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Catalog of Hawaiian Earthquakes, 1823–1959

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Catalog of Hawaiian Earthquakes, 1823–1959

By Fred W. Klein and Thomas L. Wright

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Contents

Figures

Tables

Catalog of Hawaiian Earthquakes, 1823–1959

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Abstract

We have prepared a catalog of more than 17,000 earthquakes located in the Hawaiian Islands, principally on the Island of Hawaii, from 1823 through the third quarter of 1959, ending at the beginning date for the modern computer-based earthquake catalog. We have estimated the magnitude of all earthquakes for which seismograms or published amplitudes exist, which is more than 80 percent of the earthquakes we cataloged. We have compiled instrumental amplitudes from the Honolulu Magnetic Observatory (1903–59) and the Hawaiian Volcano Observatory (HVO) (1912–59) and combined these data with published felt reports for the entire time period, including newspaper accounts from 1856 to 1959 and unpublished felt reports sent to HVO from 1932 to 1941 and 1951 to 1958. We have devised means to assign location and magnitude for all events with at least a published distance from HVO, or those events that were widely felt. Locations for most of the small, and many large, earthquakes before 1950 are crude estimates because only one or a few stations with poor timing were used. We have expanded the determination of magnitude and intensity to levels lower than previously reported for this period in Hawaii—magnitudes about 5, intensities of greater than or equal to V. This catalog is designed to expand our ability to evaluate seismic hazard in Hawaii and also to greatly expand our knowledge of Hawaiian seismic rhythms as they relate to eruption cycles at Kilauea and Mauna Loa and to subcrustal earthquake patterns related to the tectonic evolution of the Hawaiian chain. This report attempts no interpretation but does provide a catalog of earthquake data heretofore unavailable in other than narrative accounts. We also evaluate the data sources and errors associated with them as a constraint on interpretations made from our catalog's listing of locations and magnitudes.

Introduction

A catalog of earthquakes registered by the seismic network maintained by the U.S. Geological Survey's Hawaiian Volcano Observatory (HVO) is currently available in computer form, dating from the fourth quarter of 1959 (Hawaiian Volcano Observatory, unpub. data, 1998). The beginning date of October 1, 1959, for the modern catalog is somewhat arbitrary, representing a time after which the local network was sufficient to give an accurate representation of hypocenter and magnitude using a computer-based earthquake-location program. Our catalog extends the documentation of Hawaiian earthquakes backward from October 1, 1959, to an early written earthquake account, of an event in 1823 that occurred just before the first visit of missionaries to the Island of Hawaii.

Knowledge of the seismicity of the Hawaiian Islands over the longest possible timespan supports the following goals: (1) evaluation of the seismic hazard for different parts of the Hawaiian Islands and (2) an improved understanding of how Hawaii's active volcanoes work. The relation of seismic release to eruptions, the interaction of one volcano with another, and the tectonics of a volcanic chain formed over a hotspot depend on knowledge of the long-term patterns of seismic release expressed by earthquake magnitudes, depth, and epicentral locations.

Our catalog builds on an earlier catalog and comprehensive analysis by Wyss and Koyanagi (1992), who listed events from 1833 to 1939 with a maximum intensity of V or more (generally in Hilo) and thus deal mostly with magnitudes of $5^1/_2$ or larger. They determined approximate magnitudes and locations from isoseismal maps for 20 of the larger earthquakes from 1868 to 1950. Their sources were primarily felt reports. We relied heavily on their catalog and methods, but we greatly expanded our catalog to cover all reported events, primarily those instrumentally recorded.

Going backward in time, the uncertainties in interpreting the critical earthquake parameters increase; to interpret older earthquake data, there is an essential contribution from (1) modern earthquake patterns established using an adequate seismic network and their relation to volcanic activity, and (2) inferences made as to the behavior of fault zones and deeper seismicity not directly tied to volcanic activity. Interpretation is required both because the observations from seismometers and people are sparse and because many of the original data are lost. Our purposes in this report are to outline the methodology that we used to extend our catalog backward in time and to make this earthquake data available for use by interested persons. Interpretations based on our catalog that address the two fundamental goals listed above are beyond the scope of the present report but will be the subject of future reports that make use of this catalog.

The text of this report emphasizes the sources of earthquake data and the methods we have employed to create this catalog. A companion CD–ROM contains all of the files formatted for use on VAX or UNIX workstations or desktop (PC or Macintosh) computers. A list of files on the CD–ROM is included in appendix 1. We anticipate that additional and revised files will become available in the future and will be added to those on the CD–ROM.

Scope and Sources of Data

We have consulted all of the reports of Hawaiian earthquakes that we could find, including published and unpublished data generated by HVO, published data from the seismometer(s) housed at the U.S. Coast and Geodetic Survey's

Honolulu Magnetic Observatory (HMO), a diary of earthquakes felt in Hilo, Hawaii, by the Lyman family, and earthquakes reported as felt in Hawaiian newspapers. Finally, we have incorporated (and, in some cases, refined) magnitude and intensity determinations for the larger earthquakes published in the compilations of Furumoto and others (1972), Cox (1986), and Wyss and Koyanagi (1992). The scope and limitations of each source of earthquake data are discussed in the following paragraphs.

Records of the Honolulu Magnetic Observatory

The first seismograph in Hawaii was installed on the grounds of Oahu College (now Punahou School) in 1899 by the surveyor W.D. Alexander (1899), and some of the earthquake records were subsequently published (Reid, 1905, 1906). Once established, the magnetic observatory was run by the U.S. Coast and Geodetic Survey as part of a network of magnetic observatories in the United States and Canada. The history of seismic instrumentation at the Honolulu station, taken from the January–June 1935 microfilm record of Honolulu seismograms (see next subsection), is summarized in figure 1 and table 1.

The records of earthquakes recorded at HMO from April 1903 through December 1927 are published in two series. The first series, entitled "Results of Observations Made at the Coast and Geodetic Survey Magnetic Observatory near Honolulu, Hawaii," were issued biannually, beginning in 1905–6 (Hazard, 1910, 1911, 1912, 1913, 1916, 1918, 1920, 1922, 1924; McFarland, 1929). A short section in each report entitled "Earthquakes" gives data from the single-component Milne seismometer and, after 1921, from the two-component Milne-Shaw seismometer housed at the observatory. The report for 1905–6 includes Milne data back to its time of installation in April 1903. Data given for each earthquake are beginning and ending times, times of long-wave motion and time of maximum amplitude along with the maximum amplitude registered, and remarks on the possible source and character of the seismogram. In reports from 1919 and later, *P*- and *S*-wave arrivals are specified.

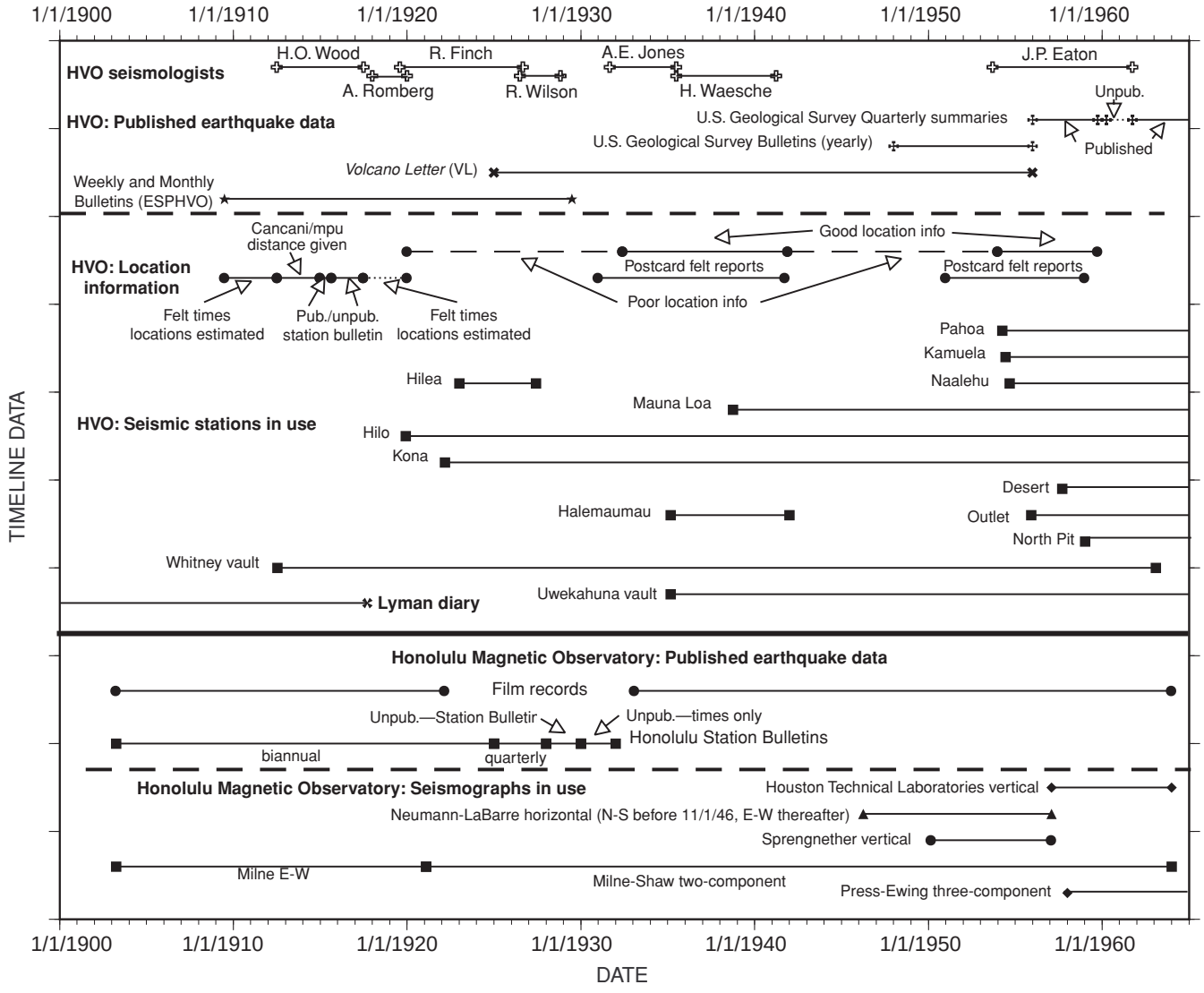

Figure 1. History of instrumentation and reporting of earthquakes at the Honolulu Magnetic Observatory and the Hawaiian Volcano Observatory (HVO).

Table 1. History of instrumentation and reporting of earthquakes at the Honolulu Magnetic Observatory

Period	Description
April 1903	Milne seismometer belonging to the Seismological Committee of the British Association was transferred from Oahu College to the C&GS Magnetic Observatory, located 3 km SW. of Ewa Beach. Note: Graph paper microfilmed showing that scaling is the same horizontally and vertically.
February 1921	Milne-Shaw horizontal seimometers replaced older instrument, referred to in our catalog as "M-S (N-S)" and "M-S (E-W)." Note: Before February 1921, the boom of the Milne seismometer was displaced daily, producing a signal with about a 12-s period, decaying over time.
1926	Cooperative project begun with the University of Hawaii.
April 1946	Neumann-LaBarre N-S seismometer installed, referred to in our catalog as "hor N-L." Note: Microfilm records are labeled "N-S short-period" through November 1, 1946, and "E-W short-period" thereafter. Evidently, the seismometer was rotated 90° at that time.
October 1946	Instruments relocated to a new C&GS Magnetic and Seismological Observatory at Barbers Point.
September 1948	Visual recording seismograph installed as part of tsunami-warning system. Station became central headquarters of the warning program.
October 1949–February 1950	Experimental N-S short-period and long-period seismometers temporarily installed; discontinued when Sprengnether vertical seismometer was installed.
March 1950	Sprengnether vertical seismometer installed, referred to in our catalog as "vert."
November–December 1954	Two short-period vertical seismometers installed: Wilson-Lamison (more sensitive) and Sprengnether (less sensitive).
October 1956	Houston Technical Laboratories vertical seismometer installed, referred to in our catalog as "vert."
January 1957	Neumann-LaBarre and Sprengnether seismometers discontinued. Note: Records for vertical (Sprengnether) seismometer extend through January 1957, and records for vertical (Houston Technical Laboratories) seismometer begin in February 1957.
January 1958	Three-component Press-Ewing seismometer operated for Lamont Geological Observatory.
June 1960	New observatory site occupied at Ewa Beach.

The Milne seismometer recorded at a low gain of about 6 to 15 (Abe, 1988) on a paper strip at a rate of about 6 cm/h. Sensitivity and time resolution were thus very low. The seismometer was also underdamped and rings for many minutes with its own decay rate. These factors make the recognition of phases difficult and amplitude scaling imprecise. Small events appear as a thickening of the line or a small blip, and it is often impossible to distinguish local from distant events. Some fine detail is also lost in the microfilm process. We used the Milne records to estimate the magnitudes of events that were strongly felt. We could not identify new earthquakes that were not reported elsewhere.

Beginning at the end of 1914 (Humphreys, 1914) and extending through the end of 1924 (Humphreys, 1924), information from the biannual reports was reprinted each month in the *Monthly Weather Review* as part of "Section V. Seismology." So far as we can determine, these reports only duplicate information available from HMO.

From 1925 through 1927, the seismic data were published separately in a series of quarterly reports of the U.S. Coast and Geodetic Survey entitled "Seismological Report" (Neumann, 1926a, b, 1927, 1928a–c, 1929, 1930a, b, 1931; Neumann and Service, 1926, 1927) These reports contain data from the entire network of magnetic observatories, including the station at Honolulu. These reports are more detailed than the earlier series, containing, in addition to the instrumental record, a section covering noninstrumental, felt reports from places all over the world. There are many entries for earthquakes felt in Hawaii, often from several different places in the Hawaiian Islands.

In 1928 the "Seismological Report" series was discontinued in favor of a publication series entitled "United States Earthquakes" (Heck and Bodle, 1930, 1931; Neumann, 1932, 1934, 1935, 1936, 1937, 1938, 1940, 1941, 1942, 1943; Neumann and Bodle, 1932; Bodle, 1944, 1945, 1946; Bodle and Murphy, 1947, 1948; Murphy, 1950; Murphy and Ulrich, 1951, 1952; Murphy and Cloud, 1953, 1954, 1955, 1956, 1957; Brazee and Cloud, 1958, 1960; Eppley and Cloud, 1961). Unfortunately for our catalog, this publication series treated only the larger earthquakes, estimating location, magnitude, and intensities but omitting the station data and felt reports used to make these estimates that were found in earlier publications. In perusing "United States Earthquakes," we noted many incomplete and possibly erroneous records. The national scope may not have allowed time to research or confirm each felt report.

The U.S. Coast and Geodetic Survey, however, continued to make available by private subscription mimeographed reports of Honolulu-station data. For 1928 and 1929, the data follows the format of the "Seismological Report" but without the noninstrumental data. In 1930, the mimeographed reports revert to the format of "United States Earthquakes," and all detail is lost.

Seismogram Microfilm Records

Microfilm records of seismograms from the network of geomagnetic observatories, including the Honolulu station HON, were made in the early 1980's under the auspices of the "Historical Seismogram Filming Project," headed by Willie Lee of the U.S. Geological Survey (Glover and others, 1985; Lee and others, 1988). The Honolulu film records cover all or parts of the years 1903–22, and 1933–63. The film records from 1933 onward are critical to our data base because no issues of the *Honolulu Station Bulletin* were published for this period of time.

The Milne-Shaw seismograms provide better information than the published bulletins. Depending on the size of the event, we can estimate distance, measure amplitude and period of the maximums of the seismogram (essential for determining magnitude), and note the dominant frequency of the initial arrival as a clue to the earthquake's depth. The film records for both the Milne and Milne-Shaw seismograms are also important because they show that some earthquakes on the Island of Hawaii are present on the station HON film record at the appropriate time but were not clear enough to warrant inclusion in the published *Honolulu Station Bulletin*. This allows us to assign a Honolulu magnitude near the threshold magnitude of the respective instruments. For many events, we read the noise at periods of 1 to 3 s to establish a maximum magnitude. Timeline data outlining the reporting history are summarized in figure 1.

The "Historical Seismogram Filming Project" demonstrates the great importance of preserving seismic records for future generations. As long as we know the characteristics of the seismometer recording the earthquake traces, we can apply modern knowledge to old records. As the time of this writing, the records generated on smoked paper at HVO are deteriorating, even in humidity-controlled storage, such that they are very difficult to separate from each other. Our catalog would be considerably improved had we been able to look at original traces or recover original measurements.

History of Seismology at the Hawaiian Volcano Observatory

Thomas Jaggar, at the time of the founding of HVO in 1912, was able to establish a seismic program that in many ways was ahead of its time. Seismology in 1912 was only in the formative stages in the United States; installation of the first seismographs in the Western Hemisphere at Berkeley and Mount Hamilton, Calif., had taken place only 15 years earlier (J.P. Eaton, written commun., 1986), and the classic work of Beno Gutenberg and Charles Richter (1945) was more than two decades in the future. Jaggar was able to acquire a Bosch-Omori seismometer, the most advanced of its time, which he installed in the basement of the new observatory. He called this room the "Whitney Laboratory of Seismology." Significant improvements in the seismic network occurred in 1913–22, 1927–28, 1938, 1948, 1950–54, and 1957–58, as summarized in figure 1 and table 2.

Seismology at HVO depended critically on having a professionally trained seismologist on the staff (see staff profiles in Takahashi and Wright, 1987). This was the case for only two periods before the U.S. Geological Survey assumed control of HVO in 1948. H.O. Wood came with Jaggar in 1912 and left in 1917. Wood trained as a seismologist at Harvard. Wood's *Station Bulletin* (see below) is one of the most thorough earthquake records for the time. Had it been continued, the HVO record would rank among the best seismic catalogs produced in the first half of the 20th century.

Ruy Finch served well as a seismologist from 1919 to 1926. R.M. Wilson admirably filled the role of seismologist from 1926 to 1928, although we remember him primarily as a topographic engineer. From his many short articles in the *Volcano Letter*, he appears to be a prime mover in the installation and calibration of the "Hawaiian type" mechanical seismograph. Austin Jones was the second staff scientist with formal training as a seismologist. Jones arrived in 1931 and left in 1935; he wrote many interpretative articles and improved seismic reporting. Hugh Waesche succeeded Jones, reporting seismic data from 1935 to 1941. Ruy Finch returned to the staff in 1940 and remained there until 1951.

The quality of HVO instrumentation progressed over the years, largely owing to the ability to build and modify instruments provided by a trained machinist on staff. However, the reporting of seismic data was erratic at times when HVO was without a trained seismologist, particularly during the period between Wood's departure and Jones' arrival, and during the period after Waesche's departure. By 1948, HVO was far behind the standards of the seismological profession.

The revitalization of seismology at HVO began in 1953, with the arrival of Jerry Eaton, a young seismologist trained at Berkeley. He was able to take advantage of new technologies available to seismology to greatly expand the number of stations in HVO's network. By the end of his 10-year tenure, a true seismic network was in place. Beginning in 1957, HVO was assigning magnitudes based on recordings of the classic Wood-Anderson seismometer. By 1958, HVO no longer reported the qualitative earthquake size classes begun in the *Volcano Letter* in 1932. The size class was greatly inferior to magnitude because it only measured the amplitude on a low-gain mechanical seismometer and, unlike magnitude, was not a property of the earthquake size alone. Further information on the development of the seismic network at HVO was summarized by Klein and Koyanagi (1980).

Records of the Hawaiian Volcano Observatory

Our primary catalog of data from 1912 through 1959 comes from determinations made by HVO. Earthquakes were first recorded in the weekly and monthly bulletins and special reports published by HVO, now reprinted and bound in three volumes (Bevens and others, 1988), supplemented by material published for the seismic buildup to the Mauna Loa eruption of 1914 (Wood, 1915a), and much later for (1) the period 1912–13 (Jaggar, 1947, p. 5–88) and (2) May 1924, encompassing detailed observations from the explosive eruption of Halemaumau (Jaggar, 1947, p. 214–259). Systematic reporting in the bulletin series begins with the week ending April 11, 1912 (Jaggar, 1947, p. 9), and ends with the month of July 1929 (Bevens and others, 1988, v. 3, p. 1217). Information on earthquakes felt at Kilauea's summit before the founding of HVO was summarized by Jaggar (Bevens and others, 1988, v. 1, p. 17–49, 1912) and Wood (Bevens and others, 1988, v. 1, p. 117–118; 1917b, charts 1, 2).

Instrumental estimates of earthquake locations were made after the arrival of the Bosch-Omori seismometer in July 1912 (Jaggar, 1947, p. 22–23). By October, some earthquakes were assigned distances, presumably based on a reading of s-p time,

Table 2. History of instrumentation and reporting of earthquakes at the Hawaiian Volcano Observatory

A. Network history

Site	Date	Instrumentation	References
	1/12	Founding of HVO.	
Whitney vault 19°25′53″ N., 155°15′40″ W.	7/1/12	Station established.	Jaggar (1947, p. 22–23).
	1913	Omori: 100-kg long-period; mechanical recording; in use 1913–18; not used.	
	1913	Bosch-Omori: two-component having pendulum with mechanical recording; T_0=15 s, V=115; damping ratios, 7.8/1 N-S and 4.9/1 E-W; ε=0.5 critical; recording speed, ?; in use 1913–61; by 1950, period changed to 7.7 s.	Wood (1915b).
	10/28	Jaggar vertical: short-period, T_0=0.4 s, V=250, vertical with mechanical recording; in use 1929–41.	Finch and Macdonald (1953). Fiske and others (1987); *Volcano Letter*, no. 464, p. 1–4.
	1961	Station discontinued.	
Hilo 19°43′11″ N., 155°05′20″ W.	1919	Station established. Romberg: one-component short-period vertical; V=25; operated at St. Mary's school; in use 1919–21.	Bevens and others (1988, v. 2, p. 1065, v. 3, p. 1033).
	9/21	Romberg: one-component small-mass long-period; M=30 kg, T_0=7.0 s, V=70, ε=2.6/1; paper speed, 23.5 mm/min; operated at Brothers' school.	
	9/27	Hawaiian type: two-component long-period; M=70 kg, T_0=6 s, V=120, ε~2.6/1; paper speed, 30 mm/min	
	10/50	Loucks-Omori: two-component long-period; M=100 kg, T_0=3 s, V=175 (Hilo only; all others had V=200), ε=critical; paper speed, 30 mm/min; operated at St. Joseph's school; removed, 10/58.	
	7/58	Wood-Anderson: two-component; V= 2,080, T_0=0.8 s, ε=0.7 critical; removed, 10/92.	Klein and Koyanagi (1980).
	10/58	HVO–1: vertical, electromagnetic; T_0= 0.5 s; galvanometer period, 0.5 s, overdamped; V=20,000 at period of 0.25 s.	Klein and Koyanagi (1980).
Kona 19°30′47″ N., 155°55′07″ W.	3/4/22	Station established. Romberg: one-component long-period; see Hilo; replaced 6/28.	Fiske and others (1987); *Volcano Letter*, no. 183.
	6/28	Hawaiian type: long-period; T_0=7.3 s, V=115; operated intermittently until 12/60.	Finch and Macdonald (1953).
Hilea 19°08′19″ N., 155°32′12″ W.	Pre-7/24	Station established. Romberg: one-component; see Hilo.	Bevens and others (1988, v. 3, p. 588). Bevens and others (1988, v. 3, p. 970, 989).
	5/27	Station discontinued.	
Uwekahuna Museum 19°25′26″ N., 155°17′36″ W.	12/27	Imamura strong-motion seismometer; T_0= 3.0 s, V=15.	Fiske and others (1987); *Volcano Letter*, no. 197; *Volcano Letter*, no. 268, photograph.
Halemaumau 19°24′26″ N., 155°16′59″ W.	9/28	Romberg: one-component; see Hilo, 9/21.	Fiske and others (1987); *Volcano Letter*, no. 197
Waikii 19°51′35″ N., 155°39′36″ W.	1/32?	Station established; in use until 9/34(?).	Macdonald and Eaton (1957, table 1, p. 22).
Mauna Loa truck trail 19°29′32″ N., 155°23′29″ W.	10/38	Seismic station established.	Fiske and others (1987); *Volcano Letter*, no. 464, p. 1.
	1938–39	Hawaiian-type: see Hilo, 9/27; phantom telephone circuit tested to tie time to Whitney vault.	
	6/53	Loucks-Omori: see Hilo, 10/50; replaced, 4/57.	
	4/57	HVO–2: ; vertical; electromagnetic; T_0= 0.8 s, response similar to HVO–1; hardwired for recording at HVO.	Eaton and Krivoy (1963a).
Haleakala 20°46′00″ N., 156°15′00″ W.	1940	Station established. Hawaiian-type: see Hilo, 1927.	
	8/53	Loucks-Omori: see Hilo, 10/50; replaced, 5/57. HVO–1: see Hilo, 10/58.	Eaton and Krivoy (1963a); Finch and Macdonald (1953).
	5/57	Wood-Anderson: see Hilo, 10/58.	
	5/57		

Table 2. History of instrumentation and reporting of earthquakes at the Hawaiian Volcano Observatory—Continued

Site	Date	Instrumentation	References
HNP hq basement (see Whitney)	1941	Station established. Jaggar: vertical: see Whitney, 10/28; in use until 1948.	
Uwekahuna vault 19°25′26″ N., 155°17′36″ W.	1/48	Station established. Jaggar: vertical; see Whitney, 10/28; in use, 1948–57	Finch and Macdonald (1951, p. 106).
	11/53	Sprengnether: vertical and E-W; galvanometer, 1.5 s; T_0=0.5 s, V=1,500 at 0.5 s, ε=2 times critical; discontinued, 10/92.	
	4/57	Press-Ewing: three-component electromagnetic; T_0=15 s; galvanometer, 90 s. HVO–1: see Hilo, 10/58	Eaton and Krivoy (1963a).
	4/57		
Pahoa 19°29′39″ N., 154°56′47″ W.	4/1/54	Station established.	Fiske and others (1987); *Volcano Letter*, no. 524, p. 9.
		Loucks-Omori: see Hilo, 10/50.	Eaton and Krivoy (1963a).
	1/58	HVO–1: see Hilo, 10/58; discontinued, 7/61.	
Kamuela (Waimea) 20°01′20″ N., 155°40′18″ W.	6/9/54	Station established.	Fiske and others (1987); *Volcano Letter*, no. 524, p. 10.
		Loucks-Omori: see Hilo, 10/50; locally recorded; discontinued, 1/62.	Eaton and Krivoy (1963a).
	1959(?)		
Naalehu 19°03′48″ N., 155°35′10″ W.	9/1/54	Station established. Loucks-Omori: see Hilo, 10/50	Eaton and Krivoy (1963a).
	1959(?)	HVO–2: see Mauna Loa, 4/57; locally recorded; discontinued, 12/60.	
Outlet 19°23′24″ N., 155°16′56″ W.	1954	Vault built.	
	12/55	HVO–2 (developmental): T_0=1.0 s, V= 10,000. HVO–2: see Mauna Loa, 4/57.	Finch and Macdonald (1953).
	6/57		Eaton and Krivoy (1963a).
Barbers Point, Oahu	6/57	HVO–1: see Hilo, 10/50; paper records sent back to HVO.	
Desert 19°20′12″ N., 155°23′20″ W.	9/57	Station established. HVO–2: see Mauna Loa, 4/57.	Eaton and Krivoy (1963a).
North Pit Halemaumau 19°24′54″ N., 155°17′00″ W.	7/58	Station established. HVO–2: see Mauna Loa, 4/57.	Eaton and Krivoy (1963a).

