:54:37	150	12 S 78 W	5 3/4	CCC
180	1939, April 25	12:53:37	150	12 1/2 S 75 1/2 W	6 1/4	BBC
185	1937, March 28	12:21:42	120	13 1/2 S 75 W	5 1/2	CCC
190	1937, Oct. 15	03:41:15	90	13 1/2 S 77 W	5 1/4	CCA
195	1941, Sept. 18	13:14:09	100	13 3/4 S 72 1/4 W	7.0	BBA
200	1925, Jan. 5	13:45:46	200	14 S 73 1/2 W	6 1/2	CCC
205	1940, Aug. 4	16:07:05	120	14 S 74 W	5 1/2	CCC
210	1944, Feb. 29	03:41:53	200	14 1/2 S 70 1/2 W	7	BBB
215	1928, Sept. 21	13:27:05	250	15 S 70 1/2 W	6 3/4	BBA
220	1943, Feb. 16	07:28:35	190	15 S 72 W	7	BBB
225	1932, Dec. 9	08:34:55	75	15 S 75 W	6 1/2	ABB
230	1933, Aug. 9	23:02:45	170	15 1/2 S 68 1/2 W	6 1/4	BBB
235	1940, Dec. 22	18:59:46	230	15 1/2 S 68 1/2 W	7.1	BBA
240	1935, Sept. 19	09:55:47	250	15 1/2 S 70 W	6 1/2	BCB
245	1937, March 29	07:49:47	120	15 1/2 S 71 W	6 3/4	BBA
250	1935, March 26	19:54:47	120	15 1/2 S 73 W	6	BBB
255	1941, Oct. 15	09:35:15	110	15 1/2 S 74 W	6	CCB
260	1933, July 31	15:23:07	80	15 1/2 S 75 1/2 W	6	BBB
265	1933, July 23	04:13:11	80	15 3/4 S 75 1/4 W	6	ABB
270	1923, Sept. 2	22:38:12	150	16 S 68 1/2 W	7.0	BBB
275	1937, July 9	17:27:40	180	16 S 72 W	6	BCC
280	1936, Sept. 16	17:44:13	130	16 S 72 1/2 W	5 3/4	BBA
283	1943, July 6	09:40:00	160	17 S 70 W	5 3/4±	CCB
285	1939, Dec. 13	18:45:24	100	17 S 74 W	5 1/2	CCB
290	1914, Feb. 26	04:58.2	130	18 S 67 W	7.2	CCB
295	1939, May 19	18:25:35	100	18 S 69 W	6 1/4	BCA
300	1936, July 4	08:52:35	140	18 S 70 W	6	BBA
305	1921, Oct. 20	06:03:24	120	18 1/2 S 68 W	7	BAC
310	1915, June 6	21:29:37	160	18 1/2 S 68 1/2 W	7.6	BBB
315	1939, Oct. 7	23:51:18	110	18 1/2 S 70 W	6	BBB

No.	Date	Time	Depth	Location	M	Quality
320	1941, July 10	09:29:42	120	18 1/2 S 70 W	6	CCB
325	1939, Sept. 13	18:03:30	130	18 1/2 S 70 1/2 W	5 3/4	BBA
330	1932, May 30	00:22:45	160	19 S 69 W	5 3/4	BBB
335	1932, July 29	00:45:18	110	19 S 70 W	6	BAA
340	1933, Sept. 14	07:59:24	100	19 S 70 1/2 W	5 1/4	BCB
345	1934, Dec. 4	17:24:38	130	19 1/2 S 69 1/2 W	6.9	BBC
355	1909, May 17	08:02.9	250	20 S 64 W	7.1	CCC
360	1920, Aug. 13	02:03:00	150	20 S 68 W	6 1/2	CCB
365	1943, March 14	18:37:55	150	20 S 69 1/2 W	7.2	CCC
370	1936, Dec. 5	00:37:58	100	20 S 70 1/2 W	6	BBA
375	1932, June 18	00:13:39	70	20 S 71 W	6 1/4	BCB
380	1931, May 28	03:15:04	120	20 1/2 S 70 1/2 W	6 1/2	CCB
385	1939, July 4	18:26:12	290	21 S 66 W	6 3/4	BBA
390	1927, May 22	01:45:10	140	21 S 67 W	6 1/4	BCC
395	1916, Aug. 25	09:44.7	180	21 S 68 W	7 1/2?	CCC
400	1922, March 28	03:57:54	90	21 S 68 W	7.2	BCB
405	1927, Oct. 3	23:55:52	100	21 S 68 W	6 1/2	CCC
410	1934, Dec. 23	09:52:28	100	21 S 68 W	6 1/2	BBA
412	1943, Dec. 1	10:34:45	100	21 S 69 W	7 1/4	BBC
415	1940, Oct. 3	04:56:08	110	21 S 70 W	6 1/4	CCB
420	1939, Nov. 1	19:11:45	240	21 1/2 S 68 W	5 3/4	CCB
425	1939, Jan. 18	12:40:11	70	21 1/2 S 70 W	5 3/4	BBB
430	1939, May 13	00:43:35	210	22 S 66 W	5 1/2	CCC
435	1936, Jan. 31	15:14:15	160	22 S 67 W	5 1/2	CCC
440	1939, Oct. 5	04:55:50	240	22 S 67 W	6	CCC
445	1941, Nov. 10	09:44:50	200	22 S 67 W	6 1/4	CCA
450	1940, Aug. 7	02:55:57	110	22 S 68 1/2 W	6 1/4	BBA
455	1934, June 24	05:59:34	100	22.0 S 68.6 W	6.9	BAA
460	1910, Oct. 4	23:00.1	120	22 S 69 W	7 1/4	CCC
465	1933, Nov. 3	04:14:43	70	22 S 70 1/2 W	5 1/2	CCB
470	1940, Oct. 4	07:54:42	75	22 S 71 W	7.3	BBB
475	1941, April 3	14:55:16	260	22 1/2 S 66 W	6 1/2	BCB
476	1941, April 3	15:21:39	260	22 1/2 S 66 W	7.2	BBA
480	1936, Nov. 29	14:55:10	230	22 1/2 S 67 W	6	BCC

No.	Date	Time	Depth	Location	M	Quality
485	1936, June 22	10:28:06	100	22 S 68 W	6	CBA
490	1931, July 18	05:27:05	150	22 1/2 S 69 W	6 3/4	BAB
495	1934, Nov. 28	05:48:50	80	22 1/2 S 69 W	5 3/4	BCB
500	1933, Oct. 10	03:34:12	110	22 1/2 S 69 1/2 W	5 1/2	BBB
505	1932, Feb. 27	08:49:40	120	22 1/2 S 70 W	5 1/2	BCB
510	1937, Sept. 24	19:09:52	130	22 1/2 S 70 W	6	BCB
515	1940, March 24	11:48:39	280	23 S 66 W	5 3/4	CCC
516	1934, March 24	22:52:46	270	23 S 66 W	5 3/4	BCC
520	1933, Oct. 25	23:28:16	220	23.0 S 66.7 W	7.0	AAA
522	1941, Aug. 14	01:43:40	180	23 S 66 3/4 W	6	BBB
525	1935, Feb. 28	07:10:25	200	23 S 67 W	6 1/4	CCC
530	1936, Nov. 7	06:32:47	200	23 S 67 W	6	BBB
535	1937, Feb. 24	18:45:45	260	23 S 67 W	5 1/4	CCC
540	1933, Feb. 10	08:46:01	110	23 S 68 W	5 3/4	CCB
545	1940, Sept. 18	15:09:03	110	23 S 68 W	6 1/2	CCB
550	1935, Sept. 28	04:00:30	100	23 S 68 1/2 W	5 1/4	CCC
555	1929, Oct. 19	10:12:52	100	23 S 69 W	7.5	BAB
556	1929, Oct. 19	20:20:42	100	23 S 69 W	6	BAB
560	1933, Oct. 12	07:12:50	100	23 S 69 1/2 W	6 1/4	BCB
565	1938, April 24	14:10:58	180	23 1/2 S 66 W	6	BCC
570	1928, May 26	08:28:56	130	23 1/2 S 69 W	6 1/4	BBB
575	1936, Nov. 7	05:07:30	200	24 S 66 W	5 3/4	CCC
580	1927, Aug. 1	11:28:36	200	24 S 66 1/2 W	6 1/2	BCB
585	1927, Nov. 17	20:54:47	200	24 S 66 1/2 W	5 1/2	BBB
587	1944, July 23	16:13:39	250	24 S 66 1/2 W	6	BBB
590	1938, Aug. 4	08:54:51	220	24 S 68 W	6 3/4	BAA
595	1934, Dec. 16	16:31:10	150	24 S 68 W	6	CCC
600	1939, Aug. 12	19:41:04	70	24 S 68 1/2 W	5 3/4	BCB
605	1926, April 28	11:13:50	180	24 S 69 W	7.0	BCB
610	1942, July 8	06:55:45	140	24 S 70 W	7.0	BCC
615	1932, Nov. 1	10:38:54	100	24 S 70 W	6	CCB
620	1927, Nov. 26	12:53:58	180	24 1/2 S 67 W	6 3/4	AAA
625	1937, Oct. 12	20:50:55	110	25 S 68 1/2 W	6 1/2	ABA
630	1932, April 26	07:54:48	70	25 S 69 1/2 W	6 1/2	ABB

No.	Date	Time	Depth	Location	M	Quality
632	1944, Dec. 22	22:31:47	120	25 S 70 W	6 1/2	BBB
635	1935, Feb. 13	17:22:01	100	25 1/2 S 69 W	6 1/2	BAA
640	1930, Sept. 23	23:34:10	150	26 S 66 W	6 1/2	BCC
645	1940, Feb. 12	00:01:30	70	26 1/2 S 71 W	6 1/2	CBB
650	1931, April 3	05:19:06	180	27 S 65 W	6 1/4	ABB
655	1939, April 18	06:22:45	100	27 S 70 1/2 W	7.4	AAA
660	1932, June 9	06:30:43	80	27 1/2 S 70 1/2 W	5 3/4	BCB
665	1936, Dec. 19	02:57:37	160	28 1/2 S 68 1/2 W	5 3/4	CCB
670	1918, May 20	17:55:10	80	28 1/2 S 71 1/2 W	7.5	BCC
675	1939, July 8	02:38:00	170	29 S 68 W	5 1/2	BCB
680	1937, March 19	18:11:55	70	29 S 70 W	6	BCB
682	1943, Nov. 29	19:37:00	100	29 1/2 S 68 1/2 W	6 3/4	CCC
685	1939, Jan. 18	01:44:18	70	29 1/2 S 71 W	6 1/4	BBA
690	1940, Oct. 1	10:42:38	80	30 S 72 1/2 W	6 1/2	CCB
695	1938, Jan. 9	20:26:00	120	30 1/2 S 69 W	5 3/4	CCB
700	1938, June 23	01:03:58	70	30 1/2 S 70 W	6 1/2	CBA
705	1939, Feb. 19	12:51:40	100	30 1/2 S 71 W	5 1/2	CCB
710	1936, April 30	17:06:19	200	31 S 65 W	6	BBB
715	1933, Dec. 21	04:31:55	120	31 S 69 W	6 1/4	BBB
720	1938, June 15	07:43:50	70	31 S 70 1/2 W	6	BBA
725	1939, Oct. 1	10:56:54	200	31 1/2 S 66 1/2 W	5 3/4	CCC
730	1937, Feb. 12	18:32:58	200	32 S 66 1/2 W	5 1/2	BBB
735	1927, April 14	06:23:34	110	32 S 69 1/2 W	7.1	BAA
740	1933, Nov. 14	14:05:09	110	32 S 69 1/2 W	6 1/2	BAA
745	1932, May 8	19:21:27	110	32 S 70 W	5 1/2	DDD
746	1932, May 10	11:53:04	110	32 S 70 W	5 1/2	DDD
750	1932, Nov. 29	11:11:05	110	32 S 71 W	6 3/4	BBA
755	1942, June 29	06:26:40	100	32 S 71 W	6.9	CCB
760	1931, Aug. 17	05:05:25	120	32 1/2 S 69 1/2 W	5 3/4	BCB
765	1945, Sept. 13	11:17:11	100	33 1/4 S 70 1/2 W	7.1	BBA
770	1934, June 11	03:07:09	100	33 1/2 S 64 1/2 W	6	BBB
775	1934, June 11	06:00:33	100	33 1/2 S 64 1/2 W	6	BBB
780	1935, May 28	12:08:54	200	33 1/2 S 68 W	5 3/4	CCB
785	1937, Oct. 27	00:21:20	110	34 1/2 S 71 W	6	BCA

No.	Date	Time	Depth	Location	M	Quality
790	1940, Sept. 29	01:21:22	110	35 S 70 W	6 1/4	CCB
795	1932, June 11	13:11:32	80	35 S 71 W	5 3/4	BCC
800	1940, Oct. 24	20:06:40	80	35 S 72 1/2 W	6 3/4	CBA
805	1937, Jan. 30	10:31:52	100	36 S 72 W	5 1/2	CCB
810	1932, March 1	19:01:50	290	36 1/2 S 70 W	5 1/2	BCC
815	1937, Dec. 24	03:23:38	70	37 S 72 W	5 1/2	BCB
				REGION 8, Deep Shocks		
40	1911, April 28	09:52.9	600	0 71 W	7.1	CCC
80	1921, Dec. 18	15:29:35	650	2 1/2 S 71 W	7.6	BBB
81	1922, Jan. 17	03:50:33	650	2 1/2 S 71 W	7.6	CBB
120	1939, Dec. 24	22:27:40	600	6 1/2 S 71 W	5 1/2	CCC
160	1915, April 23	15:29.3	650	8 S 68 W	7 1/4	CCB
200	1930, Aug. 4	05:04:31	650	9 1/2 S 70 1/2 W	6 1/2	AAA
201	1940, Sept. 24	09:55:44	600	9 1/2 S 70 1/2 W	6	CCB
240	1935, Dec. 14	01:31:13	650	9 1/2 S 70 1/2 W	6.9	AAA
241	1935, Dec. 16	16:57:24	650	9 1/2 S 70 1/2 W	6 1/4	AAA
242	1935, Dec. 28	04:50:49	650	9 1/2 S 70 1/2 W	5 3/4	AAA
280	1927, April 6	18:54:05	600	10 S 70 W	6	CDC
300	1944, June 8	02:38:04	600	10 S 71 W	6 1/4	CCB
320	1922, Sept. 4	17:04:08	660	10 1/2 S 69 1/2 W	6.9	BAB
360	1933, Aug. 29	14:52:36	650	10.9 S 69.5 W	6 1/2	AAA
400	1922, July 10	09:38:10	630	19 S 62 1/2 W	6 3/4	BBC
440	1928, Jan. 5	21:46:13	640	19 1/2 S 64 W	6 3/4	BBB
480	1940, Sept. 23	07:15:10	550	23 S 64 W	6 1/2	BBB
500	1940, May 1	02:34:02	580	25 1/2 S 62 1/2 W	6 1/4	CCB
520	1939, Jan. 24	19:48:53	580	26 1/2 S 63 W	6	BBA
560	1942, Nov. 30	00:47:58	590	27 S 63 1/2 W	6 1/2	CCA
600	1926, Feb. 9	00:24:24	660	28 S 62 W	6 1/2	CCC
640	1928, Aug. 15	17:15:43	620	28 S 62 1/2 W	6.5	AAA
680	1916, June 21	21:32:30	600	28 1/2 S 63 W	7.5	BCC
720	1934, Jan. 9	07:32:32	630	28 1/2 S 63 W	6	BBB
760	1912, Dec. 7	22:46:50	620	29 S 62 1/2 W	7 1/2	CCC
800	1936, Jan. 14	14:12:13	620	29 S 62 1/2 W	6.9	AAA

REGION 9 (South America 37° - 59° S), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
200	1934, March 1	21:45:25	120	40 S 72 1/2 W	7.1	AAB

REGION 10 (Southern Antilles), Intermediate Shocks

200	1937, Sept. 8	00:40:01	130	57 S 27 W	7.2	BBB
250	1936, Sept. 7	12:17:26	160	58 S 30 W	6 3/4	CCB
300	1941, Nov. 15	04:19:54	80	59 S 27 1/2 W	7.0	BCC
400	1926, June 20	06:54:28	170	59 S 27 W	6.9	CCC
500	1935, May 14	23:23:10	155	59 S 26 1/2 W	7.0	BBB

REGION 11 (New Zealand), Intermediate Shocks

300	1914, Nov. 22	08:14.3	100	39 S 176 E	7±	CCC
400	1921, June 28	13:58:55	140	38 1/2 S 175 1/2 E	6 3/4	BCC
500	1938, Oct. 30	12:45:23	150	38 1/2 S 176 1/2 E	5±	BCC
510	1938, Nov. 1	23:21:20	150	38 1/2 S 176 1/2 E	5±	BCC
700	1940, Oct. 7	01:25:39	170	38 1/2 S 176 3/4 E	5 3/4±	AAA
800	1931, Sept. 21	13:34:25	80	37 1/2 S 178 E	6 3/4	BCB
900	1939, May 14	18:12:24	80	36 1/2 S 179 E	6±	BCB

REGION 12 (Kermadec and Tonga Islands), Intermediate Shocks

25	1933, May 21	08:13:42	100	35 S 180	6	CCC
75	1943, July 11	02:10:25	180	32 1/2 S 178 1/2 W	7.0	BBB
100	1937, Sept. 1	08:38:59	120	32 S 180	7.0	BBC
125	1940, Jan. 21	04:19:36	230	32 S 178 W	6 1/4	CCB
140	1932, Oct. 20	17:36:43	70	30 S 179 W	6	CCB
150	1912, May 15	00:04.3	250	30 S 178 1/2 W	6 1/2	CCC
175	1943, Sept. 27	22:03:44	90	30 S 178 W	7.1	BBB
200	1933, Nov. 7	12:08:17	80	30 S 177 W	5 1/2	CCB
225	1934, Sept. 23	07:59:03	80	30 S 177 W	6	BBB
250	1911, July 19	10:01.0	200	29 S 179 W	6.9	CCC
275	1941, Nov. 24	21:46:23	80	28 S 177 1/2 W	7.3	ABA
300	1932, July 20	20:05:46	170	27 S 178 W	6 1/2	BAA
325	1944, Nov. 30	01:45:53	180	23 S 179 W	6 3/4	CCB
350	1940, Feb. 12	08:20:57	200	23 S 177 1/2 W	6 3/4	AAB
375	1943, March 26	17:38:14	100	23 S 176 1/2 W	6.9	BBB
400	1933, June 11	13:09:12	80	22 S 176 W	6 1/2	CCB
425	1936, April 7	01:37:44	100	21 S 177 W	6±	CCC

No.	Date	Time	Depth	Location	M	Quality
450	1934, Feb. 9	22:32:13	230	20 1/2 S 176 1/2 W	6 1/2	BCB
475	1930, April 30	16:06:10	180	20 S 176 W	6 3/4	BCB
500	1932, June 16	23:13:05	200	20 S 176 W	6	CCB
525	1943, May 12	08:23:15	270	20 S 175 W	5 3/4	CCB
550	1919, Jan. 1	02:59:57	180	19 1/2 S 176 1/2 W	7 3/4-8	BCC
575	1918, Oct. 14	12:00.5	130	19 S 174 W	7	CCC
625	1944, Aug. 25	12:25:02	240	18 S 175 1/2 W	6 1/4	BCB
650	1935, Jan. 1	13:21:00	300	17 1/2 S 174 1/2 W	7.1	BAA
660	1934, Nov. 9	03:58:56	80	17 1/2 S 174 W	6 1/4	BBB
675	1913, May 8	18:35.4	200	17 S 174 1/2 W	7.0	CCC
725	1935, Aug. 21	13:48:44	100	16 S 174 W	6 1/4	BBB
750	1939, Oct. 30	13:12:36	150	16 S 174 W	6 1/2	BCA
760	1940, April 14	09:33:22	200	16 S 174 W	6 1/4	CCB
765	1940, July 16	22:05:50	150	16 S 174 W	5 1/2	CCB
825	1939, June 8	20:46:53	100	15 1/2 S 174 W	7.2	AAA
850	1941, Feb. 24	12:44:09	80	15 1/2 S 173 1/2 W	5 3/4	CCB
875	1944, Oct. 11	09:45:15	80	15 S 173 W	6 3/4	BBB
880	1944, July 10	13:24:59	180	14 1/2 S 175 1/2 W	6 3/4	CCC
900	1931, July 20	08:30:30	80	14.S 173 W	6 1/2	BCB

REGION 12, Deep Shocks

No.	Date	Time	Depth	Location	M	Quality
10	1938, April 15	02:59:17	580	33 S 179 E	5 3/4	CCC
20	1942, June 15	13:47:12	550	31 1/2 S 179 E	6 3/4	BCC
30	1935, April 20	09:35:23	500	31 1/2 S 179 1/2 W	5 3/4	CCC
40	1928, Sept. 12	01:20:00	500	31 S 180	6 1/4	BCC
50	1931, May 15	07:41:58	500	29 S 180	6	CCC
60	1939, Aug. 2	04:56:50	380	28 S 178 W	5 1/2	CCC
70	1938, May 16	01:07:20	600	27 S 179 E	5 3/4	CCB
80	1911, April 28	18:35.7	600	27 S 179 1/2 E	6 1/2	CCC
90	1937, May 10	15:25:38	640	26 1/2 S 178 E	6 1/2	CBB
100	1937, June 19	17:07:27	650	26 1/2 S 178 1/2 E	6 1/4	BBB
110	1931, Oct. 18	04:30:33	500	26 S 180	6 3/4	AAA
120	1940, Aug. 1	12:39:38	500	26 S 180	6 3/4	BBA
130	1932, May 26	16:09:40	600	25 1/2 S 179 1/4 E	7 3/4	BCB
131	1932, May 26	22:21:54	600	25 1/2 S 179 1/4 E	6 1/2	BCB