B. Staffing and changes in procedure

Date	Seismologist/procedure	References
1/12	Founding of HVO	Jaggar (1947, p. 5–88, 205–259); Bevens and others (1988).
7/12–6/17	Harry Wood	Takahashi and Wright (1987).
6/18–9/19	Arnold Romberg	Bevens and others (1988, v. 2, p. 787).
1919–26	Ruy Finch	Takahashi and Wright (1987).
7/26–10/28	Ronald M. Wilson	Fiske and others (1987); *Volcano Letter*, no. 235.
11/26	Radio time corrections applied to Kona station	Fiske and others (1987); *Volcano Letter*, no. 98.
9/31–6/35	Austin Jones	Fiske and others (1987); *Volcano Letter*, no. 351, p. 2; *Volcano Letter*, no. 371.
2/32	Jones formalizes earthquake-size classification	Fiske and others (1987); *Volcano Letter*, no. 371, p. 2.
3/35–12/41	Seismographs at Uwekahuna and Halemaumau used to refine locations local to Kilauea.	Fiske and others (1987); *Volcano Letter*, no. 421.
7/35–3/41	Hugh Waesche	Fiske and others (1987); *Volcano Letter*, no. 435, p. 2.
12/36–12/38	Recording speed and summit network timing im-proved at Whitney vault.	Fiske and others (1987); *Volcano Letter*, no. 464, p. 1–4.
1952	Synchronized time signal at Whitney, Uwekahuna, and Halemaumau stations.	Klein and Koyanagi (1980, p. 4).
9/53–12/62	Jerry Eaton	Takahashi and Wright (1987).
1957	First routine computation of local earthquake mag-nitude.	Eaton and Fraser (1957a).
1958	Common recording of four high-gain summit-area stations at HVO July; Jones magnitude classifi-cation abandoned.	Eaton and Krivoy (1958a).
10/1/59	Systematic notebooks of accurate P and S times form the basis for the existing computer catalog.	– – –

Table 2. History of instrumentation and reporting of earthquakes at the Hawaiian Volcano Observatory—Continued

C. Publication history

Date	Publication series	References
1/12	Founding of HVO; publication of weekly and monthly summaries.	Jaggar (1947, p. 5–88, 205–259); Bevens and others (1988, v. 1).
1/1/25	The *Volcano Letter* begins publication———	Fiske and others (1987).
7/29	Weekly and monthly summaries discontinued———	Bevens and others (1988, v. 3).
1948–55	U.S. Geological Survey Bulletins covering volcanic and seismic activity for the year.	Finch and Macdonald (1951); Macdonald and Wentworth (1954); Macdonald (1955); Macdonald and Eaton (1955, 1957, 1964).
12/31/55	The *Volcano Letter* ceases publication———	Fiske and others (1987); *Volcano Letter*, no. 529–530.
1/1/56	HVO quarterly summaries begin———	Macdonald and Eaton, 1956

applied to traveltime tables developed in Germany (Jaggar, 1947, p. 45). The direction of motion on the two components sometimes permitted guesses about the earthquake location deduced from one station and felt reports.

Intensities based on amplitudes were expressed as a fraction of the amplitude at which an earthquake would become perceptible to the senses (minimum perceptible unit or "mpu"). In December 1912, Wood began reporting intensities in terms of the Cancani scale (Jaggar, 1947, p. 59), a logarithmic scale with 12 levels based on the acceleration of earthquake motion as viewed on the seismic record (table 3). Level IV, with accelerations of 10 to 25 mm/s/s, corresponds to 1.0 to 2.5 mpu. Cancani ratings of V and above were thus likely to be felt. Wood continued reporting mpu and Cancani readings through the end of 1914. These intensities reflect the strength of ground shaking at the recording site and must be combined with distance to infer a magnitude.

Figure 2, which summarizes our understanding of the various "intensity" scales used at HVO, is a logarithmic diagram of both ground motion amplitude and acceleration combined. The various scales will be discussed where appropriate in the text. The first scales used were based on amplitude of the Bosch-Omori seismometer. The anchor of the early scales is the felt threshold, defined as 1.0 mpu and the intensity III-IV Cancani boundary. This corresponds to 12.5 mm peak to peak of amplitude on the Bosch-Omori seismogram at a period of 0.5 s. The period of oscillation does not enter directly into this diagram, and the diagram is a mixture of acceleration and displacement measures. Correspondence of the different scales is thus approximate.

Beginning in 1915, Wood established a bimonthly publication devoted exclusively to earthquake data (Wood, 1915b). He called it the *Systematic Report of the Whitney Laboratory of Seismology*, and it was patterned after the earthquake bulletins of other seismological laboratories. Only four bimonthly issues were published, even though Wood stayed on the HVO staff through the summer of 1917. During this time earthquake reporting in HVO's weekly bulletins (Bevens and others, 1988) was greatly curtailed. Curious as to why the earthquake reporting had died off, we sought to discover whether Wood had left any unpublished records. Remarkably, we found the missing data from September 1915 through June 1917 in the H.O. Wood archives at the California Institute of Technology (Wood, 1917a), thereby almost doubling the time during which his quantitative reporting of HVO earthquake data was available.

Wood left HVO in July 1917. With his departure, reporting of earthquake data was much less satisfactory. Most events have a time, no distance, and a terminology to describe earthquake size (for example, small, feeble, slight) that is not entirely consistent with similar terminology formalized in the 1930's (see below). Earthquakes listed from the second half of 1917 through the end of 1919 generally have no distance estimated. Thus, we had to guess their locations from associated volcanic activity (for example, Mauna Loa eruption, draining of Halemaumau lava lake) or from felt reports. Beginning in 1920, distances are given for some events, presumably as a result of the installation of an additional station at Hilo in 1919. Sporadic reporting of distance and location remains the case after two more stations were installed, Kona in March 1922 and Hilea (Kau) sometime before July 1924. Distances were estimated from uncertain s-p intervals, and locations relied only on approximate station distances because of the absence of accurate relative timing. The weekly and monthly bulletins describe volcanic activity in great detail, particularly the activity of Halemaumau lava lake up to its demise in 1924, and the different Kilauea and Mauna Loa eruptions that occurred during its time of publication. The volcanic detail is an invaluable aid to locating earthquakes that are temporally associated with volcanic activity.

A second HVO publication began in 1925, the *Volcano Letter*, also published at weekly, monthly, or quarterly intervals, and has been reprinted in a single volume (Fiske and others, 1987). The two publications overlapped through the last *Monthly Bulletin* (Bevens and others, 1988) published for July 1929. The *Volcano Letter* had a different emphasis, geared more to broad volcanologic topics than to detailed monitoring data. During the period of overlap, the *Volcano Letter* sometimes gave additional felt information for earthquakes tabulated in the weekly and monthly bulletins, but otherwise it did not add to the monitoring data. After July 1929, the *Volcano Letter* did not immediately pick up the monitoring focus of the earlier publication. This difference showed up immediately for the big earthquake swarm at Hualalai in September and October 1929, where the summary of what actually occurred seismically has to be pieced together from many different tabulations. Over the next few years, earthquake data were embedded in the narrative associated with a subsection of each *Volcano Letter*, beginning with "Kilauea Report No. 677" covering the first week of 1925. These reports were short and commonly listed only the number

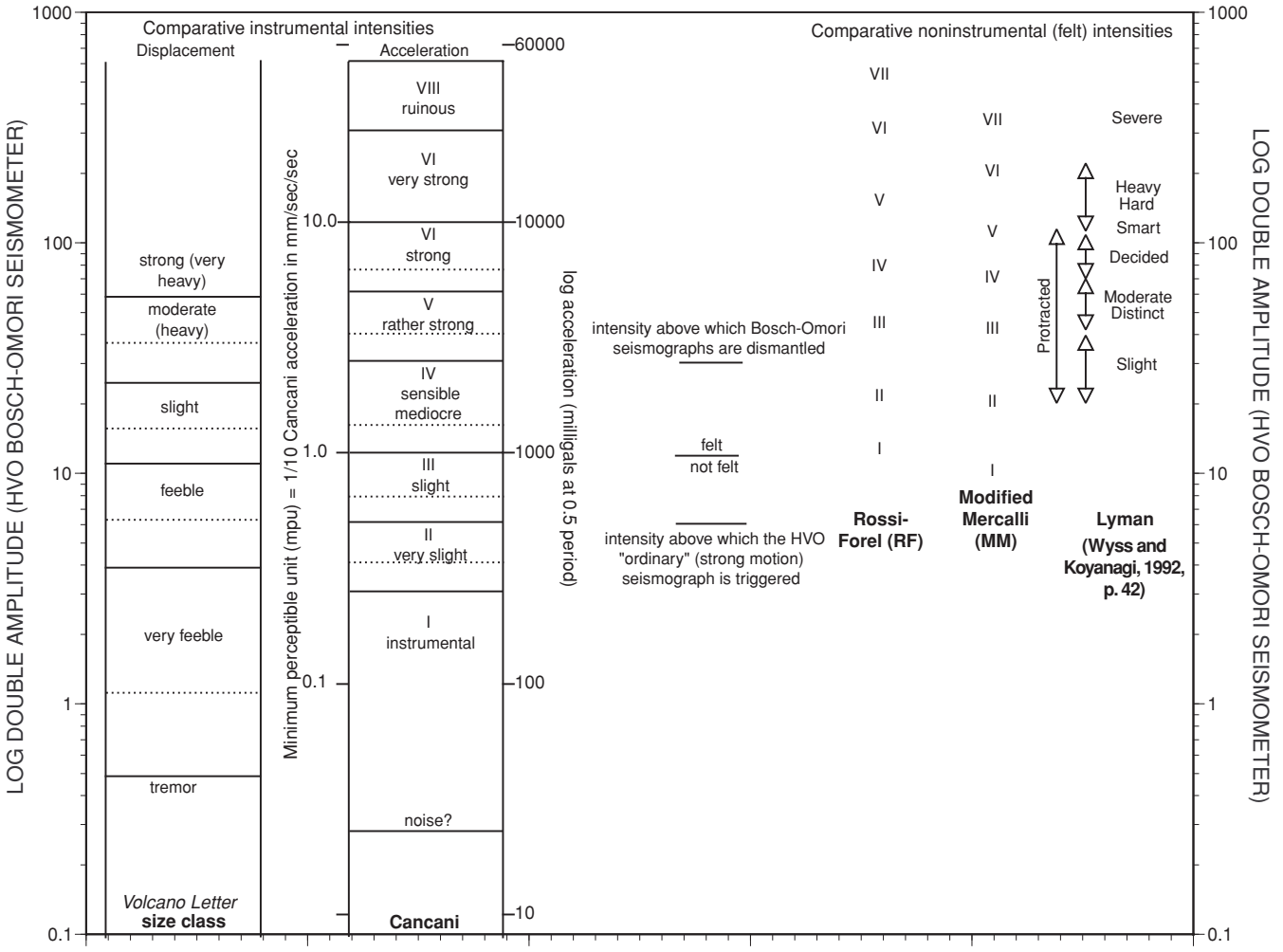

Figure 2. Comparison of intensity and amplitude scales used by the Hawaiian Volcano Observatory (HVO).

of events during the week, with times and distances given for a very small number of the total events.

In June 1932, the reporting of earthquakes became more systematic, with a separate section devoted to them and with more information on actual location (narrative description; rarely latitude and longitude), and greater consistency in the reporting of the size of events. The impetus to improved reporting was the arrival on the HVO staff of another trained seismologist, the first since Wood left in 1917. Ironically, this improvement in reporting coincided with drastic funding cuts that forced the *Volcano Letter* to change from a weekly to a monthly publication (Fiske and others, 1987; *Volcano Letter*, no. 385).

Austin E. Jones arrived in September 1931 (Fiske and others, 1987; *Volcano Letter*, no. 351, p. 2) and immediately busied himself with summarizing the seismicity for the year (Fiske and others, 1987; *Volcano Letter*, no. 371). He also formalized the reporting of earthquake classes, related directly to amplitude ranges of signals on the Bosch-Omori seismometer, as listed in table 4. He used the weighted numbers of earthquakes in each class to calculate weekly indices of seismicity. After July 1932, there is increased reporting of location in terms of latitude and longitude; beginning in 1934, latitude and longitude are routinely estimated. Jones' last report was in June 1935 (Fiske and others, 1987; *Volcano Letter*, no. 424), but the earthquake reporting continued in much the same manner (fig. 1).

Jones was the first of HVO's seismologists to attempt to quantify the interpretation of seismic data. In addition to formalizing the reporting of seismicity, he attempted to track seismicity associated with eruptions of Kilauea and Mauna Loa (Jones, 1934, 1935a, 1935c) and was the first person to derive traveltime curves applicable to the Island of Hawaii (Jones, 1935b). Finally, Jones was the first to identify different types of earthquakes and tremor (Jones, 1938). Unfortunately, Jones' best efforts were severely compromised by the absence of an adequate local network and the lack of common timing for the seismometers at different locations. Short-lived efforts to tie several stations together by means of telephone lines were attempted in 1931 by Jones and in 1938 by Waesche, but neither effort was sustained for long.

Earthquake reporting in the *Volcano Letter* changes toward the end of 1941 for unspecified reasons. The reporting of latitude and longitude is discontinued beginning in the third quarter of 1941 (Fiske and others, 1987; *Volcano Letter*, no. 473) although narrative descriptions of location continued. At the end of the fourth quarter of 1941 (Fiske and others, 1987; *Volcano Letter*, no. 474), reporting of earthquake data dropped off

Table 3. Cancani scale of seismic intensity

[Maximum and minimum accelerations in millimeters per second squared. Minimum perceptible unit (mpu) is directly related to Cancani scale, with 1.0 mpu, occurring at the Cancani intensity III-IV boundary, defined as the intensity above which an earthquake is perceptible (felt)]

Intensity	Description	Minimum acceleration	Maximum acceleration	mpu
I	Instrumental	0.0	2.5	0–0.25
II	Very slight	2.5	5.0	.25–0.5
III	Slight	5.0	10.0	.5–1.0
IV	Sensible, mediocre	10.0	25.0	1.0–2.5
V	Rather strong	25.0	50.0	2.5–5.0
VI	Strong	50.0	100.0	5.0–10.0
VII	Very strong	100.0	250.0	10.0–25.0
VIII	Ruinous	250.0	500.0	25.0–50.0
IX	Disastrous	500.0	1000.0	50.0–100.0
X	Very disastrous	1,000.0	2,500.0	100.0–250.0
XI	Catastrophic	2,500.0	5,000.0	250.0–500.0
XII	Great catastrophe	5,000.0	10,000.0	500.0–1,000.0

Table 4. Early (1932–57) classification of earthquake magnitudes at the Hawaiian Volcano Observatory

[Weight was used to calculate a seismicity index for the week. From *Volcano Letter*, no. 371]

Amplitude class	Weight	Bosch-Omori amplitude (mm)	Qualitative description
Tremor (t)	1/4	<0.5	Can barely be seen on the seismograph records; when continuous, the unit is the minute of duration.
Very feeble (vf)	1/2	.5–4	Not felt or only very rarely felt by very few persons in especially favorable positions, generally lying down.
Feeble (f)	1	4–11	Not felt or felt by few persons in favorable positions. Upper range of feeble is intensity I on the Rossi-Forel and modified Mercalli scales.
Slight (s)	2	11–25	Felt by many persons at rest. Hanging objects may swing. Inten-sity II on the Rossi-Forel and modified Mercalli scales.
Moderate (m)	3	25–60	Felt generally, by persons in or out of doors. Hanging objects swing. Intensity III on the Rossi-Forel and modified Mercalli scales.
Strong (st)	4	>60	Felt by everyone or nearly everyone. Objects swing. Dishes, doors, and windows rattle. Minor damage may result. Intensity IV or larger on the Rossi-Forel and modified Mercalli scales.

further. Although the number of earthquakes reported seems comparable to earlier periods, many events have only the time given with no indication of location whatsoever. This situation continued through 1953.

Following the arrival of Jerry Eaton, HVO's third trained seismologist, on September 15, 1953, earthquake reporting again became more quantitative. The *Volcano Letter* ceased publication at the end of 1955, its last issue covering the second half of the year (Fiske and others, 1987; *Volcano Letter*, nos. 529–530). Meanwhile, a new series had begun, entitled "Hawaii Volcanoes During [Year]," beginning with 1948–49, also ending in 1955 (Finch and Macdonald, 1951; Finch and Macdonald, 1953; Macdonald and Wentworth, 1954; Macdonald, 1955; Macdonald and Eaton, 1955, 1957, 1964); these issues were published as U.S. Geological Survey Bulletins. They largely duplicate information published in the *Volcano Letter*, though with some differences noted below in the subsection entitled "Errors and Uncertainties."

Eaton greatly advanced the conduct of seismology at HVO, including (1) more sophisticated discrimination of earthquake "families" based on their seismic signatures and (2) derivation of greatly improved traveltime curves related to a more realistic velocity structure for the Island of Hawaii. These topics are discussed and illustrated in Eaton's report on the 1955 eruption of Kilauea (Macdonald and Eaton, 1964, p. 113–140 and associated figures).

Beginning in 1956, HVO began publishing quarterly reports, retaining the qualitative classification of earthquake size initiated by Austin Jones. The first "local" magnitudes were assigned, beginning in 1957[1]; and by 1958, magnitudes were assigned to all events, and the terms used by Jones to classify earthquake size were no longer reported. Reporting of local magnitudes (M_L) was based on the installation of Wood-Anderson torsion seismometers in Hilo. The instrumentation and magnitude calculation emulated that begun by Richter at the California Institute of Technology in the 1930's (see Richter, 1958). These quarterly "summaries" have a higher size threshold (M~2.5) and report fewer events than previously.

Quarterly reports were continuous through the third quarter of 1959 (Eaton and Fraser, 1956a, b, 1957a–d, 1958a, b; Macdonald and Eaton, 1956a, b; Eaton and Krivoy, 1958a, b, 1963a–c) and from the fourth quarter of 1961 to the present.

[1] HVO is listed as a source of magnitude estimates for six large events in 1954–56, reported in the revised history of seismicity in the United States (Stover and Coffmann, 1993). It is unclear how these estimates were obtained and reported because they do not appear in any HVO publication series covering this period.

The paired Kilauea eruptions of 1959 and 1960 produced such a backlog of seismic records that formal publication did not take place for 2 years. Seismograms from the last three quarters of 1960 and the first three quarters of 1961 were subsequently read, and earthquake locations were directly entered into a computer data base along with the data from unpublished compilations for the fourth quarter of 1959 and the first quarter of 1960. Our catalog thus fills in the data from before the beginning of the present computer catalog in October 1959.

The Lyman Diary, 1833–1917

Sarah Lyman and her daughter Isabella Lyman, members of a large early missionary family living on the Island of Hawaii, kept a diary of earthquakes felt at their homes in Hilo, covering the period 1833–1917. The diary has recently been reprinted with a commentary (Wyss and others, 1992). This is an invaluable reference for the early seismic history, particularly in the days before any instrumentation was available to record earthquakes. Comparison with contemporary newspaper reports (see below) and instrumental data shows that the Lyman diary is not a complete record of events felt in Hilo. The most likely explanation for events reported as being felt in Hilo but missing from the Lyman compilation is that Sarah or Isabella Lyman were not at home. Unfortunately, their travels are not documented in the diary. There are some events recorded in the diary for which there is no corroborative newspaper or other documentation. We assume that these events were either local to Hilo (which is shown by modern records to have a low but persistent record of seismic activity) or were near the threshold magnitude of events that would be widely felt and therefore newsworthy.

Newspaper Reports, 1856–1959

Newspaper mention of earthquakes is critical to our data base for several reasons. Before instrumental records were available, the newspapers are the sole source of information, with the exception of the Lyman diary (see above), for any but the very largest earthquakes. Even after the installation of seismometers in 1903 and 1912, newspaper reports expand the information on where, and with what effect, earthquakes were felt. Felt information is essential for recreating intensity maps for the larger events (for example, Wyss and Koyanagi, 1992) and refining locations for events less widely felt. Figure 3 and table 5 list the newspapers we have consulted, since continuous reporting began in 1856. Of those listed, we have not yet been able to access the Kona *Echo*, published in Japanese over much of its history and in English for a limited number of years. Newspaper information is abstracted in the "Location/felt" column of our catalog. Newspaper accounts are distinguished from other felt reports by preceding the information with "Warshauer notes:" (see section below entitled "Acknowledgments"). Fuller description of events, including detailed damage reports, are included in the abstract field of the bibliographic file and in quotations in Wyss and Koyanagi (1992).

The newspapers continue to be of use after HVO began systematic recording and publication of information on earthquakes. We have found instances where newspapers reported earthquakes as felt that were not reported by HVO. In a few instances, newspaper dates or times differ markedly from those reported by HVO or HMO, a result of recording errors that can be corrected from the newspaper accounts. We make judgments to choose as correct the information that is most corroborated.

One of the most complete and interesting newspaper sources was the *Pacific Commercial Advertiser*'s monthly meteorologic reports (1900–4), succeeded in 1905 by weekly reports published under various titles. Correspondents were employed at several places on the more populous Hawaiian Islands to report rainfall and temperature data, as well as making note of unusual weather conditions such as storms that did significant damage. Folded into these accounts were reports of felt earthquakes. Some of these reports match events reported in the Lyman diary or at HMO; for others, the meteorologic reports are the only record. These reports end in 1911, very close to the founding of HVO.

Newspaper accounts, like the HVO reporting, tend to be uneven, especially for events not felt over an entire island or over more than one island. The founding of HVO led newspapers in both Hilo and Honolulu to accept, over certain periods of time, reports directly from HVO, probably reducing their tendency to gather and publish felt reports independently of what was being recorded by HVO. However, in one peculiar circumstance, a newspaper actually gives more information than was published by HVO. In 1941, the Hilo *Tribune-Herald* published a weekly column entitled "Volcano Report." These columns, obtained directly from HVO, contain distances and felt information not reported in the *Volcano Letter* for these dates.

Times of earthquakes as reported in newspaper accounts are quite variable relative to the precise times reported by HVO and HMO, for two principal reasons. The first reason is that the newspapers are not charged with recording exact times, relying on their own experience or that of their correspondents. Often the accounts say an earthquake occurred "about" a certain time. The second reason is the use of "plantation time."[2] According to this practice, peculiar to Hawaii, each plantation or ranch had the option of keeping its own time, separate and independent from adjacent plantations. Each of these times could differ, in turn, from the time recorded in the larger cities. Thus, it is hard to know what time is being used when someone calls a newspaper to report an earthquake. We have assumed that widely reported events with felt times that differ by as much as half an hour are most likely the same event. If an instrumental record is available we use that time; otherwise an arbitrary time within the range reported is used. After the attack on Pearl Harbor in December 1941, Hawaii went briefly on "war time," equivalent to our current daylight-saving time, exactly 1 hour later than Hawaii standard time (H.s.t.). Both HVO and HMO continued to report earthquakes in Hawaii standard time, explaining why some newspaper times during this period differ by one hour from the observatory times.

[2] The description of plantation time was provided by Doak Cox.

Table 5. Beginning and ending dates of publication of Hawaiian newspapers

[Do., ditto]

Place of publication	Dates of publication	Full name	Abbreviation in catalog
Honolulu	7/2/1856–3/30/1921	*Pacific Commercial Advertiser*	PCA
Do.	1/1/1865–11/29/1918	*Hawaiian Gazette*	HG
Do.	3/28/1893–6/29/1912	*Hawaiian Star*	HS
Do.	5/16/1895–6/29/1912	*Evening Bulletin*	HEB
Hilo	11/23/1895–6/27/1917	Hilo *Tribune*	HT
Do.	8/13/1896–2/22/1923	*Hawaii Herald*	HH
Do.	11/1/1916–9/25/1917	*Hawaii Post*	HP
Holualoa	2/3/1897–1951	Kona *Echo*	KE
Wailuku, Maui	2/17/1900–present	*Maui News*	MN
Hilo	7/1/1917–2/18/1923	Hilo *Daily Tribune*	HDT
Do.	9/26/1917–12/1/1917	*Hawaii Daily Post*	HDP
Do.	12/3/1917–2/17/1923	*Daily Post Herald*	DPH
Do.	2/19/1923–3/1/1964	Hilo *Tribune-Herald*	HTH
Honolulu	7/1/1912–present	Honolulu *Star-Bulletin*	HSB
Do.	3/31/1921–present	Honolulu *Advertiser*	HA

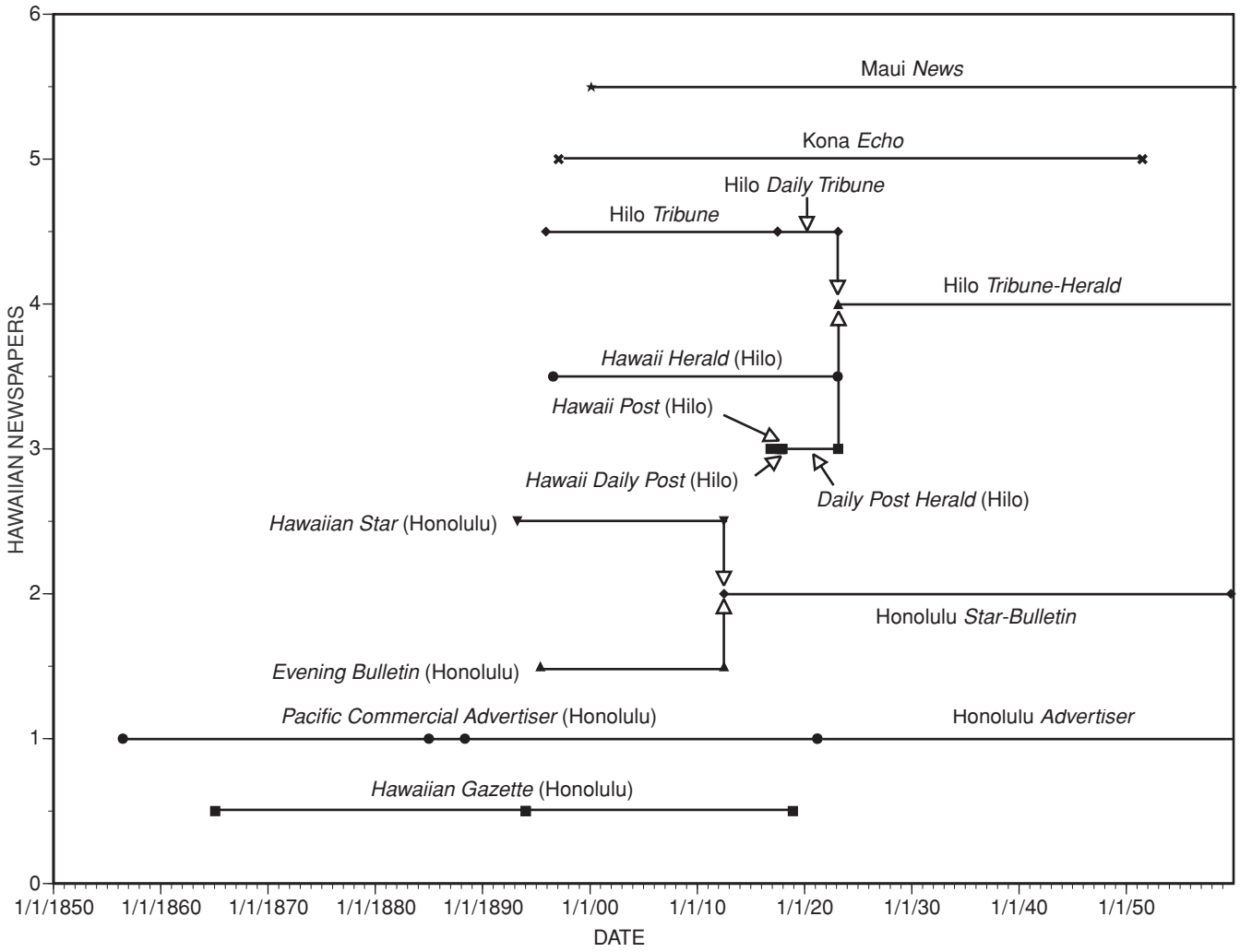

Figure 3. Publication history of Hawaiian newspapers and other sources of information for felt earthquakes in Hawaii.

HVO Felt-Report Postcards

HVO used various means to try to increase its receipt of felt information. In 1913, after a large earthquake felt throughout the island chain, Thomas Jaggar issued a newspaper plea for the public to send HVO detailed information on how the earthquake of October 25, 1913, had been experienced (Pacific Commercial Advertiser, 1913; reprinted in Bevens and others, 1988, v. 2, p. 64). The form provided had a list of questions that could apply to any earthquake which was felt. There is no published evidence that this plea was heeded.

Beginning in 1932, HVO distributed postcards to persons situated at various locations on the Island of Hawaii, with an abbreviated version of Jaggar's questionnaire including, in different versions, an intensity scale (table 6) and (or) a checklist of factors used to estimate intensity. Postcards filled in with information on felt earthquakes have been saved at HVO and were consulted by us. Whereas the *Volcano Letter* reports where an earthquake was felt, the postcards provide relative intensities for those locations.[3] They provide a check on the HVO location and provide data with which isoseismal maps may be prepared for widely felt events. Our use of postcard information is cited in the "Comment" column of our catalog with the designation "HVO, unpub."

We mapped the HVO postcard intensities into modified Mercalli intensities for comparison with other intensity sources (table 6). The lower postcard intensities are defined solely in terms of the number of persons feeling the event rather than the severity of the event used by other scales, making the postcard intensities useful but imprecise.

Other Earthquake Reports

The earliest accounts of earthquakes are contained in magazines or newspapers that were circulated within more specific groups. Some of these early papers include those published locally, such as *The Friend*, the *Sandwich Islands Gazette*, *The Polynesian*, and at least one, the *Missionary Herald*, published in London and Boston for the missionary community. Surprisingly and unpredictably, these journals contain important narrative information on certain events, particularly in association with trips made to the Island of Hawaii. Later newspapers, such as the Hilo *Tribune-Herald* or the *Pacific Commercial Advertiser*, were directed at the entire population. Other sources are early diaries, not as complete as the Lyman diary but nonetheless a source of information for larger felt earthquakes. Entries from the diary of the Greenwell family, long-time residents of the Kona section of the Island of Hawaii, were provided to us by Jean Greenwell, a descendant who works closely with the Kona Historical Society.

The Volcano House, founded in 1865 as a hotel on the edge of Kilauea Caldera, kept a register in which travelers recorded their observations on volcanic activity. The register has been transcribed (Bevens and transcriber, 1988) and is available for viewing in Hawaii Volcanoes National Park. It contains some references to earthquakes, although these references are scattered throughout the volumes and record only those earthquakes felt in the immediate vicinity.

Some earthquake accounts are scattered through books and articles about the volcanic activity of Kilauea and Mauna Loa (for example, Dana, 1888; Hitchcock, 1909), as well as published reports of specific eruptions or earthquakes. The *Bulletin of the Seismological Society of America*, published as a monthly journal beginning in 1911, included a section entitled "Seismological Notes" as part of each issue. All information on Hawaiian events appears to be drawn from other sources and so does not add any information. Unfortunately, inaccuracies in locations and times of events seemed to have crept into these summaries. Therefore, it is best to use the original instrumental reports from HMO and HVO when they are available.

We include as a separate file on the CD–ROM a bibliography of all published reports of earthquakes and earthquake swarms, drawn from the Hawaii bibliographic data base, recently made available (Wright and Takahashi, 1998).

Construction of the Earthquake Catalog

Our master earthquake catalogs have as many as 26 columns, formatted so as to print legibly on 8.5- by 11-in. paper in landscape mode. We have divided them into four files: (1) pre-April 1903, the date of installation of the first seismometer on Oahu; (2) April 1903 to February 1921, when the one-component Milne seismometer was replaced by the two-component Milne-Shaw seismometer; (3) February 1921 through 1932; and (4) 1933 to September 30, 1959, the time period for which we have continuous film records of seismograms generated on Oahu. The column headings used in files 1 through 4 are listed in table 7. Table 13 (see app. 1) is the 1903–59, $M \geq 4$ portion of the entire catalog.

Published data from HMO, and from Wood's published and unpublished HVO *Station Bulletin*, use Greenwich mean time (G.m.t.). Until June 8, 1947, Hawaii standard time was 10 1/2 hours earlier than Greenwich mean time; after that date, it became 10 hours earlier (Fiske and others, 1987; *Volcano Letter*, no. 496, p. 3). Hawaii standard time has been the time used by HVO for all other published geologic and seismologic reports. We have corrected all times to Hawaiian standard time in our catalog.

Latitude and longitude are given for some events reported in the *Volcano Letter*. For these events, no location information is given in the "Comment" column of our catalog. Where latitude and longitude are not published but a precise narrative de-

[3] We acknowledge Amy Greenwell of Captain Cook, Kona, for her unusually complete and accurate information, which contributes directly to our evaluation of seismic intensity. She reported every earthquake felt in Kona from 1951 to the late 1950's, relying not only on herself but also on her many acquaintances in the local community. She faithfully records where the earthquake was felt and by how many, what type of structure the person(s) feeling it was in, and whether persons were asleep or awake. She also describes the type of earthquake motion, discriminating rapid "jolts" from much longer and gentler motions, both occurring over a range of strengths. Finally, for the larger events, she gives the relative strength of an earthquake as perceived at various locations along the mid-Kona coast. If all correspondents had been as assiduous in their reporting, valid macroseismic (contoured intensity) maps could have been produced for all widely felt events.

Table 6. Hawaiian Volcano Observatory intensity scale used on postcards after 1933

HVO intensity	Modified Mercalli equivalent	Felt designation
I	I	Not felt.
II	II	Felt by very few people.
III	III, IV	Felt by several people.
IV	III, IV	Felt by many people.
V	IV, V	Felt generally.
VI	V	Felt by nearly everyone.
VII	VI, VII	Flight from houses; some damage.
VIII	VIII, IX	Ruinous; great terror, some people wounded, much damage.
IX	X, XI	Disastrous; a few lives lost, general ruin.
X	XII	Very disastrous; great loss of life, utter ruin.
	Greenwell diary descriptions	
– – –	II	Windows rattle; slight, gentle.
– – –	III, IV	Dogs bark; "a pretty good one"; a jar (III).
– – –	IV	A jolt (IV).

Table 7. Explanation of column headings used in our catalog

File 1 1823–3/1903	File 2 4/1903–2/1921	File 3 2/1921–1932	File 4 1933–9/1959	Explanation
Date	Date	Date	Date	Local date.
Time (HST)	Time (HST)	Time (HST)	Time (HST)	Local time (Hawaii standard time).[1]
Lat (deg)	Lat (deg)	Lat (deg)	Lat (deg)	Latitude, in degrees N.
Lat (min)	Lat (min)	Lat (min)	Lat (min)	Latitude, in minutes.
Long (deg)	Long (deg)	Long (deg)	Long (deg)	Longitude, in degrees W.
Long (min)	Long (min)	Long (min)	Long (min)	Longitude, in minutes.
Region	Region	Region	Region	Geographic region assigned from description.
Publ. Depth	Publ. Depth	Publ. Depth	Publ. Depth	Published depth.
Pref. Depth	Pref. Depth	Pref. Depth	Pref. Depth	Preferred depth indicated from felt reports or other information.
Publ. Dist.	Publ. Dist.	Publ. Dist.	Publ. Dist.	Published distance.
Calc. Dist.	Calc. Dist.	Calc. Dist.	Calc. Dist.	Distance calculated from latitude and longitude or from assumed location.
Slant dist.	Slant dist.	Slant dist.	Slant dist.	Hypocentral distance calculated from preferred depth and calculated distance.
– – –	Mag. class (after July 1912).	Mag. class	Mag. class (before 1958).	HVO size (magnitude) class.
– – –	Pref. amp. (after July 1912).	Pref. amp.	Pref. amp. (before 1958).	Amplitude used for calculation of nomogram magnitude.
– – –	M calc. (after July 1912).	M calc.	M calc.	Magnitude calculated from HVO's published or inferred amplitude and distance.
– – –	Milne E-W	M M-S E-W	M M-S E-W	Magnitude determined from Milne or Milne-Shaw E-W component at HMO.
– – –	– – –	M M-S N-S	M M-S N-S	Magnitude determined from Milne-Shaw N-S compo-nent at HMO.
– – –	– – –	– – –	M vert SPN (1950–57) HTL (1957–59)	Magnitude determined from Sprengnether or Houston Technical Laboratories verti-cal seismometer at HMO.
– – –	– – –	– – –	M hor (N-L)	Magnitude calculated from Neumann-LaBarre horizontal seismometer at HMO.
M (other)	M (other)	M (other)	M (other)	Magnitude from other source.
M (other) source	M (other) source	M (other) source	M (other) source	Source of other magnitude.
M (pref)	M (pref)	M (pref)	M (pref)	Preferred magnitude.
M (pref) source	M (pref) source	M (pref) source	M (pref) source	Source of preferred magnitude.
I (max)	I (max)	I (max)	I (max)	Maximum intensity.
Location/felt report	Location/felt report.	Location/felt report	Location/felt report	Felt reports and their locations.
Comment	Comment	Comment	Comment	Bibliographic reference and (or) author's comments.

[1]After June 8, 1947, Hawaii standard time (H.s.t.) = Greenwich mean time (G.m.t.) minus 10 hours. Before that date, H.s.t. = G.m.t. minus 10.5 hours (Fiske and others, 1987; *Volcano Letter*, no. 496, p. 3).

scription of location is available, we have converted the description to latitude and longitude, using Hawaii base maps, and entered the coordinates. Thus, inclusion of narrative locations means that our derived coordinates were not explicitly given in the *Volcano Letter*. For each earthquake, we assign a geographic region based on latitude and longitude, or on the basis of distance from the Whitney seismometer, supplemented by felt reports. For events where only the general area of Hawaii rather than the specific region can be inferred, we use the broad regional names. Definition of earthquake regions is discussed below.

Depths and epicentral distances are included when published. We default to a preferred depth of 9 km where none is given. For some events, we assigned depth on the basis of felt reports. Where this depth differs from a published depth, we fill in both the "Preferred depth" and "Published depth" columns in our catalog. There is some ambiguity regarding distance in the earlier HVO reports. Where only distance and no real location is given, we assumed that these values were derived from s-p time and so are hypocentral (that is, slant) distances rather than epicentral distances, and we listed them as such. Distance is to the seismometer measuring the amplitude, generally the Whitney laboratory at HVO. If distance is to another station, this difference is noted in the "Comment" column of our catalog.

Magnitude class is that used in the published HVO reports and is irrelevant for the period before 1912 and after 1957. It appears that the classification using terms ranging from "tremor" to "strong," formalized as noted above in 1931, may apply back as far as 1928. We use this classification to calculate magnitudes for the period 1928–57 by the methods outlined below. For data utilizing the Cancani scale and the minimum perceptible unit (1912–17), we had to devise different methodologies to estimate magnitude, as outlined below. Between 1917 and 1928 and before 1903, we made approximate assignments of magnitude, calibrated to be consistent with felt information. In this period, the familiar terms—for example, "feeble"—do not appear to refer to the same amplitude range as later, and additional terms—for example, "small"—are not used consistently enough to be able to define them in terms of specific amplitude ranges.

We calculated magnitudes from HMO or HVO data, using the methods outlined below. Agreement is generally better than the error estimates listed in table 11. Where discrepancies occur, we note these in the "Comment" column of our catalog. After 1930, earthquakes of $M>6$ commonly have an externally determined magnitude, for example, one determined at Berkeley or Pasadena. Wyss and Koyanagi (1992) calculated the magnitudes for many large events from their isoseismal maps; we put these values in the "Other magnitude" column of our catalog and cite their source. Preferred magnitudes represent our evaluation of the best source or averages derived from multiple sources, using the criteria outlined below.

We derived intensities from felt reports and (or) HVO or HMO information. Where a single intensity is given, it represents the maximum reported or observed. Most intensities are from HVO or Hilo, and the location and source are generally given. Magnitudes and intensities of the largest events ($M\geq5.5$, $I\geq$V) are cross-referenced to, and rarely modified from, Wyss and Koyanagi (1992).

Table 8. "Lyman" scale of seismic intensity

[Approximate modified Mercalli intensity interpreted from Wyss and Koyanagi (1992, p. 42, table 8)]

Attribute used to describe shaking	Approximate modified Mercalli intensity
Severe	VII
Heavy	V–VI
Hard	V–VI
Smart	V, IV–V [1]
Decided	IV–V
Moderate	III–IV
Distinct	III–IV
Slight	II–III
Protracted [2]	II–V

[1] Interpreted by us from newspaper reports of events recorded in the Lyman diary.
[2] Not used by us for intensity assignment because the range is too large.

All intensities (I values) are modified Mercalli (MM) unless otherwise noted. Early HVO accounts commonly used Rossi-Forel (RF), which is about the same as MM below an intensity of V. Some early intensities are derived from descriptive words used in the Lyman diary. We generally follow Wyss and Koyanagi (1992) in the use of the "Lyman" scale to convert their terms to intensities (table 8).

The "Comment" column of our catalog lists the primary references from which the earthquake information is derived; our comments are enclosed in brackets, including discrepancies in published magnitudes or intensities and their reconciliation. The "Location/felt report" column records duration and felt information gathered from the references cited. Both columns are used to give information regarding the beginning and end of eruptions, the relation of earthquake swarms to eruptions, important changes in the seismic network, and the like.

Definition of Geographic Regions and the Assignment of Earthquakes to Them

We have defined geographic regions for the Island of Hawaii within which earthquakes are clustered, as shown in figure 4. Mauna Loa and Kilauea, Hawaii's two recently active volcanoes, are subdivided into several regions, on the basis of concentrations of modern (post-1959) earthquakes associated with known fault zones or tectonically active areas. Older, less seismically active volcanoes are covered by a single region. We append the abbreviation "os" to indicate earthquakes whose epicenters lie in the offshore part of a region.

Over much of the time period covered, the assignment of an earthquake to a particular geographic region is based on recordings on a primitive network of one to three stations and so is subject to large error (see subsection below entitled "Errors and Uncertainties"). Our regional assignment is made directly from the latitude and longitude, or from felt reports where no other information is available. When only the distance from HVO was given, we generally assigned the event to the most active region at that distance. We preferentially chose regions

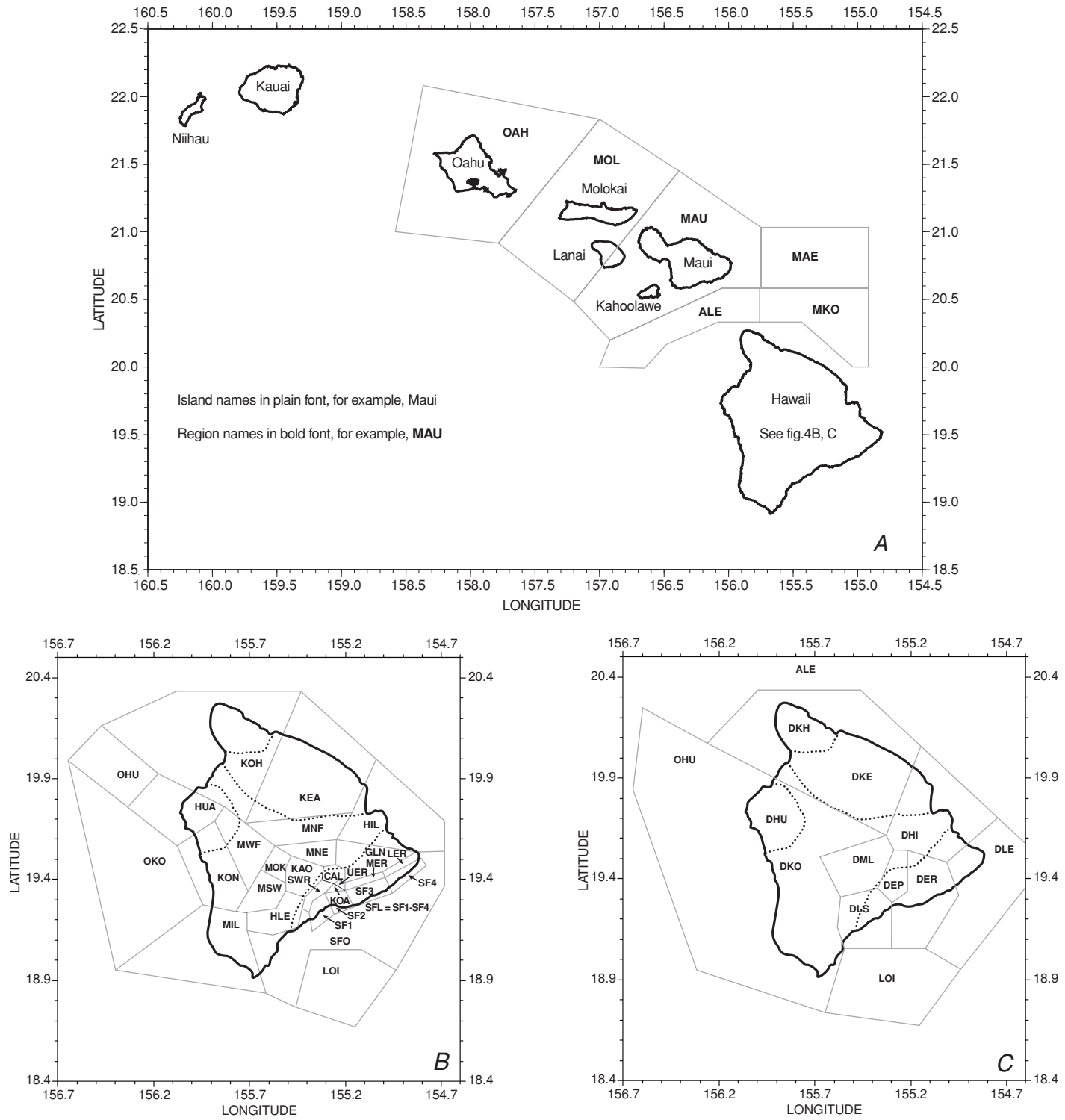

Figure 4. Geographic regions defined for earthquakes in Hawaii. *A*, State of Hawaii, showing regions other than Hawaii County. *B*, Hawaii County, showing shallow-earthquake (<20-km depth) regions broadly defined from density of earthquake occurrence. Dotted lines, boundaries of five volcanoes that make up island. *C*, Hawaii County, showing deep-earthquake (>20-km depth) regions broadly defined from density of earthquake occurrence. Dotted lines, boundaries of five volcanoes that make up island.

in or adjacent to areas of concurrent eruptions or main shocks. Rarely, we revised or reinterpreted the region to place the event in an active seismic area. We use general terms, such as "south Hawaii," when specific information is unavailable to choose a region. Even when latitude and longitude or detailed narrative descriptions were published, errors could still be several to a few tens of kilometers.

Commonly, the errors are such that many earthquakes could be in a region adjacent to the one that we assigned. Earthquakes large enough to be widely recorded and widely

Table 9. Synonymy relating the geographic regions defined in figure 4 to the abbreviations in our catalog

A. Shallow-earthquake regions

Name[1]	Region[2]	D typ[3] (km)	D all[4] (km)	Abbreviation[5]	Map[6]
Loihi	Loihi undersea edifice	All	All	loihi	LOI
Kilauea	Glenwood (north flank)	– –	0–20	kl gln	GLN
	Summit caldera	1–3	0–5	kl cal 0–5	CAL
	Summit caldera	7–10	5–10	kl cal 05–10	INT
	Summit caldera	10–13	10–20	kl cal 10–20	INT
	Upper East Rift Zone	1–4	0–20	kl uer	UER
	Middle East Rift Zone	1–4	0–20	kl mer	MER
	Lower East Rift Zone	1–6	0–20	kl ler	LER
	Southwest Rift Zone	1–4	0–20	kl swr	SWR
	Koae Fault Zone	1–4	0–20	kl koae	KOA
	South flank (unspecified)	5–10	0–20	kl sf	SFL
	Far-eastern south flank	5–10	0–20	kl ler sf	SF4
	Eastern south flank	5–10	0–20	kl mer sf	SF3
	Central south flank	5–10	0–20	kl kuer sf	SF2
	Western south flank	5–10	0–20	kl swr sf	SF1
	South flank offshore	5–10	0–20	kl sf os	SFO
Mauna Loa	Summit (Mokuaweoweo)	0–5	0–20	ml mok	MOK
	Northeast Rift Zone	0–5	0–20	ml ner	MNE
	Southwest Rift Zone	0–5	0–20	ml swr	MSW
	Kaoiki Fault Zone	4–16	0–20	kaoiki	KAO
	Hilea Fault Zone	4–16	0–20	hilea	HLE
	Milolii (includes offshore)	– –	0–20	milolii	MIL
	Kona (including near offshore)	– –	0–20	kona	KON
	Kona offshore	– –	0–20	kona os	OKO
	North flank (including ml-mk saddle)	– –	0–20	ml nf	MNF
	West flank	– –	0–20	ml wf	MWF
	Hilo area (includes offshore)	– –	0–20	hilo	HIL
Hualalai	Onshore	– –	All	hualalai	HUA
	Offshore	– –	All	hualalai os	OHU
Mauna Kea	Onshore	– –	All	mauna kea	KEA
	Offshore	– –	All	mauna kea os	MKO
Kohala	Kohala (includes near offshore)	– –	All	kohala	KOH
Alenuihaha	Channel between Hawaii and Maui	– –	All	alenuihaha	ALE
Maui	Maui (includes near offshore)	– –	All	maui	MAU
	Maui (far offshore east)	– –	All	maui east	MAE
Lanai	Lanai northwest	– –	All	lanai nw	MOL
	Lanai southeast	– –	All	lanai se	MAU
Molokai	Molokai (includes offshore)	– –	All	molokai	MOL
Oahu	Oahu	– –	All	oahu	OAH

[1]Volcano (on the Island of Hawaii) or island.
[2]Subdivision defined by concentrations of earthquake epicenters within volcanoes on the Island of Hawaii (see fig. 4*B*) or for the rest of the Hawaiian chain (see fig. 4*A*).
[3]Typical depth range of well-defined hypocenters in our catalog.
[4]Depth range assumed where accurate depth determinations are unavailable.
[5]Abbreviation used in the "Region" column of our catalog.
[6]Three-letter regional code (see fig. 4) conforming to regions identified in our catalog, also used as code in the fixed-column computer file.

felt, or which are aftershocks or associated with a volcanic swarm, are probably located in the region assigned. Smaller earthquakes not associated with a well-located event will have larger uncertainties. It is possible but rare that an earthquake is two regions away from the one assigned.

In our catalog, the notation "(?)" after the region indicates a moderate uncertainty, for example, where only distance and a rough direction from one station is known. The notation "(??)" indicates a region that is inferred without any specified location and for which the true location error cannot be determined. A location may be precisely specified by HVO without stating how many data were actually used. For example, many early descriptions placed earthquakes in the saddle area between Mauna Loa and Mauna Kea. This area currently is nearly aseismic, and so we suspect that the early locations are in error, rather than that a cessation of activity occurred in the saddle coinciding with the time when the network improved.