No.	Date	Time	Depth	Location	M	Quality
132	1932, May 27	01:29:48	600	25 1/2 S 179 1/4 E	6 1/4	BCB
133	1932, May 27	05:55:23	600	25 1/2 S 179 1/4 E	5 3/4	CCC
140	1934, Dec. 12	08:40:49	600	25 S 178 E	6 1/2	BBA
145	1944, Nov. 13	19:23:30	610	24 1/2 S 179 E	6±	CCA
150	1943, April 28	23:43:18	530	24 1/2 S 180	6 1/2	BCB
160	1942, Aug. 29	01:39:20	570	24 S 179 1/2 E	6 3/4	BBB
170	1934, Oct. 10	15:42:06	540	23 1/2 S 180	7.3	AAB
180	1934, Dec. 15	19:14:26	530	23 1/2 S 179 1/2 W	6.9	AAA
190	1943, March 24	11:11:27	430	23 S 179 W	6 1/4	CCB
195	1944, May 14	08:51:36	600	23 S 179 1/2 E	6	CCB
200	1939, May 21	20:21:53	600	22 1/2 S 179 W	6	BCA
210	1940, July 21	18:28:15	550	22 S 179 E	5 3/4	CCB
220	1922, March 10	16:52:30	570	22 S 180	6 3/4	BCC
230	1939, July 5	22:41:04	650	22 S 180	6.9	CBB
240	1939, July 20	02:23:00	650	22 S 179 1/2 W	7.0	CCC
250	1943, March 4	06:32:23	600	22 S 179 1/2 W	6	CCB
260	1940, May 21	18:48:56	350	22 S 178 1/2 W	6 1/2	AAA
270	1944, April 23	10:57:45	370	22 S 177 1/2 W	6 1/2	BBB
280	1933, Sept. 6	22:08:29	600	21 1/2 S 179 3/4 W	7.1	BAA
290	1928, June 17	06:41:53	640	21 1/2 S 179 1/2 W	6 1/4	BAB
300	1944, May 25	01:06:37	640	21 1/2 S 179 1/2 W	7.2	BBB
310	1924, Dec. 26	23:32:00	540	21 1/2 S 179 W	6 1/4	CCC
320	1940, Oct. 30	11:48:28	610	21 1/2 S 179 W	6 1/4	BBA
330	1939, Nov. 17	18:39:30	600	21 1/2 S 178 W	6	BBB
340	1937, April 16	03:01:37	400	21 1/2 S 177 W	7 3/4	BAA
350	1933, Jan. 23	18:14.6	600	21 S 180	6 1/4	CCC
360	1945, Nov. 26	05:13:10	600	21 S 180	7.0	BBA
370	1943, May 28	20:01:30	630	21 S 179 1/2 W	6 1/2	CCA
380	1934, Jan. 18	03:21:05	580	21 S 179 W	6 1/2	CCC
390	1944, Dec. 1	04:00:25	600	21 S 178 1/2 W	6.4	CCB
400	1910, Dec. 14	20:46.2	600	21 S 178 W	7	CCB
410	1924, May 4	16:51:43	560	21 S 178 W	7.3	BAA
420	1936, Nov. 15	21:50:16	540	21 S 178 W	6 1/2	BBB
430	1942, July 7	02:53:52	430	21 S 178 W	6 3/4	BBA

TABLE 18 (cont.), REGION 12, Deep Shocks

No.	Date	Time	Depth	Location	M	Quality
440	1911, Aug. 21	16:28:55	300	21 S 176 W	7.3	BCC
450	1924, Jan. 16	21:38:00	350	21 S 176 W	7.0	CCC
460	1935, July 29	07:38:53	510	20 3/4 S 178 W	7.2	AAA
470	1941, Dec. 31	17:23:20	630	20 1/2 S 180	6 1/4	CCC
480	1919, Aug. 18	16:55:25	300	20 1/2 S 178 1/2 W	7.2	BCC
490	1941, Feb. 22	19:14:49	500	20 1/2 S 177 1/2 W	6	BCB
500	1931, April 3	23:19:18	680	20 S 179 3/4 E	6 3/4	BAA
510	1915, Feb. 25	20:36.2	600	20 S 180	7 1/4	BCB
520	1935, Sept. 12	16:01:22	600	20 S 179 W	6	CCC
530	1935, July 15	14:13:35	580	20 S 178 1/2 W	6 1/2	BBB
540	1941, June 21	17:41:35	580	20 S 178 1/2 W	6 1/4	BCA
550	1927, April 1	19:06:09	400	20 S 177 1/2 W	7.1	CCB
560	1910, April 20	22:22.0	330	20 S 177 W	7	CCC
570	1924, May 25	13:46:35	550	19 S 179 W	6 1/4	CCC
580	1938, March 6	16:54:05	500	19 S 178 W	6	CCC
590	1938, April 25	09:20:16	400	19 S 176 1/2 W	5 1/2	CCC
600	1936, Feb. 10	18:05:40	570	18 1/2 S 178 W	6 3/4	BBB
610	1936, Nov. 26	08:33:32	560	18 1/2 S 178 W	6 1/2	BBB
620	1941, Nov. 4	02:26:47	570	18 1/4 S 178 W	6 1/4	BBA
630	1916, July 8	09:34.5	600	18 S 180	7	CCC
640	1909, Feb. 22	09:21.7	550	18 S 179 W	7.5	CCB
650	1940, Jan. 1	12:15:13	570	18 S 178 1/2 W	6 1/4	BBB
660	1943, June 25	19:13:28	550	18 S 178 W	6 1/4	CCA
670	1907, March 31	22:00.6	400	18 S 177 W	7 1/4	CCB
680	1910, Aug. 21	05:38.6	600	17 S 179 W	7 1/4	CCC
690	1941, May 8	10:21:48	580	17 S 179 W	6.9	ABA
700	1918, May 22	06:31:27	380	17 S 177 1/2 W	7	BCC
710	1939, Oct. 3	13:41:22	600	16 1/2 S 179 1/2 W	6 1/4	CCA

REGION 13 (Fiji), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
500	1939, Jan. 25	20:26:22	220	13 S 178 W	5 3/4	CCC

REGION 13 (Fiji), Deep Shocks

No.	Date	Time	Depth	Location	M	Quality
200	1941, Jan. 25	23:35:13	370	16 S 176 1/2 W	6 1/2	BCA
400	1941, Nov. 22	04:41:54	380	16 S 174 W	5 3/4	CCB
600	1939, Jan. 5	03:24:55	380	15 S 176 W	5 1/2	CCB
800	1943, March 15	22:59:15	300	14 1/2 S 177 W	6 3/4	BBA

REGION 14 (New Hebrides), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
10	1936, Feb. 16	14:16:56	160	24 S 173 E	6 1/2	BBB
20	1918, Sept. 30	17:51:45	80	24 S 171 1/2 E	6 3/4	BBB
30	1940, Sept. 19	18:19:48	80	24 S 171 E	7.0	AAA
40	1941, July 20	06:01:00	100	24 S 170 1/2 E	5 3/4	CCC
50	1941, Nov. 23	15:59:00	100	23 1/2 S 173 E	5 3/4	CCC
60	1944, Dec. 21	09:01:30	100	23 1/2 S 172 1/2 E	6 1/2	CCC
70	1911, Sept. 12	12:53.3	150	23 S 172 1/2 E	6 3/4	CCC
80	1941, Nov. 5	11:05:29	100	23 S 172 1/2 E	6	CCC
90	1941, Nov. 5	13:05:22	100	23 S 172 E	6 1/4	CCC
100	1913, Nov. 15	05:27.1	150	23 S 171 E	7	CCC
110	1944, Sept. 6	05:52:31	120	22 1/2 S 172 E	6 1/2	BBB
113	1944, Oct. 5	17:28:27	120	22 1/2 S 172 E	7 1/2	BBB
120	1935, Aug. 17	01:44:42	120	22 1/2 S 171 E	7.2	BBB
130	1944, Dec. 8	07:17:05	90	22 1/2 S 170 E	6 1/4	CCB
131	1944, Dec. 8	12:59:25	70	22 1/2 S 170 E	6 1/4	CCB
140	1909, Aug. 18	00:39.5	100	22 S 172 E	7 1/4	CCC
150	1931, March 2	02:18:34	110	22 S 172 E	7.1	BBA
160	1940, Sept. 3	01:28:01	100	22 S 171 3/4 E	6	BBB
170	1942, Sept. 14	11:31:01	130	22 S 171 1/2 E	7.0	BBA
180	1940, Jan. 6	14:03:24	90	22 S 171 E	7.2	AAA
190	1943, March 11	09:34:11	80	22 S 170 E	6 3/4	BBB
200	1944, June 25	14:17:30	80	22 S 169 1/2 E	6 3/4	CCC
210	1941, April 18	06:15:58	120	20 1/2 S 170 E	6 1/4	BBB
220	1910, March 30	16:55.8	80	21 S 170 E	7 1/4	CCC
230	1931, July 21	03:36:22	140	21 S 170 E	7.0	AAA
240	1938, June 23	12:55:28	90	20 3/4 S 169 1/2 E	6.9	BBB
250	1933, July 14	01:38:14	110	20 1/2 S 169 1/2 E	6	CDD
260	1938, May 30	14:29:50	70	20 1/2 S 169 1/2 E	7.0	BBB
263	1938, June 30	16:44:48	70	20 1/2 S 169 1/2 E	6 1/4	BBB
270	1933, Dec. 1	10:26:26	140	20 1/2 S 169 E	6 1/2	BCB
280	1931, Oct. 23	11:45:29	80	20 S 170 E	6	BCB
290	1943, Aug. 1	16:18:41	230	20 S 170 E	7.0	ABB
300	1910, May 1	18:30.6	80	20 S 169 E	7.1	CCC

No.	Date	Time	Depth	Location	M	Quality
303	1910, June 1	05:55.5	80	20 S 169 E	7 1/2	CCC
304	1910, June 1	06:48.3	80	20 S 169 E	7 1/4	CCC
310	1934, April 11	21:11:57	150	19 1/2 S 169 1/2 E	6 3/4	ABB
320	1913, Oct. 14	08:08.8	230	19 1/2 S 169 E	7 3/4	CCC
330	1939, April 5	16:42:40	70	19 1/2 S 168 E	7.1	AAA
340	1939, Aug. 27	11:18:00	280	19 S 170 E	6 1/2	CCC
350	1910, June 16	06:30.7	100	19 S 169 1/2 E	8.1	BBB
360	1941, May 7	12:19:44	140	19 S 169 1/2 E	6 3/4	BCB
370	1942, Jan. 29	09:23:44	130	19 S 169 E	7.1	BBB
380	1944, Nov. 24	04:49:03	170	19 S 169 E	7.5	AAA
382	1944, Nov. 29	18:51:21	170	19 S 169 E	7.0	AAB
390	1912, March 25	04:49.5	240	18 S 169 E	7	CCC
400	1913, Nov. 10	21:12.5	80	18 S 169 E	7 1/2	CCC
410	1939, Aug. 12	02:07:27	180	16 1/4 S 168 1/2 E	7.2	AAA
420	1940, July 21	05:16:03	160	16 S 169 1/2 E	6	CCA
430	1919, Aug. 31	17:20:46	180	16 S 169 E	7 1/4	BBB
440	1935, June 24	23:23:14	140	15 3/4 S 167 3/4 E	7.1	AAA
450	1934, June 3	16:15:40	120	15 1/2 S 168 E	6 1/2	BBB
460	1924, Dec. 15	20:49:15	210	15 1/2 S 167 1/2 E	6 1/2	BCC
470	1911, Nov. 22	23:05.4	200	15 S 169 E	7 1/4	CCB
480	1915, Jan. 5	14:33:15	200	15 S 168 E	7 1/4	BCC
490	1928, Aug. 24	21:43:30	220	15 S 168 E	7.0	BAB
500	1933, July 30	17:15:31	160	15 S 167 E	6 1/2	CCB
510	1942, June 3	16:31:10	120	15 S 166 1/2 E	6 1/4	CCC
520	1910, Nov. 9	06:02.0	80	15 S 166 E	7 3/4	CCC
530	1933, Jan. 1	08:48:39	140	14 3/4 S 168 E	7.0	AAA
540	1932, July 9	12:56:10	120	14 1/2 S 167 1/4 E	6 1/2	ABB
550	1930, Sept. 14	17:13:33	280	14 1/2 S 165 1/2 E	6 1/2	BCC
560	1939, Oct. 17	06:22:06	120	14 S 167 3/4 E	7.4	BBA
570	1911, July 11	21:22:18	150	14 S 167 E	6.9	BBB
580	1912, Aug. 6	21:11.3	260	14 S 167 E	7.2	CCC
590	1920, Aug. 15	08:16:43	240	14 S 167 E	6 3/4	CCC
600	1910, Nov. 10	12:19.9	90	14 S 166 1/2 E	7.2	CCC
605	1945, Oct. 28	05:37:44	200	13 3/4 S 167 1/2 E	6 3/4	BBB

TABLE 18 (cont.), REGION 14

No.	Date	Time	Depth	Location	M	Quality
610	1940, Feb. 20	02:18:20	200	13 1/2 S 167 E	7.0	AAA
620	1939, Sept. 2	08:58:48	100	13 S 167 1/2 E	6 3/4	BCC
630	1919, Nov. 20	14:11:43	210	13 S 167 E	7	BCC
640	1933, Sept. 9	21:20:00	130	13 S 166 1/2 E	6.9	ABB
650	1920, May 20	07:26:05	110	12 1/2 S 167 E	6 3/4	BCB
660	1911, Oct. 20	17:44.0	160	12 1/2 S 166 E	7.1	CCC
670	1940, Sept. 26	03:56:31	150	11 1/2 S 166 1/4 E	6 3/4	BBB
680	1942, Feb. 16	18:08:15	110	11 1/2 S 166 E	6.9	BBB

REGION 14, Deep Shocks

No.	Date	Time	Depth	Location	M	Quality
200	1940, May 2	08:24:00	370	19 1/2 S 169 1/2 E	6	CCC
700	1938, Nov. 18	14:12:35	360	13 S 168 E	6 1/2	BCB

REGION 15 (Solomon Islands to New Britain), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
40	1913, Feb. 15	19:03.1	200	15 S 168 E	6 1/2	CCC
80	1913, Feb. 25	14:18.4	200	15 S 168 E	6 1/2	CCC
120	1913, Feb. 14	18:52.0	100	9 S 162 E	6.8	CCC
160	1937, Sept. 15	12:27:32	80	10 1/2 S 161 1/2 E	7.3	AAA
200	1932, Oct. 17	13:25:31	100	7 1/2 S 157 E	6 1/4	BCB
240	1938, Sept. 7	12:58:20	160	6 1/2 S 155 E	6 1/2	BAA
280	1934, Feb. 11	08:59:31	80	6 1/2 S 154 1/2 E	6 1/2	BCC
320	1939, Nov. 17	09:01:28	140	6 S 154 1/2 E	6	CCB
360	1937, May 31	15:31:57	100	6 1/2 S 154 E	6 1/2	BBB
400	1932, March 8	03:11:09	70	6 S 154 E	6 1/2	BCB
440	1934, Feb. 27	21:29:35	180	6 S 154 E	6 1/2	ABA
480	1934, May 13	09:02:09	100	5 1/4 S 154 E	6 3/4	ABB
520	1941, Sept. 4	10:21:44	90	4 3/4 S 154 E	7.1	AAA
560	1932, July 14	08:53:28	150	3 1/2 S 154 E	6 1/4	BCB
600	1936, Dec. 29	14:47:56	100	4 1/2 S 153 1/2 E	7.0	BBC
640	1928, March 13	18:31:52	100	5 1/2 S 153 E	7.0	CCC
660	1945, April 23	06:22:31	160	4 1/2 S 153 E	6 3/4	BBB
680	1939, Aug. 25	03:48:17	90	5 S 152 3/4 E	6 3/4	BBB
720	1941, May 2	09:55:06	80	6 S 152 1/2 E	6 1/2	BCB
760	1944, Oct. 5	16:57:02	110	4 1/2 S 152 1/2 E	6.9	BBB
800	1932, April 12	23:52:40	100	4 S 152 E	6 3/4	BCB
840	1944, Dec. 27	15:25:49	90	6 1/2 S 152 E	7.0	BCC

TABLE 13 (cont.), REGION 15

No.	Date	Time	Depth	Location	M	Quality
880	1934, Sept. 25	19:14:25	100	5 S 152 E	6 1/2	CCC
920	1910, Sept. 7	07:11.3	80	6 S 151 E	7 1/4	CCC
960	1937, Aug. 5	14:43:58	140	5 1/2 S 150 E	6 3/4	BBB
REGION 15, Deep Shocks						
200	1931, July 23	14:20:56	400	6 1/2 S 155 E	6 3/4	BBB
300	1912, Sept. 1	04:10.0	430	4 1/2 S 155 E	7	CCC
400	1932, Jan. 9	10:21:42	380	6.2 S 154.5 E	7.3	AAA
500	1918, Dec. 25	10:21:18	450?	7 S 153 E	6 3/4	BCC
600	1926, Feb. 7	02:44:04	390	4 S 152 E	6 1/2	CCB
700	1932, March 19	23:10:47	350	3 S 152 E	6 1/2	CCD
800	1938, Aug. 31	17:45:13	350	4 S 151 1/2 E	6 3/4	BBB
REGION 16 (New Guinea), Intermediate Shocks						
50	1933, Jan. 15	18:02:02	140	5 1/2 S 147 1/2 E	6 1/4	BAB
100	1934, June 9	12:58:44	130	5 3/4 S 147 1/4 E	6.9	AAA
150	1936, June 10	08:23:21	190	5 1/2 S 147 E	6.9	AAA
200	1939, Jan. 30	23:50:24	200	5 1/2 S 147 E	6 1/2	BCB
250	1931, June 17	17:02:00	140	6 1/2 S 146 1/2 E	6 1/2	BBB
300	1928, Sept. 7	02:49:22	140	5 1/2 S 146 1/2 E	6 3/4	BAB
350	1926, Sept. 7	12:23:04	100	6 S 146 E	6 3/4	BCC
400	1935, May 21	06:51:50	140	6 S 146 E	6 3/4	BBB
425	1935, May 21	13:06:13	140	6 S 146 E	6	CCC
450	1934, March 16	14:13:41	120	5 1/2 S 146 E	6 3/4	BBA
500	1933, June 4	13:40:17	120	5 S 146 E	6	BBB
530	1936, Feb. 8	12:11:10	80	5 1/4 S 145 3/4 E	6 3/4	BBA
540	1936, Feb. 21	16:57:16	75	5 S 144 1/2 E	6.9	ABB
550	1943, Dec. 1	06:04:55	120	4 3/4 S 144 E	7.2	BBB
600	1937, May 12	02:44:55	150	4 1/2 S 144 E	6 3/4	BBB
650	1929, June 12	11:43:02	110	5 S 143 1/2 E	6 3/4	BBB
700	1910, July 29	10:26.7	80	5 S 143 E	6.9	CCC
750	1939, March 2	07:00:27	130	4 S 143 E	6.9	BBA
800	1944, Jan. 7	02:49:20	120	4 1/2 S 143 1/2 E	7.1	BBA
850	1939, Dec. 27	03:02:36	80	2 3/4 S 135 3/4 E	6 1/2	BBB
950	1937, April 5	06:56:41	90	1 S 133 E	6.9	BBB