For some earthquakes, the geographic coordinates are outside the assigned region. We assigned a region by using all location information described by HVO plus a knowledge of where earthquake activity was most likely at the time. We thus tended to assign aftershocks to the same region as the main shock and earthquakes during an eruption to the rift or adjacent flank, even if the coordinates stated by HVO placed them elsewhere.

Catalog abbreviations for geographic regions in relation to the Hawaiian volcanoes and tectonic subregions are listed in table 9.

Table 9. Synonymy relating the geographic regions defined in figure 4 to the abbreviations in our catalog—Continued

B. Deep-earthquake regions

Name[1]	Region[2]	D all[3] (km)	Abbreviation[4]	Map[5]
Loihi	Loihi undersea edifice	All	loihi	LOI
Kilauea	Glenwood (north flank)	≥20	kl gln deep	DEP
	Summit caldera	≥20	kl cal deep	DEP
	Upper East Rift Zone	≥20	kl uer deep	DEP
	Middle East Rift Zone	≥20	kl mer deep	DER
	Lower East Rift Zone	≥20	kl ler deep	DLE
	Southwest Rift Zone	≥20	kl swr deep	DLS
	Koae Fault Zone	≥20	kl koae deep	DEP
	South flank (unspecified)	≥20	kl sf deep	DER
	Far-eastern south flank	≥20	kl ler sf deep	DLE
	Eastern south flank	≥20	kl mer sf deep	DER
	Central south flank	≥20	kl kuer sf deep	DER
	Western south flank	≥20	kl swr sf deep	DLS
Mauna Loa	Summit (Mokuaweoweo)	≥20	ml mok deep	DML
	Northeast Rift Zone	≥20	ml ner deep	DML
	Southwest Rift Zone	≥20	ml swr deep	DLS
	Kaoiki Fault Zone	≥20	kaoiki deep	DML
	Hilea Fault Zone	≥20	hilea deep	DLS
	Milolii (including offshore)	≥20	milolii	DKO
	Kona (including near offshore)	≥20	kona deep	DKO
	North flank (inc. ml-mk saddle)	≥20	ml nf deep	DML
	West flank	≥20	ml wf deep	DKO
	Hilo area (including offshore)	≥20	hilo deep	DHI
	Deep (all Mauna Loa regions)	≥20	mauna loa deep	DML
Hualalai	All	≥20	hualalai deep	DHU
Mauna Kea	All (including offshore)	≥20	mauna kea deep	DKE, ALE
Kohala	Kohala (including offshore)	≥20	kohala deep	DKH, ALE
Hawaii	Offshore deep	≥20	(catalog) os deep	([6])

[1]Volcano (on the Island of Hawaii) or island.
[2]Subdivision defined by concentrations of earthquake epicenters within volcanoes on the Island of Hawaii (see fig. 4*C*).
[3]Depth range assumed where accurate depth determinations are unavailable.
[4]Abbreviation used in the "Region" column of our catalog.
[5]Three-letter regional code (see fig. 4) conforming to regions identified in our catalog, also used as code in the fixed-column computer file.
[6]See figure 4*C*.

C. Earthquake regions specified in the absence of definitive instrumental data or felt reports

Name[1]	Region[2]	Catalog[1]	Code[3]
Kilauea	Unspecified; assume distance and depth for central part of Kilauea Volcano.	kilauea	KIL
Mauna Loa	Unpecified; assume Kaoiki distance and depth	mauna loa	MLO
Hawaii	Island of Hawaii	hawaii	HAW
South Hawaii	Southern part of the Island of Hawaii (including south-flank regions of Mauna Loa and Kilauea).	south hawaii	SHA
East Hawaii	Eastern part of the Island of Hawaii (including Hilo and eastern part of Mauna Kea).	east hawaii	EHA
North Hawaii	Northern part of the Island of Hawaii (including Kohala and parts of Mauna Kea).	north hawaii	NHA
West Hawaii	Western part of the Island of Hawaii; north and south Kona (including Hualalai and Mauna Loa west flank).	west hawaii	WHA
Offshore	Far offshore, outside of Hawaiian chain	off chain	DIS
a0513	Annulus of 5 to 13 km around the Whitney vault	a0513	A05
a1320	Annulus of 13 to 20 km around the Whitney vault	a1320	A13
a2025	Annulus of 20 to 25 km around the Whitney vault	a2025	A20
a2530	Annulus of 25 to 30 km around the Whitney vault	a2530	A25
a3035	Annulus of 30 to 35 km around the Whitney vault	a3035	A30
a3540	Annulus of 35 to 40 km around the Whitney vault	a3540	A35

[1]Used when only distance from the seismometer in Whitney vault is known.
[2]Distance range from Whitney vault (hypocentral); for example, "a3035" could refer to a shallow earthquake below Mokuaweoweo, or to an earthquake at 30-km depth beneath Kilauea caldera.
[3]Used in the fixed-column computer file.

Calculation of Earthquake Magnitude

The method of calculating earthquake magnitude differs for each of the seismometers used at HMO and HVO. Calculations are based on a relation for the seismometer recording the event, using the maximum peak-to-peak amplitude of the seismic trace and the hypocentral distance from the seismometer. If we know the response parameters, we convert the response to that of a Wood-Anderson seismometer and use the local magnitude calculated from the formulas of Richter (1958). If we cannot convert the response to that of a Wood-Anderson seismometer and we do not know the period of the maximum amplitude, we develop an empirical relation between earthquake magnitude and the logarithm of amplitude.

Derivation of the Magnitude Scale for HMO Seismograms

Station constants from the January 1957 film record are listed in table 10. We looked at the Honolulu records for all earthquakes reported by HVO as "moderate" or larger after converting the Hawaii standard time given in the *Volcano Letter* to Greenwich mean time. After deriving the nomogram for the HVO Bosch-Omori seismometer (see below), we looked for additional earthquakes reported as "slight" or "feeble," whose distance from the Whitney vault resulted in a calculation of M>4.0. For many undetected events we recorded the level of background noise as a threshold magnitude, designated "M<" in our catalog. A few earthquakes, by accident or design, were reread at different times, and agreement was excellent. This result gave us confidence that our readings were precise and consistent. Repeats are included in the CD–ROM files covering the Honolulu readings and noted in the corresponding catalog entry.

Records are available only from the Honolulu station; commonly, magnitudes can be averaged from different HON components, but not from a set of independent stations.

Magnitudes from the Milne Seismometer, 1903–21

Magnitudes determined from the Milne seismometer are empirical. We assume that magnitudes are of the form

$$M = a + b\left[\log\left(\frac{A_{pp}}{2}\right) - \log A_0\right],$$

where a and b are constants to be determined, A_{pp} is the peak-to-peak amplitude, and -log A_0 is the distance term defined by Richter (1958). Ideally, we would want to know the period response of the Milne seismometer relative to the Wood-Anderson seismometer. This value would relate amplitudes measured on the Milne seismometer to the local magnitude scale defined for the Wood-Anderson seismometer. At least three factors, however, prevent us from knowing this value: (1) The period response of the Milne seismometer is underdamped and not well known; (2) the 1- to 3-s periods of local Hawaii earthquakes place them in the displacement response part of the Milne seismometer's spectrum (free period, 12 s), but the acceleration part of the Wood-Anderson seismometer's spectrum (free period, 0.8 s) and, thus, the ratio of their gains is frequency dependent; and (3) periods are unmeasurable on the 6-cm/h Milne records. Therefore, we chose an empirical approach.

To calibrate the Milne magnitude scale, we could find only three Hawaiian earthquakes with previously determined magnitudes recorded on the Milne seismometer with measurable amplitudes (fig. 5). These earthquakes all have M=6.1–6.8. In addition, for several earthquakes recorded on the Milne seismometer, we can crudely estimate magnitude from the maximum felt intensity: two earthquakes of intensity VI (M=5.9) and five earthquakes of intensity V (M=5.3) earthquakes. Also, four earthquakes were recorded on the Milne seismometer with magnitude estimates from the size class recorded on HVO's Bosch-Omori seismometer (discussed below). Derivation of the Milne magnitude relation from HVO magnitudes determined from the Bosch-Omori seismometer is difficult because the Bosch-Omori seismometer goes off scale and begins to dismantle at about the magnitude at which the Milne seismometer just begins to record. We gave low weights to these points with approximate size class and maximum intensity magnitudes in fitting the Milne magnitude relation because we did not want to calibrate one empirical scale from another. We graphically fitted the empirical line through the earthquakes plotted in figure 5 to derive the Milne magnitude relation

$$M = 3.16 + 0.625\left[\log\left(\frac{A_{pp}}{2}\right) - \log A_0\right].$$

Milne magnitudes are thus poorly calibrated but probably good in a relative sense. Our fit of the Milne magnitude relation means that various magnitudes should be self-consistent. Milne magnitudes probably have accuracies comparable to those esti-

Table 10. Station constants from the January 1957 film record

[Do., ditto]

Seismometer	Component	Free period (s)	Magnification	Damping	Up
Neumann-LaBarre	East-west	0.85	– –	– –	E
Milne-Shaw	North-south	12	152	20:1	S
Do	East-west	12	159	20:1	E
Sprengnether	Vertical	1.65	4,000(?)	Critical	Up
Houston Technical Laboratories.	do	– –	– –	– –	– –

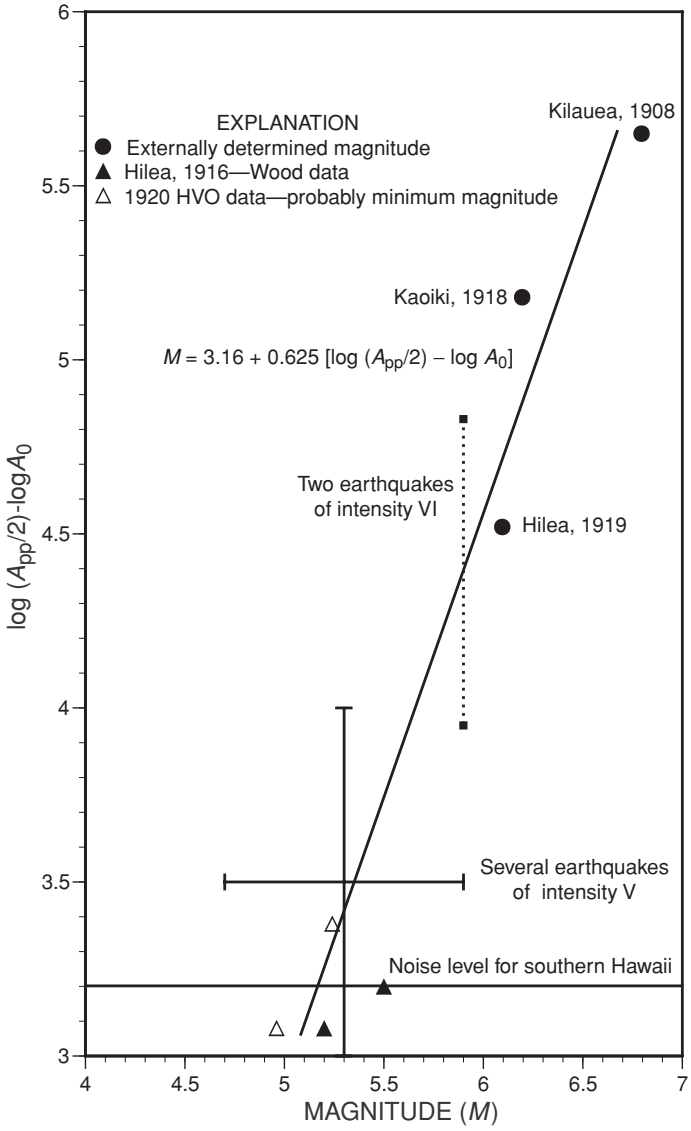

Figure 5. Empirical calibration of Milne seismometer. Small squares, two earthquakes of maximum intensity VI plotted at *M*=5.9; triangles, earthquake magnitudes determined by Hawaiian Volcano Observatory's Bosch-Omori seismometer. Error bars represent five earthquakes of intensity V: Vertical bar shows range of amplitudes, and horizontal bar shows probable error in magnitude defined by maximum intensity. Line is graphically fitted to magnitude-amplitude relation. Equation was used to calculate Milne magnitude (*M*) from peak-to-peak amplitude (A_{pp}) and distance term ($-\log A_0$).

mated by other methods used on early earthquakes, such as from areas of felt intensities or from maximum intensity.

Milne-Shaw Intermediate Period, 1921–59

The method to derive a magnitude relation for the Milne-Shaw horizontal seismometers uses an "absolute" formulation of the response of the seismometer and a conversion of amplitudes to what would have been seen on a Wood-Anderson seismometer. The theoretical response of the Milne-Shaw was ratioed to the theoretical response of the Wood-Anderson and the ratio was used to convert Milne-Shaw to Wood-Anderson amplitudes. The magnification is a function of these three parameters:

	Milne-Shaw	*Wood-Anderson*
Static (very short period) magnification (v)	155	2,080
Seismometer period (τ, in seconds)	12	.8
Damping factor (h)	.69	.7

The dynamic magnification of a seismometer is given by (Richter, 1958)

$$H = \frac{v}{\sqrt{A^2 + B^2}} \quad \Big| \quad A = 1 - \frac{T^2}{\tau^2},\ B = \frac{2hT}{\tau},$$

where T is the period of ground motion, v is the static magnification, τ is the seismometer free period, and h is the damping factor. The ratio of zero-to-peak Wood-Anderson amplitude A_{WA} to peak-to-peak Milne-Shaw amplitude A_{MS} is then

$$\frac{A_{WA}}{A_{MS}} = 0.5\frac{H_{WA}}{H_{MS}}.$$

We plotted this ratio and did a graphical fit in the period range 1–3 s to obtain the approximation

$$A_{WA} = 0.5 \cdot 7.18\left(\frac{1}{T^{1.9}}\right)A_{MS}.$$

In the period range of interest (1–3 s), the Milne-Shaw displacement response is nearly flat, and the Wood-Anderson response falls off as $1/T^{1.9}$ with period T.

Richter's original magnitude formula is $M_{WA}=\log A_{WA}-\log A_0$, where A_{WA} is the maximum half-amplitude on a Wood-Anderson seismometer and $-\log A_0$ is a tabulated term that depends on distance and regional attenuation. The Milne-Shaw version of this formula is

$$M_{MS} = \log\left[0.5 \cdot 7.18\left(\frac{1}{T^{1.9}}\right)A_{MS}\right] - \log A_0,$$

where T is the period (limited to 1–3 s if outside that range; that is, periods of 1–3 s are taken as given, periods less than 1 s are assigned 1 s, and periods greater than 3 s are assigned 3 s), A_{MS} is the maximum peak-to-peak amplitude (in millimeters), and $-\log A_0$ is the distance term, either obtained from a table in Richter (1958) or approximated by Eaton's (1975) relation

$$-\log A_0 = -0.15 + 1.6 \log SD \qquad \text{for SD<200 km}$$

$$-\log A_0 = -3.38 + 3.0 \log SD \qquad \text{for SD>200 km,}$$

where SD is the slant distance (in kilometers). We considered but did not find it necessary to use geographic correction terms for M_{MS}.

The distance term $-\log A_0$ depends on the typical attenuation factor Q for the region. We use the $-\log A_0$ relation that Richter developed for southern California. We realize that the attenuation along the volcanic path from Hawaii to Honolulu is probably larger, but comparisons of Honolulu magnitudes with local Wood-Anderson magnitudes from Hilo during a limited time period suggest that an adjustment is unnecessary. Data for earthquakes that have both an external magnitude estimate and a Milne-Shaw magnitude show good agreement (figs. 7*A*, 7*C*).

Horizontal and Vertical Short Period

The approach used for the verticals does not attempt an absolute formula for instruments whose response is not well known, but simply regresses the logarithm of amplitude against the Milne-Shaw magnitude for events observed on both instruments. The form of the relation is

$$M_v = \log A_v - \log A_0 - B - C,$$

where A_v is the maximum peak-to-peak amplitude on the vertical seismometer, $-\log A_0$ is the distance term described above, B is a correction for the epicentral and depth region, and C is a term determined for each of the three vertical instruments used in Honolulu.

The B and C values were determined iteratively by graphically fitting plots of $\log A_v - \log A_0$ versus M_{MS} with a line of slope 1.0. Plots of data for each instrument where the C values were fitted alternated with plots of each region where the B values were fitted. Deep (>20 km) earthquakes were fitted differently from shallow (crustal) earthquakes for several regions. It took about three to four iterations until the B and C values were chosen and the data fit well. The tradeoff of the "floating constant" between the B and C values was fixed by letting the average of the regional B values be about zero.

The C values for each vertical seismometer are 0.52 for the Neumann-LaBarre, 0.17 for the Sprengnether, and 0.66 for the Houston Technical Laboratories.

The B values for each region are as follows:

−0.17 for Kilauea south flank (SFL), Koae fault zone (KOA), and Kilauea Caldera shallow (CAL)
0.22 for Kaoiki (KAO) and Hilea (HLE)
0.06 for Mauna Loa shallow (MOK, MNE, SAD, MSW) and Hilo shallow (HIL), and Mauna Kea shallow (KEA)
0.09 for Kona (KON), Mauna Loa west flank (MWF), and Milolii (MIL)
−0.10 for Kohala and Hualalai (KOH, HUA)
−0.02 for Kilauea Caldera deep (DEP) and Kilauea rift and south flank deep (DER)
0.65 for Hilo and Mauna Kea deep (DHI, DKE) and Mauna Loa deep (DML)
0.51 for Maui (MAU, MAE)

The $-\log A_0$ values for each region (when distances cannot be calculated directly from epicenter coordinates) are as follows:

3.80 for Kohala offshore
3.85 for Kohala
3.95 for Hualalai
4.05 for Kona
4.10 for Mauna Kea, Mauna Loa north flank, and Mokuaweoweo
4.15 for Mauna Loa northeast rift and Mauna Loa southwest rift
4.20 for Kaoiki, Hilea, and Hilo
4.30 for all Kilauea (4.4 for south flank off shore)

The governing equations on the spreadsheet for calculating magnitudes are as follows:

for the Milne-Shaw seismometer:

$$M = \log\left[0.5 \cdot 7.18\left(\frac{1}{T^{1.9}}\right)A_{pp}\right]$$

for the Neumann-LaBarre, Sprengnether, and Houston Technical Laboratories seismometers:

$$M = \log A_{pp} - \log A_0 - B - C$$

where T is the period (in seconds) and A_{pp} is the peak-to-peak amplitude (in millimeters).

The magnitude determined from the Neumann-LaBarre seismometer was not used from the time of its installation on May 1, 1946, until it was rotated, rebuilt, and reinstalled in the new vault on September 28, 1946. There were no calibration events during this early period, and Neumann-LaBarre magnitudes, assuming the latter calibration, are typically 0.5 to 0.8 units higher than the other components.

Magnitude Determination for Earthquakes Not Recorded in Honolulu

For HVO data before 1958, we had to develop methods for assigning magnitudes to earthquakes for which we had a location, or at least an epicentral distance, but lacked a directly determined amplitude. Earthquakes lacking both location and amplitude were assigned a provisional location and magnitude only if they were large enough to be felt. The following subsections describe how we assigned magnitudes to earthquakes recorded by HVO or noted in newspaper reports but not recorded on Oahu.

HVO Magnitude Data, 1928–57

A nomogram (fig. 6) was constructed relating magnitude, hypocentral distance from Kilauea's summit, and the size class on the Bosch-Omori seismometer. We used two sets of earthquake data to determine the magnitude contours. The first set of about 20 earthquakes is from the 1957 HVO "Summaries" (Eaton and Fraser, 1957a–d), for which both size classes and Wood-Anderson magnitudes are available. The second set of earthquakes, from 1951–56, have both Milne-Shaw magnitudes and a qualitative size class from the *Volcano Letter*. The bands in figure 6 correspond to the size classes defined as ranges of Bosch-Omori amplitudes (table 4).

The magnitude contours were drawn by hand through the data at equal intervals to give the best fit to all of the earthquake data used. For the Bosch-Omori seismometer in the Whitney vault, we empirically found that peak amplitude decays approximately as distance to the −1.24 power, though this relation is not well constrained. Richter's near-source decay for the Wood-Anderson local magnitudes in southern California

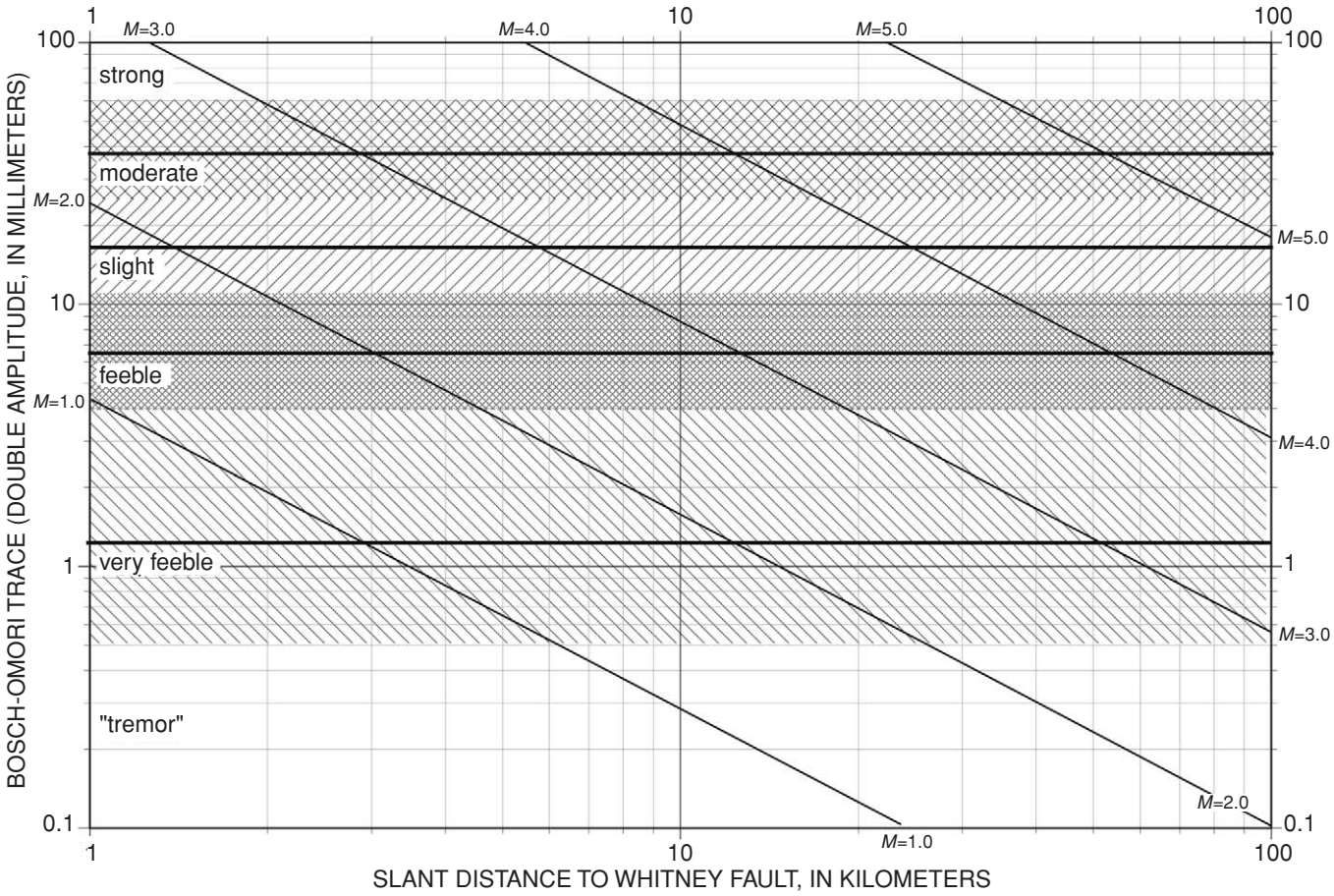

Figure 6. Nomogram for determining magnitude of earthquakes recorded at the Hawaiian Volcano Observatory during period 1928–57, using distance and size class given in the *Volcano Letter*. Governing equation: magnitude (*M*)=1.35log (amplitude, in millimeters)+1.6log (distance, in kilometers)+0.15.

(also used in Hawaii) is distance to the −1.6 power. Our graphical fit finds *M* proportional to 1.35log *A*, in comparison with M~1.0log *A* assumed for the Wood-Anderson seismometer. The success of our initial calibration is shown in figures 7*B* and 7*D*, where the magnitudes derived from our nomogram are plotted against the corresponding magnitudes determined on the Milne-Shaw seismometer for a much larger set of events. Agreement for most events lies within 0.5 magnitude unit, well within the expected error (see table 11).

The nomogram relates Bosch-Omori amplitude (ordinate) to slant distance from the Whitney vault (abscissa) and is contoured for magnitude. This relation allows us to compute magnitude given the numerical amplitude, but how do we assume an amplitude representative for a class when only the class is known? We assumed a linear F-M (logarithm of frequency versus magnitude) Gutenburg-Richter distribution of earthquake magnitudes within each size group (for example, "feeble"), and a characteristic amplitude for each group is plotted as a heavy horizontal line in the nomogram. The characteristic amplitude is such that 100 "characteristic"-size earthquakes in the class have the same total moment as 100 earthquakes that follow a linear F-M distribution throughout the magnitude class, with slope *b*=1.0. The characteristic amplitude for each size class are: very feeble, 1.12 mm; feeble, 6.3 mm; slight, 16 mm; and moderate, 37 mm. (See app. 2 for derivation of these amplitudes.)

Earthquakes are assigned a magnitude based on where the slant distance intersects the characteristic amplitude for its class. Our catalog magnitudes might thus show some steps or irregularities, but the magnitudes should conserve seismic moment when taken all together. In our catalog, magnitudes are calculated by using the analytical expression

$$M = 1.35\log(\text{preferred amplitude}) + 0.15 + 1.6\log(\text{slant distance}),$$

and are tabulated in the "M calc." column of our catalog.

Beginning in 1951 (and, rarely, earlier) the size classification of earthquakes was reported from more than one station (for example, very feeble at Whitney, feeble at Mauna Loa). For these events, we adjusted the Whitney amplitude within the constraints of its class to fit, if possible, a magnitude range calculated for the other station. The amplitudes are adjusted according to the magnification of the different seismometers, as listed in table 2. For example, the range 11–25 mm for a feeble classification at Whitney is reduced by 115/200 for a feeble classification at Pahoa before calculating a range of magnitudes for the Pahoa station. Horizontal distances are either the calculated station distance or are derived from the written description of earthquake location in the *Volcano Letter*. Slant distances are then calculated by using the depth either given or

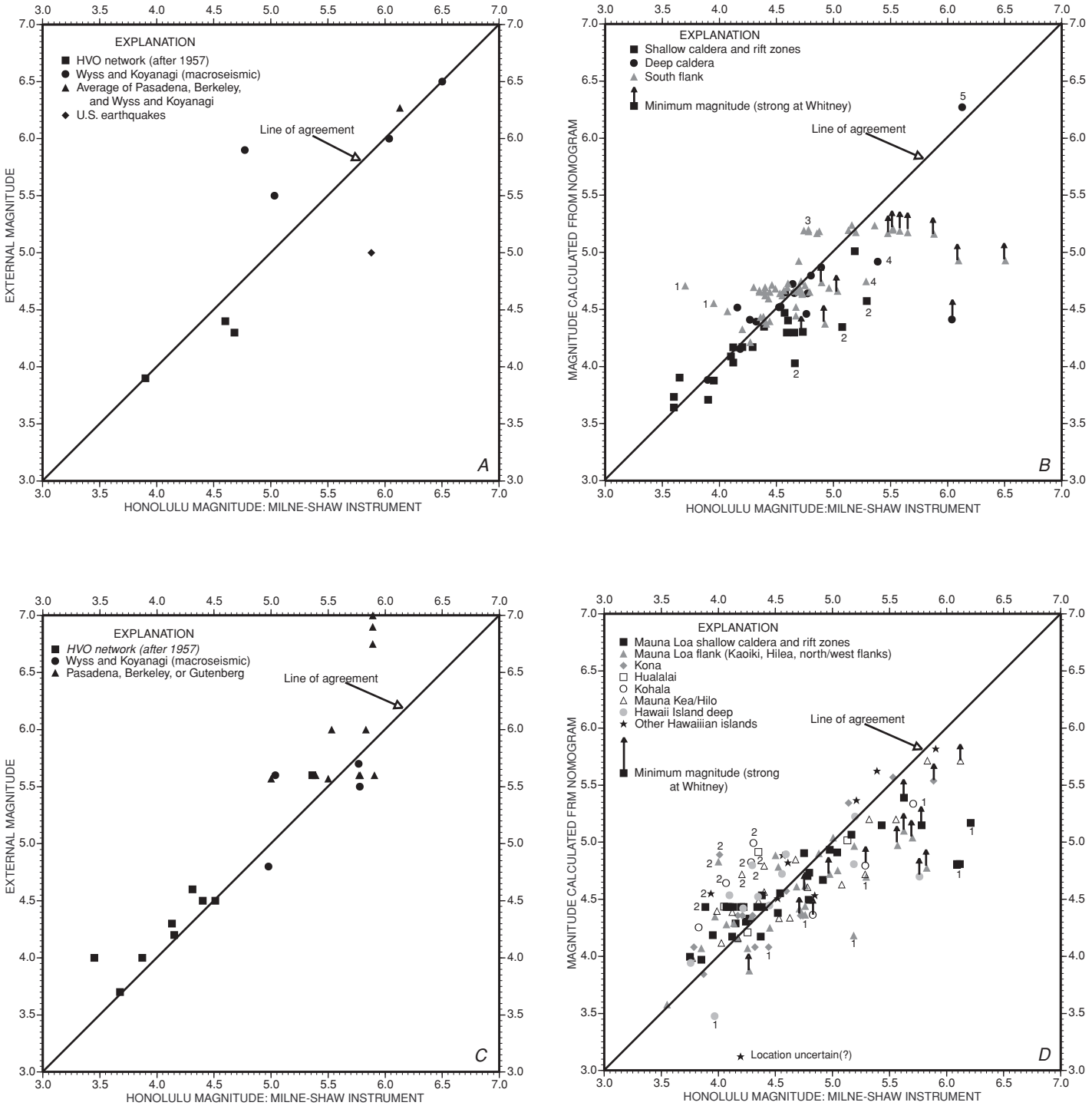

Figure 7. Magnitude comparisons for earthquakes during period 1933–59. *A*, Kilauea earthquakes, comparing Milne-Shaw (Honolulu) magnitudes with those determined from external data sources. *B*, Kilauea earthquakes, comparing Milne-Shaw (Honolulu) magnitudes with Hawaiian Volcano Observatory (HVO) magnitudes calculated from nomogram (fig. 6). Numbered data points denote earthquakes that fall outside normal range, for the following reasons: (1) Milne-Shaw magnitude low, Sprengnether and (or) Neumann-LaBarre magnitude agrees with nomogram magnitude; (2) nomogram magnitude, calculated at 7-km depth, would fit if 30 km deep or if strong at Whitney; (3) magnitude fits if *Volcano Letter* class were one unit higher (for example, slight→moderate); (4) magnitude fits if *Volcano Letter* class were one unit lower (for example, strong→moderate); (5) magnitude "very strong" at Whitney, amplitude assumed. *C*, Non-Kilauea earthquakes, comparing Milne-Shaw (Honolulu) magnitudes with those determined from external data sources. *D*, Non-Kilauea earthquakes, comparing Milne-Shaw (Honolulu) magnitudes with HVO magnitudes calculated from nomogram (fig. 6). Numbers denote earthquakes that fall outside normal range, reasons for which are as follows: (1) Magnitude fits if *Volcano Letter* class were one unit higher (for example, slight→moderate); (2) magnitude fits if *Volcano Letter* class were one unit lower (for example, strong→moderate).

Table 11. Magnitude types and codes used to identify them, with associated uncertainties

[Listed in approximate order of decreasing reliability. Uncertainty is estimated absolute error in magnitude (*M*), based on our experience and self-agreement of values]

Code	Name	Description	Uncertainty
L	hvo	Local magnitude from Wood-Anderson or Sprengnether seismograph	±0.3 (1957–92)
S	gute	Surface-wave magnitude as from Gutenberg and Richter (1945)	±0.3, ±0.6 (1903–21)
H	hono	Amplitude on one of the Honolulu seismographs	±0.4 (1921–59)
A	aver	Average of two magnitudes	±0.4
I	w&k	Determined by Wyss and Koyanagi (1992) from isoseismal map	±0.4
N	nomo	Nomogram, using "average" amplitude for size class on HVO's Bosch-Omori seismometer.	±0.6
M	int	Maximum intensity observed	±0.6
P	poor	Poor; location known only generally, for example, Kilauea	±0.7
F	felt	Reliable felt report; intensity and location uncertain	±0.8
D	desp	Desperate; guessed from an undefined term, used only when nothing else is available.	±1.0
E	ind	Indeterminate	– –
C	calc	Equivalent magnitude calculated from the moment sum of an earthquake swarm where times for individual events are unspecified.	– –

assumed. The nomogram magnitude is given for the Whitney station or for the station nearest to the epicenter. Magnitude ranges for additional stations are summarized in the "Comment" column of our catalog. For most events, agreement is satisfactory for different stations. Where it is not, this discrepancy is also noted in the "Comment" column.

HVO Magnitude Data, 1912–17

During his time at HVO (1912–17), Wood tried to directly relate the seismograms recorded at Whitney to quantified intensity scales as felt by people. However, these two measures do not record the same motion. At the periods of local south Hawaii earthquakes (0.2–1 s), the Bosch-Omori seismometer (period, 8 s) records ground displacement, but the human body feels acceleration. Also, the sensitivity of the seismometer and human sensibility generally did not overlap: earthquakes too small to feel were easy to record and measure, but most earthquakes large enough to be widely felt dismantled the mechanical seismographs.

HVO and Wood generally preferred stating recorded earthquake size in units of acceleration or scales related to acceleration. Wood related seismography and "felt intensity" by converting seismogram displacement measurements to acceleration in milligals. HVO also adopted the Cancani intensity scale, which is tied to units of acceleration (fig. 2; table 3); the Cancani scale was listed in most of the early weekly reports. HVO derived Cancani intensities primarily from seismometric measurements (Jaggar, 1947, p. 59). Some accelerations (Cancani intensities) were apparently inferred from such other low-gain instruments as the triggered "ordinary" seismograph because intensities are published for events that flung the pens off the Bosch-Omori seismometer. Unlike the Rossi-Forel and modified Mercalli intensity scales, the Cancani scale has several intensities below the felt threshold and so was theoretically suitable for both instrumental and human-perception use.

The anchor of the Cancani scale is the felt threshold set at the Cancani intensity III-IV boundary. The felt threshold was also anchored at 1,000 mGal. Because g, the force of gravity, is 980,000 mGal, the felt threshold is thus about 0.001 g, which is generally true from experience. Units of the Cancani scale were defined by limits of acceleration in millimeters per second squared, where 1 mm/s^2 equals 100 mGal. The felt threshold is also 1.0 on the scale of minimum perceptible units. HVO thus had three equivalent acceleration scales spanning the whole range of possible sizes, which were used at different times—acceleration in milligals, Cancani intensity, and size in minimum perceptible units (fig. 2).

Wood converted measured seismogram amplitudes (displacements) to accelerations for many of the published reports of size, and we reversed his procedure to recover approximate amplitudes for the magnitude calculations. For harmonic motion d=sin ωt, where the frequency $\omega=2\pi/T$, the physical relation between maximum ground displacement d (zero-to-peak amplitude, in millimeters), the maximum acceleration a (in millimeters per second squared), and the period T (in seconds) is given by

$$a = (2\pi/T)^2 d$$

or

$$d = 0.025 T^2 a.$$

The version of this relation used by Wood (1915) is

$$d' = 0.25 T^2 a',$$

where d' is the ground amplitude (in micrometers) and a' is the acceleration (in milligals).

Our tables and magnitude scale use the double amplitude (peak to peak) measured on the Bosch-Omori seismometer running at a gain of 115. When only the acceleration (expressed as Cancani intensity, minimum perceptible units, or acceleration in milligals) is available, we attempt to convert back to the seismogram peak-to-peak amplitude (in millimeters) that Wood originally measured but never published in that form. This conversion ties Wood's accelerations with the later size classes used by HVO measured from amplitudes on the Bosch-Omori

seismograms. We assumed that the typical period is 0.5 s, which was the most common period published by Wood (1915) for local earthquakes. The relation we use, as expressed in figure 2, is

$$D = 0.012a',$$

where D is the peak-to-peak amplitude (in millimeters) on the seismogram and a' is the acceleration (in milligals).

It is legitimate to ask whether the amplitudes that we derived from the "acceleration" descriptions published by HVO for 1912–17 give magnitudes comparable to those from the amplitude classes used during 1928–57. HVO may have used (but did not publish) a shorter period to convert from measured amplitude to published acceleration. If the period assumed by HVO when going from D to a' was 0.2 s but the period used by us when converting back from a' to D was 0.5 s, our inferred amplitudes would be increased by the factor $(0.5/0.2)^2$=6.2, resulting in our overestimation of magnitude by 0.8. We do not believe that we are making systematic errors this large, and the Milne calibration shown in figure 5 suggests that we are not. Individual earthquakes could, however, easily have a cumulative error from several uncertainties amounting to 0.5 to 1.0 magnitude unit in either direction.

However, there are very few ways to compare magnitudes from this early 1912–17 catalog. A small magnitude window exists near M=5 below which earthquakes are too small to record on the Milne seismometer in Honolulu and above which they clip or dismantle the Bosch-Omori seismometers at HVO. We could find only four earthquakes on scale on both instruments (fig. 5): two from 1916 and two from 1920. Several earthquakes in our catalog were recorded in Honolulu with intensities at HVO estimated by Jaggar (1947), Wyss and Koyanagi (1992), or us. When these intensities are converted to Bosch-Omori amplitudes, using figure 2, the resulting magnitudes do not systematically deviate from the Honolulu magnitudes, but their scatter is about 0.5 to 1.0 magnitude unit. In addition, many earthquakes with calculated magnitudes exceeding 4 have no published felt reports, but we interpret this absence as an incompleteness in felt reporting rather than a systematic overestimation of the magnitude scale.

HVO Magnitude Data, 1917–27

We tried without much success to establish a magnitude scale responsive to the various terms used to describe earthquakes in the HVO publications. As noted above, some terms are identical to those used later—for example, "feeble"—yet do not yield magnitudes consistent with each other or with felt reports when the post-1928 nomogram formulation is applied. Other terms (such as "small") are peculiar to this time period. This problem is made essentially intractable by the fact that the terms are used inconsistently. For this period, we have been rather arbitrary in assigning magnitudes within the constraints of felt reports and descriptions of relative strength (for example, "This earthquake was the largest of this series.").

The best test of magnitudes derived from HVO's magnitude classes during the period 1921–27 is comparison with the Milne-Shaw magnitudes from Honolulu. The close agreement of station HON and HVO magnitudes after 1932 (figs. 7*B*, 7*D*) gives us confidence in the station HON and HVO magnitude scales when the size classes are defined and adhered to.[4]

If the only description of the event is one of the undefined terms "light," "medium," or "heavy" and no intensity or felt information is recorded, we interpret these terms to correspond to "very feeble," "feeble," and "slight." If this nomogram magnitude is the only one available, we note the preferred magnitude as "desperate."

Magnitudes Based on Area of Felt Intensities

Wyss and Koyanagi (1992) based most of their new magnitude determinations on the areas of intensity V or VI from their isoseismal maps. For some earthquakes before 1920, not enough intensities were available for them to draw an isoseismal map, and no seismogram amplitudes are recorded. When enough intensities are available to estimate the approximate location, we use their magnitude-versus-intensity area relation to approximate the earthquake magnitude. If A(VI) is the area (in square kilometers) of modified Mercalli intensity VI and A(V) is the area of modified Mercalli intensity V, then

$$M = 1.0\log A(\mathrm{VI}) + 2.9$$

and

$$M = 1.1\log A(\mathrm{V}) + 1.6.$$

Magnitudes Based on Maximum Intensity

Many older earthquakes have only one or two felt reports from which an intensity can be inferred or guessed. Magnitudes inferred from maximum intensity are subject to error but are better than nothing. Maximum intensities for events with a

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[4] There are eight events with both HON and HVO magnitudes during 1921–27. We proceed by assuming that the size-class names were used loosely before 1933, and with definite numerical limits designed to approximate their former usage after the arrival of Austin Jones. The classes "very feeble," "feeble," and "slight" all refer to a range of sizes, because each has a class above it. There is one earthquake in the slight class (3/20/26) whose HVO magnitude is 1.0 unit larger than the station HON magnitude, and one feeble earthquake (7/31/27) whose HVO magnitude is 1.1 unit smaller than the station HON magnitude. We believe that there is no justification for altering the HVO magnitudes from their post-1932 definition of these three class names because no large and systematic shift is apparent. Later analysis of the catalog, however, might reveal a better assumption.

The class name "moderate" as used during 1917–27, however, does not appear to be as consistently applied as it was after 1932. We suspect that this class includes both the "moderate" and "strong" classes as later defined, and thus the "moderate" class during circa 1917–27 has no maximum amplitude. If we use the post-1932 definition of moderate and use the "median" amplitude for that class, six earthquakes from 1922–27 have HVO magnitudes too small by an average of 0.78 unit in comparison with station HON magnitudes. We therefore quote only the minimum "moderate" magnitude using a peak-to-peak amplitude of 25 mm, or 40 mm if the seismographs were dismantled by the earthquake. We note these magnitudes with "M>". In our catalog, we prefer magnitudes determined from station HON (if available) or derived from an intensity to the minimum magnitude derived from a "moderate" magnitude classification. During the period 1917–27, we quote the HVO nomogram magnitude as preferred only if no other magnitude is available.

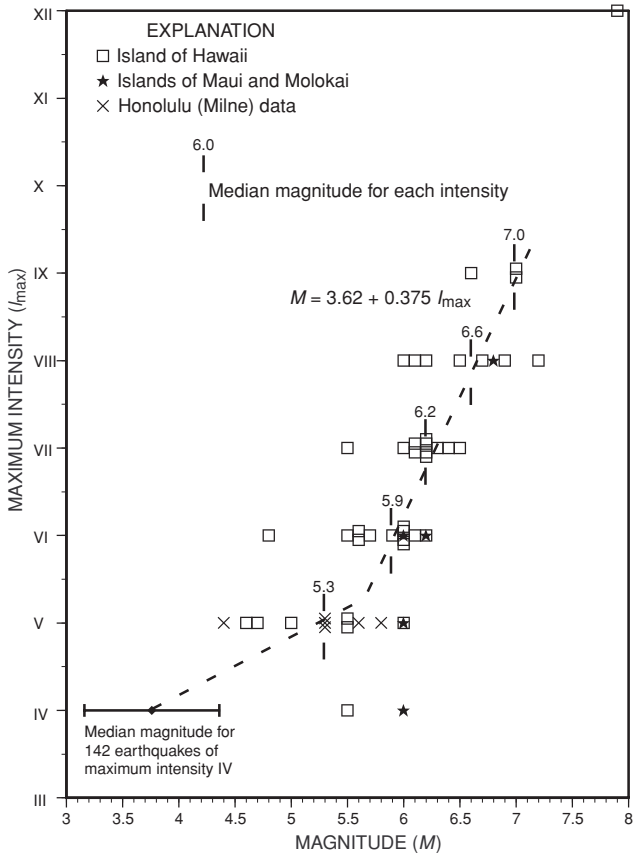


Figure 8. Maximum intensity (I_{max}) versus magnitude (M) for Hawaiian earthquakes. For intensity IV, we use a median magnitude of 3.76, based on 142 earthquakes during period 1933–59. Steeper dashed line is fit to data with equation shown; shallower dashed line connects median magnitudes for intensities IV and V.

well-determined instrumental or intensity-area magnitude are plotted in figure 8. The median magnitude for each intensity range (marked by vertical bars) is surprisingly linear with magnitude in the range VI–IX but is less than the extrapolated value (5.3) for intensity V. The relation

$$M = 3.62 + 0.375 I_{max}$$

fits the data for $I_{max} \geq$ IV and is close to the relation M=3.7 +0.4I_{max} found by Wyss and Koyanagi (1992), using fewer earthquakes.

Adoption of a "Preferred" Magnitude

We have tabulated magnitudes determined from the six principal sources listed in table 11. The magnitudes are listed in their approximate order of reliability. The order is generally that used by us in selecting the preferred magnitude. Modern magnitudes have the luxury of different magnitude scales based on different phases with different periods, each consisting of averages from several stations. Our catalog seldom has redundancy of either different magnitude types or different stations. When it does, the redundancy is commonly the source for calibrating one magnitude scale against another. Our catalog preserves original magnitudes, and the use of averages or a different preference order is easy to accomplish. Where discrepancies among magnitudes obtained from different sources are evident, data may be averaged, indicated in the "Preferred magnitude source" column of our catalog; possible reasons for a discrepancy are noted in the "Comment" column. Where we have no way of calculating an earthquake magnitude, or just have terms like "light," "medium," or "heavy" (see above), our "best guesses" as to magnitude are entered directly into the "Preferred magnitude" column, and the source is noted as "desperate."

Earthquake Swarms

Earthquake swarms are commonly noted in the published HVO sources. We want to make use of all information for estimating total seismic-moment release during a time interval. For swarms, we list the number and size of events in the "Comment" column of our catalog when only the location and number of events are also listed. Only a small subset of individual swarm events are tabulated with a time and a magnitude classification. Commonly, events registering as "moderate" or "strong" are reported with individual times, and the number of "slight" and smaller events is listed for at least the early part of the sequence. For many of these events, we were able to read additional events on the Honolulu records, evidently obscured in the traces of the larger events on the Whitney records. These events are listed in our catalog with the time adjusted to Hawaii local time and "Not in VL" entered in the "Comment" column. We have handled the swarm earthquakes that are not individually tabulated in two different ways, both of which assume that all or parts of the swarm within a particular magnitude range fit a Richter magnitude distribution.

When swarm events are not individually listed in the *Volcano Letter*, we attempt to account for the total seismic moment released from whatever information is available. We generally list the daily number of earthquakes in each size class for the swarm. When these numbers are not published directly, we infer them from published weekly event counts by size class. When only the total number of events in a range of size classes is published, we distribute them in different size classes to approximate a Richter distribution. We then calculate the contribution for each size class by converting the representative nomogram magnitude for that class to a moment, multiplying by the number of events in the class and converting back to a magnitude.

During the years 1957–59, when local magnitudes are tabulated only for the largest events, we use a Richter distribution with a b value of 1.5 to estimate the minimum magnitude and number of events in each magnitude interval:

$$\log (\text{total number of events reported}) = 1.5(M_{max} - M_{min})$$

and

$$\log (\text{number of events larger than } M) = 1.5(M_{max} - M).$$

The moments are summed in increments of 0.1 magnitude unit for each interval between the minimum and maximum magnitude (up to the total number of events), then converted to a calculated magnitude for the group of events contributing to the swarm. The contribution of small events to the total moment is

thus always an approximation but generally is small in comparison with that of the larger events.

For both classes of events, the calculated magnitude is listed in the "Preferred magnitude" column of our catalog, and "Calc." is entered as the preferred magnitude source. The preferred magnitude emphasizes the fact that during earthquake swarms, a significant amount of additional seismic moment is tied up in events that are not reported individually.

Errors and Uncertainties

For much of the period of our catalog, the primary seismic station used for locations was the Whitney vault at HVO. The independent stations at Kona and Hilo were sometimes, but not always, available. The absence of an accurate, common time base meant that the measurable quantities were s-p time (and thus a distance estimate), relative amplitudes, comparison with other seismograms from better located earthquakes, and the polarization to infer the approximate azimuth to the source of the seismic waves. A feel for the seismograms and the types of uncertainties involved can be gleaned from the early seismic reports (see Jones, 1938). In constructing a catalog from early seismic data, we were unable to recover original HVO seismograms or notebook entries. The original Whitney seismograms are nearly impossible to reread, and we have found no tabulations of actual amplitudes from which the qualitative assignment of earthquake size in the *Volcano Letter* was made. Locations are approximate because at most five seismometers (typically, 1–3) were operating on the Island of Hawaii before 1957, when expansion and modernization of the HVO net began (see above). Discrepancies that we found in the course of compiling our catalog are summarized in appendix 3.

The reporting of earthquakes changed after the introduction of the U.S. Geological Survey Bulletin series, the first of which covered the years 1948–49 and did not report any seismic data. Bulletins covering the years 1950–55 repeated, with one exception noted in appendix 3, the *Volcano Letter* tabulations for the same years. Through the first quarter of 1954, both the *Volcano Letter* and the Bulletins tabulated earthquakes of class "very feeble" and stronger. Without any explanation, however, the last three quarters of 1954 reported only "feeble" and greater, and from 1955 through the end of 1957 cut back further to report only "slight" and greater. We use the more complete listing in the *Volcano Letter* for our catalog. Beginning in 1958, a lower threshold magnitude of 2.5 was adopted, with some exceptions for smaller events of special interest or those that were favorably located such that a smaller magnitude could be reasonably estimated. The same threshold was honored through 1963, the last year in which Honolulu records for the Milne-Shaw seismometer are available.

Viewed in hindsight, it is unfortunate that more attention was not given to the transition between the old ways of reporting and the assignment of increasingly precise magnitudes from the expanding HVO network. We recognize that the constraints of frequent new seismic events, in combination with no reasonable anticipation that someone would actually try to assign magnitudes to early earthquakes, probably explains the absence of analysis of the overlap time between old and new instruments. The Bosch-Omori seismometer, which was in use as a tiltmeter through 1962, would have served to improve the calibration of the earlier records if Bosch-Omori amplitudes had continued to be tabulated up to the time the seismometer was retired. Likewise the continuation of the Jones classification scheme for several more years after 1957 would have made it easier to calibrate the older data by using the expanded HVO network.

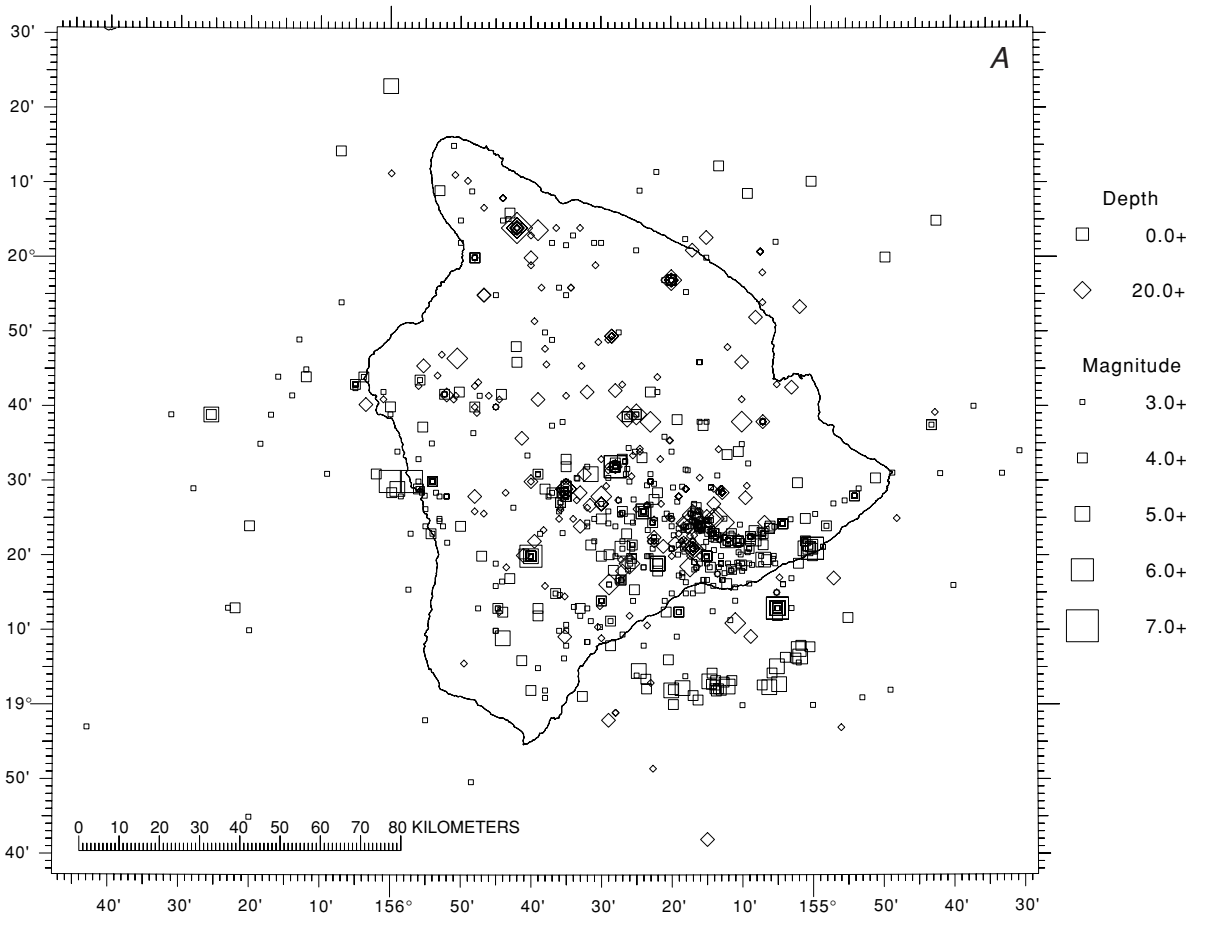
The arbitrary changes in reporting threshold affect the completeness of our catalog, particularly for the years 1954–57. We cannot assure uniformity of the 1958–63 record with the pre-1954 catalog because different criteria were used for reporting. If our nomogram determinations are correct and reporting in the *Volcano Letter* is complete, reporting of earthquakes of $M \geq 3.0$ should be complete, at least in the 1950's. A future study will address the issue of our catalog's completeness.