REGION 17 (Caroline Islands), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
800	1939, Nov. 9	16:06:20	90	12 N 143 1/2 E	6 1/4	BCC
REGION 18 (Marianne Islands), Intermediate Shocks						
20	1944, Aug. 15	11:47:40	110	13 N 143 E	6.9	CCB
40	1932, Feb. 13	19:12:30	90	13 1/2 N 146 E	6	CCC
60	1912, Oct. 26	09:00.6	130	14 N 146 E	7	CCC
80	1942, June 14	03:09:45	80	15 N 145 E	7.0	BCB
100	1932, Nov. 3	19:42:53	170	16 1/2 N 146 1/2 E	6	BBB
120	1931, Nov. 3	02:35:55	100	17 N 147 E	6 1/4	CCC
140	1940, Jan. 17	01:15:00	80	17 N 148 E	7.3	AAA
160	1945, July 15	05:35:13	120	17 1/2 N 146 1/2 E	7.1	BBB
180	1936, Nov. 12	02:15:58	170	17 1/2 N 147 E	6 1/4	BCC
200	1933, Nov. 7	06:39:58	70	18 N 146 E	6	CCB
210	1934, Oct. 21	17:53:44	210	18 N 146 E	6 1/2	BAA
220	1940, Aug. 15	21:23:28	150	18 N 146 E	6	CCB
240	1940, Dec. 28	16:37:44	80	18 N 147 1/2 E	7.3	AAA
260	1929, March 10	14:34:43	170	18 1/2 N 146 E	6 3/4	AAA
280	1930, Jan. 26	12:20:30	190	18 1/2 N 146 1/2 E	6 1/4	BCB
300	1931, Sept. 9	20:38:26	180	19 N 145 1/2 E	7.1	AAA
320	1935, July 29	04:12:49	200	19 N 146 E	6	BBA
340	1943, April 9	08:48:59	170	19 N 146 E	7.0	BBC
360	1937, May 5	21:15:39	190	19 1/4 N 145 3/4 E	6 1/4	AAA
380	1934, June 19	03:50:15	170	20 N 147 E	5 3/4	CCB
400	1932, Jan. 5	11:22:25	130	20 N 148 E	6	CCC
420	1936, March 31	03:33:10	290	21 1/2 N 143 1/4 E	6	ABB
440	1928, Dec. 19	15:15:50	200	21 1/2 N 143 1/2 E	6	BBB
460	1935, Dec. 14	12:47:29	270	21 1/2 N 143 1/2 E	6 1/2	BBB
480	1914, Nov. 24	11:53:30	110	22 N 143 E	8.1	BBB
500	1932, Dec. 26	22:31:06	280	22 N 143 1/2 E	6 1/2	AAA
520	1933, May 21	21:54:05	200	22 N 145 1/2 E	6 1/4	CCC
540	1932, Sept. 2	12:56:30	140	23 N 142 1/2 E	6 1/2	ABB
560	1941, June 13	22:14:15	220	23 N 146 1/2 E	5 3/4	CCC
580	1913, March 23	20:47.3	80	24 N 142 E	7.0	BCC
600	1931, July 2	03:38:50	120	24 N 142 1/2 E	6	BCC

No.	Date	Time	Depth	Location	M	Quality
620	1940, April 5	16:35:23	220	24 1/2 N 143 E	6 1/2	CCB
640	1921, July 4	14:18:20	200	25 1/2 N 141 1/2 E	7.2	BBD
660	1931, Oct. 17	15:33:52	180	25 1/2 N 141 1/2 E	6	BBA
680	1907, May 4	08:36.8	200	28 N 141 E	7	CCC
690	1936, April 5	14:27:46	100	29 N 141 E	5 3/4	CCC
700	1933, June 18	13:11:25	80	30 N 142 E	6 1/4	BCC
720	1927, April 3	13:47:08	150	30 1/2 N 142 E	6	CBC
740	1923, Sept. 17	03:39:32	150	31 N 140 E	6	CCC
750	1941, July 6	00:34:28	110	31 N 141 E	6 1/4	BBB
760	1909, March 13	14:29.0	80	31 1/2 N 142 1/2 E	7.7	BCC
780	1940, June 12	18:36:58	100	31 1/2 N 142 1/2 E	6 1/2	BBB
800	1926, Sept. 26	01:00:39	200	32 N 140 E	6	CCC
820	1935, Sept. 14	08:28:01	100	32 N 141 1/2 E	5 1/2	CCC
840	1933, March 18	15:51:32	170	32 1/4 N 139 3/4 E	6 1/2	AAA
860	1933, Nov. 19	01:33:39	230	32 1/2 N 139 E	5	AAB
900	1932, Feb. 19	13:25:32	150	33 N 141 E	5 1/2	BAB
920	1933, Sept. 15	13:53:45	120	33 N 141 1/4 E	5 1/2	AAB
940	1932, May 11	06:53:35	80	33 N 142 E	6	BCC
960	1915, Oct. 8	15:36:03	170	33 1/2 N 138 E	7	CCC
980	1930, May 23	16:38:03	130	33 3/4 N 140 1/4 E	6 3/4	AAA

REGION 18, Deep Shocks

20	1931, Oct. 29	08:39:18	520	17 N 146 E	6 1/2	BCC
40	1934, Feb. 4	03:10:45	570	18 1/2 N 145 E	6 1/2	BBB
50	1934, April 25	05:03:23	570	18 1/2 N 145 E	5 1/2	BBB
60	1905, July 11	15:37.5	450	22 N 143 E	7 1/4	CCC
80	1937, May 28	19:56:03	530	24 N 142 E	6 1/2	AAA
90	1937, May 29	02:00:01	530	24 N 142 E	5 1/2	AAA
100	1937, June 12	18:08:10	430	26 N 141 E	6	BBB
120	1931, Aug. 15	12:43:44	440	26 1/4 N 140 1/2 E	5 3/4	BAB
140	1933, March 11	19:32:39	510	26 1/2 N 140 1/2 E	6 3/4	AAA
160	1923, June 29	10:47:38	400	27 N 140 E	5 3/4	CCC
170	1923, June 29	10:53:20	400	27 N 140 E	5 3/4	CCC
180	1930, March 6	03:31:36	540	27 N 140 E	6	BCC
200	1940, March 9	10:47:04	500	27 N 140 E	6 1/2	BCA
220	1940 July 8	15:16:30	500	27 1/2 N 139 1/2 E	6	CCC

No.	Date	Time	Depth	Location	M	Quality
240	1937, Jan. 5	11:09:12	500	27 1/2 N 139 E	6	BAB
260	1927, Aug. 12	00:33:50	530	27 1/2 N 140 1/2 E	6 3/4	BBB
280	1932, Oct. 1	15:08:05	450	28 N 140 1/2 E	6	ABB
300	1928, Aug. 16	03:49:08	500	28 N 140 E	6	BBC
320	1938, Sept. 21	11:36:20	400	28 N 140 E	5 3/4	CDB
340	1925, March 27	04:16:33	500	28 N 139 E	6	CCC
360	1933, Feb. 4	06:17:58	550	28 N 139 E	6	BBB
380	1931, June 12	01:45:02	410	28 1/2 N 140 1/2 E	6 1/4	BBC
400	1933, July 31	02:56:20	400	29 N 141 E	5 1/4	CCC
420	1932, Jan. 7	11:27:20	400	29 N 140 E	5 3/4	CCC
430	1932, Feb. 3	07:34:34	400	29 N 140 E	6 1/4	BAB
440	1925, Oct. 20	09:41:51	380	29 N 139 1/2 E	6 1/4	BCC
460	1921, March 4	12:51:03	450	29 N 139 E	6	BCC
480	1933, July 11	08:28:07	400	29 N 139 E	5 1/2	CCC
500	1933, Sept. 2	16:41:08	410	29.1 N 138.8 E	6 3/4	AAA
520	1935, Feb. 10	18:29:33	500	29 1/2 N 139 E	6 1/4	CCC
540	1934, April 19	16:13:29	430	29 3/4 N 139 1/4 E	6 1/2	AAA
560	1925, May 15	18:25:34	360	30 N 139 E	6 1/4	BBC
580	1930, Jan. 11	21:21:00	500	30 N 139 E	5	CCC
600	1932, April 4	19:16:38	410	30 N 139 E	6 3/4	AAA
620	1940, June 27	06:52:30	400	30 N 139 E	5 1/2	CCC
640	1940, Nov. 7	13:57:54	500	30 N 138 1/2 E	6 3/4	BBB
660	1932, Oct. 6	05:00:53	500	30 N 138 E	5 3/4	CCC
680	1934, June 19	15:47:10	480	30 1/4 N 139 1/2 E	6 1/4	BBB
700	1932, July 27	00:30:53	380	31 N 139 E	5 3/4	AAB
720	1912, July 24	23:24.4	500	31 N 137 E	6	CCC
740	1932, Oct. 14	12:35:57	330	31 1/2 N 139 E	5 1/2	ABB
760	1928, March 29	05:06:03	410	31.7 N 138.2 E	7.1	AAA
780	1933, Feb. 9	03:56:53	370	31 3/4 N 138 3/4 E	6	AAA
800	1924, April 3	02:30:30	350	32 N 139 E	6	BCC
820	1927, June 18	02:26:23	400	32 N 139 E	5 3/4	CCC
840	1933, May 28	23:40:04	400	32 1/2 N 138 E	5 1/4	AAB
860	1910, Feb. 12	18:10.1	350	32 1/2 N 138 E	7.4	BCB
880	1936, June 25	16:51:52	370	32 1/2 N 137 1/2 E	6 1/4	BAB

No.	Date	Time	Depth	Location	M	Quality
900	1925, April 19	15:46:39	330	33 N 138 E	6 3/4	AAB
920	1927, Aug. 20	22:12:36	350	33 N 138 E	5	CCC
940	1935, July 5	09:11:20	420	33 N 137 E	5 1/2	BBC
960	1943, Nov. 17	14:57:17	300	33 1/2 N 138 E	7.0	BCC
980	1932, Dec. 5	00:19:20	420	33 1/2 N 137 E	5 3/4	AAB

REGION 19 (Japan to Kamchatka), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
10	1905, Oct. 24	03:46.7	250	34 N 139 E	7 1/4	CCC
20	1934, April 15	10:33:18	70	34 1/4 N 140 1/2 E	6 1/2	AAA
30	1935, June 28	18:57:54	100	34 1/4 N 140 1/2 E	6 1/4	BBC
40	1933, Sept. 6	14:05:20	280	34 1/2 N 137 3/4 E	5 1/4	AAB
60	1916, Sept. 15	07:01.3	100	34 1/2 N 141 E	7 1/4	CCC
70	1936, Oct. 25	15:30:25	80	34 3/4 N 140 1/2 E	6 1/4	AAB
80	1937, May 15	12:22:56	80	35 N 139 1/2 E	5	ABB
90	1934, Feb. 1	00:15:59	90	35 1/4 N 139 1/4 E	5	AAA
100	1920, May 12	21:53:14	100	36 N 137 1/2 E	6 3/4	BBB
110	1931, June 2	02:37:52	260	36 N 137 1/2 E	6 1/2	AAA
120	1938, June 5	16:31:38	80	36 N 140 1/4 E	5 1/2	BBB
125	1935, April 15	11:15:07	270	36 1/4 N 137 1/4 E	6 1/4	AAA
130	1934, May 30	23:03:58	70	36 1/4 N 140 1/2 E	6	AAA
140	1938, Feb. 7	14:43:00	100	36 1/2 N 139 1/2 E	6 1/2	BBB
150	1924, Aug. 6	14:22:40	75	36 1/2 N 140 1/2 E	6 1/2	BCB
160	1929, April 17	18:34:12	100	36 1/2 N 141 E	6	ABA
180	1934, April 6	19:09:36	100	37 1/4 N 141 1/2 E	6 3/4	ABB
190	1944, Aug. 18	10:33:17	150	38 N 140 E	6.9	CCC
200	1931, May 25	06:48:55	100	38 1/2 N 141 E	5	AAB
210	1937, July 26	19:56:37	90	38 1/2 N 141 1/2 E	7.1	AAA
220	1933, July 20	23:14:05	100	38 1/2 N 144 1/2 E	6 3/4	AAA
230	1931, Jan. 9	01:45:40	140	39 3/4 N 140 3/4 E	6	AAA
240	1931, Jan. 10	16:07:48	80	40 N 141 E	5	AAA
250	1940, July 21	00:01:54	90	40 1/2 N 142 1/2 E	5 1/2	BCA
260	1933, Jan. 3	22:41:04	280	41 N 138 E	5 1/2	BCC
270	1926, Feb. 4	06:44:18	150	41 N 140 E	6 1/4	BBC
280	1912, June 8	04:41.5	100	41 N 141 E	6 3/4	CCC
290	1936, June 3	02:55:36	80	41 1/2 N 142 E	6	BBB

No.	Date	Time	Depth	Location	M	Quality
300	1939, Jan. 13	22:21:56	70	41 1/2 N 142 1/2 E	5 1/4	CCC
310	1934, Oct. 29	17:23:04	100	42 N 141 E	5 1/4	BCB
320	1915, March 17	18:45:00	100	42 N 142 E	7 1/4	BCC
330	1933, July 13	07:57:45	100	42 1/2 N 139 1/2 E	6	CCC
340	1944, Oct. 2	20:29:51	75	42 1/2 N 142 1/2 E	7.0	BBA
350	1931, Jan. 6	03:22:46	100	42 1/2 N 142 3/4 E	5 1/4	AAB
360	1939, Oct. 22	14:39:42	90	42 1/2 N 144 E	6	BCB
365	1935, Dec. 3	17:44:01	75	42 1/2 N 146 E	5 3/4	BCC
370	1931, March 29	17:51:52	120	42 3/4 N 143 3/4 E	6 3/4	AAB
380	1941, March 15	19:07:33	120	43 N 140 E	5 3/4	CCC
390	1930, Dec. 13	14:22:50	100	43 N 142 1/2 E	6 1/2	ABB
400	1930, Dec, 23	23:55:06	150	43 N 143 E	6	BBC
410	1931, Jan. 21	08:58:04	120	43 1/4 N 146 E	6 1/4	ABB
415	1935, Oct. 2	05:33:00	70	43 1/2 N 146 1/2 E	7.0	AAA
420	1945, Oct. 9	14:36:33	80	43 1/2 N 147 1/2 E	7.0	BBB
430	1939, Dec. 16	10:46:32	75	43 3/4 N 147 3/4 E	7.1	AAA
450	1907, Dec. 23	01:13.0	100	44 N 145 E	6.9	BBB
460	1907, July 5	15:46.1	100	44 N 145 E	6 3/4	CCB
470	1927, July 12	21:07:58	100	44 N 145 1/2 E	6 3/4	AAB
480	1932, Dec. 8	15:17:00	100	44 N 146 E	5 3/4	CCC
500	1945, June 22	09:18:40	120	44 N 146 E	7.0	BBA
510	1933, Aug. 28	08:47:42	130	44 N 147 1/2 E	5 1/4	BCB
520	1943, Nov. 9	11:46:32	90	44 N 147 1/2 E	6 3/4	BBB
530	1934, June 13	01:50:54	90	44 N 147 3/4 E	6.9	AAA
540	1930, Aug. 29	20:02:33	210	44 1/4 N 146 1/2 E	6	BBC
548	1938, Oct. 17	15:26:58	250	44 1/2 N 140 1/2 E	6 1/2	BCA
550	1942, March 5	19:48:16	260	44 1/2 N 142 1/2 E	6.9	BBA
560	1940, July 4	09:00:28	250	44 1/2 N 143 1/2 E	5 3/4	BBA
570	1938, Nov. 13	13:13:40	70	44 1/2 N 149 1/2 E	6.9	BAA
580	1930, July 22	19:25:53	140	44 3/4 N 147 1/2 E	7.1	AAA
590	1905, Sept. 1	02:45.6	230	45 N 143 E	7 1/2	CCC
600	1924, Dec. 27	11:22:05	150	45 N 146 E	7.3	BBB
610	1924, June 30	15:44:25	120	45 N 147 1/2 E	7.3	ABC
620	1938, Aug. 17	01:45:35	100	45 N 148 E	6	BCC

No.	Date	Time	Depth	Location	M	Quality
625	1941, Nov. 14	06:49:09	130	45 1/2 N 148 E	6 1/4	BBB
630	1934, May 28	05:32:44	140	45 1/2 N 149 1/2 E	6 1/4	ABB
640	1942, Nov. 26	14:27:28	110	45 1/2 N 150 E	7.4	BBB
650	1936, Nov. 12	20:04:46	150	46 N 148 E	6 1/2	BBB
660	1937, June 8	18:00:35	130	46 1/2 N 150 E	6 1/2	BBB
670	1933, Feb. 3	22:11:50	70	46 N 151 1/2 E	6 1/2	ABA
680	1913, Jan. 19	23:47:55	150	46 N 152 E	7	CCC
690	1922, Oct. 24	21:21:06	80	47 N 151 1/2 E	7.4	BCB
700	1932, April 26	13:31:39	150	47 1/2 N 154 E	5 1/2	CCC
710	1929, Feb. 6	06:49:13	150	48 1/4 N 152 1/2 E	6 3/4	BCB
720	1921, Sept. 29	13:09:20	100	48 1/2 N 153 E	6 1/4	CCC
730	1930, Jan. 5	01:19:48	140	49 N 154 E	6.9	BBB
740	1927, Aug. 8	00:57:50	110	49 1/2 N 155 E	6 3/4	BBB
750	1929, Jan. 13	00:03:12	140	49 3/4 N 154 3/4 E	7.7	AAA
760	1934, March 18	04:33:15	100	49 3/4 N 156 1/2 E	6 3/4	AAB
770	1911, Sept. 8	22:44.0	80	50 N 156 1/2 E	6 1/2	CCC
780	1909, July 13	13:13.5	250	50 1/2 N 152 1/2 E	6 1/2	BBB
790	1939, Aug. 1	15:55:59	140	50 1/2 N 156 E	6 1/2	BBA
800	1911, May 4	23:36.9	240	51 N 157 E	7.6	BBB
810	1941, Sept. 24	01:01:24	75	51 N 158 E	7.0	BBA
820	1907, Aug. 17	17:27.9	120	52 N 157 E	7 1/4	CCC
830	1939, Nov. 18	01:32:48	75	52 N 157 E	6 1/2	BBB
840	1937, July 15	19:03:26	140	52 N 159 E	6 1/2	BBB
850	1906, Oct. 8	04:53:58	200	52 1/2 N 154 1/2 E	7	CCB
860	1922, March 4	13:07:38	220	52 1/2 N 157 E	7.0	AAA
870	1934, Jan. 3	09:42:27	280	52.8 N 156.6 E	6.9	AAA
880	1932, Aug. 4	06:37:27	100	53 N 160 E	6 1/4	CBB
890	1912, May 13	19:35.8	100	57 N 162 E	6 3/4	CCB

REGION 19, Deep Shocks

No.	Date	Time	Depth	Location	M	Quality
40	1931, June 29	16:43:17	380	34 N 136 1/2 E	6 1/2	AAA
80	1933, Sept. 20	03:56:35	380	34 N 136 1/2 E	5 1/2	AAB
120	1926, April 1	16:03:51	350	34 N 137 1/2 E	6.9	BBC
160	1906, Jan. 21	13:49:35	340	34 N 138 E	8.0	BCC
200	1936, Oct. 26	09:33:32	380	34 1/4 N 136 1/2 E	6 1/4	AAB

TABLE 18 (cont.), REGION 19

No.	Date	Time	Depth	Location	M	Quality
240	1932, May 5	04:11:01	380	34 1/2 N 135 1/2 E	6 1/2	AAA
280	1932, April 28	03:43:04	370	34 1/2 N 137 E	5 3/4	AAB
320	1942, April 20	08:40:31	350	34 1/2 N 137 E	6 1/2	BBB
360	1929, June 2	21:38:34	360	34 1/2 N 137 1/4 E	7.1	AAA
400	1940, April 20	20:18:04	400	35 N 136 E	6	CCC
440	1926, July 26	18:54:50	360	35 1/2 N 135 1/2 E	6 3/4	BAA
480	1932, July 25	08:24:39	360	35 1/2 N 135 1/2 E	6 3/4	AAA
520	1937, Nov. 22	04:53:03	360	35 1/2 N 135 1/2 E	5 3/4	BAB
600	1927, Jan. 15	14:31:16	420	36 1/4 N 134 1/2 E	6 1/2	AAB
680	1925, May 27	02:29:58	400	36 1/2 N 134 1/2 E	6 1/2	BAA
720	1936, Oct. 19	19:56:00	350	37 N 135 E	5 3/4	BAB
760	1907, March 26	11:21:22	360	37 N 136 E	6 3/4	CCC
800	1935, Oct. 15	14:35:09	330	37 1/2 N 135 E	5 3/4	AAB
840	1931, April 21	00:02:03	320	38 3/4 N 133 3/4 E	6	AAB
880	1935, May 31	08:18:37	450	38 3/4 N 134 E	6 1/2	AAA
920	1904, June 7	08:17.9	350	40 N 134 E	7 1/2	CCC

REGION 20 (Riukiu Islands), Intermediate Shocks

50	1926, June 29	14:27:06	130	27 N 127 E	7.5	BCB
100	1913, March 3	20:02.2	150	28 N 129 E	6 3/4	CCC
150	1909, Sept. 10	18:08.9	90	28 1/2 N 129 E	6 3/4	CCB
160	1933, July 18	11:24:54	100	28 1/2 N 129 E	5 1/2	BBC
200	1914, July 4	17:48.4	210	29 N 128 E	6.9	BBB
250	1911, June 15	14:26.0	160	29 N 129 E	8.2	BBB
300	1936, Dec. 1	06:09:15	270	30 N 129 E	6 1/2	BBB
400	1930, Sept. 29	04:52:21	220	30 1/2 N 130 E	5 1/4	BCC
500	1926, June 5	09:09:39	180	31 N 130 E	6 1/2	BAB
600	1935, Oct. 2	09:27:46	120	31 N 130 E	5 1/4	AAB
700	1932, Nov. 17	20:11:40	100	31 N 130 1/2 E	5 1/4	AAB
800	1909, Nov. 10	06:13.5	190	32 N 131 E	7.6	BBA
850	1928, Sept. 25	04:58:42	120	33 1/2 N 132 E	6	CCC
900	1905, June 2	05:39.7	100	34 N 132 E	7 3/4	BCC

REGION 21 (Formosa), Intermediate Shocks

100	1932, Oct. 9	12:49:49	130	23 1/2 N 122 1/2 E	6	BBC
200	1909, April 14	19:53.7	80	24 N 123 E	7.3	CCC