Location and Magnitude Profile of the 1933–59 Catalog

A sample catalog output for Kilauea earthquakes of $M \geq 4.0$ is included in table 13 (see app. 1). A detailed analysis of our catalog will be the subject of future papers and is beyond the scope of this report, but a few comments are necessary. We have attempted to catalog the time, location, and magnitude of every Hawaiian earthquake documented during this period, using all available materials. The locations of most events, however, are those originally assigned by HVO. We could not relocate them because the original records are lost or unusable. We also could not estimate the errors in locations and the personal biases of the person assigning the location without the original data. An insight into errors and completeness can come from comparisons with the modern catalog.

A map of the 27-year 1933–59 catalog (fig. 9*A*) shows a generally similar pattern to the succeeding 27 years of computer-located earthquakes (fig. 9*B*). Kilauea, its rift zones, and the south flank are active during both periods. Many of the earthquakes assigned to Kilauea's East Rift Zone during 1933–59 may actually be south-flank events, but they were placed on the rift because that was believed to be the more active feature. Mauna Loa's summit and rifts were more seismically active during 1933–59 because seven eruptions occurred (including the large 1950 eruption), versus the two eruptions in the period 1960–86. Like Kilauea, some Mauna Loa flank events may have been placed on

Figure 9. Island of Hawaii, showing locations of all earthquakes of $M \geq 3$ during two 27-year periods beneath island and adjacent ocean. Squares, shallow (less than 20-km depth) earthquakes mostly within volcanic edifice and crust; diamonds, upper-mantle earthquakes below 20-km depth. *A*, 1933–59 earthquakes in our catalog. Most locations are those originally assigned by the Hawaiian Volcano Observatory and listed in the *Volcano Letter*; additional earthquakes without a specific location are plotted at center of likely geographic region as interpreted by us. Earthquakes assigned only to a general region (for example, Kilauea) are omitted. *B*, 1960–86 earthquakes, located from accurately timed phases of seismic network and computer calculations (omitted from our catalog).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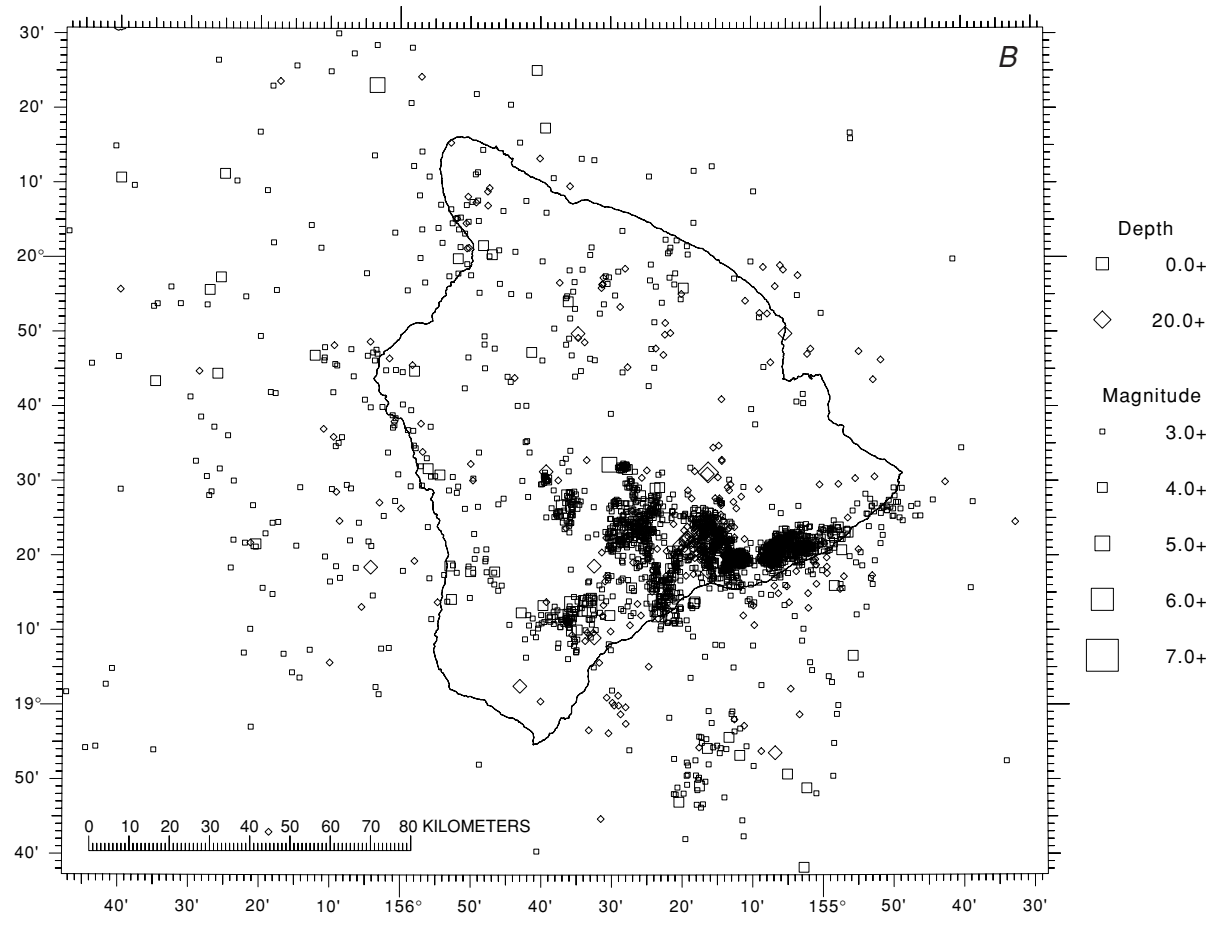
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Table 12. Numbers of cataloged earthquakes, by magnitude

Magnitude range	1933–59	1960–86	1933–59 (cumulative)	1960–86 (cumulative)
No magnitude	895	10,947	5,244	75,848
0.1–0.4	5	303	4,349	64,901
.5–0.9	170	693	4,344	64,598
1.0–1.4	545	1,885	4,174	63,905
1.5–1.9	483	15,784	3,629	62,020
2.0–2.4	623	27,653	3,146	46,236
2.5–2.9	885	12,857	2,523	18,583
3.0–3.4	753	3,880	1,638	5,726
3.5–3.9	440	1,332	885	1,846
4.0–4.4	269	380	440	514
4.5–4.9	102	102	171	134
5.0–5.4	41	18	69	32
5.5–5.9	21	10	28	14
6.0–6.4	4	2	7	4
6.5–6.9	3	1	3	2
7.0–7.4	0	1	0	1

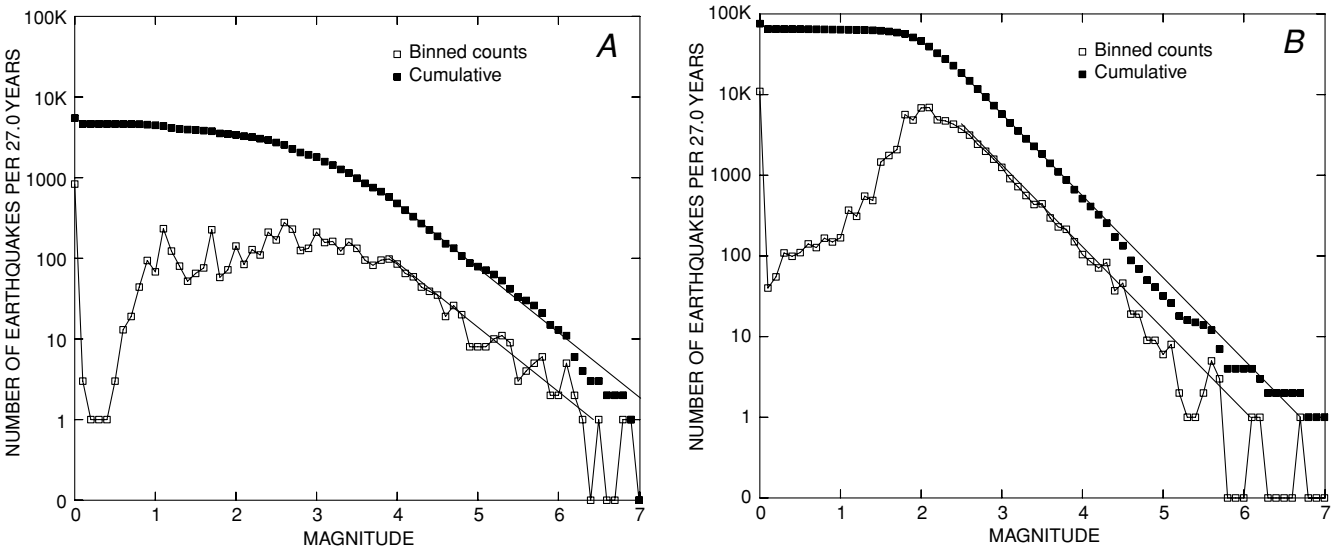

Figure 10. Magnitude distribution of Hawaiian earthquakes. Solid squares, cumulative numbers of earthquakes; open squares, number of earthquakes per 0.1 magnitude interval. Lines are of maximum-likelihood fit. *a* and *b* values were derived by using Richter's formula relating earthquake magnitude to number of events. *A*, 1933–59. a=4.4223 for $M \geq 3.9$; b=0.793±0.03, using 576 events over 27 years. *B*, 1960–86. a=5.3760 for $M \geq 2.5$; b=1.015±0.01, using 18,583 events over 27 years.

the summit caldera or rift zones because of poor station coverage in the earlier period. Mauna Loa's south flank (the Kaoiki and Hilea seismic zones) and west flank (Kona) were active in both periods. Mauna Loa's north flank (excluding deeper events) is essentially aseismic in the modern period. We do not know whether the earlier north-flank events are mislocations or are caused by the higher level of Mauna Loa volcanism. The modern network locates many more small offshore earthquakes than were detectable in the period 1933–59.

We believe that there are no major and systematic magnitude biases in our catalog, although this claim is difficult to check without independent magnitude determinations. A detailed analysis of magnitudes is beyond the scope of this report but will be the subject of future efforts. Figures 7*A* and 7*C* suggest that Milne-Shaw magnitudes generally agree with those derived external to our catalog over a wide magnitude range. This result gives us confidence that our assumption of an absolute magnitude scale based on station constants and correction to Wood-Anderson response is correct.

The nomogram magnitudes based on HVO's Bosch-Omori seismometer should show a larger scatter because they are based on "average" amplitudes for a size class rather than on a specific amplitude. The nomogram magnitude should be unbiased, at least in the range M=3.5–5.0 where it was empirically calibrated against local Wood-Anderson magnitudes. The Milne-Shaw is the only numerous and stable magnitude to serve as a comparison basis for the nomogram magnitude. Figure 7*B* shows no systematic deviation of nomogram magnitude for Kilauea earthquakes. As expected, the minimum magnitudes of events assigned to the largest open-ended "strong" class (arrowed symbols, fig. 7*B*) fall below the equality line because of the minimum amplitude assumed. Many magnitudes of larger earthquakes recorded as "moderate" or "strong" on the Bosch-Omori seismometer may be underestimates because the smoked-paper recording of mechani-

cal pens does not permit accurate tracking of amplitudes at the largest excursions. Nomogram magnitudes of non-Kilauea earthquakes generally exceed their Milne-Shaw magnitudes for $M<4.5$ (fig. 7*D*), a point that we are still investigating.

More than 5,000 earthquakes are listed in the 1933–59 catalog. The number of earthquakes by magnitude for both of the 27-year catalogs is listed in table 12, and the logarithm of the number of earthquakes versus magnitude for both catalogs is plotted in figure 10. Both figure 10 and table 12 include earthquakes from all regions, including those with unknown locations. For the Island of Hawaii, the magnitude distribution's deviation from the Gutenberg-Richter law indicates that the 1933–59 catalog is probably complete for $M\geq3.9$, whereas the 1960–86 catalog is probably complete at $M=2.4$. The completeness magnitudes and *b* slope vary regionally, and these plots are useful only in a gross sense of assessing our catalog.

It is unwise to draw conclusions about the comparative level of activity strictly from figure 10 and table 11, which are like the shadow of an object that reveals a hint of shape but nothing about its structure. All regions are summed together, including off shore, and each region has its own time behavior and completeness level. The listing of earthquakes of $M\geq4$ should be approximately complete for onshore Hawaii in both catalogs. The numbers of $M\geq4$ events in the two catalogs are comparable (440 versus 514). Even with the errors and biases that we are still investigating, our catalog will be useful for the stated goals of earthquake-hazard assessment and understanding volcano behavior, using the pattern of seismic release.

Acknowledgments

Fred Klein read the Honolulu records, derived the equations used to calculate magnitude from seismogram amplitudes and from amplitude classes, and derived the constants and corrections in those equations, following the principles established by Richter (1958). He also developed the catalog format to match the computerized ASCII catalog of modern earthquakes and wrote a program to read comma-delimited output from spreadsheets maintained on a PC. Tom Wright measured the distances at azimuths reported in the *Volcano Letter*, assigned the Kilauea earthquakes to regions initially developed to study the moment history of Kilauea seismicity (Wright and Klein, 1995), and calculated latitude and longitude from azimuth and distance where not reported directly. He set up computer-based spreadsheets on which he entered all the information from the Honolulu records, HVO publications, and felt information from newspaper accounts, the Lyman diary, and postcards sent to HVO. The nomogram for calculating magnitudes from amplitude classes published in the *Volcano Letter* was jointly derived through several iterations of plotting. Both authors developed standards for choosing the best data to determine location and magnitude and laboriously applied them to the incomplete and sometimes-contradictory earthquake data.

We are indebted to Jerry Eaton for directing us to the Honolulu seismograms and for information about the early HVO network and the procedures used to determine magnitudes. He also summarized the early seismographic and station history that we incorporated into table 2. Jennifer Nakata, with the assistance of HVO volunteers, provided copies of the felt reports sent to HVO on postcards. Jerry Eaton and John Lahr reviewed the manuscript and made many suggestions for its improvement.

We are gratefully indebted to Doak C. Cox for making available unpublished intensities of earthquakes derived from the Lyman and other diaries. We thank Kent Warshauer, HVO volunteer, for allowing us to see and copy his file of newspaper references, many of which contained reports of earthquakes. His files demonstrated the necessity of using newspaper data in our location estimates and magnitude assignments. We followed up on his work by spending many additional hours looking at newspapers on microfilm.

References Cited

Abe, K., 1988, Magnitudes and origin times from Milne seismograph data; earthquakes in China and California, 1898–1912, *in* Lee, W.H.K., Meyers, H., and Shimazaki, K., eds., Historical seismograms and earthquakes of the world: San Diego, Calif., Academic Press, p. 37–50.

Alexander, W.D., 1899, The seismograph: Pacific Commercial Advertiser, July 18, 1899, p. 1.

Bevens, D., and transcriber, 1988, Volcano House Register, 1865–1955: Hawaii Volcanoes National Park Library record, 10 v., with supp. of newspaper clippings [transcription funded by Hawaii Natural History Association; available for research use at the libraries of the Hawaiian Volcano Observatory and Hawaii Volcanoes National Park].

Bevens, D., Takahashi, T.J., and Wright, T.L., eds., 1988, The early serial publications of the Hawaiian Volcano Observatory: Hawaii National Park, Hawaii Natural History Association, 3 v.

Bodle, R.R., 1944, Hawaiian Islands, *in* United States earthquakes, 1942: U.S. Coast and Geodetic Survey report, serial no. 662, p. 16 [compiled as "United States Earthquakes, 1941–1945," and reissued by the National Earthquake Information Center].

———1945, Hawaiian Islands, *in* United States earthquakes, 1943: U.S. Coast and Geodetic Survey report, serial no. 672, p. 20 [compiled as "United States Earthquakes, 1941–1945," and reissued by the National Earthquake Information Center].

———1946, Hawaiian Islands, *in* United States earthquakes, 1944: U.S. Coast and Geodetic Survey report, serial no. 682, p. 24 [compiled as "United States Earthquakes, 1941–1945," and reissued by the National Earthquake Information Center].

Bodle, R.R., and Murphy, L.M., 1947, Hawaiian Islands, *in* United States earthquakes, 1945: U.S. Coast and Geodetic Survey report, serial no. 699, p. 18 [compiled as "United States Earthquakes, 1941–1945," and reissued by the National Earthquake Information Center].

———1948, Hawaiian Islands, *in* United States earthquakes, 1946: U.S. Coast and Geodetic Survey report, serial no. 714, p. 22.

Brazee, R.J., and Cloud, W.K., 1958, Hawaiian Islands, *in* United States earthquakes, 1956: U.S. Coast and Geodetic Survey report, p. 36–37.

———1959, Hawaiian Islands, *in* United States earthquakes, 1957: U.S. Coast and

Geodetic Survey report, p. 42–43.

———1960, Hawaiian Islands, *in* United States earthquakes, 1958: U.S. Coast and Geodetic Survey report, p. 34.

Cox, D.C., 1986, Earthquakes felt on Oahu, Hawaii and their intensities: Honolulu, University of Hawaii, Environmental Center, 120 p.

Dana, J.D., 1888, History of the changes in the Mt. Loa craters, on Hawaii: American Journal of Science, 3d ser., v. 35, p. 15–34, 213–228, 282–289 [includes maps]; v. 36, p. 14–32, 81–112, 167–175 [includes maps].

Eaton, J.P., 1975, Harmonic magnification of the complete telemetered seismic system, from seismometer to film viewer screen: U.S. Geological Survey Open-File Report 75–95, 46 p.

Eaton, J.P., and Fraser, G.D., 1956a, Hawaiian Volcano Observatory summary, 03-July–September 1956: U.S. Geological Survey Administrative Report, 5 p.

———1956b, Hawaiian Volcano Observatory summary, 04-October–December 1956: U.S. Geological Survey Administrative Report, 5 p.

———1957a, Hawaiian Volcano Observatory summary, 05-January to March 1957: U.S. Geological Survey Administrative Report, 12 p.

———1957b, Hawaiian Volcano Observatory summary, 06-April–June 1957: U.S. Geological Survey Administrative Report, 10 p.

———1957c, Hawaiian Volcano Observatory summary, 07-July–September 1957: U.S. Geological Survey Administrative Report, 8 p.

———1957d, Hawaiian Volcano Observatory summary, 08-October–December 1957: U.S. Geological Survey Administrative Report, 6 p.

———1958a, Hawaiian Volcano Observatory summary, 09-January to March 1958: U.S. Geological Survey Administrative Report, 8 p.

———1958b, Hawaiian Volcano Observatory summary, 10-April–June 1958: U.S. Geological Survey Administrative Report, 9 p.

Eaton, J.P., and Krivoy, H.L., 1958a, Hawaiian Volcano Observatory summary, 11-July–September 1958: U.S. Geological Survey Administrative Report, 13 p.

———1958b, Hawaiian Volcano Observatory summary, 12-October–December 1958: U.S. Geological Survey Administrative Report, 8 p.

———1963a, Hawaiian Volcano Observatory summary, 13-January–March 1959: U.S. Geological Survey Administrative Report, 26 p.

———1963b, Hawaiian Volcano Observatory summary, 14-April–June 1959: U.S. Geological Survey Administrative Report, 25 p.

———1963c, Hawaiian Volcano Observatory summary, 15-July–September 1959: U.S. Geological Survey Administrative Report, 32 p.

Eppley, R.A., and Cloud, W.K., 1961, Hawaiian Islands, *in* United States earthquakes, 1959: U.S. Coast and Geodetic Survey report, p. 60–61.

Finch, R.H., and Macdonald, G.A., 1951, Report of the Hawaiian Volcano Observatory for 1948 and 1949: U.S. Geological Survey Bulletin 974–D, p. 103–133.

———1953, Hawaiian volcanoes during 1950: U.S. Geological Survey Bulletin 996–B, p. 27–89.

Fiske, R.S., Simkin, T., and Nielsen, E.A., eds., 1987, The Volcano Letter: Washington, D.C., Smithsonian Institution Press, 539 p. [compiled and reprinted; originally published 1925–1955 by the Hawaiian Volcano Observatory].

Furumoto, A.S., Nielsen, N.N., and Phillips, W.R., 1972, A study of past earthquakes, isoseismic zones of intensity, and recommended zones for structural design for Hawaii: Honolulu, University of Hawaii Engineering Bulletin, PACE 72033, 53 p. [Joint report with the Center for Engineering Research, with minor corrections (notably tables 1 and 2, and figures 3 and 6) and additions to the text (two appendixes); originally issued by the University of Hawaii, Center for Engineering Research, as Engineering Bulletin, PACE 72033, June 15, 1972, under the same authorship].

Glover, D.P., Meyers, H., Herrmann, R.B., and Whittington, M., 1985, Inventory of filmed historical seismograms and station bulletins at World Data Center A: Boulder, Colo., U.S. Department of Commerce, National Oceanic and Atmospheric Administration Report SE–37, 215 p.

Gutenberg, Beno, and Richter, C.F., 1945, Seismicity of the Earth: Geological Society of America Bulletin, v. 56 supp., p. 644–645.

Hazard, D.L., 1910, Earthquakes, *in* Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1905 and 1906: U.S. Coast and Geodetic Survey, p. 90–95.

———1911, Earthquakes, *in* Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1907 and 1908: U.S. Coast and Geodetic Survey, p. 90–94 [see abstract for Hazard (1910)].

———1912, Earthquakes, *in* Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1909 and 1910: U.S. Coast and Geodetic Survey, p. 90–94 [see abstract for Hazard (1910)].

———1913, Earthquakes, *in* Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1911 and 1912: U.S. Coast and Geodetic Survey, p. 94–98 [see abstract for Hazard (1910)].

———1916, Earthquakes, *in* Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1913 and 1914: U.S. Coast and Geodetic Survey, serial no. 21, p. 98–104 [see abstract for Hazard (1910)].

———1918, Earthquakes, *in* Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1915 and 1916: U.S. Coast and Geodetic Survey, serial no. 86, p. 95–100 [see abstract for Hazard (1910)].

———1920, Earthquakes, *in* Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1917 and 1918: U.S. Coast and Geodetic Survey, serial no. 133, p. 97–103 [see abstract for Hazard (1910)].

———1922, Earthquakes, *in* Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1919 and 1920: U.S. Coast and Geodetic Survey, serial no. 200, p. 91–96 [see abstract for Hazard (1910)].

———1924, Earthquakes, *in* Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1921 and 1922: U.S. Coast and Geodetic Survey, serial no. 276, p. 93–104.

Heck, N.H., and Bodle, R.R., 1930, Hawaiian Islands, *in* United States earthquakes, 1928: U.S. Coast and Geodetic Survey report, serial no. 483, p. 3 [This series takes up where the quarterly seismological reports of the U.S. Coast and Geodetic Survey leave off. Station data are omitted from the "United States Earthquakes" series but were preserved as monthly mimeographed reports made available by subscription].

Heck, N.H., and Bodle, R.R., 1931, Hawaiian Islands, *in* United States earthquakes, 1929: U.S. Coast and Geodetic Survey report, serial no. 511, p. 16.

Hitchcock, C.H., 1909, Hawaii and its volcanoes: Honolulu, Hawaiian Gazette Co., 314 p. [2d ed., with supp., 1911, 314 p.].

Humphreys, W.J., 1914, Seismology, *in* Marvin, C.F., ed., Section V—Seismology: Monthly Weather Review, v. 42, no. 12, p. 687–689 [no data for Honolulu given in this issue].

———1924, Seismology, *in* Marvin, C.F., ed., Section V—Seismology: Monthly Weather Review, v. 52, no. 7, p. 375 [The "Seismology" section was discontinued, coincident with the end of the biannual Coast and Geodetic Survey Reports (see Hazard, 1929)].

Jaggar, T.A., Jr., 1912, [Kilauea in 1909–1912], *in* [First Special] Report of the Hawaiian Volcano Observatory: Boston, Massachusetts Institute of Technology, Society of Arts, p. 1–74 [compiled and reprinted in Bevens, D., Takahashi, T.J., and Wright, T.L., 1988, The early serial publications of the Hawaiian Volcano Observatory: Hawaii National Park, Hawaii Natural History Association, v. 1, p. 1–80].

———1947, Origin and development of craters: Geological Society of America Memoir 21, 508 p.

Jones, A.E., 1934, Earthquakes associated with the 1933 eruption of Mauna Loa, Hawaii: Washington Academy of Sciences Journal, v. 24, p. 413–418.

———1935a, Earthquakes associated with the 1934 eruption of Kilauea, Hawaii: Washington Academy of Sciences Journal, v. 25, p. 429–435.

———1935b, Hawaiian travel times: Seismological Society of America Bulletin, v. 25, p. 33–61.

———1935c, A seismologic study of the Kilauea eruption, 1931–1932: University of Hawaii Research Publication 9, 60 p.

———1938, Empirical studies of some of the seismic phenomena of Hawaii: Seismological Society of America Bulletin, v. 28, p. 313–337.

Klein, F.W., and Koyanagi, R.Y., 1980, Hawaiian Volcano Observatory seismic network history 1950–1979: U.S. Geological Survey Open-File Report 80–302, 84 p.

Lee, W.H.K., Meyers, H., and Shimazaki, K., 1988, Historical seismograms and earthquakes of the world: San Diego, Calif., Academic Press, 513 p.

Macdonald, G.A., 1955, Hawaiian volcanoes during 1952: U.S. Geological Survey Bulletin 1021–B, p. 15–107.

Macdonald, G.A., and Eaton, J.P., 1955, Hawaiian volcanoes during 1953: U.S. Geological Survey Bulletin 1021–D, p. 127–166.

———1956a, Hawaiian Volcano Observatory summary 01-January to March 1956: U.S. Geological Survey Administrative Report, 5 p.

———1956b, Hawaiian Volcano Observatory summary 02-April–June 1956: U.S. Geological Survey Administrative Report, 5 p.

———1957, Hawaiian volcanoes during 1954: U.S. Geological Survey Bulletin 1061–B, p. 17–72.

———1964, Hawaiian volcanoes during 1955: U.S. Geological Survey Bulletin 1171, p. 1–170.

Macdonald, G.A., and Wentworth, C.K., 1954, Hawaiian volcanoes during 1951: U.S. Geological Survey Bulletin 996–D, p. 141–216.

McFarland, W.N., 1929, Earthquakes, in Results of observations made at the Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii, 1923 and 1924: Washington, DC, Department of Commerce and Labor, Coast and Geodetic Survey, serial no. 452, p. 99–104 [See abstract for Hazard, (1924). This series of reports ends with June 1924; subsequent data are in quarterly seismological reports (Neumann, 1926–31)].

Murphy, L.M., 1950, Hawaiian Islands, in United States earthquakes, 1947: U.S. Coast and Geodetic Survey report, serial no. 730, p. 29.

Murphy, L.M., and Cloud, W.K., 1953, Hawaiian Islands, in United States earthquakes, 1951: U.S. Coast and Geodetic Survey report, serial no. 762, p. 18–20.

———1954, Hawaiian Islands, in United States earthquakes, 1952: U.S. Coast and Geodetic Survey report, serial no. 773, p. 48–49.

———1955, Hawaiian Islands, in United States earthquakes, 1953: U.S. Coast and Geodetic Survey report, serial no. 785, p. 27–29.

———1956, Hawaiian Islands, in United States earthquakes, 1954: U.S. Coast and Geodetic Survey report, serial no. 793, p. 55–56.

———1957, Hawaiian Islands, in United States earthquakes, 1955: U.S. Coast and Geodetic Survey report, p. 36–38.

Murphy, L.M., and Ulrich, F.P., 1951, Hawaiian Islands, in United States earthquakes, 1948: U.S. Coast and Geodetic Survey report, serial no. 746, p. 27.

———1952, Hawaiian Islands, in United States earthquakes, 1950: U.S. Coast and Geodetic Survey report, serial no. 755, p. 18.

Neumann, F., 1926a, Seismological report; January, February, March, 1925: U.S. Coast and Geodetic Survey, Serial no. 328, p. 20–24, 42–43 [This series of reports is the successor to the biannual seismology summaries published by the U.S. Coast and Geodetic survey (see Hazard, 1910–13, 1916, 1918, 1920, 1922, 1924; McFarland, 1929)].

———1926b, Seismological report: July, August, September, 1925: U.S. Coast and Geodetic Survey, serial no. 328, p. 20–24, 42–43.

———1927, Seismological report: October, November, December, 1925 and supplement for 1924: U.S. Coast and Geodetic Survey, serial no. 388, p. 9, 33–38, 56–57, 97–103 [covers July 1–December 31, 1924 in addition to the fourth quarter of 1925].

———1928a, Seismological report: April, May, June, 1926: U.S. Coast and Geodetic Survey, serial no. 406, p. 5–6, 9–11, 31–39, 53, 55–56.

———1928b, Seismological report: July, August, September, 1926: U.S. Coast and Geodetic Survey, serial no. 424, p. 5, 7, 32–46, 67, 69.

———1928c, Seismological report: October, November, December, 1926: U.S. Coast and Geodetic Survey, serial no. 431, p. 18, 44–53.

———1929, Seismological report: January, February, March, 1927: U.S. Coast and Geodetic Survey, serial no. 463, p. 8, 13, 34–37, 75.

———1930a, Seismological report: April, May, June, 1927: U.S. Coast and Geodetic Survey, serial no. 468, p. 6, 26–29, 40, 42–43.

———1930b, Seismological report: July, August, September, 1927: U.S. Coast and Geodetic Survey, serial no. 495, p. 5–7, 12, 31–38, 53–56.

———1931, Seismological report: October, November, December, 1927: U.S. Coast and Geodetic Survey, serial no. 503, p. 24–25, 41–42 [This issue ends formal publication of the results of the magnetic observatories run by the U.S. Coast and Geodetic Survey. Subsequent material is abstracted for the "United States Earthquakes" series (see Heck and Bodle, 1930), published yearly without the detailed readings for each earthquake. These reports were mimeographed and made available to interested parties by subscription].

———1932, Hawaiian Islands, *in* United States earthquakes, 1931: U.S. Coast and Geodetic Survey report, serial no. 553, p. 22.

———1934, Hawaiian Islands, *in* United States earthquakes, 1932: U.S. Coast and Geodetic Survey report, serial no. 563, p. 18.

———1935, Hawaiian Islands, *in* United States earthquakes, 1933: U.S. Coast and Geodetic Survey report, Serial no. 579, p. 22.

———1936, Hawaiian Islands, *in* United States earthquakes, 1934: U.S. Coast and Geodetic Survey report, serial no. 593, p. 40.

———1937, Hawaiian Islands, *in* United States earthquakes, 1935: U.S. Coast and Geodetic Survey report, serial no. 600, p. 39.

———1938, Hawaiian Islands, *in* United States earthquakes, 1936: U.S. Coast and Geodetic Survey report, serial no. 610, p. 24 [compiled as "United States Earthquakes, 1936–1940," and reissued by the National Earthquake Information Center].

———1940, Hawaiian Islands, *in* United States earthquakes, 1938: U.S. Coast and Geodetic Survey report, serial no. 629, p. 28–30 [compiled as "United States Earthquakes, 1936–1940," and reissued by the National Earthquake Information Center].

———1941, Hawaiian Islands, *in* United States earthquakes, 1939: U.S. Coast and Geodetic Survey report, serial no. 637, p. 29 [compiled as "United States Earthquakes, 1936–1940," and reissued by the National Earthquake Information Center].

———1942, Hawaiian Islands, *in* United States earthquakes, 1940: U.S. Coast and Geodetic Survey report, serial no. 647, p. 32–33 [compiled as "United States Earthquakes, 1936–1940," and reissued by the National Earthquake Information Center].

———1943, Hawaiian Islands, *in* United States earthquakes, 1941: U.S. Coast and Geodetic Survey report, serial no. 655, p. 21–22 [compiled as "United States Earthquakes, 1941–1945," and reissued by the National Earthquake Information Center].

Neumann, F., and Bodle, R.R., 1932, Hawaiian Islands, *in* United States earthquakes, 1930: U.S. Coast and Geodetic Survey report, serial no. 539, p. 15.

Neumann, F., and Service, J.H., 1926, Seismological report; April, May, June, 1925: U.S. Coast and Geodetic Survey, serial no. 337, p. 20–26.

———1927, Seismological report; January, February, March, 1926: U.S. Coast and Geodetic Survey, serial no. 395, p. 5–8, 27–31, 45–47.

Pacific Commercial Advertiser, 1913, Instruments broken by quake; Professor Jaggar, from Kilauea, tells of Earth tremors that awakened Hilo-people of other islands asked to send in reports whether or not they felt the shocks: November 3, 1913, p. 9 [reprinted in Bevens and others, 1988, v. 2, p. 64].

Reid, H.F., 1905, Records of seismographs in North America and the Hawaiian Islands: Terrestrial Magnetism and Atmospheric Electricity, v. 10, no. 2, p. 81–96; no. 4, p. 177–189.

———1906, Records of seismographs in North America and the Hawaiian Islands: Terrestrial Magnetism and Atmospheric Electricity, v. 11, no. 4, p. 185–187 [The first two papers of this series appeared in this journal for June and December 1905 (v. 10, p. 81 and 177, respectively)].

Richter, C.F., 1958, Elementary seismology: San Francisco, W.H.Freeman, 768 p.

Stover, C.W., and Coffmann, J.L., 1993, Seismicity of the United States, 1568–1989 (revised): U.S. Geological Survey Professional Paper 1527, p. 201–213.

Takahashi, T.J., and Wright, T.L., 1987, Staff of the Hawaiian Volcano Observatory, 1912–present, chap. 62 *of* Decker, R.W., Wright, T.L., and Stauffer, P.H., eds., Volcanism in Hawaii: U.S. Geological Survey Professional Paper 1350, v. 2, p. 1645–1662.

Wood, H.O., 1915a, The seismic prelude to the 1914 eruption of Mauna Loa: Seismological Society of America Bulletin, v. 5, p. 39–51.

———1915b, Systematic report of the Whitney Laboratory of Seismology: Hawaiian Volcano Observatory Seismometric Bulletin, v. 1, no. 1–4.

———1917a, [no title]: Pasadena, Calif., H.O. Wood archives, unpub. earthquake catalog [Hawaii], September 1915–June 1917, [unpag.] 228 p.

———1917b, On cyclical variations in eruption at Kilauea, in Second Special Report of the Hawaiian Volcano Observatory: Cambridge, Massachusetts Institute of Technology, 59 p. [compiled and reprinted in Bevens, D., Takahashi, T.J., and Wright, T.L., 1988, The early serial publications of the Hawaiian Volcano Observatory: Hawaii National Park, Hawaii Natural History Association, v. 1, p. 81–143].

Wright, T.L., and Klein, F.W., 1995, Seismic moment history of Kilauea Volcano, Hawaii, 1933–1975 [abs.]: Eos (American Geophysical Union Transactions), supp., v. 76, no. 46, p. F681–682.

Wright, T.L., and Takahashi, T.J., 1998, Hawaii bibliographic database: Bulletin of Volcanology, v. 59, no. 4, p. 276–280.

Wyss, M., and Koyanagi, R.Y., 1992, Isoseismal maps, macroseismic epicenters, and estimated magnitudes of historical earthquakes in the Hawaiian Islands: U.S. Geological Survey Bulletin 2006, 93 p.

Wyss, M., Koyanagi, R.Y., and Cox, D.C., 1992, The Lyman Hawaiian earthquake diary, 1833–1917: U.S. Geological Survey Bulletin 2072, 34 p.

Zuniga, F.R., Wyss, M., and Scherbaum, F., 1988, A moment-magnitude relation for Hawaii: Seismological Society of America Bulletin, v. 78, no. 1, p. 370–373.

Appendix 1. Files Available on the Accompanying CD–ROM

The accompanying CD–ROM is in ISO 9660 level 2 format (PC, Macintosh, Unix) and contains the following files and formats. The earthquake-catalog files are stored in native Excel format for use by persons with PC or Macintosh workstations, as comma-delimited text files and fixed-column ASCII files for other programs or computers, and in formatted tables in PDF and PostScript formats. A bibliographic file is available in ASCII EndNote format and as a text file. Information is complete for files covering the period 1903–59 for which instrumental records are available. We are working on a noninstrumental catalog covering the period 1823–1903, a preliminary version of which is on the CD–ROM. These files will be posted online. Catalog filenames consist of a base name indicating the time period, and a file extension indicating the platform and format. For example, "1903-1921cat.xls" is that part of the catalog in PC Excel format. More details including system requirements and software versions are given in the file 1_README.TXT on the CD–ROM.

Table 14. Column headings and formatting for ASCII catalog data

[HST, Hawaii standard time. Do., ditto]

Columns	Format	Data
1–8	I4, 2I2, 1X	Year, month, and day, HST.
10–13	2I2	Hour and minute, HST.
14–19	F6.2	Origin time (seconds).
20–22	F3.0, 1X	Latitude (degrees).
24–28	F5.2	Latitude (minutes).
29–32	F4.0, 1X	Longitude (degrees).
34–38	F5.2	Longitude (minutes).
39–45	F7.2	Depth, in kilometers.
46	1X	– – –
47	A1	Preferred magnitude-type code.
48–52	F5.2	Preferred magnitude.
53–55	I3	Unused.
56–58	I4	Year, including century.
60–64	F5.1	Unused.
65–69	F5.2	Do.
70–74	F5.1	Do.
75–79	F5.1	Do.
80	A1	Remark: "*" if lat/long assigned as region center
81	A1	Remark: "?" if region assignment is questionable
82	A1, 13X	Remark: Unused.
84–86	A3	Geographic-region code.

Earthquake-catalog filenames

Base filename	*Description*	*Status*
1823-1903cat	1823–1903: all earthquakes	In process.
1903-1921cat	1903–21: all earthquakes	Complete.
1921-1932cat	1921–32: all earthquakes	Complete.
1933-1959cat	1933–59: all earthquakes	Complete.
1959-1963cat	1959–63: earthquakes with new magnitude information	Complete.
Appendix table1	1903–59: M≥4.0 earthquakes	Complete.

Filename extensions and platforms

Filename extension	*Directory*	*Platform and format*
csv	csv	ASCII, comma-delimited fields.
H72	H72	ASCII, fixed columns, hypo71–2000 format (see table 14).
exl	mac	Microsoft Excel, Macintosh platform.
xls	pc	Microsoft Excel 2000, PC-windows platform.
pdf	pdf	Adobe Acrobat, multiplatform, formatted table.
ps	postscript	PostScript printer file, UNIX or other workstation (Adobe illustrator compatible)

Bibliographic files in the bib directory

Filename	*Description*	*Format*
Eqbibi.txt	Newspaper and other accounts of felt earthquakes	ASCII, importable by EndNote software.
Eqbibf.txt	do	ASCII text, bibliographic format.
eqpcardi.txt	Postcard felt reports sent to HVO	ASCII, importable by EndNote software.
eqpcardf.txt	do	ASCII text, bibliographic format.

Honolulu readings

Base filename	*Description*	*Status*
Honmilne	Milne seismometer readings, 1903–21	Complete.
Honm-s	Milne-Shaw seismometer readings, 1921–59	Complete.
Hon59-63	Milne-Shaw seismometer readings, 1959–63	Complete.

Table 13 shows a useful portion of our catalog, listing all 1903–1959 earthquakes of $M \geq 4.0$, representing our best-determined magnitude range.

Table 14 shows the formatting of the ASCII files for use on mainframe computers, designed for consistency with the post-1959 earthquake catalog. The latitude and longitude are normally from the *Volcano Letter* or the original source. If no coordinates were assigned but a region was inferred, the latitude and longitude are the center of the region, and a "*" remark is entered in column 78. The format specifications are for format statements in the FORTRAN language: I is a right-aligned integer, A is an alphanumeric, and Fm.n is a real number in *m* columns with *n* decimal places.

Appendix 2. Calculation of a "Characteristic" Amplitude for HVO Earthquake Classes

The "average" or "moment preserving" magnitude in a range of magnitudes for a given magnitude class is derived as follows. Moment (**M**) is related to magnitude (M) by a relation of the form

$$\log \mathbf{M} = c + dM.$$

For Hawaii, we use the relation of Zuniga and others (1988):

$$\log \mathbf{M} = 16.59 + 1.1M.$$

We also use the Gutenberg-Richter law:

$$\log N = A - bM,$$

where N is the number of earthquakes of magnitude M or larger. Its differential form is

$$\log n = a - bM,$$

where n is the number of events in a small interval dM. Then, $10^A b \ln 10 = 10^a$. Let $\mathbf{M}_{avg}$ be the average moment of events between $\mathbf{M}_1$ and $\mathbf{M}_2$. Let M_{avg} be the "average" magnitude of events between M_1 and M_2. Let $DM = M_2 - M_1$. $\mathbf{M}_{avg}$ and M_{avg} are related by the equation above. The total moment $\mathbf{M}_t$ of events between M_1 and M_2 is given by

$$\mathbf{M}_t = \int_{M_1}^{M_2} \mathbf{M}(M) n(M) dM.$$

The total number of events between M_1 and M_2 is given by

$$N_1 - N_2 = 10^A (10^{-bM_1} - 10^{-bM_2}).$$

The average moment of an event in the magnitude range is the ratio of the two above equations:

$$\mathbf{M}_{avg} = \mathbf{M}_1 \frac{-b}{d-b} \frac{10^{(d-b)DM} - 1}{10^{-bDM} - 1}.$$

This average moment then yields the "average" magnitude and "average" amplitude for the size class.

Appendix 3. Errors and Uncertainties

The qualitative magnitude class of most, if not all, earthquakes originating beneath Hualalai Volcano was apparently referenced to distances from the much closer Kona seismometer, which had the same magnification as the Whitney seismometer. Magnitudes calculated from the nomogram using the Kona distance are consistent with magnitudes measured in Honolulu, whereas if the Whitney distance is assumed, nomogram magnitudes are consistently too high. Some smaller events have nomogram magnitudes of a size that should have been detected in Honolulu if the Whitney distance is assumed, but calculate to well below M=4.0 if the Kona distance is assumed. This discrepancy is particularly vexing because nowhere in the earthquake tabulations in the *Volcano Letter* is it stated that anything other than the Whitney seismometer was used, until 1951, when both Kona and Whitney qualitative classes were reported. Our preferred magnitudes are based either on the Honolulu determination or on an assumed distance from Kona, as noted in our catalog.

Epicentral locations and magnitude classes reported in the *Volcano Letter* agree surprisingly well with the magnitudes recorded in Honolulu and with modern understanding of the distribution of earthquakes at Kilauea. Note that the Honolulu and HVO nomogram magnitude scales were derived independently. We note two exceptions to this agreement. First, in May and August 1938, earthquake swarms were reported as occurring in the upper east rift and eastern Koae Fault Zone. In the modern era, earthquakes in these areas rarely exceed M=3. Empirically, we find that even strong earthquakes at shallow (<5 km) depths are not recorded on Oahu. However we find that many events at depths characteristic of Kilauea's south flank or Mauna Loa's Kaoiki Fault Zone (approx 10 km) are recorded on Oahu. We recorded several events on Oahu during the period covered by the two 1938 swarms, some at times not given in the *Volcano Letter*. We conclude that these "extra" 1938 events were significantly deeper than earthquakes in well-located modern rift swarms. We consider two possibilities, which we will evaluate in subsequent papers: (1) a south flank response to rift intrusion, consistent with what we have seen at Kilauea in the modern era, or (2) deep (20–35 km) "magma supply" earthquakes, also well defined in the modern era as having followed certain eruption/intrusion sequences (Wright and Klein, 1995).

Second, on March 7, 1955, a series of strong earthquakes was reported in the *Volcano Letter* as being on Kilauea's East Rift Zone near Heiheiahulu. These earthquakes were relocated and reported by Macdonald and Eaton (1964) as being near Kalapana, on Kilauea's south flank. The appearance of earthquakes under both the East Rift Zone and the south flank on modern seismographs is generally similar, and it is easy to see how events recorded on older seismographs could be confused.

The apparent discrepancy between the earthquakes described by HVO before the modern network as being located under rift systems but larger relative to modern flank earth-

quakes could result from early misconceptions. First, our prejudices of where the earthquake "should" be located can be made consistent with the poor ability of HVO to locate with one or two low-gain stations. Second, the concept of large earthquakes under the mobile volcano flanks is a modern one. Many early reports favored the rift systems as fault lines and a natural source of earthquakes, and so it is natural to suspect them as the origin of most earthquakes.

Depths are far more uncertain. In our magnitude calculations, we use a depth of 9 km where none is reported in the *Volcano Letter*, indicated by no entry in the "Depth given" column of our catalog. Except for the Kilauea Caldera area, we believe that the only depth discrimination resolvable with the pre-1959 seismic network was between crustal earthquakes (typically, 5–12-km depth) and upper-mantle earthquakes (typically, 30–40-km depth). We guess the typical depth error might be 20 to 25 km, and so crust and mantle earthquakes are not always separable. Near Kilauea Caldera, greater depth resolution is generally possible because of the proximity of the epicenter to the recording station. For such events, the slant distance used in the magnitude calculation depends far more on depth than on horizontal distance from the Whitney vault.

Some earthquakes reported as shallow were both widely felt and recorded on Oahu. This combination is not by itself sufficient to prove that an earthquake is deep. We also take into account the calculated magnitude in our evaluation of depth. For example, moderate earthquakes that are widely felt are more likely to be deep than large earthquakes that would be widely felt and recorded no matter what their depth. Earthquakes for which we believe that the reported depth is in error are recognized by differences in the "Depth given" and "Depth preferred" columns of our catalog, and also noted in the "Comment" column. Particularly for larger earthquakes beneath or close to Kilauea Caldera, depth can be estimated from matching a calculated nomogram magnitude with an independent determination of magnitude made in Honolulu.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
9/01/1903	19:16					east hawaii								5.16						5.16	hono	felt	Warshauer notes: Felt at Hilo.	Not listed in Honolulu Station Bulletin (Hazard, 1910); found on station HON film record; PCA, 10/14/1903; HG, 10/16/1903; not found in HS, HEB, HH, HT, or MN.
2/18/04	10:25					east hawaii								4.97						4.97	hono	IV?	Warshauer notes: Vigorous earthquake felt in Hilo between 10 and 11 o'clock.	Not found in Honolulu Station Bulletin (Hazard, 1910); found on station HON film record; PCA, 2/22/1904; HS, 2/20/1904; HT, 2/19/1904; not found in HG, HEB, HH, or MN.
3/19/04	21:00					east hawaii								<5.2						5.00	int	V?	Lyman notes: One smart shock from SW.	Not found in Honolulu Station Bulletin (Hazard, 1910); not found on station HON film record; WKC, 1992, p. 28; not found in HS, HEB, HG, MN, HT, HH, or PCA.
3/29/04	11:45					kohala								5.38						5.38	hono	felt	Warshauer notes: A severe earthquake was felt in Kohala on the afternoon of the 29th inst. It lasted ten minutes, moved NW from Kohala toward Mahukona; felt in Kohala [11:45] and Waimea [no time].	Found on station HON film record; HG, 4/5/1904; PCA, 4/13/1904; not found in HS, HEB, MN, HH, or HT.
3/29/04	11:48					kohala(?)								5.32						5.32	hono			Not recognized in newspaper reports; Honolulu seismogram suggests different location.
4/4/04	7:39					molokai?														5.30	int	V (S&C)	Honolulu notes: Local earthquake about 18:05 [G.m.t. April 4]; instrument not recording at that time. Warshauer notes: Quite a severe shock was felt here Monday morning at 7:30. No damage done.	*Honolulu Station Bulletin* (Hazard, 1910); PCA, 4/11/1904; HH, 4/7/1904; not found in MN.
4/29/04	22:30					kaoiki??								5.79						5.79	hono	VI?	Warshauer notes: On Friday, April 29, at 10:30 o'clock [p.m.] a most severe earthquake shock was felt at Keauhou and Punaluu. The shock lasted about eight seconds and was apparently from north to south; heavy shock at Pepeekeo [10:15] [same quake?].	Not listed in Honolulu Station Bulletin (Hazard, 1910); found on station HON film record; PCA, 5/7/1904; 5/16/1904; not found in HH or HT.
6/4/04	12:25					molokai?								5.63						5.63	hono	VI; V (S&C)	HON notes: Local; boom caught by spider web. Lyman notes: A long gentle shake about 12 noon [suggests farther from Hilo than Kilauea's distance]. Warshauer notes: Felt sharply at Wailuku and around the island of Maui; some damage done outside of Wailuku.	*Honolulu Station Bulletin* (Hazard, 1910) [appearance of Honolulu seismogram suggests distance of Hawaii or closer]; WKC, 1992, p. 28; MN, 6/11/1904.
7/17/04	14:00					kaoiki??								4.97						4.97	hono	V-VI (hilo); ≤ V (Kau)	Lyman notes: A two-shock quake, the second quite hard; In the afternoon [of July 17] there was an earthquake accompanied by rumbling sounds; also felt and heard by the Lymans while resting by the three craters.	Not reported in Honolulu Station Bulletin (Hazard, 1910); found on station HON film record; WKC, 1992, p. 28; VHR, v. 4, W.D. Westerveldt entry dated 7/20/1904.
10/14/04	3:40					maui?								5.35						5.35	hono	V	Lyman notes: A slight shock. Warshauer notes: 3:40 a.m.; distinct shock in Hilo; sharp and prolonged in Honolulu; heavy at Lahaina; violent shaking in East Maui; felt reports from Kohala, Puueo (Hilo), Waiawa and Aliamanu (Oahu), and Kipahulu (Maui).	Not reported in Honolulu Station Bulletin (Hazard, 1910); seen on station HON film record; WKC, 1992, p. 28; HT, 10/18/1904; PCA, 10/15; 17, 11/18/1904; MN, 10/15/1904; not found in HH.
5/3/05	15:16					kl sf?								5.33						5.33	hono	V	Lyman notes: A long tremble, hard at the end, throwing down some things, 3:30 p.m. Warshauer notes: First of 3 shocks, felt in Hilo (heaviest in 9 yr) and volcano (distinct) and Hamakua coast; dishes rattled and damage to furniture and bric-a-brac (Hilo).	WKC, 1992, p. 28; HH, 5/4/1905; HT, 5/9/1905; PCA, 5/10; 12/1905: time given as 3:18 p.m.; HS, 5/6; 10, 1905 [Lyman comment may be exchanged with the following event; possible foreshock to event at 16:07].
5/3/05	16:07					kl sf?								6.18						6.18	hono	VI; V (W&K; S&C)	Lyman notes: A long tremble and a twister. W&K notes: E or S Hawaii. Warshauer notes: Another shock at 4:10 p.m., stronger (Hilo) than the first; rang church bell; damage to furniture, bric-a-brac, and china; also felt-volcano and Hamakua coast.	*Hon Station Bulletin* (Hazard, 1910); WKC, 1992, p. 28; WK, 1992, p. 32; HH, 5/4/1905; HT, 5/9/1905; PCA, 5/10, 12/1905; HS, 5/6, 10/1905; not in MN [Lyman comment exchanged with previous event(?); seismogram shows this as larger event, s-p about 1 min].