No.	Date	Time	Depth	Location	M	Quality
300	1915, Jan. 5	23:26.7	160	25 N 123 E	7 1/4	BCC
400	1933, Feb. 19	04:26:11	120	25 N 123 E	5 3/4	ABC
500	1910, April 12	00:22:13	200	25 1/2 N 122 1/2 E	7 3/4	BCC
600	1934, April 13	22:03:53	250	25 1/2 N 124 1/2 E	6	BBC
700	1932, Dec. 26	21:14:44	210	26 N 125 E	6 1/4	AAA
800	1919, June 1	06:51:20	200	26 1/2 N 125 E	7	BBB

REGION 22 (Philippine Islands), Intermediate Shocks

30	1920, Aug. 3	03:02:28	250	5 N 128 E	6 3/4	CCC
60	1940, Oct. 7	06:43:04	100	5 N 126 E	7.0	BCB
70	1945, March 11	17:45:05	100	5 N 126 1/2 E	6 3/4	CCC
90	1932, June 10	20:21:20	80	5 1/2 N 127 E	6 3/4	ABB
120	1932, July 9	20:23:54	120	5 1/2 N 126 1/2 E	6	BCB
150	1925, March 26	10:25:12	180	5 1/2 N 125 E	6 1/2	CCC
180	1941, June 16	11:26:56	100	6 N 127 1/2 E	6 1/2	CCC
210	1936, Jan. 20	16:56:19	80	6 N 127 E	7.1	AAA
220	1911, March 6	17:30.0	100	6 N 126 E	6 3/4	CCC
240	1918, Feb. 7	05:20:30	120	6 1/2 N 126 1/2 E	7 1/2	BCC
270	1933, Sept. 7	17:53:38	150	6 1/2 N 126 E	6 1/4	BCC
300	1934, Sept. 6	02:16:52	150	6 1/2 N 126 E	6	BBC
330	1933, Sept. 28	00:27:58	100	7 N 127 E	5 3/4	CCC
360	1939, Feb. 4	11:34:05	100	7 N 126 1/2 E	6	BBC
390	1935, June 1	14:39:52	100	7 1/2 N 126 1/2 E	6	BBB
420	1932, June 8	14:54:38	100	8 N 126 E	6 1/4	BBB
450	1938, Feb. 5	09:55:10	160	14 N 124 E	6 1/2	BBB
500	1942, July 25	06:22:35	80	11 1/2 N 124 1/2 E	6 3/4	CCB
600	1933, Sept. 20	23:33:40	100	13 N 121 E	6 1/2	BBB
620	1936, May 20	00:16:01	160	13 1/2 N 121 1/2 E	6±	CCC
630	1939, May 6	17:00:07	110	13 1/2 N 121 1/4 E	6 1/2	BBB
660	1932, July 18	05:02:05	100	14 N 120 E	6	BCC
690	1940, March 28	15:48:52	200	14 1/2 N 120 E	6 3/4	ABA
720	1933, March 3	02:19:38	120	15 1/2 N 120 E	6 1/2	BBC
750	1927, April 19	17:30:10	100	16 N 120 E	6 3/4	BCB
780	1927, April 13	13:44:14	140	16 N 120 1/2 E	6 3/4	ABB
781	1927, April 13	14:34:37	140	16 N 120 1/2 E	6 1/4	ABB

TABLE 18 REGION 22

No.	Date	Time	Depth	Location	M	Quality
810	1938, May 23	08:21:53	80	18 N 119 1/2 E	7.0	ACB
840	1937, March 16	15:45:46	100	18 N 121 E	6 1/2	AAB
870	1932, June 14	05:59:38	80	18 1/2 N 120 1/4 E	6 1/2	ABB
900	1930, Dec. 21	14:51:24	170	20 N 122 1/4 E	6.9	AAB

REGION 22, Deep Shocks

No.	Date	Time	Depth	Location	M	Quality
50	1945, April 22	09:51:18	650	5 N 123 E	6 3/4	CCC
100	1915, Sept. 11	23:59.2	600	5 1/2 N 123 1/2 E	6 3/4	CCC
200	1940, June 18	13:52:33	570	5 1/2 N 123 1/2 E	6 1/2	BBB
300	1935, Oct. 4	05:15:36	500	6 N 125 E	6 1/2	ABB
400	1929, June 4	15:15:58	380	6 1/2 N 124 1/2 E	7.0	BBB
500	1929, April 8	10:16:53	610	7.8 N 124.6 E	6 3/4	AAA
600	1940, Sept. 22	22:51:56	680	8 N 124 E	6 3/4	BBB
700	1941, Feb. 4	14:03:12	600	9 N 124 E	6.9	BBB
800	1926, Oct. 30	13:46:34	520	9 1/2 N 124 1/2 E	6 1/4	AAA
900	1929, Sept. 21	18:54:23	300	10 N 125 E	6	BCC

REGION 23 (Celebes), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
30	1909, April 25	22:36.0	100	4 N 127 E	7	CCC
60	1939, Sept. 16	07:16:26	90	3 1/2 N 127 3/4 E	5 3/4	CCC
90	1925, Oct. 18	08:25:58	220	3 1/2 N 128 E	6 1/4	CCC
120	1935, Feb. 4	21:07:31	80	2 1/2 N 127 E	6 1/2	ABB
150	1932, June 6	06:26:21	280	2 N 122 1/2 E	5 3/4	CCC
180	1940, Sept. 12	00:21:21	100	2 N 123 E	6 1/2	CCC
210	1932, Nov. 18	13:47:16	280	2 N 124 1/2 E	6 1/2	BBB
240	1943, June 29	09:05:06	180	2 N 125 E	6 1/2	CCB
270	1921, July 15	18:06:22	140	2 N 128 E	6	BCB
300	1926, July 14	16:46:48	180	2 N 129 E	6 1/4	BCC
301	1926, July 14	16:59:27	180	2 N 129 E	6 1/4	BCC
330	1932, Aug. 2	04:25:38	100	1 1/2 N 126 E	6 1/2	ABC
360	1905, Jan. 22	02:43.9	90	1 N 123 E	7 3/4	CCC
390	1936, June 5	14:37:31	180	1/2 N 124 E	6 3/4	BBB
420	1907, June 25	17:54.6	200	1 N 127 E	7 1/2	CCC
430	1928, Aug. 12	08:08:50	130	1 N 127 E	6.9	BBB
450	1939, June 13	20:39:55	150	3/4 N 125 3/4 E	6.9	BBC
480	1932, May 4	05:05:08	200	1/2 N 122 E	6	BCC

No.	Date	Time	Depth	Location	M	Quality
510	1924, Dec. 5	09:36:25	200	1/2 N 126 E	6 1/2	CCC
540	1932, May 12	06:08:05	170	1/4 N 126 E	6 1/2	BBB
570	1940, June 22	11:36:46	200	0 N 122 1/2 E	6 3/4	BBC
600	1934, Sept. 11	08:13:43	130	0 N 123 E	6 1/4	BBC
630	1939, Dec. 21	21:00:40	150	0 123 E	8.0	ABC
640	1941, Jan. 7	10:37:51	220	0 123 E	6	CCC
660	1932, Oct. 18	04:09:50	200	0 123 1/2 E	6 1/2	BCB
690	1937, May 13	18:47:55	200	0 123 1/2 E	6 1/4	BBB
691	1937, Sept. 28	13:17:43	200	0 123 1/2 E	6 1/2	BBB
720	1942, May 28	01:01:48	120	0 124 E	7.5	ABB
750	1941, Sept. 17	06:47:57	190	1/2 S 121 1/2 E	7.1	BCC
780	1939, Dec. 25	20:56:07	125	1/2 S 123 1/2 E	6 1/4	BCC
810	1932, July 29	20:58:37	200	1/2 S 124 E	6 1/2	ABB
840	1929, Dec. 27	13:32:07	230	3 S 125 E	6 1/2	CCC
870	1933, May 21	11:51:28	120	3 1/2 S 130 1/2 E	6 1/4	CCC
900	1933, Oct. 17	12:23:52	130	3 1/2 S 131 E	6 1/2	BCB
930	1914, July 4	23:38.9	200	5 1/2 S 129 E	7	CCB

REGION 23, Deep Shocks

No.	Date	Time	Depth	Location	M	Quality
100	1930, Nov. 8	03:22:40	670	4 N 122 1/2 E	6.9	ABB
200	1926, Sept. 30	05:17:43	600	3 N 122 1/2 E	6 1/4	BCD
250	1941, Jan. 2	16:49:38	500	3 N 122 1/2 E	6 1/4	CCB
300	1907, March 29	20:46.5	500	3 N 122 E	7 1/4	CCB
400	1930, May 30	12:56:55	300	2 N 124 1/2 E	6 1/4	BCD

REGION 24 (Sunda arc), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
15	1936, March 4	06:30:00	150	5 S 131 E	5 3/4	CCC
30	1909, Oct. 30	10:17.5	250	6 S 131 E	6.9	CCC
45	1927, June 3	07:12:11	150	7 S 131 E	7.4	ABC
60	1909, May 30	21:01.3	100	8 S 131 E	7.2	CCC
75	1927, Nov. 6	15:34:32	230	7 S 130 E	6 3/4	BBB
90	1941, Feb. 23	22:30:43	170	6 3/4 S 129 1/2 E	6 1/4	CCC
105	1931, March 28	12:38:37	80	7 S 129 1/2 E	7.3	CAB
120	1940, Dec. 18	05:32:15	150	7 S 129 1/2 E	6 1/2	CCC
130	1941, July 8	17:13:10	170	7 1/2 S 129 E	5 3/4	CCC
135	1918, Nov. 18	18:41:55	190	7 S 129 E	7.8	BCC

No.	Date	Time	Depth	Location	M	Quality
140	1918, Nov. 23	22:57:55	190	7 S 129 E	7 1/4	BCC
150	1924, March 5	04:25:04	180	7 S 129 E	6 3/4	BCB
165	1931, June 4	09:50:18	150	6 1/2 S 129 E	6 1/2	BCC
180	1936, April 28	13:35:45	200	6 1/2 S 129 E	6 1/2	BBC
195	1938, April 26	12:53:35	150	6 1/2 S 129 E	6 1/2	CCC
200	1941, Jan. 31	02:38:40	270	6 S 129 E	6 3/4	CBC
210	1926, June 24	21:16:30	150	7 1/2 S 128 1/4 E	6 1/2	BCC
225	1921, March 30	15:02:17	170	7 S 128 E	6 3/4	BCB
240	1917, Aug. 30	04:07:15	100	7 1/2 S 128 E	7 3/4	BCC
255	1932, May 10	14:23:03	170	7 1/2 S 128 E	6	BCC
270	1932, Nov. 22	14:51:25	180	8 S 128 E	6 1/2	BBC
285	1933, May 21	21:23:50	180	7 S 127 E	6 1/4	BCC
300	1936, Feb. 27	10:04:08	180	7 S 127 E	6 3/4	BBA
315	1927, April 17	09:05:52	200	7 1/2 S 127 E	6 1/4	CCC
330	1931, April 2	12:22:56	130	6 S 126 1/2 E	6	CCC
345	1941, Feb. 25	05:37:45	180	9 S 125 E	6.9	CCB
355	1936, May 19	20:50:09	90	9 S 124 E	6 3/4	BBB
360	1944, March 22	00:43:18	220	8 1/2 S 123 1/2 E	7.5	BBB
375	1939, June 4	00:24:00	80	9 S 123 1/2 E	6 1/4	CCC
390	1924, Sept. 10	05:54:30	200	7 1/2 S 123 E	6 1/2	BCC
405	1942, Nov. 7	07:32:09	100	8 1/2 S 123 E	6 3/4	CCC
420	1938, Oct. 20	02:19:27	90	9 S 123 E	7.3	ABA
435	1934, Feb. 14	01:21:13	100	6 S 122 1/2 E	6 1/4	ACB
450	1931, Feb. 22	21:27:27	100	8 S 120 E	6	CCC
465	1932, May 17	12:56:30	80	8 1/2 S 115 E	6 1/4	BCB
480	1916, Sept. 11	06:30.6	100	9 S 113 E	7 1/4	CCC
495	1931, April 24	05:47:00	100	10 S 112 E	6	CCC
510	1926, Sept. 10	10:34:29	80	9 S 111 E	7.0	AAA
525	1936, April 15	06:05:58	100	9 S 111 E	6	BBB
540	1943, July 23	14:53:09	90	9 1/2 S 110 E	7 3/4	BBB
555	1924, June 22	16:36:43	100	7 S 107 E	6	CCC
570	1933, July 13	14:23:25	70	7 3/4 S 106 1/2 E	6 1/4	BBB
585	1931, Nov. 23	13:35:47	140	5 S 106 E	5 1/4	BCA
600	1932, May 21	21:39:24	100	6 1/2 S 105 E	6 1/2	BBB

No.	Date	Time	Depth	Location	M	Quality
615	1913, Aug. 13	04:25.7	75	5 1/2 S 105 E	7.2	BCB
630	1932, July 5	10:52:15	80	6 S 103 1/2 E	6	BBB
645	1936, Jan. 22	09:25:25	80	4 S 103 E	6 1/4	BCC
660	1932, April 22	04:58:08	80	4 1/2 S 103 E	6 1/2	BCB
675	1938, Aug. 18	09:30:04	100	4 S 103 E	6.9	BBA
690	1938, Aug. 25	01:28:07	70	5 1/2 S 102 E	6.9	BCB
705	1933, June 21	13:41:12	80	4 S 102 E	6 1/2	BBB
720	1938, Jan. 18	04:20:04	100	4 S 101 1/2 E	6 1/2	CCC
735	1938, Feb. 2	09:37:03	120	3 S 100 E	6	CCC
750	1943, Nov. 26	21:25:22	130	2 1/2 S 100 E	7.1	CCC
765	1941, March 3	07:27:47	100	2 S 100 1/2 E	5 3/4	CCB
780	1938, July 29	13:06:38	80	1 S 99 E	6 1/2	BCB
795	1934, Sept. 21	12:38:54	100	2 N 99 E	6 1/4	BBB
810	1932, June 16	01:18:45	80	3 N 97 1/2 E	6 3/4	AAA
825	1934, May 1	07:04:56	145	3 1/2 N 97 1/2 E	7.0	ABA
840	1936, July 4	08:57:11	200	4 N 99 E	6 1/2	BBB
855	1931, Jan. 20	15:26:32	150	4 N 99 E	6 1/4	BCC
870	1916, July 27	11:52.7	100	4 N 96 1/2 E	7	CCC
885	1912, Sept. 11	00:47.9	100	5 N 96 1/2 E	6 1/2	CCC
900	1928, July 27	15:23:04	100	6 N 95 1/2 E	6	CCC
915	1937, Aug. 4	23:35:22	120	6 N 95 1/2 E	6	BBB
930	1938, Oct. 7	16:23:45	120	9 1/2 N 94 E	6 1/4	BBB
945	1914, Oct. 11	16:17.1	80	12 N 94 E	7.2	CCC
960	1939, Sept. 14	09:01:06	100	12 N 95 E	6	CBC

REGION 24 (Sunda arc), Deep Shocks

No.	Date	Time	Depth	Location	M	Quality
30	1920, May 10	18:49:48	370	5 S 130 E	6 1/2	BCC
60	1930, June 4	09:50:29	400	6 1/2 S 128 1/2 E	6 3/4	ACC
90	1938, April 4	21:09:03	420	7 S 127 E	6	BCB
120	1927, Aug. 4	15:48:05	500	5 S 126 E	6 3/4	BBB
150	1934, Oct. 26	14:44:29	700	6 S 124 E	6 3/4	BBB
180	1938, May 8	14:40:35	700	6 S 124 E	5 3/4	CCC
210	1927, Aug. 8	18:43:48	680	7 S 124 E	6 1/4	AAB
240	1945, May 9	03:31:13	550	7 1/2 S 124 E	6 3/4	CCC
270	1934, June 29	08:25:17	720	6 3/4 S 123 3/4 E	6.9	AAA

TABLE 18 (cont.), REGION 24

No.	Date	Time	Depth	Location	M	Quality
300	1914, Aug. 6	04:10.7	600	6 S 123 E	7	CCC
330	1912, Aug. 18	13:20.0	650	7 S 123 E	6 1/2	CCC
360	1943, June 30	10:49:02	720	7 S 122 E	6 3/4	CCC
390	1934, June 29	12:34:45	670	5 3/4 S 121 1/2 E	6 1/4	ABB
420	1941, Nov. 27	08:37:43	600	7 1/2 S 121 1/2 E	6 3/4	BBC
450	1933, Aug. 25	09:26:05	720	6 S 121 E	6 1/2	CCC
480	1926, Dec. 25	15:43:52	610	6 S 120 E	6 3/4	BBB
510	1939, Dec. 20	13:04:06	700	7 S 120 E	6	CCC
540	1941, March 14	16:08:18	550	7 S 120 E	6	CCC
570	1933, Oct. 27	05:40:20	420	7 1/2 S 120 E	6	CCC
600	1911, July 5	18:40.1	370	7 1/2 S 117 1/2 E	7	CCC
630	1937, Aug. 11	00:55:54	610	6 1/4 S 116 1/2 E	7.2	AAA
660	1936, Feb. 12	09:34:30	600	6 S 116 E	6 1/2	BBB
690	1920, May 27	05:48:12	600	6 S 113 E	6 1/2	BCC
720	1938, Feb. 1	18:52:17	600	6 S 113 E	5 1/2	CCC
750	1936, May 8	09:11:34	620	5 3/4 S 112 3/4 E	6 1/2	BAB
760	1936, May 19	07:22:26	610	5 3/4 S 112 3/4 E	6 1/2	AAA
780	1935, July 11	23:03:42	620	4 S 111 E	6	CBC
810	1932, Aug. 11	11:49:33	600	6 S 110 E	6	CBB
840	1921, Sept. 20	20:21:23	600	5 S 110 E	6	CCC

REGION 25 (Andaman Islands to Burma), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
100	1938, April 14	01:16:35	130	23 1/2 N 95 E	6 3/4	AAA
200	1940, May 11	21:00:20	80	23 3/4 N 94 1/4 E	6 1/2	ABB
300	1935, April 23	16:45:41	110	24 N 94 3/4 E	6 1/4	AAA
400	1927, March 15	16:56:32	130	24 1/2 N 95 E	6 1/2	BBC
500	1934, June 2	05:54:29	130	24 1/2 N 95 E	6 1/2	AAA
600	1938, May 6	03:41:08	100	24 1/2 N 95 E	5 3/4	CCC
700	1939, May 27	03:45:44	75	24 1/2 N 94 E	6 3/4	ABA

REGION 26 (Szechuan, Southern Tibet), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
100	1914, March 28	10:44.8	100	25 N 99 E	6.9	CCC
200	1926, May 10	08:19:10	80	26 N 97 E	6 1/4	BCC
300	1906, Aug. 31	14:57.5	100	27 N 97 E	7	CCC
350	1941, Feb. 23	09:56:40	90	28 N 96 E	5 1/2	BBC
400	1932, Aug. 14	04:39:32	120	26 N 95 1/2 E	7.0	AAA

No.	Date	Time	Depth	Location	M	Quality
500	1941, Jan. 27	02:30:16	180	26 1/2 N 92 1/2 E	6 1/2	BCB
600	1941, Jan. 21	12:41:48	100	27 N 92 E	6 3/4	ABC
700	1935, March 21	00:04:02	80	24 1/4 N 89 1/2 E	6 1/4	ABB
800	1935, May 21	04:22:31	140	28 3/4 N 89 1/4 E	6 1/4	AAB
900	1937, Nov. 15	21:37:34	100	35 N 78 E	6 1/2	ACC
REGION 27 (Kansu to Sinkiang), Intermediate Shocks						
800	1910, July 12	07:36.2	120	37 N 76 E	6 3/4	CCC
REGION 29 (Iran - Urals), Intermediate Shocks						
300	1914, Feb. 6	11:42.3	100	29 1/2 N 65 E	7	BBC
400	1934, June 13	22:10:28	80	27 1/2 N 62 1/2 E	7.0	AAA
500	1929, Sept. 3	12:07:39	110	26 1/2 N 62 1/4 E	6 1/2	ABB
600	1927, July 7	20:06:30	100	27 N 62 E	6 1/2	BBB
REGION 30 (Asia Minor - Levant - Balkans), Intermediate Shocks						
28	1940, July 24	22:15:27	80	34 1/2 N 34 E	5 3/4	BBB
30	1941, Jan. 20	03:37:07	100	35 N 34 E	6 1/2	BBB
60	1910, Aug. 21	16:11.5	170	34 N 27 E	6 1/2	CCC
65	1927, June 5	02:24:58	120	36 N 31 E	6 1/4	BBB
90	1911, April 30	20:42.5	180	36 N 30 E	6 1/4	CCC
120	1933, July 19	20:07:08	100	38 1/4 N 29 3/4 E	6	BBC
150	1945, Sept. 2	11:53:57	80	33 3/4 N 28 1/2 E	6 1/2	BBB
165	1941, Dec. 13	06:16:05	100	37 N 28 E	6	ABC
180	1926, June 26	19:46:34	100	36 1/2 N 27 1/2 E	7.9	BCB
185	1943, Oct. 16	13:08:53	110	36 1/2 N 27 1/2 E	6 1/4	BBB
187	1944, May 27	23:52:30	100	36 N 27 1/2 E	6 1/4	CCC
188	1944, Aug. 9	17:36:37	100	36 1/2 N 27 1/2 E	5 1/2	CCC
210	1926, July 5	09:21:54	150	36 1/2 N 27 E	5 1/2	BCC
215	1942, June 21	04:38:43	130	36 1/2 N 27 E	6 1/4	BBB
240	1935, March 18	08:40:41	130	35 1/2 N 27 E	6 1/4	AAB
260	1936, April 28	23:15:26	170	36 3/4 N 26 3/4 E	5 3/4±	BBC
270	1938, June 3	16:58:03	120	34 1/2 N 26 1/2 E	5 3/4	BCC
300	1929, March 27	07:41:46	120	36 3/4 N 26 1/2 E	5 3/4	BCC
320	1942, May 9	04:37:07	100	35 1/2 N 26 E	5 3/4	CCC
330	1943, June 27	10:05:37	100	35 N 26 E	5 3/4	CCC
360	1930, March 6	08:21:42	130	34 1/2 N 26 E	5 3/4	BBC

No.	Date	Time	Depth	Location	M	Quality
390	1934, Nov. 9	13:40:56	140	36 3/4 N 25 3/4 E	6 1/4	BBB
420	1911, April 4	15:43.9	140	36 1/2 N 25 1/2 E	7	CCC
450	1918, July 16	20:03:46	150	35 1/2 N 25 1/2 E	6 1/2	CCC
480	1923, Aug. 1	08:16:38	150	35 N 25 E	6.7	BBB
510	1935, Feb. 25	02:51:37	80	35 3/4 N 25 E	6 3/4	AAA
540	1930, Feb. 14	18:38:20	130	35 3/4 N 24 3/4 E	6 3/4	ABB
570	1910, Feb. 18	05:09.3	150	36 N 24 1/2 E	7	CCC
600	1930, March 6	09:18:32	100	35 N 24 1/2 E	6	ABB
630	1908, May 17	12:30.9	100	35 N 24 E	6 3/4	CCC
660	1937, Dec. 16	17:35:30	100	35 N 23 1/2 E	6 1/2	BBB
690	1926, Aug. 30	11:38:12	100	36 3/4 N 23 1/4 E	7.0	ABB
720	1931, June 30	10:23:56	100	36 1/2 N 23 E	5 1/2	CCC
750	1927, July 1	08:19:04	120	36 3/4 N 22 3/4 E	6.9	BBB
780	1938, Sept. 18	03:50:38	100	38 N 22 1/2 E	6 1/2	BBB
810	1926, Sept. 19	01:03:57	80	36 N 22 E	6 1/4	BBC
840	1932, Aug. 15	04:34:40	100	39 1/4 N 22 E	5 1/2	BBB
870	1925, July 6	12:15:55	120	38 1/4 N 21 3/4 E	6 1/2	AAA
900	1942, May 21	03:42:41	150	37 1/2 N 20 1/2 E	5 1/2	BBB
930	1939, Sept. 20	00:19:31	80	38 N 20 1/2 E	6 1/2	BBB
960	1943, Jan. 7	11:14:45	100	38 1/2 N 20 1/2 E	5 1/2	CCB

REGION 31 (Western Mediterranean), Intermediate Shocks

100	1928, March 7	10:55:12	120	38 3/4 N 16 E	6	ABB
200	1943, Sept. 17	03:39:20	270	39 1/2 N 15 1/2 E	5 1/2	CCC
300	1911, April 5	15:28.2	200	40 N 15 1/2 E	5 3/4	CCC
400	1938, April 13	02:45:46	270	39.2 N 15.2 E	6 3/4	AAA
500	1910, Aug. 1	10:40.4	200	39 N 15 E	6 1/2	CCC
600	1915, July 7	16:42.9	300	40 N 15 E	6	BBC
700	1926, Aug. 17	01:42:53	100	39 N 14 3/4 E	5 3/4	BCC
800	1941, March 16	16:35:15	100	38 1/2 N 11 1/2 E	6 1/2	BBB
900	1941, March 16	18:48:21	100	38 1/2 N 11 1/2 E	5 3/4	BBB

REGION 46 (Manchuria to Sea of Okhotsk), Deep Shocks

15	1905, Aug. 25	09:46:45	470	43 N 129 E	6 3/4	BCC
30	1918, Feb. 9	20:46:26	450	43 N 130 E	6 1/2	CCC
45	1923, July 26	23:27:06	430	43 N 130 E	5 3/4	CCC

No.	Date	Time	Depth	Location	M	Quality
60	1933, Sept. 9	05:02:35	590	44 N 130 E	6 1/4	ABA
75	1918, April 10	02:03:54	570	43 1/2 N 130 1/2 E	7.2	BBB
90	1917, July 31	03:23:10	460	42 1/2 N 131 E	7.5	BCC
105	1933, July 24	08:37:57	550	42 1/2 N 131 E	5 3/4	AAA
120	1935, March 28	23:47:51	550	43 N 131 E	6 1/4	AAA
135	1933, July 14	16:03:35	530	43 N 131 E	5 1/2	BBB
150	1920, May 6	09:40:35	520	43 N 131 1/2 E	6 1/4	CCC
165	1938, Oct. 21	06:46:22	550	43 1/2 N 131 E	6 1/4	BCB
180	1928, June 7	06:24:35	430	44 N 131 E	6	AAC
195	1927, May 17	21:44:16	430	44 N 131 E	6 1/2	AAC
210	1940, July 10	05:49:55	580	44 N 131 E	7.3	BBA
225	1940, Nov. 22	13:06:40	570	44 N 132 E	6	CCB
240	1927, Dec. 18	19:49:19	300	41 N 133 E	5 1/4	BBD
255	1939, Oct. 24	14:43:35	500	42 N 133 E	5 3/4	BCC
270	1908, April 19	07:58.8	480	42 N 134 E	6.9	CCB
285	1938, July 31	21:54:20	450	44 N 134 E	6	CCC
300	1924, Feb. 24	16:46:05	320	44 N 135 E	5 3/4	BAB
315	1918, Jan. 30	21:18:33	330	45 1/2 N 135 E	7.7	BCC
330	1931, Feb. 20	05:33:24	350	44.3 N 135.5 E	7.4	AAA
345	1933, May 22	15:29:08	350	43 N 136 1/2 E	5 1/2	BCC
360	1932, Nov. 13	04:47:00	320	43 3/4 N 137 E	7.0	AAA
375	1937, April 29	20:18:58	370	46 1/2 N 137 E	6 1/4	BBB
390	1932, Sept. 23	14:22:12	300	44 3/4 N 138 E	6.9	AAA
405	1924, Nov. 25	17:26:52	320	46 N 141 1/2 E	6	CCC
410	1935, Nov. 21	08:41:18	320	46 1/2 N 142 E	5 1/2	CCC
420	1926, Jan. 15	14:52:48	360	45 1/2 N 143 E	6 1/4	BBB
435	1911, Sept. 6	00:54.3	350	46 N 143 E	7.3	BBC
450	1937, July 21	00:07:37	400	46 N 143 E	6	BBC
465	1931, March 1	14:23:06	330	46 1/2 N 143 E	6 1/2	BBC
480	1932, Oct. 25	17:02:12	410	46 3/4 N 144 E	6 1/2	AAA
495	1933, Dec. 4	19:33:55	360	47 N 144 E	6 3/4	AAA
510	1939, May 26	12:18:17	420	47 N 144 E	6	BCA
525	1939, April 21	04:29:04	520	47 1/2 N 139 3/4 E	7.0	AAA
540	1929, March 17	12:14:22	310	48 N 144 E	6	BCC
555	1928, April 22	04:55:01	350	47 1/2 N 145 E	6 1/2	BCC

No.	Date	Time	Depth	Location	M	Quality
570	1933, May 24	04:35:48	420	47 1/2 N 145 1/2 E	6	BAB
585	1935, July 26	08:03:39	480	48 N 145 1/2 E	6 1/4	AAA
600	1929, Sept. 28	14:56:23	430	47 N 146 E	6 1/4	BCC
615	1920, Feb. 22	17:35:50	340	47 1/2 N 146 E	7	BCB
630	1924, May 28	09:51:59	500	48 N 146 E	7.0	BAB
645	1936, March 1	10:21:57	430	47 1/2 N 146 1/2 E	6 1/4	BBB
660	1935, July 27	10:13:09	490	48 3/4 N 146 1/2 E	6 1/4	AAA
675	1928, Aug. 23	01:17:53	620	50 N 147 E	6 1/4	BAB
677	1935, Nov. 11	18:55:29	590	50 N 147 E	6	BBB
690	1907, May 25	14:02:08	600	51 1/2 N 147 E	7.4	CCD
705	1931, Feb. 23	02:15:02	600	50 N 148 E	6	CCC
720	1930, March 10	16:27:26	620	50 N 149 E	6 1/2	BBC
735	1930, June 3	18:09:28	650	50 1/2 N 149 E	6 1/4	BCD
750	1933, Jan. 18	17:15:01	570	51 N 149 E	6 1/2	BBB
765	1940, May 19	15:17:55	580	51 N 149 E	6 3/4	ABA
780	1928, May 8	04:46:02	570	50 1/2 N 149 1/2 E	6 1/2	BAA
795	1932, Nov. 6	12:47:53	520	51 N 150 E	6	BCC
810	1922, Aug. 14	11:41:13	530	53 N 150 E	6.8	CCC
825	1912, June 14	01:31.7	500	52 N 151 E	6 1/2	CCC
840	1928, Jan. 1	18:43:27	530	53 N 151 E	6 1/2	CCC
855	1931, Aug. 2	23:29:45	400	51 1/2 N 151 1/2 E	6 1/2	BCC
870	1942, Dec. 13	08:42:40	530	53 N 152 E	6	CCB
885	1924, Jan. 21	01:52:54	340	55 N 156 1/2 E	7.0	CBC

REGION 47 (Baluchistan), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
200	1925, March 8	11:27:47	200	34 N 67 E	5 3/4	CCC

REGION 48 (Hindukush and Pamir), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
3	1907, April 13	17:57.3	260	36 1/2 N 70 1/2 E	7	BCB
5	1907, Dec. 25	22:36.0	240	36 1/2 N 70 1/2 E	6 3/4	BBB
7	1908, March 12	19:26.4	200	36 1/2 N 70 1/2 E	6 1/2	CCC
9	1908, April 16	17:38.8	220	36 1/2 N 70 1/2 E	6 3/4	CCC
11	1908, Oct. 23	20:14.1	220	36 1/2 N 70 1/2 E	7.0	CCC
12	1908, Oct. 24	21:16.6	220	36 1/2 N 70 1/2 E	7.0	CCC
14	1909, July 7	21:37:50	230	36 1/2 N 70 1/2 E	7 3/4	ABB
17	1911, July 4	13:33:26	190	36 N 70 1/2 E	7.6	BBB

No.	Date	Time	Depth	Location	M	Quality
19	1912, April 25	10:27.8	220	36 1/2 N 70 1/2 E	6 3/4	CCC
21	1912, May 22	23:08.3	220	36 1/2 N 70 1/2 E	6 1/4	CCC
23	1912, June 1	00:31.3	200	36 1/2 N 70 1/2 E	6	CCC
25	1912, Aug. 23	21:14.5	200	36 1/2 N 70 1/2 E	6 3/4	BBB
27	1912, Nov. 28	20:55.1	230	36 1/2 N 70 1/2 E	6 1/2	CCC
32	1915, June 3	08:08.6	200	36 1/2 N 70 1/2 E	5 3/4	CCC
34	1916, April 21	13:56:22	220	36 1/2 N 70 1/2 E	6 1/4	BCC
36	1917, April 21	00:49:49	220	37 N 70 1/2 E	7.0	BAA
40	1921, May 20	00:43:20	220	36 N 70 1/2 E	6 3/4	BCB
42	1921, Nov. 15	20:36:38	215	36 1/2 N 70 1/2 E	7 3/4	AAA
44	1922, Dec. 6	13:55:36	230	36 1/2 N 70 1/2 E	7 1/2	AAA
46	1922, Dec. 17	00:51:20	210	36 1/2 N 70 1/2 E	6 1/4	BBB
50	1924, Oct. 13	16:17:45	220	36 N 70 1/2 E	7.3	AAA
52	1925, June 20	13:04:15	230	36 1/2 N 71 1/2 E	6 1/2	AAB
54	1925, Dec. 18	18:10:25	230	36 1/2 N 71 E	6	BBB
58	1927, April 18	15:02:00	200	37 N 71 E	6	BCC
60	1927, July 15	03:46:43	250	36 1/2 N 70 1/2 E	5 3/4	BAA
63	1928, June 24	04:34:38	120	36 N 70 1/2 E	6 1/2	BCB
65	1928, Aug. 10	15:33:48	230	36 1/2 N 70 1/2 E	6 3/4	AAA
67	1929, Feb. 1	17:14:26	220	36 1/2 N 70 1/2 E	7.1	AAA
69	1929, March 3	03:11:02	250	36 1/2 N 71 E	6 1/4	ABB
71	1929, March 13	11:01:37	200	36 1/2 N 70 E	5 3/4	CCC
73	1930, Sept. 11	17:20:16	250	36 1/2 N 70 1/2 E	5 3/4	BCB
75	1931, Jan. 7	03:49:42	200	36 1/2 N 71 E	5 1/2	CCC
77	1931, Jan. 20	09:27:22	220	36 1/2 N 71 1/2 E	6 1/2	AAA
80	1931, Aug. 15	04:01:08	240	36 1/2 N 70 1/2 E	6	BCB
82	1931, Sept. 14	03:32:16	220	36 1/2 N 70 1/2 E	5 3/4	ABB
84	1931, Oct. 5	22:31:27	220	36 1/2 N 70 1/2 E	6 3/4	AAA
86	1932, Feb. 9	02:19:44	220	36 1/2 N 70 1/2 E	5 1/4	CCC
88	1932, April 30	10:52:41	250	36 3/4 N 70 1/2 E	6	ABB
91	1933, Jan. 9	02:01:43	230	36 1/2 N 70 1/2 E	6 1/2	AAA
93	1933, Jan. 20	12:12:12	230	36 1/2 N 70 1/2 E	5 1/2	BBB
95	1933, May 21	17:53:43	220	36 1/2 N 70 1/2 E	5 1/2	CCC
97	1933, May 27	22:41:58	230	37 N 70 1/2 E	5 3/4	CCC
99	1934, July 22	19:56:57	240	36 1/2 N 70 1/2 E	6 3/4	BBB

TABLE 18 (cont.), REGION 48

No.	Date	Time	Depth	Location	M	Quality
102	1934, Nov. 18	03:21:24	220	36 1/2 N 70 1/2 E	6 1/2	BBB
105	1935, Feb. 3	02:10:47	230	36 1/2 N 70 1/2 E	6	AAA
107	1935, April 3	11:11:59	250	36 1/2 N 70 1/2 E	6 1/4	ABB
109	1935, July 28	05:23:58	150	36 N 71 E	6	ABC
111	1935, Oct. 11	04:20:18	230	36 1/2 N 70 1/2 E	5 3/4	ABB
112	1935, Dec. 19	23:10:45	230	36 1/2 N 70 1/2 E	5 1/2	BBC
114	1936, June 29	14:30:10	230	36 1/2 N 71 E	6 3/4	AAA
118	1937, Oct. 29	07:26:30	230	36 1/2 N 70 1/2 E	6 1/4	BBB
122	1937, Nov. 14	10:58:12	240	36 1/2 N 70 1/2 E	7.2	AAA
128	1938, Jan. 18	09:29:02	250	36 1/2 N 70 1/2 E	5 3/4	BBB
130	1938, Jan. 26	10:48:12	250	36 1/2 N 70 1/2 E	5 1/4	CCC
134	1938, April 6	01:14:30	240	36 1/2 N 70 1/2 E	5 1/4	CCC
144	1939, Nov. 21	11:01:50	220	36 1/2 N 70 1/2 E	6.9	AAA
148	1940, May 27	04:10:38	240	37 N 71 E	6 1/4	AAA
152	1940, Sept. 21	13:49:03	250	36 1/2 N 70 1/2 E	6 1/4	BBB
156	1940, Nov. 20	17:59:59	200	36 N 70 1/2 E	5 3/4	CCC
160	1941, March 11	21:48:55	210	36 1/2 N 71 E	6	BBB
164	1941, April 14	19:32:45	240	36 N 71 E	5 1/2	CCC
168	1941, May 15	15:19:52	230	36 1/2 N 70 E	6	CCC
170	1941, May 17	21:29:34	250	36 1/2 N 70 1/2 E	5 3/4	CCB
174	1941, Nov. 28	12:23:23	220	36 1/2 N 70 1/2 E	5 3/4	CCC
177	1942, March 22	02:08:33	210	36 1/2 N 70 1/4 E	6	AAA
180	1942, May 15	16:55:30	250	36 1/2 N 70 1/2 E	5 1/2	CCC
185	1942, Nov. 16	21:26:17	230	36 1/2 N 70 1/2 E	5 1/2	CCC
190	1943, Feb. 28	12:54:33	210	36 1/2 N 70 1/2 E	7.0	AAA
195	1943, Sept. 9	04:06:10	200	36 1/2 N 70 1/2 E	6 1/4	CCB
200	1943, Dec. 12	15:54:21	230	36 N 70 1/2 E	5 1/2	BBB
205	1944, April 29	21:41:26	200	36 1/2 N 71 E	5 1/2	CCC
210	1944, Nov. 14	23:18:10	200	36 1/2 N 70 1/2 E	5 1/2	CCC
600	1943, Sept. 24	11:31:37	120	36 1/2 N 74 E	6 3/4	BBC
650	1928, Nov. 14	04:33:09	110	35 N 72 1/2 E	6	BBC
800	1928, April 25	01:16:58	150	38 1/2 N 73 1/2 E	5 3/4	BCC
850	1943, April 5	01:56:14	100	39 N 72 1/2 E	6 1/2	BBC
900	1933, July 25	13:38:23	250	39 N 72 E	5 1/2	BCC

REGION 51 (Rumania), Intermediate Shocks

No.	Date	Time	Depth	Location	M	Quality
10	1908, Oct. 6	21:39.8	150	45 1/2 N 26 1/2 E	6 3/4	CCC
30	1912, May 25	18:01.7	100	45 3/4 N 27 1/4 E	6	BBC
100	1929, Nov. 1	06:57:21	160	45.9 N 26.5 E	5 3/4	ABC
120	1934, Feb. 2	19:59:16	150	45 N 26 E	5 1/4	BBC
125	1934, March 29	20:06:51	150	45 3/4 N 26 1/2 E	6 1/4	ABB
130	1935, July 13	00:03:46	150	46 N 26 1/4 E	5 1/4	BBC
150	1938, July 13	20:15:17	150	45 3/4 N 26 3/4 E	5 1/4	AAB
160	1939, Sept. 5	06:02:02	150	45 3/4 N 26 1/2 E	5 1/4	BBB
170	1940, Oct. 22	06:37:00	150	45 3/4 N 26 1/2 E	6 1/2	AAA
190	1940, Nov. 10	01:39:09	150	45 3/4 N 26 1/2 E	7.4	AAA
250	1945, Sept. 7	15:48:22	100	46 N 26 3/4 E	6 1/2	BBB
270	1945, Dec. 9	06:08:45	100	45 N 26 1/2 E	6	CCC

TABLE 19

LIST OF ACTIVE VOLCANOES

(Coordinates in degrees and decimal fractions.)

Name of Volcano	Location	Lat. and Long.	Last Eruption Date	Last Eruption Character	Remarks
Pinnacle Islet	Pribilof Is.	60.27 N 172.38 W	1874	?	
Kiska	Aleutians	52.10 N 177.60 E	1943	Expl.	
Little Sitkin	"	51.95 N 178.53 E	1828	Smoke	
Semisopochnoi	"	51.98 N 179.58 E	1873	?	
Gareloi	"	51.80 N 178.80 W	1930	Lava	
Tanaga	"	51.88 N 178.09 W	1914	Lava	
Kanaga	"	51.92 N 177.17 W	1933	?	
Great Sitkin	"	52.07 N 176.09 W	1947	Lava dome	
Sarichef, Atka I.	"	52.32 N 174.05 W	1812!	?	
Seguam	"	52.32 N 172.38 W	1902	Expl.	
Amukta	"	52.50 N 171.27 W	1876	Smoke	
Yunaska	"	52.63 N 170.65 W	1937!	Expl.	
Carlisle	"	52.90 N 170.07 W	1828	?	
Mt. Cleveland	"	52.82 N 169.97 W	1944	Expl., lava	
Kagamil	"	52.97 N 169.73 W	1929	?	
Recheschnoi, Umnak I.	"	53.13 N 168.70 W	1878	Expl.	
Bogoslof I.	"	53.93 N 168.03 W	1931	Lava	
Okmok, Umnak I.	"	53.42 N 168.13 W	1945	Lava and ash	Formerly Tuliskoi
Makushin, Unalaska I.	"	53.87 N 166.93 W	1938	Expl.	
Akutan	"	54.13 N 166.00 W	1947	Lava	
Pogromni, Unimak I.	"	54.57 N 164.70 W	1830	Expl.	Ash eruption 1795
Shishaldin, Unimak I.	"	54.75 N 163.96 W	1932	Expl., lava	Ash, 1947
Isanotski, Unimak I.	"	54.75 N 163.73 W	1831	Effusive	
Frosty	Alaska	55.07 N 162.85 W	1768	?	
Dutton	"	55.17 N 162.28 W	1817	Lapilli	Formerly Medwenikoff
Pavlof	"	55.42 N 161.90 W	1946	Ash	
Veniaminof	"	56.17 N 159.38 W	1939	Ash	

TABLE 19

Name of Volcano	Location	Lat. and long.	Last Eruption		Remarks
			Date	Character	
Aniakchak	Alaska	56.88 N 158.17 W	1931	Ash, lava	
Chiginagak	"	57.13 N 157.00 W	1929	?	
Peulik	"	57.75 N 156.35 W	1814	Expl.	1852, smoke
Mageik	"	58.20 N 155.25 W	1927	Ash,pumice	(1929?)
Katmai	"	58.27 N 154.98 W	1912!!	Ash	(1929?)
Novarupta	"	58.28 N 155.25 W	1912	Ash	
Kukak	"	58.45 N 154.35 W	1889 ?	?	
St. Augustine	"	59.37 N 153.42 W	1935	Ash and Lava	
Iliamna	"	60.03 N 153.10 W	1867	Expl.	
Redoubt	"	60.47 N 152.75 W	1902	Ash	
Wrangell	"	61.53 N 143.95 W	1819	?	
Near Atlin Lake	"	59.25 N 133.50 W	1898	Ash	
Onnimah-Strasse (Near Cape Ommaney?)	"	56.2± N 134.7± W	1856		Submarine; whaler "Alice Frazer"
Mt. Baker	Washington	48.73 N 121.77 W	1854 ?	?	
Mt. Rainier	"	46.87 N 121.77 W	1843	?	
Mt. St. Helens	"	46.20 N 122.17 W	1841-43	Lava, ash	
Mt. Hood	Oregon	45.38 N 121.17 W	1854	Ash	
Mt. Shasta	California	41.41 N 122.20 W	1876 ?	Ash	
Cinder Cone	"	40.50 N 121.30 W	1851±	?	
Lassen	"	40.48 N 121.30 W	1917	Lava	
Sunset Crater	Arizona	35.37 N 111.50 W	1060±	Ash	dated by tree rings
Near Valle de San Rafael	Baja Calif.	31.9± N 116.2± W	1870	Ash	Exact location Doubtful
Tres Virgenes	"	27.53 N 112.67 W	1746	?	
Parícutin	Mexico	19.50 N 102.05 W	1948	Lava,ash	New,1943
Ceboruco	"	21.37 N 104.70 W	1870	Lava flow	
Colima	"	19.42 N 103.72 W	1941	?	Ash expl. 1913
Jorullo	"	18.85 N 101.82 W	1759	Lava	New, 1759
Popocatépetl	"	19.02 N 98.69 W	1921	Steam	1523, fragmentary ejecta
Orizaba	"	19.03 N 97.32 W	1687	Lava	
San Martin Tuxtla	"	18.51 N 95.23 W	1793	Ash, lava	
Cerro Quemado	Guatemala	14.79 N 91.52 W	1785	?	
Santa Maria	"	14.75 N 91.55 W	1934	Ash	
Atitlan	"	14.58 N 91.18 W	1856 ?	Fragmentary ejecta	

TABLE 19

Name of Volcano	Location	Lat. and Long.	Last Eruption Date	Last Eruption Character	Remarks
Acatenango	Guatemala	14.49 N 90.87 W	1924-27	Fragmentary ejecta	
Fuego	"	14.47 N 90.88 W	1945	Ash	
Pacaya	"	14.37 N 90.60 W	1846	?	Eruptions chiefly ash and lapilli
Izalco	Salvador	13.81 N 89.64 W	1946	Lava	
El Playon	"	13.7 N 89.3 W	1659	Lava flow	
El Salvador	"	13.74 N 89.26 W	1917	Lava flow	
Ilopango	"	13.67 N 89.05 W	1880	Lava	New, 1880
Bouquerón	"	13.73 N 89.29 W	1917	Lava	
San Miguel	"	13.43 N 88.27 W	1931	Ash	
Conchagua	"	13.27 N 87.84 W	1868	Ash	
Coseguina	Nicaragua	12.97 N 87.59 W	1835!!	Ash	
Chinandega	"	12.70 N 87.02 W	1685	?	
Telica	"	12.60 N 86.86 W	1529	Ash	
Las Pilas	"	12.49 N 86.68 W	1923	?	Lava, 1867
Momotombo	"	12.42 N 86.55 W	1905	Ash, lava flow	
Masaya-Nindirí	"	11.97 N 86.17 W	1927		Lava Lake
Ometepec	"	11.56 N 85.62 W	1921-6	Ash	
Orosi	Costa Rica	10.98 N 85.48 W	1849	Lava	(or Góngora, 10.92 N, 85.92 W
Rincón de la Vieja	"	10.83 N 85.37 W	1922	Ash	
Poás	"	10.17 N 84.23 W	1910	Ash expl.	
Turrialba	"	10.02 N 83.77 W	1864-6	Ash	
Irazu	"	9.98 N 83.87 W	1933	Ash	
Chiriquí	Panama	8.80 N 82.50 W	15xx ?	?	
Near St. Vincent I.	West Indies	14.00 N 60.92 W	1902	Submarine	
Soufrière, St. Lucia I.	"	13.82 N 61.06 W	1766	?	
Soufrière, St. Vincent I.	"	13.33 N 61.18 W	1902!	Nuées ardentes	
Pelée, Martinique I.	"	14.81 N 61.17 W	1929	Ash	
Mt. Misery, St. Kitts I.	"	17.38 N 62.80 W	1692	?	
Grande Soufrière, Guadeloupe I.	"	16.04 N 61.66 W	1903	?	Nuées ardentes, 1798
Near Guadeloupe I.	"	16.0 N 61.4 W	1843	Submarine	
Grande Soufrière, Dominica	"	15.30 N 61.31 W	1880	Ash	

TABLE 19

Name of Volcano	Location	Lat. and Long.	Last Eruption		Remarks
			Date	Character	
Sanare	Venezuela	9.75 N 69.77 W	1927	Steam explosions ?	
Tolima	Colombia	4.68 N 75.30 W	1826!	?	
Ruiz	"	4.50 N 75.28 W	1845	?	Mud flow apparently due to lava melting snow
Puracé	"	2.33 N 76.35 W	1869	Ash, bombs	
Dona Juana	"	1.5 N 76.8 W	1899	?	
Pasto, or LaGalera	"	1.21 N 77.25 W	1936	Lava	
Reventador	Ecuador	0.05 S 77.68 W	1926	Ash	
Pichincha	"	0.07 S 78.58 W	1881	?	Ash, 1660
Antisana	"	0.50 S 78.08 W	1728	Lava flow ?	
Cotopaxi	"	0.68 S 78.47 W	1926	?	1906,ash
Tungurahua	"	1.53 S 78.49 W	1903	Steam expl.	1886, lava flow
Sangay	"	1.68 S 78.37 W	1935	Explosive	
Ubinas	Peru	16.17 S 70.78 W	1937	Lava(Press)	1865,ash expl.
Misti	"	16.28 S 71.40 W	1869	?	Ash, 1830
Omate	"	16.62 S 70.90 W	1752 ?	?	1660,ash!
Tutupaca	"	16.88 S 70.33 W	1802	Ash	
Andahua	"	17± S 70± W	1913 ?	?	
Huallatiri	Chile	17.57 S 68.88 W	1913	?	Ash and steam in previous centuries
Yucamani	"	18± S 70± W	1787	?	
Isluga	"	18.77 S 69.95 W	1913	?	
San Pedro-San Pablo	Bolivia	21.87 S 68.3 W	1911	Strombolian	
Llascar	Chile	23.35 S 67.68 W	1933	Ash	
Turitari	Argentina	23.55 S 66.60 W	1937	?	Press Report
Near La Poma	"	25± S 66± W	1931	?	" " unconfirmed
Nevado	"	34± S 69± W	1929	Lava	Press Report unconfirmed
San José	Chile-Argent.	33.78 S 69.90 W	1895	Ash	Also 1939 (Press)
Maipo	Chile	34.12 S 69.87 W	1912	Heavy smoke	
Tinguiririca	"	34.82 S 70.37 W	1934	?	
Peteroa	"	35.20 S 70.60 W	1937	Ash(Press)	Flank flow, 1762
Planchon	"	35.2 S 70.7 W	1937	Ash	
Cerro Azul	"	35.67 S 70.75 W	1927	?	Lava flow, 1847

TABLE 19

Name of Volcano	Location	Lat. and Long.		Last Eruption		Remarks
				Date	Character	
Quizapu	Chile	35.64 S	70.75 W	1932	Ash	
Chillan	"	36.82 S	71.50 W	1935	Lava	
Tromen	Argentina	37.12 S	70.10 W	1822	?	
Antuco	Chile	37.42 S	71.34 W	1861	Lava flow	
Trolhuaco	"	38.30 S	71.56 W	1940	"smoke and flame"	Press report
Lonquimai	"	38.39 S	71.59 W	1933	?	
Llaima	"	38.70 S	71.73 W	1940	Lava, ash	
Villarica	"	39.42 S	71.93 W	1920	?	Ash, 1908
Rininahue	"	39.93 S	72.03 W	1907	Lapilli, ash	
Los Azufres	"	40.47 S	71.89 W	1929	Lava	
Puyehue	"	40.59 S	72.12 W	1905	?	
Caulle	"	41± S	72± W	1934	Incandescent bombs	
Osorno	"	41.12 S	72.49 W	1835	Lava	
Puntiagudo	"	40.97 S	72.28 W	1930	?	
Calbuco	"	41.34 S	72.66 W	1929	Ash	
Huequi	"	42.68 S	72.60 W	1906-7	Explosive	
Minchinmavida	"	42.78 S	72.43 W	1835	Lava	
Corcovado	"	43.18 S	72.77 W	1835	Explosive	
San Martin	"	49.0 S	73.0 W	1879	?	Uncertain
Mt. Burney	"	52.33 S	73.40 W	1910	?	
Zavodovskii I.	S.Sandwich Is.	56.3 S	27.5 W	?	?	Sulfur flowing, 1908
Darnley, Bristol I.	"	58.0 S	26.8 W	1936	Lava flow	
Bridgeman I.	Antarctic	62.07 S	56.67 W	1839	?	
Mt. Pond, Deception I.	"	62.93 S	60.57 W	?	?	Glacier contains layers of ash and ice
New Island	"	65.2 S	72.2 W	1877		Vessel "Lutterfeld"
Lindenberg I.	"	65± S	60± W	1893	Smoke, stones	
Near Juan-Fernandez Is.	Pacific	33.60 S	78.85 W	1837	Submarine	
Ruapehu	New Zealand	39.26 S	175.55 E	1945-46	Lava dome and ash eruptions	
Ngauruhoe	"	39.17 S	175.64 E	1934	Ash	
Te Mari, Tongariro	"	39.1 S	175.7 E	1896	Explosive	
Tarawera	"	38.22 S	176.49 E	1886	Ash, Lapilli	

TABLE 19

Name of Volcano	Location	Lat. and Long.		Last Eruption		Remarks
				Date	Character	
White I.	New Zealand	37.46 S	177.15 E	1914	Steam expl.?	
	Kermadec Is.	30.0 S	178.50 E	1877	Submarine	
Brimstone I.	"	30.23 S	178.92 E	1825	New island	
Denham Bay	Raoul I.	29.25 S	177.92 W	1870	New island	
	Tonga Is.	21.17 S	175.73 W	1907	Submarine	
Near Honga Hapai I.	"	20.85 S	175.20 W	1912	Submarine	
Falcon I.	"	20.32 S	175.40 W	1927	Ash, lava	
Tofua I.	"	19.85 S	175.05 W	1906	Lava flow	
Metis I.	"	19.20 S	174.86 W	1894	Submarine	
Maurelle Is.	"	19± S	175± W	1781	New island	
Late I.	"	18.82 S	174.64 W	1854	Flank eruption	
Fanua Lai I.	"	18.04 S	174.29 W	1847	Strombolian	
Niuafoou I.	"	15.58 S	175.72 W	1946	Lava	
Manua Group	Samoa Is.	14.20 S	169.58 W	1866	Submarine	
Matavanu, Sawaii I.	"	13.6 S	172.45 W	1905-1911	Ash, lava flow	
Maúga Afi	"	13.6 S	172.7 W	1902	Lava flow	
Hunter I.	New Hebrides	22.28 S	172.10 E	1895	?	1835, lava
Yasowa, Tanna I.	"	19.48 S	169.40 E	1878	New Crater	
Eromanga I.	"	18.65 S	169.15 E	1881	Submarine	
Epi I.	"	16.83 S	168.53 E	1901	New island	
Lopevi I.	"	16.46 S	168.37 E	1908	Lava flow	
Minnei, Ambrym I.	"	16.20 S	168.10 E	1935	Scoriae	
Vanua Lava I.	"	13.7 S	167.5 E	1861	Ash	
Ureparapara I.	"	13.47 S	167.35 E	1872	?	
Tinakula I.	"	10.40 S	165.78 E	1909	Lava	
Savo I.	Solomon Is.	9.14 S	159.80 E	1850	Explosive	
Bagana	Bougainville I.	6.20 S	155.05 E	1943	Lava, ash	
Matupi	New Britain	4.40 S	152.47 E	1937	Ash	
Vulcan I.	"	4.40 S	152.47 E	1937	Ash	
Ulawon (Vater)	"	5.03 S	151.23 E	1915	Lapilli?	
Lolobau I.	"	4.88 S	151.05 E	1905	Lava	
Pago	"	5.55 S	150.62 E	1905±	?	Basalt flows recently
Benda	"	5.08 S	150.13 E	1900±	?	

TABLE 19

Name of Volcano	Location	Lat. and Long.		Last Eruption		Remarks
				Date	Character	
Langila	New Britain	5.55 S	148.30 E	1905±	Lapilli	
Vitu Is.	"	4.6 S	149.4 E	1863±	New island	
Goropu Mts.	New Guinea	9.7 S	149.0 E	1944	Ash, lapilli	
Ritter I.	"	5.45 S	148.10 E	1888!	Explosive	
Karkar I.	"	4.7 S	146.0 E	1895	Ash	
Manam I.	"	4.13 S	145.05 E	1937	Stones and dust	1919, lava flow
Lesson I.	"	3.60 S	144.77 E	1919	Ash	
Oemsini	"	1.2 S	134.0 E	1864	? ?	
Guguan I.	Marianas	17.3 N	145.9 E	1901	Ash	
Uracas I.	"	20.54 N	144.90 E	1936	Flame	Strombolian
Shinto, near Minami Iwo	Bonins	24.22 N	141.48 E	1914	Lava	New island, 1904, 1914
Near Kita Iwo	"	25.4 N	141.3 E	1880	Submarine	
Near Mitsugo	"	30 N	140 E	1871	Submarine	
Torishima	"	30.55 N	140.25 E	1902	Explosive	Mitsugo Jima
Near Smith I.	"	31 N	139 E	1916	Submarine	
Urania	"	31.9 N	140.0 E	1946	New island	
Near Bayonnaise	"	31.9 N	139.9 E	1905	Submarine	
" "	"	32.05 N	140.10 E	1915	Submarine	
Aoga Shima	"	32.40 N	139.80 E	1785	?	
Hachijo Shima	"	33.10 N	139.82 E	1605	Lava flow	
Miyakeshima	"	34.10 N	139.55 E	1940	Lava flow, etc.	
Kozushima	"	34.22 N	139.17 E	838	Liparitic	
Niizima	"	34.4 N	139.28 E	886	Liparitic	
Miharayama, O Shima	"	34.75 N	139.40 E	1938	Scoriae	
Fuji	Honshu	35.36 N	138.24 E	1707	Ash	
Asama	"	36.40 N	138.53 E	1947	Ash	
Shirane-Kusatsu	"	36.63 N	138.55 E	1938	Ash	
Shirane, Nikko	"	36.77 N	139.40 E	1872	?	
Iwodake	"	36.10 N	137.55 E	1932	Ash	
Hakusan	"	36.15 N	136.78 E	1575	Explosive	
Tateyama	"	36.55 N	137.62 E	704	?	
Nasuyama	"	37.15 N	139.92 E	1880	?	
Bandai	"	37.58 N	140.05 E	1888	Explosive!!	

TABLE 19

Name of Volcano	Location	Lat. and Long.	Last Eruption Date	Last Eruption Character	Remarks
Adatara	Honshu	37.11 N 140.27 E	1900	Fragmentary ejecta	
Azumasan	"	37.73 N 140.14 E	1895	Explosive	
Zaosan	"	38.11 N 140.42 E	1918	Subaqueous, in crater lake	
Komagatake	"	38.95 N 140.80 E	1932	Ash	
Iwatesan	"	39.84 N 141.03 E	1824	?	Ash, 1686
Yake-Yama, Ugo	"	40± N 141± E	1875	?	
Iwakisan	"	40.65 N 140.32 E	1848	? ?	
Oshima	"	41.50 N 139.35 E	1741	Explosive!	
Tarumai	Hokkaido	42.70 N 141.37 E	1933	Explosive	Ash, 1926
Usudake	"	42.52 N 140.85 E	1944-1945	Ash. Marked changes in topography, (intrusions?).	
Komagatake	"	42.08 N 140.67 E.	1929	Ash and glowing avalanches	
Tokachi	"	43.42 N 142.68 E	1926	Explosive	
Shiretoko-Iwo- San	"	44.20 N 145.30 E	1890	Explosions	1936, sulfur flow
Chirip, Etorofu I.	Kuriles	45.35 N 147.93 E	1843	?	
Myorodake, Etorofu I.	"	45.39 N 148.84 E	1883	?	
Rebuntsiridake, Kita Jima, Chirihoi To	"	46.53 N 150.88 E	1859	Explosive	N.Brother
Shimushirudake	"	46.83 N 151.80 E	1914	Ash	
Ketoi	"	47.33 N 152.45 E	1843	? ?	
Raikoke	"	48.29 N 153.25 E	1924	Ash	
Sarichev, Matsuwa I.	"	48.09 N 153.22 E	1930	Ash, Lapilli	(Fuyo)
Harimukotan	"	49.15 N 154.50 E	1933	Explosion	Ash, 1931
Kurodake, Shasukotan	"	48.87 N 154.18 E	1855	?	
Chirinkotan	"	49.00 N 153.50 E	1878	"Throws out stones"	
	"	49.8± N 155.0± E	1937	2 new islands	
Chikura Dake	"	50.30 N 155.47 E	1945	?	Press report
Fuss Peak, Paramushiro I.	"	50.27 N 155.26 E	1793	?	
Io-Yama, "	"	50.69 N 156.02 E	1935	Explosive	
Masakariyama, Paramushiro I.	Kuriles				
Araito I.	"	50.85 N 155.58 E	1854	Ash	

TABLE 19

Name of Volcano	Location	Lat. and Long.	Last Eruption		Remarks
			Date	Character	
Taketomi I.	Kuriles	50.84 N 155.67 E	1934	New island	
Kosheleva	Kamchatka	51.35 N 156.75 E	16xx	?	
Ilina	"	51.49 N 157.22 E	1901	Explosive	
Zheltovski	"	51.57 N 157.34 E	1923	"	
Shtyubelya	"	51.80 N 157.51 E	1907!	Ash	
Khadutka	"	52.1 N 157.7 E	1855	?	
Opala	"	52.54 N 157.32 E	17xx	?	
Gorely	"	52.56 N 158.02 E	1930	Ash	
Mutnovski	"	52.46 N 158.20 E	1927	?	Ash, 1897-1907
Avachinski	"	53.35 N 158.83 E	1927	Lava	
Koryatski	"	53.32 N 158.63 E	1896	?	
Igorevski	"	53.47 N 159.04 E	1923	?	
Zhupanovski	"	53.60 N 159.18 E	1925	?	
Veyer	"	53.63 N 158.50 E	1858	Lava flows	
Karymski	"	54.03 N 159.51 E	1935	Lava	
Maly Semyachik	"	54.13 N 159.74 E	1854	Ash	
Bolshoi Semyachik	"	54.29 N 160.03 E	1852	Ash	
Kronotski	"	54.77 N 160.58 E	1923	Ash	
Kizimen	"	55.23 N 160.18 E	1932	Ash	
Tolbachik	"	55.83 N 160.27 E	1931	Ash	
Klyuchevskoi	"	56.05 N 160.65 E	1945	Lava, ash	
Shiveluch	"	56.66 N 161.32 E	1930	Ash	
Off Formosa		24.0 N 121.8 E	1853	Submarine, ash	
" "		25.4 N 122.2 E	? ?	Submarine	(Noack, quoted by Sapper)
Hatoma	Ryukyu Is.	24.57 N 123.93 E	1925	Submarine; pumice	
Torishima	"	27.85 N 128.23 E	1902	Explosive	
Suwanose Jima	"	29.68 N 129.72 E	1938	Incandescent ejecta	
Hachido, Kuchinoerabu	"	30.48 N 130.25 E	1934	Ash	
Io-Zima-Sintô	"	30.82 N 130.33 E	1935	New island	
Iwo Jima	"	30.8 N 130.3 E	1934	Explosion	
Kirishima	"	31.92 N 130.85 E	1914	Ash, Lapilli	
Asodake	Kyushu	32.88 N 131.15 E	1946	Ash, scoriae	

TABLE 19

Name of Volcano	Location	Lat. and Long.	Last Eruption Date	Last Eruption Character	Remarks
Kaimondake	Kyushu	31.17 N 130.55 E	1615	?	
Sakurajima	"	31.60 N 131.70 E	1946	Lava flow	
Unzendake	"	32.7 N 130.3 E	1792	Lava	
Saishuto I.	Korea	33.4 N 126.5 E	1007	Lava ?	
Sulu I.	Philippines	6.0 N 121.2 E	1641	?	
Macaturín, Mindanao	"	7.60 N 124.43 E	1871	?	
Ragang Mindanao	"	7.67 N 124.48 E	1916 ?	Ash	
Calayo	"	7.83 N 124.67 E	1886	?	
Camiguin de Mindanao	"	9.20 N 124.70 E	1871	Ash, lava	
Canlaón, Negros I.	"	10.41 N 123.10 E	1906	Ash	
Bulusan, Luzon	"	12.78 N 124.02 E	1918	Lava, ash	
Mayon, Luzon	"	13.28 N 123.67 E	1947	Explosive	
Taal, Luzon	"	14.03 N 120.95 E	1911 !	Ash, explosive !	
Banájao, Luzon	"	14.09 N 121.49 E	1730	Explosion	
Didica, off Luzon	"	19.03 N 122.15 E	1856-1860	Growing island	
Babuyán Claro	"	19.50 N 121.95 E	1919	?	1831, ash!
Near Sabtan I.	"	20.3 N 121.9 E	1854	Submarine	
Makian	West of Halmahera	0.33 N 127.41 E	1890	Ash, lava	
Motir	" "	0.45 N 127.41 E	1744	Explosive	
Peak of Ternate	" "	0.81 N 127.34 E	1933	Explosive	
Gamkonora	Halmahera	1.38 N 127.54 E	1926	Lava	
Iboe	"	1.50 N 127.64 E	1911	Explosive	
Doekono	"	1.70 N 127.90 E	1941	Ash	
Oena Oena	Celebes	0.16 S 121.60 E	1898	Ash	
Api, Siaoe I.	"	2.81 N 125.44 E	1941	Ash, lava	
Banoe Woehoe, Mahengetany I.	"	3.15 N 125.46 E	1919	Lava	
Awoe, Sangihe I.	"	3.70 N 125.46 E	1931	Lava	
West of Sangihe I.	"	4.0 N 124.2 E	1922	Submarine	
Sopoetan	"	1.12 N 124.74 E	1923	Lava, ash	
Mahawoe	"	1.41 N 124.89 E	1789	Explosive	
Lokon	"	1.40 N 124.79 E	1893	Explosive	

TABLE 19

Name of Volcano	Location	Lat. and Long.		Last Eruption		Remarks
				Date	Character	
Tongkoko	Celebes	1.54 N	125.16 E	1821	Ash, lava	
Roeang	"	2.32 N	125.38 E	1915	Lava	
Emperor of China	Banda Sea	6.67 S	124.67 E	1927 ?	Submarine	
Nieuwerkerk	"	6.66 S	124.20 E	1927 ?	"	
Api, N. of Wetar	"	6.66 S	126.64 E	1699	Explosive	
Banda Api	"	4.52 S	129.88 E	1901	Lava	
Seroea	"	6.31 S	130.03 E	1921	Explosive	
Nila I.	"	6.75 S	129.51 E	1932	Ash	
Teon	"	6.98 S	129.15 E	1904	Ash	
Damar I.	"	7.14 S	128.61 E	1892	Ash	
Siroeng, Pantar I.	"	8.48 S	124.12 E	1934	Ash, lava	
Batoe Tara	"	7.77 S	123.60 E	1850	Lava flow	
Ili Weroeng, Lomblen I.	"	8.52 S	123.56 E	1928	Ash, lava	
Ili Lewotolo, Lomblen I.	"	8.28 S	123.52 E	1899	Explosive	
Ili Boeleng, Adonara I.	"	8.35 S	123.30 E	1925	Ash	
Rokatinda, Paloeweh I.	"	8.32 S	121.73 E	1928!	Pumice, ash, lava blocks	
Leweno	Flores	8.34 S	122.85 E	1881	Ash	
Lewotobi Laki Laki	"	8.53 S	122.76 E	1940	Ash	
Lewotobi Perampoean	"	8.57 S	122.80 E	1935	Explosive	
Keli Moetoe	"	8.76 S	121.84 E	1860-1870	Explosive	
Endeh Api	"	8.78 S	121.67 E	1882	"	
Poei	"	8.85 S	121.65 E	1671	"	
Amboe Romboe	"	8.80 S	121.16 E	1924	Lava	
Inië Lika	"	8.74 S	120.99 E	1905	Old debris	
Sangeang Api	Soembawa	8.20 S	119.07 E	1927	Ash	
Tambora	"	8.20 S	118.00 E	1815!	Ash!	
Rindjani	Lombok I.	8.35 S	116.42 E	1900	Lava flow	
Agoeng	Bali	8.34 S	115.50 E	1843	Ash, lava flow	
Batoer	"	8.23 S	115.42 E	1926	Ash, lava	
Kawah Idjen	Java	8.07 S	114.25 E	1917	Steam, ash	
Raoeng	"	8.11 S	114.10 E	1941	Ash	

TABLE 19

Name of Volcano	Location	Lat. and Long.		Last Eruption		Remarks
				Date	Character	
Lamongan	Java	7.99 S	113.35 E	1898	Lapilli, Lava flow	
Semeroe	"	8.11 S	112.95 E	1941	Lava	
Bromo, Tengger	"	7.99 S	112.96 E	1940	Ash	
Keloed	"	7.95 S	112.35 E	1920	Lava	
Merapi	"	7.56 S	110.45 E	1934	Lava-dome and glowing avalanches	
Soendoro	"	7.30 S	109.99 E	1906	Ash	
Pakoe Wodjo	"	7.20 S	109.92 E	1847	Ash	
Boetak Petarang	"	7.20 S	109.8 E	1786	Explosive	
Slamat	"	7.25 S	109.22 E	1939	Ash	
Tjerimai	"	6.90 S	109.22 E	1938	Ash	
Galoengoeng	"	7.2 S	108.3 E	1918	Lava	
Papandajan	"	7.4 S	107.9 E	1924	Explosive	1772, lava flow
Goentoer	"	7.0 S	108.1 E	1847	Ash	
Tangkoeban Prahoe	"	6.7 S	107.6 E	1910	Ash, scoriae	
Gedeh	"	6.77 S	106.95 E	1947	Ash	
Krakatau	Sumatra	6.10 S	105.42 E	1941	Mud, ash	Great explosion, 1883
Soeoh, Pematang Bata	"	5.23 S	104.27 E	1933	Phreatic explosion	
Dempo	"	4.00 S	103.10 E	1940	Lava	
Kaba	"	3.4 S	102.7 E	1941	Ash	
Kerintji	"	1.7 S	101.3 E	1936-7	Phreatic	1842 strombolian
Talang	"	0.9 S	100.8 E	1845	Explosive	1833, lava
Tandikat	"	0.5 S	100.4 E	1914	Lava	
Marapi	"	0.2 S	100.5 E	1930	Ash	
Sorikmarapi	"	0.8 N	99.5 E	1917	Ash	
Boer Ni Telong	"	4.7 N	96.8 E	1856	Ash	
Peuëtsagoë	"	4.9 N	96.3 E	1919-1920	Ash, lava	
Barren I.	Andamans	12.20 N	93.83 E	1803	Strombolian	
Puppa	Burma	21.0 N	95.3 E	?	?	
	Indian Ocean	6± S	89± E	1883	Floating lava	Vessel "Siam"
Near Pondicherry	" "	12± N	80± E	1757	Submarine	
L'Île des Cendres	China Sea	10.1 N	109.0 E	1923	New island	

TABLE 19

Name of Volcano	Location	Lat. and Long.	Last Date	Eruption Character	Remarks
Nimrod	Armenia	38.60 N 42.16 E	1441	?	
Nisyros I.	Aegean	36.58 N 27.20 E	1422	Strombolian	
Santorini	"	36.4 N 25.4 E	1940	Lava	
Methana	Greece	37.60 N 23.38 E	3d Cent. B.C.	New volcano	
	Mediterranean	36.68 N 13.74 E	1845	Submarine	Vessel "Victory"
	"	36.28 N 21.28 E	1886	"	Vessel "LaValette"
	Ionian Sea	35.90 N 18.67 E	1886	"	
	W. of Malta	36.1 N 14 E	1911	"	
Monte Nuovo	Italy	40.83 N 14.10 E	1538	New volcano	
La Solfatara	Italy	40.80 N 14.15 E	1935	Explosion	
Epomeo, Ischia I.	"	40.75 N 13.92 E	1301	Lava flow	
Etna	Sicily	37.75 N 15.02 E	1946	Explosive	1947, lava flow
Vulcano	N. of Sicily	38.40 N 14.95 E	1890	Explosive	
Stromboli	" "	38.80 N 15.22 E	1937	Lava	
Vesuvius	Italy	40.82 N 14.42 E	1944	Lava	
Ferdinandea, or Graham's Reef	Mediterranean	37.02 N 12.70 E	1868	New island	
Förstner	"	36.84 N 11.92 E	1891	Submarine	
	Atlantic	1/2 S 20-22 W	18xx	Submarine	
	"	0.6 S 15.8 W	1836	Submarine	
	"	4.3 N 21.7 W	1878	"	
	"	7 N 21.8 W	1824	"	
Pico de Cano, Fogo I.	Cape Verde Is.	14.9 N 24.4 W	1909	Weak, ash	
La Palma I.	Canary Is.	28.67 N 17.83 W	1785	Scoriae	
Teyde, Tenerife I.	"	28.33 N 16.72 W	1909	Lava flow	
Lanzarote I.	"	29.00 N 13.67 W	1824	Explosive	
Furnas, São Miguel I.	Azores	37.67 N 25.30 W	1630	Explosive	
Agua de Pau	"	37.67 N 25.48 W	1652	Ash, lava	
Sete Cidades	"	37.75 N 25.80 W	1811	Submarine	
	"	38.25 N 26.6 W	1720	New island	N.W. of São Miguel I.
Pico I.	"	38.50 N 28.3 W	1720	Ash, lava	

TABLE 19

Name of Volcano	Location	Lat. and Long.	Last Date	Eruption Character	Remarks
Caldeira, Fayal I.	Azores	38.58 N 28.75 W	1672	Ash, lava	
São Jorge I.	"	38.60 N 28.00 W	1808	Ash, lava	
Santa Barbara, Terceira I.	"	38.75 N 27.25 W	1761	Ash, lava	
	"	38.8 N 27.4 W	1867	Submarine	W. of Terceira I.
Askja	Iceland	65.03 N 16.68 W	1875	Pumice	
Dalfjall	"	65.6 N 16.7 W	1728	Lava!	
Leirhnúkur	"	65.7 N 16.7 W	1729	Lava	
Öraefa-Jökull	"	64.05 N 16.70 W	1727	Lava	
Sveinagjá	"	65.7 N 16.3 W	1875	Lava	
Kverkfjöll	"	64.59 N 16.60 W	1929	?	1717,ash
Katla	"	63.59 N 18.94 W	1918	Ash	
Eyjafjallajökull	"	63.61 N 19.64 W	1822	Melted glacier	
Laki	"	64.2 N 18.2 W	1783!	Ash, lava!	
Hágöngur	"	64.27 N 17.30 W	1774	?	
Helgafell, Heimaey I.	"	63.43 N 20.22 W	9xx ?	?	
Hekla	"	63.98 N 19.70 W	1947	Ash,bombs	
Trölladyngja	"	63.93 N 22.10 W	1389	?	
Eldeyar Is.	"	63.8 N 23.0 W	1879	?	Eruptions, chiefly submarine
Grimsvötn Skeidara-Jökull	"	64.41 N 17.33 W	1934	Explosive	Subglacial
Beerenberg	Jan Mayen I.	71.0 N 8.0 W	1818	Ash	
Harra-en-Nár	Arabia	24 1/2±N 40 1/2± E	600±		
Schadar Valley	"	24± N 42± E	1254	Lava flow	Location doubtful
	Yemen	14.5 N 44.5 E	1937?		Near Damâr
Erta-Ale	Abyssinia	13.62 N 40.57 E	1928	Smoke, lighted by lava in crater	
Afderá	"	13.18 N 41.01 E	1907	Lava	
Edd, or Dubbi	Eritrea	13.74 N 41.55 E	1861	?	
Teleki	Kenya	2.34 N 36.56 E	1896	New crater	
Nyamlagira	Belgian Congo	1.42 S 29.20 E	1938	Lava	
Niragongo	"	1.52 S 29.24 E	1912	Lava flow	
Kanamaharagi	"	1.41 S 29.30 E	1905	?	
Oldongo-lengai	Tanganyika	3 ± S 36 ± E	1917	Gas explosion	

TABLE 19

Name of Volcano	Location	Lat. and Long.	Last Eruption		Remarks
			Date	Character	
Kartala	Grand Comoro I.	11.85 S 43.32 E	1904	Lava	
Cameroun	West Africa	4.20 N 9.15 E	1925	Lava	
Piton de la Fournaise	Réunion I.	21.3 S 55.8 E	1942	Lava	
Kilauea	Hawaii	19.37 N 155.30 W	1934	Pumice	
Mauna Loa	"	19.50 N 155.92 W	1942	Lava flow	
Hualalai	"	19.70 N 155.87 W	1801	" "	
Haleakala	Maui	20.72 N 156.25 W	1750±	" "	
Narborough I.	Galápagos	0.40 S 91.62 W	1936	?	Lava, 1825
Albemarle I.	"	0.0 S 91.4 W	1948	Lava flow	
James I.	"	0.3 S 90.8 W	1906-1907	?	
Wassilieff	Manchuria	48.90 N 126.10 E	1721	Lava	
Chang Pai	"	42.00 N 128.10 E	1702	?	
Erebus	Antarctic	77.5 S 168 E	1912	Ash, pumice	
Buckle I.	"	66.80 S 163.3 E	1899	Smoke	

Added in proof. (List closed June 1948)

Pagan I.	Marianas	18.11 N 145.79 E	1925	Lava flow	
Agrigan I.	"	18.75 N 145.67 E	1917	Ash	
Asuncion I.	"	19.17 N 145.4 E	1906	Ash, lava flow	

AUTHOR INDEX

Adams, C. E., 104, 120
Adams, L. H., 101, 104
Adams, T. C., 85, 104
Adkins, J. N., 104, 128
Agostinho, J., 71, 104
Aguilera, F. G., 85, 104
Akyol, I. H., 112, 121
Allen, E. T., 33, 106
Allen, M. W., 34, 114, 123
Altinli, E., 112, 121
Anderson, E. M., 26, 87, 101, 104, 109
Anderson, T., 8, 36 104
Angenheister, G., 47, 96, 97, 104
Anonymous, 45, 48, 97, 104, 121
Arni, P., 64, 68, 104
Arnold, R., 36, 104, 110
Aslakson, C. I., 40, 104
Auden, J. B., 106, 121

Banerji, S. K., 9, 104
Barksdale, J. D., 32, 104, 106
Barnett, M. A. F., 104, 120
Bartrum, J. A., 47, 104
Bastings, L., 47, 104, 125
Becker, 58
Benioff, H., 95, 101, 104
Benson, W. N., 98, 104
Berlage, H. P., 9, 63, 104
Birch, F., 101, 104
Blackwelder, E., 36, 104
Blake, A., 9, 105
Bobillier, C., 8, 42, 96, 105, 126
de Böckh, 67
Bodle, R. R., 30, 36, 84, 105, 108, 111
Boese, E., 105, 119
Born, A., 26, 64, 81, 105
Bramhall, E. H., 105, 128
Branner, J. C., 81, 91, 105
Bridge, F., 51, 105
Bridgman, P. W., 101, 105
Brown, B. H., 32, 105
Brown, J. C., 105, 126
Brüggen, J., 8, 42, 105
Brunner, G. J., 9, 20, 48, 105
Bryan, W. H., 26, 87, 94, 105
Bucher, W. H., 100, 105
Buddington, A. F., 101, 105
Bullard, E. C., 21, 68, 70, 79, 101, 105, 109, 110
Bullen, K. E., 47, 105, 127
Buwalda, J. P., 33, 105, 107
Byerly, P., 9, 34, 36, 85, 96, 105, 116, 124, 126

Callaghan, E., 36, 105, 107, 126
Caloi, P., 70, 86, 106
Camacho, H., 36, 115
Carder, D. S., 98, 106
Cassinis, G., 68, 106
Castellanos, A., 42, 106, 130
Cavasino, A., 6, 106
Centeno-Graü, M., 39, 106
Christensen, A., 8, 106
Chubb, L. J., 26, 51, 106
Clapp, F. G., 64, 67, 106
Cloos, H., 8, 71, 79, 81, 87, 106
Close, U., 106, 120
Coats, R. R., 30, 106
Conrad, V., 21, 25, 106
Coombs, H. A., 32, 104, 106
Coster, H. P., 70, 71, 106
Cotton, C. A., 45, 46, 100, 106
Cox, D. C., 95, 110
Crary, A. P., 27, 107
Critikos, N. A., 69, 70, 106
Crompton, W., 8, 64, 116

Daly, R. A., 26, 101, 106
Dammann, Y., 106, 120
Davison, C., 21, 25, 32, 33, 53, 57, 67, 70, 72, 82, 87, 96, 97, 106, 120, 126
Day, A. L., 33, 106
De La Rüe, E. A., 8, 48, 106
Demetrescu, G., 70, 106
De Roever, W. P., 62
Descotes, P. M., 6
Di Filippo, D., 70, 106
Donoso, E., 106
Dow, R. B., 101, 104
Doyle, P., 82, 106
Doxsee, W. W., 109, 125
Duerksen, J. A., 79, 106
Dunn, J. A., 66, 106, 121
Du Toit, A. L, 100, 106
Dutton, C. E., 85, 97, 106

Egeran, E. N., 64, 68, 116
Emery, K. O., 32, 34, 113
Eppenstein, O., 6, 106
Erola, V., 73, 106
Escher, B. G., 60, 106
Etzold, F., 87, 107
Evans, P., 8, 64, 116
Ewing, J. A., 53
Ewing, M., 27, 39, 40, 77, 84, 107, 116

Farquharson, W. I., 77, 107
Ferrar, H. T., 46, 107
Fisher, N. H., 8, 50, 107, 129
Fu, C. Y., 10, 107
Fujiwhara, S., 8, 101, 107
Fuller, M. L., 85, 107
Fyfe, H. E., 47, 107

Galitzin, B., 107, 119
Gane, P. G., 10, 88, 107
García, J., 105, 119
Gee, E. R., 107, 125
Geinitz, E., 96, 107
Geldart, L. P., 25, 111
Gherzi, E., 99, 107
Ghosh, A. M. N., 106, 121
Gianella, V. P., 36, 105, 107, 126
Glennie, E. A., 66, 107
Graaff-Hunter, J. de, 66, 107
Grange, L. I., 46, 107
Gray, T., 53
Green, C. K., 95, 107
Gregory, J. W., 64, 67, 107
Griesbach, C. L., 67, 107
Griggs, D. T., 101, 107
Guild, P. W., 39, 114
Gutenberg, B., 3, 4, 8, 9, 10, 21, 25, 26, 27, 28, 32, 33, 36, 39, 43, 50, 70, 84, 85, 86, 87, 90, 91, 93, 95, 96, 99, 101, 103, 107, 108, 113, 120, 121, 126

Hagiwara, T., 108, 129
Hales, A. L., 107
Hantke, G., 8, 57, 112
Haskell, N. A., 101, 108
Hayes, R. C., 9, 47, 48, 89, 104, 108, 112
Heck, N. H., 30, 36, 74, 84, 95, 108
Hecker, O., 47
Heim, A., 73, 108, 123
Heinrich, R. R., 84, 108
Heiskanen, W., 8, 48, 53, 68, 73, 79, 108
Henderson, J., 45, 47, 108, 125
Hess, H. H., 39, 51, 62, 98, 108
Hiller, W., 86, 108
Hobbs, W. H., 33, 108
Hochstetter, F. von, 96, 109
Hodgson, E. A., 109, 123, 125
Hoffmeister, J. E., 77, 109
Holmes, A., 101, 109
Holopainen, P. E., 86, 109
Honda, H., 101, 109
Horsfield, W., 79, 109
Hulin, C. D., 73, 109

Imamura, A., 54, 95, 96, 97, 109, 126
Inglada, V., 42, 109
Ishimoto, M., 96, 109

Jaggar, T. A., 8, 95, 96, 109
Jeffreys, H., 9, 101, 109, 119
Jenkins, O. P., 33, 109
Jersey, N. J. de, 26, 47, 87, 94, 106
Jillson, W. R., 33, 109
Johnson, M., 84, 116
Jones, J. C., 33, 109, 120
Junner, N. R., 81, 109

Kawasumi, H., 99, 109
Keith, A., 97, 109, 125
Kennedy, W. Q., 8, 26, 87, 101, 109
Ketin, I., 112, 121
Kew, W. S. W., 36, 110
Kober, L., 98, 109
Koch, L., 81, 109
Kodaira, T., 53, 116
Kolderup, C. F., 87, 109

Koto, B., 53, 109
Krenkel, E., 79, 109
Krige, L. J., 88, 109
Krijanovsky, N., 8, 53, 109
Kuenen, Ph. H., 110
Kumagi, N., 53, 109
Kunitomi, S. I., 98, 109, 126

Lais, R., 8, 86, 113
Landsberg, H., 25, 109
Laughlin, H., 36, 110
Lawson, A. C., 33, 110, 119
Lee, A. W., 84, 110, 126
Lee, J. S., 72, 110
Lee, S. P., 73, 110, 120
Lees, 67
Leet, L. D., 25, 110
Lefebvre, J. H., 81, 110
Leicester, P., 105, 126
Lehmann, I., 110, 124, 125
Leushin, P. I., 68, 110
Linden, N., 74, 112
Linehan, D., 39, 110
Littlehales, G. W., 74, 110
Longwell, C. R., 84, 110
Lúnkenheimer, F., 157
Lyell, C., 46, 110
Lynch, J., 66, 110

Macdonald, G. A., 26, 47, 79, 95, 110, 114
Mace, C., 68, 70, 110
Macelwane, J. B., 110, 120, 122
Magnani, M., 70, 110
Marshall, P., 26, 47, 110
Martin, L., 19, 32, 114
Masó, M. S., 58, 96, 110, 120
Matuyama, M., 53, 110
Matuzawa, T., 110, 121
McCormick, E., 106
McKay, A., 46, 47, 110
McMahon, A. H., 67, 110
McMurry, H., 21, 110
Meinesz, F. A. V., 8, 28, 29, 34, 37, 51, 58, 60, 62, 70, 71, 74, 100, 110
Middlemiss, C. S., 110, 119
Mihailovic, F., 70, 110
Miller, B. L., 27, 107
Milne, J., 4, 8, 19, 32, 53, 93, 110, 111
Minakami, T., 57, 111
Mitchell, G. D., 36, 111
Miyabe, N., 58, 97, 111, 127, 129
Miyamoto, M., 9, 111
Miyamura, S., 53, 111
Montandon, F., 86, 111
Montessus de Ballore, F. de, 8, 47, 85, 90, 95, 96, 97, 111, 119
Morelli, C., 70, 111
Moriya, M., 95, 96, 97, 109
Mukherjee, S. M., 82, 111, 112, 121
Murray, H. W., 30, 111
Mushketov, D., 64, 72, 74, 91, 111

Nasu, N., 58, 111, 121
Neumann, F., 30, 36, 84, 85, 111
Neumayr, M., 8, 111
Nielsen, N., 8, 111
Nishimura, S., 58, 111, 127
Nordquist, J. M., 8, 9, 11, 25, 111

Obruchev, V. A., 68, 111
O'Connell, D. J. K., 6, 20, 48, 111
Oczapowski, B. L., 66, 73, 111
Oddone, E., 8, 111
Oldham, R. D., 66, 82, 86, 111
Oliver, H. O., 10, 88, 107
Omori, F., 58, 111, 112, 119, 122
Ongley, M., 46, 47, 112, 129
Oppenheim, V., 40, 112
Ordoñez, E., 112, 120
Otuka, Y., 58

Page, B. M., 33, 112, 120
Pamir, H. N., 112, 121
Paréjas, E., 68, 112, 121
Perret, F. A., 39, 112
Pettersson, H., 77, 112
Plett, G., 110, 124, 125
Poisson, C., 81, 112
Popoff, V., 91, 115
Pough, F. H., 8
Press, F., 39

Raiko, N., 68, 74, 112, 126
Ramanathan, K. R., 112, 127
Rangaswami, M. R., 111, 121
Ravet, J., 90, 112
Rebeur-Paschwitz, E. von, 4, 112
Reck, H., 8, 57, 112
Reed, R. D., 33, 112
Reid, H. F., 19, 40, 62, 72, 97, 112, 122
Renquist, H., 87, 98,
Repetti, W. C., 51, 58, 59, 112
Rich, J. L., 40, 112
Richardson, 67
Richey, J. E., 8, 109
Richter, C. F., 3, 4, 9, 20, 21, 25, 26, 28, 32, 33, 36, 39, 43, 50, 84, 85, 86, 90, 91, 93, 96, 99, 103, 105, 107, 108, 112, 121, 126
Rittmann, A., 8, 26, 112
Robinson, G. D., 30, 112
Rodriguez, J. G., 71, 112
Rosenthal, E., 4, 113, 119
Rothé, J. P., 8, 86, 113
Roy, S. C., 106, 121
Rozova, E., 68, 73, 113
Rudolph, E., 8, 32, 43, 72, 77, 94, 95, 96, 97, 113, 119
Ruiz, E., 36, 113
Russell, I. C., 8, 113
Rutherford, H. M., 27, 107

Salomon-Calvi, W., 113
Sanchez, P. C., 8, 113
Scheu, E., 8, 113
Schafer, S., 33, 115
Scherer, J., 39, 97, 113
Schmehl, H., 48, 113
Schmidt, J., 69, 113
Schuppli, H. M., 60, 62, 113
Scrase, F. J., 9, 113
Shepard, F. P., 32, 34, 95, 110, 113
Sieberg, A., 8, 20, 69, 82, 86, 87, 90, 91, 92, 96, 97, 113, 119, 120
Silgado, F. E., 40, 113
Skeels, D. C., 68, 113
Sommer, H., 113, 124
Somville, O., 99, 114
Sparks, N. R., 36, 114
Stearns, H. T., 26, 47, 79, 114
Stechschulte, V. C., 9, 114
Stehn, C. E., 8, 114
Stenz, E., 66, 114
Stetson, H. T., 21, 114
Stille, H., 68, 70, 86, 87, 114
Stoneley, R., 9, 114
Straubel, R., 6
Suda, K., 53, 114
Suess, F. E., 26, 42
Symons, G. J., 97, 114
Szirtes, S., 4, 20, 96, 113, 114, 119

Taber, S., 39, 40, 97, 112, 114, 122
Tams, E., 21, 42, 74, 77, 81, 113, 114, 119, 120
Tanakadate, H., 8, 53, 114
Tanni, L., 68, 70, 114
Tarr, R. S., 19, 32, 114
Thayer, T. P., 39, 114
Tillotson, E., 86, 114, 125
Timoshenko, S., 101, 114
Tolstoy, I., 39
Townley, S. D., 34, 36, 114, 123
Tsuboi, C., 19, 84, 99, 114
Tsuya, H., 51, 114
Turner, H. H., 3, 4, 9, 115
Tuve, M. A., 84, 115

Uhrig, L. F., 33, 115
Ulrich, F. P., 33, 36, 85, 115
Umbgrove, J. H. F., 62, 110, 115
Urbina, F., 36, 115

Van Bemmelen, R. W., 50, 60, 115
Vardanjanc, L., 68, 115
Vaughn, T. W., 8, 74, 115
Vening Meinesz, F. A., 8, 28, 29, 34, 37, 51, 58, 60, 62, 70, 71, 74, 100, 110
Venter, F. A., 88, 109
Verbeek, R. D. M., 97, 115
Vesanen, E., 99, 115
Villafana, A., 105, 119
Visser, S. W., 9, 25, 115, 125
Von dem Borne, G., 69, 115

Wadati, K., 9, 53, 115
Wadia, D. N., 66, 106, 121
Walshe, H. E., 112
Wanner, E., 21, 86, 115
Weeks, L. G., 40, 115
Wegener, K., 4, 115
Weiss-Xenofontova, Z., 91, 115
Wellman, H. W., 46, 115
West, W. D., 67, 115, 126, 127

Westland, A. J., 20, 48, 115
Whitcroft, H. T., 36, 115
Whitehouse, F. W., 87, 105
Willett, R. W., 46, 115
Williamson, E. D., 101, 104
Willis, B., 33, 36, 58, 59, 64, 82, 96, 99, 115, 116, 119
Willson, F. F., 85, 116
Wilser, J. L., 64, 116
Wilson, J. T., 36, 105
Wolff, F. von, 8, 26, 116
Wood, H. E., 88, 116
Wood, H. O., 33, 36, 80, 84, 85, 95, 108, 116
Woollard, G. P., 8, 82, 116
Wuenschel, P. C., 40
Wüst, G., 71, 74, 77, 116

Yasuda, T., 53, 116

Ziemendorff, G., 8, 106

SUBJECT INDEX

Accuracy of determinations, 11
Acknowledgments, 102
Active belts, 30, 64, 74, 103
Africa, 78, 81, 88, 91, 205, 266
African Rifts, 78, 79
Aftershocks, 11, 101
Alaska, 30, 85, 142, 144, 216, 253; earthquakes of 1899, 19, 32, 95
Aleutian arc, 30, 95, 142, 216, 253
Alpide belt, 64, 99, 104
Alpine folding, 68, 70, 97, 98
Alps, 86
Amplitudes, 4, 6, 9
Andaman Islands, 62, 65, 186, 245, 264
Andes, 40, 256
Andesite line, 26, 47, 51, 90
Angara shield, 85, 91
Annual energy release, 21, 22, 23; number of shocks, 17, 18, 22, 24, 103
Antarctic, 43, 44, 215, 257, 267; expeditions, 93
Antarctica, 42, 44, 82, 92, 93, 94, 267
Antilles, 39, 40, 152, 218, 255
Apia, 6, 48, 96
Apennines, 70
Appalachians, 85
Arabia, 77, 81, 93, 266
Arctic, 72, 74, 94, 207, 266; belt, 72, 74, 207
Arcuate structures, 28, 29, 57, 63, 64, 67, 98, 103, 104; orientation, 99
Argentina, 42, 256, 257
Artificial explosions, 21, 84, 86
Asia, 64, 67, 72, 85; Central, 66, 72; Minor, 68, 69, 192, 246, 265; Northeastern, 85, 209; structural lines, 67
Asiatic active zone, 64, 67, 72
Atlantic, 24, 26, 72, 74, 76, 94, 97, 196, 265; belt, 77, 196; -Indian swell, 77; Ridge, 74, 77, 100; structure, 26
Australia, 82, 83, 84, 87, 93, 94, 206
Azores, 71, 72, 194, 265

Baffin Bay, 81, 209
Balkans, 68, 192, 246
Baltic shield, 91
Baluchistan, 67, 97, 214, 249
Banda Sea, 62, 182, 242, 244, 262
Batavia, 7
Bering Sea, 85, 209
Berkeley, 7, 34
Bismarck Islands, 50
Block faulting, 32, 98
Blocks, 89, 98, 103
Borneo, 62, 82, 93
Bouvet Island, 77
Brazil, 81, 91
Brazilian shield, 81, 91, 204
British Columbia, 32, 144
Bureau Central, 7
Burma arc, 64, 186, 245, 264
Byrd expedition, 93

Caledonian folding, 87
California, 18, 24, 32, 35, 88, 96, 99, 145, 254
Canada, 81, 204; stations, 7, 81
Canadian shield, 81, 91
Caribbean region, 37, 97, 152, 218, 255
Carlsberg Ridge, 77, 100
Caroline Islands, 51, 90, 91, 169, 233
Carpathians, 70, 252
Cataloguing, 3, 4, 16
Caucasus, 68
Celebes, 60, 62, 180, 241, 262
Central America, 37, 38, 151, 218, 254, 255; Asia, 66
Chile, 41, 42, 96, 256, 257
China, 72, 73, 82, 93, 186, 188, 245, 246
China Sea, 93, 264
Circum-Pacific belt, 22, 24, 30, 53, 57, 60, 103
Class *a* shocks, 10, 16, 119, 133, 140
Class *b* shocks, 10, 16, 122, 133, 140
Classes of shocks, 10, 16
Coast Ranges, California, 33, 99
Compression and dilatation, 99
Continental displacement, 99; shields, 27, 91, 92; spreading, 99; structure, 26, 27, 74, 84, 89
Contours, submarine, 8
Córdoba, 6, 40
Core, 25
Creep, 101
Crimea, 68
Crustal structure, 8, 26, 27, 33, 47, 53, 68, 73, 74, 81, 84, 86, 87, 89, 94
Cuba, 39
Cyprus, 68, 70

Daily period, 25
De Bilt, 7
Deep-focus earthquakes, 4, 9, 10, 15, 16, 17, 22, 23, 29, 48, 49, 54, 55, 57, 64, 89, 92, 99, 101, 140, 216; large, 140; mechanism, 101
Depth of shocks, 4, 9, 27, 84, 86
Dip-slip faulting, 33, 66
Displacement, fault, 32, 33, 46, 53, 58, 62, 66, 68, 73, 82; persistent or reversed, 100

East Indies, 62, 97
Easter Island Ridge, 27, 43, 44, 210
Egypt, 92
Energy, 10, 16, 19, 20, 21, 22, 23
Epicenters, 4, 9
Eurasian stable mass, 91
Europe, 3, 68, 71, 85, 86, 87, 91, 204
Expeditions, 77, 93

Faulting, 27, 32, 33, 46, 58, 62, 66, 68, 73, 82, 85, 88, 89, 94, 98, 99, 101; persistence, 100
Fault formation delay, 58
Figures, 11, 13
Fiji, 48, 162, 228
Finland, 87
Flores Sea, 62, 63
Foredeeps, 26, 28, 64, 66, 98
Formosa, 57, 59, 117, 239
Fossa Magna, 53, 57
Fracturing, 80, 98,
France, 87
Frequency of shocks, 16

Galápagos Islands, 43, 267
Ganges depression, 66
Geography of shocks, 28
German stations, 6
Geocentric latitude, 4
Göttingen, 6
"Granitic" layer, 27, 33, 68, 73, 81, 84, 86, 89
Gravity anomalies, 29, 34, 39, 40, 48, 50, 51, 53, 54, 57, 62, 63, 64, 66, 68, 70, 71, 73, 79, 84, 100
Great Britain, 87, 98
Great shocks, 20, 102

Greenland, 81
Guam, 51

Halmahera, 51, 60, 61, 262
Hawaiian Islands, 79, 95, 206, 267
Himalayan arc, 65
Hindu Kush, 24, 66, 214, 249
Honolulu, 79
Huancayo, 7, 16, 27, 40

Iceland, 74, 266
Index maps, 12, 13
India, 66, 78, 93; earthquake of 1897, 19, 66, 82; stations, 7
Indian Ocean, 24, 26, 63, 74, 77, 78, 94, 97, 100, 200, 264, 267; Antarctic Swell, 43, 77, 78, 212
Indus Valley, 67
Instruments, 4, 6, 9, 18, 88
Intensity, 9
Intermediate shocks, 4, 10, 15, 16, 17, 22, 23, 27, 54, 69, 70, 74, 90, 92, 133, 216; and volcanoes, 100; large, 133
Internat. Seismol. Summary, 3, 4, 6, 16, 86, 90, 91, 93
Iran, 67, 190, 246
Isostasy, 84, 101
Italy, 70, 86, 265; stations, 6

Japan, 3, 24, 29, 53, 55, 56, 96, 97, 171, 236, 259, 261; Sea, 57; stations, 6, 7, 53
Java, 63, 263; Sea, 63
Jena, 6
Jesuit Seismol. Assoc., 7

Kamchatka, 56, 57, 97, 100, 171, 236, 261
Kansu, 73, 188, 246
Kermadec, 24, 47, 160, 225, 258
Kiushiu, 55, 57, 261
Korea, 98, 262
Krakatoa, 21, 94, 97, 264
Kurile Islands, 56, 57, 260

Lake Mead, 98
Largest shocks, 20, 103
La Paz, 6
Latin America, stations, 7
Levant, 68, 192, 246, 265; *Riesenbeben*, 69, 70
Lisbon earthquake, 19, 71, 97
Location of earthquakes, 3, 4, 9
Luzon, 58, 59

Mackenzie River, 81
Macquarie Islands, 43
Macroseismic data, 3, 8, 9
Madagascar, 81
Magnitude, 6, 9, 10, 11, 18, 51; scale, 9, 10
Manchuria, 28, 55, 56, 57, 73, 85, 247, 267
Manila, 7
Mantle, 25
Maps, 3, 11, 13, 29
Mareograms, 95, 96, 97
Marginal seismicity, 80, 82, 85
Marianas Islands, 24, 51, 169, 233, 259, 267
Marshall line, 26, 47, 51, 90
Maximum earthquake, 19
Mechanism, 97
Mediterranean, 16, 69, 70, 192, 194, 246, 247, 265; belt, 70
Mexico, 6, 36, 85, 96, 148, 149, 216, 254
Mindanao, 58
Minimum earthquake, 18
Minor earthquakes, 3, 19, 20, 88; seismic areas, 82
Mohorovičić discontinuity, 26, 34, 47, 53, 68, 73, 81, 84, 86, 89
Moduccas, 60, 61, 262
Mongolia, 189
Montana, 35, 85
Mountains, roots, 27, 34, 89

Nevada, 34, 35
New Britain, 50, 164, 231, 258
New Guinea, 50, 62, 96, 167, 232, 259
New Hebrides, 16, 24, 48, 96, 162, 229, 258
New Zealand, 18, 43, 45, 89, 96, 100, 159, 225, 257; stations, 7
Newfoundland, 81, 97
Nordenskjöld Sea, 74
North America, 30-40, 84, 204, 216, 253; stations, 6, 84; Polar region, 74, 94; Sea, 87
Norway, 87
Number of earthquakes, 28
Numbered regions, 12, 28

Oceanic belts, 74; ridges, 74, 99, 100; troughs, 28, 30, 36, 37, 39, 40, 42, 48, 50, 51, 54, 57, 58, 60, 63, 99, 100
Origin time, 4, 9
Orogens, 98
Osaka, 6, 53

Pacific, southeastern, 27, 41, 43, 44, 94, 210, 211, 257; arcs, 27, 28, 36, 40, 42, 48, 50, 53, 54, 58, 90; basin, 26, 89, 90, 98, 206; belt, 22, 24, 30, 53, 57, 60, 103; boundary, 26, 47, 90; structure, 26; outlying areas, 27, 94
Palestine, 79, 81
Pamir, 72, 214, 249
Panama, 39, 43, 255
Peridotites, 62, 98
Periodicities, 21, 24, 25
Peru, 40, 256
Philippine Deep, 59, 60; Fault, 58; Sea, 57, 94
Philippines, 58, 59, 96, 178, 240, 262
Pilar, 6, 40
Plastic flow, 101
Portugal, 87
Profile, Pacific arc, 29
Pyrenees, 86

Quality of locations, 11

Red Sea, 79, 81
Reflected waves, 26, 27
Rhine structures, 86, 87
Ridges, oceanic, 74, 99, 100
Rifts, 33, 46, 58, 67, 73, 79, 80, 100
Riverview, 6
Riu-kiu Islands, 57, 176, 239, 261
Rocky Mountains, 84, 204
Ronne Expedition, 93
Rumania, 28, 70, 252
Russian stations, 7, 66, 72, 91

"Safety Valve," 20, 101
St. Lawrence rift, 79, 80, 81
St. Louis, 7
Samoa, 47, 48, 258
San Andreas fault, 33, 34, 35, 36, 88, 89, 99
Scandinavia, 87
Schwäbische Alb, 86
Scott Expedition, 93
Sea of Okhotsk, 57, 247
Seaquakes, 43, 72, 77, 94
Secular changes, 97, 98
Seiches, 94
Seismic sea waves, 94
Seismol. Soc. Amer., 8
Serial numbers, 28
Serpentinite intrusions, 39
Shallow shocks, 4, 10, 14, 17, 22, 23, 27, 90, 92, 119, 142; large, 119, 122
Shields, 27, 92
Siberia, 85, 209
Sicily, 70, 265
Sierra fault, 33, 36
Sierra Nevada, California, 33, 34, 36
Socotra, 77
Solomon Islands, 50, 96, 164, 231, 258
Somaliland, 94
South America, 24, 40, 96, 155, 157, 219, 225, 256; stations, 7; Sandwich Islands, 42, 77, 257
Southeastern Pacific, 27, 41, 43, 44, 94, 210, 211, 257
Southern Antilles, 76, 158, 225, 257; hemisphere, 24, 101
Spain, 71, 86
Stable masses, 27, 80, 89, 92
Stations, 4, 5, 6, 7; bulletins, 4
Statistics, 16
Strain, 19, 20, 99
Strasbourg, 7, 8
Strength, 26, 101
Stresses, 98, 99, 101
Strike-slip faulting, 33, 40, 46, 58, 62, 66, 67, 68, 73, 99
Structure of earth, 25
Subcrustal movements, 99
Submarine slides, 95
Sumatra, 63, 65, 264

Summary, 103
Sunda arc, 62, 183, 242, 263
Sunspot period, 25
Surface waves, 26, 50, 74, 95
Swarms of shocks, 87, 98, 100
Switzerland, stations, 7
Szechuan, 73, 186, 245

Tacubaya, 6
Tahiti, 90
Tananarive, 77, 79
Tectonic processes, 98
Texas, 35, 85
"Tidal" waves, 94
Tiflis, 6
Time data, 6
Times used, 3
Tonga Salient, 24, 47, 49, 96, 160, 225, 258
Torsion seismometer, 9, 18
Transasiatic belt, 22, 64
Travel times, 4
Tucson, 7
Tsunamis, 94, 95

U.S.S.R. stations, 66, 72, 91; bulletins, 7
United States, 35, 84; Coast and Geod. Survey, 7
Uplift, fault, 32; post-glacial, 87, 98, 101
Upsala, 6
Ural mountains, 91, 190
Utah, 35, 85

Velocity of seismic waves, 26; tsunamis, 95
Venezuela, 39, 256
Viscosity, 101
Volcanic shocks, 100
Volcanism, 80; and intermediate shocks, 100
Volcanoes, 8, 29, 30, 33, 39, 42, 50, 53, 57, 60, 69, 70, 71, 79, 80, 253

West Indies, 39, 152, 218, 255

Zürich, 7