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
5/3/05	18:40					kl sf?								<5.22						5.00	desp	felt	Lyman notes: A long tremble slight, at 6:40 p.m. Warshauer notes: Probably felt on Hamakua coast; 6:35 p.m., weakest of three shocks felt in Hilo; shock at 6:34 p.m.	Aftershock; not found on station HON film record; WKC, 1992, p. 28; HH, 5/4/1905; HT, 5/9/1905; PCA, 5/10; 12/1905; HS, 5/6; 10/1905.
5/7/05	19:20					kl sf?								5.03						5.03	hono	felt	Warshauer notes: A shock at 7:20 p.m. felt in Hilo.	Aftershock(?); found on station HON film record; PCA, 5/12/1905; HT, 5/9/1905; not found in HS.
5/28/05	9:22					north hawaii								<5.22						4.50	desp	IV?	Lyman notes: One smart shock and a tremble. Warshauer notes: Felt at Honomu (10 a.m.; sharp), Kohala Mission (9:27 a.m.), Waimea (10:25 a.m. [9:25?]; smart), and Kealakekua (9:15 a.m.).	Not reported in Hon Station Bulletin (Hazard, 1910); not found on station HON film record; WKC, 1992, p. 28; PCA, 6/6/1905; not found in MN, HH, or HT.
4/25/06	1:47					north hawaii								6.01						6.01	hono	V	HON notes: Seismogram impulsive, incorrect amp in *Honolulu Station Bulletin* . Lyman notes: A smart shake at 2 a.m. Warshauer notes: Heavy in (2 a.m.), followed by two slight at intervals of 10 min., Hakalau (1:57 a.m.) and Kau (2 a.m.); direction, N to S.	*Honolulu Station Bulletin* (Hazard, 1910); WKC, 1992, p. 29; PCA, 5/1/1906; not found in MN; fred-check berkeley.
9/4/06	3:15					east hawaii								<5.41						5.30	int	V	Lyman notes: [9/3-wrong?] a smart shake, 2 shocks, SE & NW. Warshauer notes: Severe [in Hilo] at 3:15 a.m.; not perceived at the Volcano House, felt lightly at Mountain View. A sharp earthquake shock awakened most Hilonians at 3:15 a.m., no damage.	Not reported in Honolulu Station Bulletin (Hazard, 1910); not found on station HON film record-disturbed record; WKC, 1992, p. 29; PCA, 9/5/1906; HH, 9/4/1906, quoted in PCA, 9/10/1906.
1/8/07	15:00					ml swr?								<5.35						5.90	int	VI?	Warshauer notes: Slight shocks felt at several stations [north Hawaii] from 8th to 10th incl. [no individual reports]; over 50 shocks at Pahala, 8th-9th, one quite heavy on p.m. of the 8th with swaying bushes/trees [not mentioned in Lyman diary].	Time assumed; not found on station HON film record; PCA, 1/11; 15; 18/1907; HG, 1/11/1907; HS, 1/11/1907; HEB, 1/11/1907; HT, 1/15/1907; not in HH or MN [precursory seismicity north of Mokuaweoweo saddle(?); large event might be Hilea].
1/10/07	13:31					hilea?								5.82						5.82	hono	felt	HON notes: Probably local; [Honolulu seismogram is impulsive]. Lyman notes: A slight long tremble at 1:30 p.m. Warshauer notes: Earthquake shocks were felt during the week at a number of stations in the western and southern parts of Hawaii.	*Honolulu Station Bulletin* (Hazard, 1911); WKC, 1992, p. 29; PCA, 1/22/1907; HS, 1/22/1907; HT, 1/15/1907: Warshauer note—con.: Observer at Kau (Waiohinu) reports many earthquake shocks felt on the 10th and 11th, and a light one on the 16th.
1/10/07	13:31					hilea?								5.82						5.82	hono	felt	Warshauer notes: At Kapapala numerous earthquakes yesterday, none very severe. One shock at 1:30 o'clock…; quite a heavy shock [at Pahala], plainly observing the trees and bushes swaying back and forth; several thumps felt, rotary motion.	HEB, 1/12/1907; HG, 1/18/1907; HS, 1/22/1907; HEB, 1/31/1907.
6/11/07	3:40					hilea?								<5.27						4.50	int	IV-V?	Lyman notes: A two-shock mild shake. Warshauer notes: Heavy shocks of earthquakes at 3:43 on Hawaii; also felt at Paauilo, Laupahoehoe, Naalehu-heavy, and Kealakekua; Honuapo-most severe shake; duration, about 40 s; also felt at Hilo, Kona, and Waiohinu.	Not reported in *Honolulu Station Bulletin* (Hazard, 1911); not found on sta. HON film record; no mention in VHR entry on this date; WKC, 1992, p. 29; PCA, 6/15, 18/1907; HS & HEB, 6/14/1907; not in MN, HH, or HT; poss. analog to 8/20/24 quake (WK, p. 31).
7/5/07	23:45					molokai??								4.60						4.60	hono	felt	Lyman notes: A long continued shake near 12 last night. Warshauer notes: Slight shock felt over Honolulu at 11:55 p.m.; duration, a few seconds, quite distinct; slight at Makawao [Maui} at 11:40 p.m.; distinct on Maui and throughout territory at 11:45.	Not reported in *Honolulu Station Bulletin* (Hazard, 1911); found on station HON film record; WKC, 1992, p. 29; PCA, 7/6; 16/1907; MN, 7/13/1907; not found in HEB, HH, or HT.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
9/5/07	18:52					kl sf?								5.16						5.16	hono	V	HON notes: Tremor. Lyman notes: A smart 2-shock quake, dur several s. Warshauer notes: Severe quake in Hilo, dur several min; ship in dock shook stem to stern, wharf shaken; felt-all Hawaii I., esp. Kohala, Kau, Papaikou; volcano light, wire interrupted.	Hazard, 1911; WKC, 1992, p. 29; HEB, 9/6; 7/1907; PCA, 9/8/1907.
12/19/07	20:55					alenuihaha deep?								5.63				4.9	this catalog-area of intensity V (W&K, p. 26)	5.63	hono	V	HON notes: Local shock. Warshauer notes: An earthquake felt all over Honolulu. Two shocks followed within a few seconds, the entire disturbance occupying about 15 s; also felt in Nuuanu valley, Palolo, Waikiki, and Kalihi; details in references.	Hazard, 1911; PCA, 12/20; MN, 12/21/1907 [not mentioned by Cox, 1986, or WK, 1992].
9/20/08	20:15					kl sf								6.70				6.2; 6.8	USSR; (S&C) [from Abe, 1981]	6.70	hono	VII; VI (S&C)	HON notes: A sharp local shock, which probably has its origin near Kilauea Volcano on the Island of Hawaii. W&K notes: int 5-6 Hilo to Puna, probably Kilauea south flank.	Hazard, 1911 [amp on Honolulu seismogram much larger than M =6.2 11/2/18, traces large and obscure each other, max amp extrapolated]; WK, 1992, p. 32, 62.
9/26/08	20:05					kl sf								<5.2						4.00	desp	IV?	Lyman notes: Quite a smart shake. Warshauer notes: Two quakes, this one at 8:04 p.m., short but particularly sharp [largest aftershock of 9/20/08].	Aftershock; not found on station HON film record; WKC, 1992, p. 30; PCA, 10/5/1908; HH, 10/1/1908.
10/24/08	17:45					hilea?								5.16						5.16	hono	felt	Warshauer notes: The following earthquake shocks were reported felt—all from Hawaii: 24th—Naalehu, light followed by heavier, Kealakekua (Davis) 5:45 p.m., lasting 2 s.	Found on station HON film record; PCA, 11/4/1908; not found in HS, HEB, HH, or HT.
3/13/09	3:30					kl cal deep??								5.35						5.35	hono	V	HON notes: Local shock, felt generally over Island of Hawaii, recorded on magnetograph. Lyman notes: Shook water out of vases, no damage done.	Hazard, 1912 [time of large waves and ending time given]; no mention in VHR entry on this date; WKC, 1992, p. 30; PCA, 3/23/1909 [in USE, no int or mag].
4/19/10	3:45					kilauea?														5.30	int	V	Lyman notes: A smart two-shock shake, N & S. Warshauer notes: Very sharp shock Tuesday [Apr. 19] at about 3:50 a.m., awakened persons in Hilo; short duration; little damage except to crockery too close to shelf edges. Kilauea flared up after quake.	Not found on station HON film record; ESPHVO, v. 1, p. 28 [repeats info]; WKC, 1992, p. 30; HH, 4/21/1910; not found in PCA, HG, HS, HEB, or HT.
7/14/11	11:30					maui deep?								5.91						5.91	hono	V?	HON notes: Local shock. Lyman notes: Long continued slight tremble. Warshauer notes: Felt-all territory; Honolulu-duration 20 s, nowhere severe; Maui-two severe shocks at Wailuku, buildings shook, people ran out; Hawaii-felt generally, not at Halemaumau.	No mention in VHR of this date; Hazard, 1913 [Honolulu seismogram s-p<1 min]; ESPHVO, v. 1, p. 36 [repeats info but gives 13th as date]; WKC, 1992, p. 30; PCA, 7/15; 19/1911; HS, 7/14/1911; HEB, 7/14/1911; HH, 7/20/1911; not found in HT or MN.
8/25/11	7:15					kl mer?								<5.3						4.50	int	IV-V	A strong shock [felt at Halemaumau] causing a heavy landslide from the north black ledge.	Not found on station HON film record; ESPHVO, v. 1, p. 44-45; do.
4/10/12	10:00					south hawaii														5.30	int	V; IV (W&K)	Lyman notes: A slight shake, rattling things some. Warshauer notes: Shock felt by hundreds in Hilo, inside and out; motion, west to east; duration, 17 s, 5-s pause, 20-s shake, 30-s pause, three slight 10-s shocks, separated by 2- to 3-s pauses.	Not reported in *Honolulu Station Bulletin* (Hazard, 1913); not on sta. HON film record; not in ESPHVO supp. (Jaggar, 1947); WKC, 1992, p. 31; HH, 4/11/1912; HS, 4/13/1912; not in PCA, HG, HEB, or HT [kaoiki guessed if s-p is 5 s and possible aftershocks].
5/5/12	8:58					hilea?								5.16						5.16	hono	V	Warshauer notes: It appears that the shock reported at Hilo on Sunday week [May 5] was severely felt on the Kau coast as well. The quake was distinctly felt aboard the steamer *Kilauea* lying at Honuapo; landslide from seacliffs observed.	*Honolulu Station Bulletin* (Hazard, 1913); not mentioned in ESPHVO supp. (Jaggar, 1947); HS, 5/6/1912, quoted in HH, 5/16/1912; not found in HT, HEB, HG, or PCA.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
5/14/12	13:43					east hawaii								5.52						5.52	hono		Honolulu notes: Very slight; amplitude, 0.3 mm; duration, 1 h 16.3 min [strange that this doesn't correspond to the much heavier event on the 22d!]. Lyman notes: May 15, quite a shake [no time given; event on the 14th or the 22d].	*Honolulu Station Bulletin* (Hazard, 1913); not mentioned in ESPHVO supp. (Jaggar, 1947); WKC, 1992, p. 31; not found in HT, HG, HS, HEB, or PCA.
5/22/12	23:00					kl sf?								<5.33						5.90	int	VI-VII	Quake felt [Volcano-no date] and elsewhere in Hawaii. Warshauer notes: Heaviest shake in years [Hilo], tidal waves in ponds, livestock terrorized, little damage, brief but distinct in Kau; west to east; duration, 7 s; many smaller events earlier in week.	Not reported in Honolulu Station Bulletin (Hazard, 1913); not found on station HON film record; ESPHVO supp. (Jaggar, 1947, p. 15); PCA, 5/24; 27/1912; HT, 5/28/1912; HH, 5/30/1912; [int dist analog to kl sf events of 3/54 and 9/79(?)].
10/13/12	5:45					alenuihaha deep?		40	130.0	130.0	136.0			5.02						5.02	hono	V; V (W&K)	HON notes: Local shock, felt on all the islands; 8 maxima, wakened light sleepers at Volcano House, felt distinctly at Hilo, lightly in Honolulu; submarine shock, fairly deep, slight energy. Lyman notes: About 5:30 a.m., a long continued shake, not hard.	Hazard, 1913 [seismogram shape indicates some distance and not Oahu]; ESPHVO supp (Jaggar, 1947, p. 44) [origin at a moderate rather than great distance]; PCA, 10/15; 21/1912 [repeats info in Jaggar, 1947]; WKC, 1992, p. 31.
12/5/12	2:14					oahu					448.0			5.25						5.25	hono		Honolulu amp, 1.1 mm; moderate shock at its origin 280 mi from HVO; very small at HVO; duration many minutes; second phase at 2:15:06 and third phase at 2:15:53, both very distinct.	Hazard, 1913 [assume double amp of 1 mm to get separate phases]; ESPHVO supp. (Jaggar, 1947, p. 55); not reported in PCA, HSB, HH, or MN.
12/17/12	15:21					kaoiki??					22.4	IV (cancani)	4.03							4.03	nomo	felt	Duration, approx 4 min; distance 13-15 mi; not reported felt.	ESPHVO supp. (Jaggar, 1947, p. 59).
3/25/13	22:57					kl sf?					32.0	IV-V (Cancani)	4.58	<5.1						4.58	nomo		Duration, 3 min 13 s.	Not reported in *Honolulu Station Bulletin* (Hazard, 1913); ESPHVO supp. (Jaggar, 1947, p. 80); not reported in HG, HSB, or HH.
5/15/13	8:30					kohala??					108.0	medium II (Cancani)	4.23							4.23	nomo		Moderate local shock; duration, 4 min; distance, 65-70 mi.	ESPHVO supp. (Jaggar, 1947, p. 86); PCA, 5/25/1913; repeats HVO info; not reported in HH or HT.
5/18/13	19:51					kl sf?					14.0	high VII (Cancani); off scale; medium VI assumed to agree with Rossi Forel	>4.6	5.22						5.22	hono	V; IV-V (R-F)	Lyman notes: At 7:40 p.m., 2 slight tremors followed by 2 short sharp shocks; a few minutes before 8 p.m. a moderately strong focal shock was felt at Volcano House and generally felt in Hilo; pens offscale to E and S, probably close to HVO, direction NW.	Not listed in *Honolulu Station Bulletin* (Hazard, 1916); seen on station HON film record; WKC, 1992, p. 31; ESPHVO supp (Jaggar, 1947, p. 86).
6/19/13	3:38					kl cal deep??					32.0	III-IV (Cancani); 1.0 mpu	4.04							4.04	nomo		Duration, 1 min 43 s.	ESPHVO, v. 2, p. 2.
6/28/13	17:58					hilea??					48.0	III-IV (Cancani); 1.0 mpu	4.32							4.32	nomo		Duration, 3 min 33 s.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 5; not found in HG, HSB, or HH.
7/1/13	9:27					hilea??					48.0	medium III (Cancani); 0.8 mpu	4.19							4.19	nomo		Duration, 2 min 54 s.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 5; not reported in HH.
7/4/13	8:22					ml mok??					33.6	III-IV (Cancani); 1.0 mpu	4.07							4.07	nomo		Duration, 52 s.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 6; not reported in HH.
7/9/13	2:24					hilea??					41.6	medium III (Cancani); 0.75 mpu	4.05							4.05	nomo		Duration, 1 min 3 s.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 7.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
7/12/13	3:59					hilea??					48.0	III-IV (Cancani); 1.0 mpu	4.32							4.32	nomo	felt	Felt, Kapapala.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 12; not reported in HH.
9/8/13	11:37					kaoiki??					22.4	VI (Cancani); off scale	4.88	<5.22						4.88	nomo	IV (R-F)	Local shock felt at margin of Kilauea, sharply in Hilo; all pens swept off. Lyman notes: A long sharp tremble, then a short sharp shake. Warshauer notes: A very sharp and short shock was felt in Hilo Monday morning just before noon; [mag too high?].	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 19; ESPHVO, v. 2, p. 38; WKC, 1992, p. 31; PCA, 9/10/1913; not found in HG, HSB, HT, or HH; no additional felt reports in PCA.
10/2/13	7:29					hilea??					44.8	II-III (Cancani); 0.8 mpu	4.14							4.14	nomo		Duration, 2 min 0 s.	ESPHVO, v. 2, p. 55; not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; not reported in HH.
10/25/13	0:57					kl sf					15.0	off scale	5.27	5.81						5.81	hono	VII; VI (R-F)	Honolulu notes: Felt strongly at Hilo; [at HVO] shook buildings, objects fell, pictures swayed, walls cracked, rockslides, seismometers broken; felt most strongly between Hilo and HVO. Lyman notes: A long smart shaking north and southeast.	Hazard, 1916; ESPHVO, v. 2, p. 62, 64-65 [distance est. 10-20 km; distance and felt reports implies Kilauea south flank]; WKC, 1992, p. 31.
11/7/13	10:07					hualalai?					76.8	low I (Cancani); 0.5 [0.05?] mpu	4.24							4.24	nomo		Duration, 57 s.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 69; not reported in HH.
11/10/13	13:13					hilea??					41.6	III (Cancani); 0.9 mpu	4.16							4.16	nomo		Duration, 25 s.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 69; not reported in HH.
11/27/13	13:27					kona?					73.6	III (Cancani); 0.8 mpu	4.49							4.49	nomo		Duration, 2 min 20 s [mag high?].	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 78; not reported in HH.
12/14/13	5:33					alenuihaha??					108.8	III (Cancani); 0.6 mpu	4.59							4.59	nomo		Duration, 3 min 1 s [mag high?].	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 79; not reported in HH.
2/14/14	19:49					kl sf??					17.9	III-IV? (Cancani); 2.5 mpu	4.10							4.10	nomo		*d* >2 mpu, rapid vibration; duration, 1 min 49 s.	ESPHVO, v. 2, p. 116.
3/8/14	2:07					kl sf??					10.9	VI (Cancani); 3 mpu	4.47							4.47	nomo	IV	Wakened one sleeping person; several times the mpu; duration, 1 min 38 s.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 148.
3/25/14	9:38					hilea??					42.0	VII [IV?] (Cancani); 11 mpu	4.28	<5.2						4.28	nomo	IV	10-12 mpu [cannot be correct; 1.0-1.2 mpu?]; rattled windows at HVO.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 136, 148; HT, 3/31/1914 repeats ESPHVO info; not found in HH.
3/25/14	19:49					hilea??					51.2	III (Cancani); 0.6 mpu	4.07							4.07	nomo		Duration, 37 s.	ESPHVO, v. 2, p. 148.
3/29/14	20:04					molokai?					230.0	IV (Cancani); 1.5 mpu	5.65	5.22						5.22	hono	felt	Honolulu notes: Local. Felt at Honolulu but not at HMO; felt on SE flank of Mauna Loa, more strongly on Maui and Oahu. Warshauer notes: Felt strongly in all parts of Honolulu; most severe in Maui in many years; recorded in Washington, D.C.	[HVO mag high(?), station HON mag low]; *Honolulu Station Bulletin* (Hazard, 1916); ESPHVO, v. 2, p. 140, 149; PCA, 3/30/1914, repeated in HG, 3/31/1914; MN, 4/4/1914; not found in HH.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
4/13/14	4:15					hilea??					46.4	IV (Cancani); 1.1 mpu	4.35							4.35	nomo		Duration, 1 min 31 s.	ESPHVO, v. 2, p. 149; repeated in Wood, 1915, table 3, p. 49.
4/13/14	21:28					hilea??					48.0	IV (Cancani); 1.1 mpu	4.25							4.25	nomo	felt	Barely felt at HVO; duration, 2 min 53 s(?) [start time in ESPHVO given as 9:58 p.m., in disagreement with end time]; a slight tremor [see below] [mag too high?].	Not found in *Honolulu Station Bulletin* (Hazard, 1916); ESPHVO, v. 2, p. 149; repeated in Wood, 1915, table 3, p. 49; WKC, 1992, p. 31
4/29/14	14:50					ml mok??					32.0	VI-VII (Cancani); 6 mpu	5.09	<5.22						5.09	nomo	II; II (R-F)	Felt, feeble; duration, 19 min; min 6 mpu. Lyman notes: A long shake E&W then N&S; [Rossi-Forel and Cancani readings conflict]; mild shock felt in Hilo by those seated or lying down; long duration [mag high?].	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 193 [ESPHVO time given as 14:50]; repeated in Wood, 1915, table 3, p. 49; WKC, 1992, p. 31; HT, 5/5/1914; not found in HH or PCA.
4/29/14	14:59					ml mok??					32.0	V-VI (Cancani); 4.0 mpu	4.85							4.85	nomo	felt	Felt(?); 2d maximum in preceding shock; distance approximate; duration, 18 s [mag high?].	ESPHVO, v. 2, p. 193; repeated in Wood, 1915, table 3, p. 49 [aftershock(?)].
5/13/14	15:41					kl sf??					16.0	medium IV (Cancani); 2.5 mpu	4.09							4.09	nomo		Duration, 37 s.	ESPHVO, v. 2, p. 194; repeated in Wood, 1915, table 3, p. 49.
6/1/14	6:29					kl sf??					20.0	offscale	4.76	5.22						5.22	hono	IV; III (R-F)	HON notes: Apparently of a local character; amp, 0.1 mm; nearby; felt locally, duration, 6 min 37 s. Lyman notes: Quite a smart four-shock earthquake [no day or time given]. Warshauer notes: At 6:20, two distinct shocks in Hilo, first heavier, no damage.	Hazard, 1916; ESPHVO, v. 2, p. 194; repeated in Wood, 1915, table 3, p. 49 [6 assumed as minimum mpu for offscale]; WKC, 1992, p. 31; HH, 6/5/1914; not found in PCA, HSB, HT or MN [south flank(?)].
6/19/14	11:20					ml mok??					31.0	III-IV (Cancani); 1.0 mpu	4.02							4.02	nomo		Duration, 1 min 9 s.	ESPHVO, v. 2, p. 194; repeated in Wood, 1915, table 3, p. 49
6/25/14	9:29					ml mok??					32.0	III-IV (Cancani); 1.2 mpu	4.15							4.15	nomo		Duration, 3 min 18 s; started the ordinary seismograph.	ESPHVO, v. 2, p. 195; repeated in Wood, 1915, table 3, p. 49.
7/5/14	15:16					kaoiki??					19.8	V (Cancani); 3.3 mpu	4.41							4.41	nomo		Not perceived, moderate-strong; duration, 5 min 35 s.	ESPHVO, v. 2, p. 195; repeated in Wood, 1915, table 3, p. 49.
7/5/14	19:18					kaoiki??					20.8	VI (Cancani); 6.2 mpu	4.81	<5.2						4.81	nomo	felt	Moderate-strong; distinctly felt in volcano.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 195; repeated in Wood, 1915, table 3, p. 49; HT, 7/14/1914; not found in PCA or HH.
7/20/14	4:03					ml mok??					32.0	Intensity IV-V (Cancani); 2.5 mpu	4.58	5.03						5.03	hono	V (hilo); II (R-F)	Distinctly felt by two persons, one or two more were awakened [Hawaii National Park?]; a felt shock. Lyman notes: A sharp shock at 4:15 a.m. Warshauer notes: Shock felt from Hilo to volcano, sharp, 3 distinct parts; duration, several seconds; no damage.	Not found in Honolulu Station Bulletin (Hazard, 1916); detected(?) on station HON film record; ESPHVO v. 2, p.193, 196; repeated in Wood, 1915, table 3, p. 49; WKC, 1992, p. 31; HH, 7/24/1914; not found in PCA.
9/27/14	10:06					hilea?						observed-off scale		5.35						5.35	hono	II-III	No instrumental record; probably a succession of shocks, or several maxima in one shock. Lyman notes: At 10:15 a.m., two slight shocks & long tremble at end. Warshauer notes: Rather severe shock at 10:14 a.m., N to S; duration, 15 s; also felt elsewhere.	ESPHVO, v. 2, p. 227; repeated in Wood, 1915, table 1, p. 43 [shocks of 9/27-28 considered precursory to ML eruption 2 months later]; WKC, 1992, p. 31: see below; second shock closer to time recorded in Honolulu [foreshock?]; HH, 10/2/1914; not in PCA.
9/27/14	13:11					hilea?					33.6	IV (Cancani); 1.5 mpu	4.31							4.31	nomo	felt	Duration, 3 min 2 s; not felt at HVO. Warshauer notes: Quake felt [Hilo] at 1:17 p.m., not as pronounced as the one at 10:14 a.m.; also felt elsewhere [unspecified].	ESPHVO, v. 2, p. 227; repeated in Wood, 1915, table 1, p. 43; HT, 10/2/1914; not found in PCA.
11/6/14	19:24					kaoiki??					18.9	IV (Cancani); 2.2 mpu	4.13							4.13	nomo		1 mpu in ESPHVO; duration, 19 s; exceptionally short period; not perceived at HVO.	ESPHVO, v. 2, p. 249; repeated in Wood, 1915, table 1, p. 43

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
11/13/14	19:57					kaoiki??					24.8	low IV (Cancani); 1.6 mpu	4.14	<5.16						4.14	nomo	V	1.2-1.6 mpu; duration, 2 min 10 s; not felt at HVO. Warshauer notes: [Nov. 13] at 7:50 p.m. a shake of duration 15 s; distinctly felt at Puueo, where pictures hanging from walls swung to and fro; no damage.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 250; repeated in Wood, 1915, table 1, p. 44; HH, 11/20/1914; PCA, 11/23/1914.
11/15/14	12:50					kaoiki??					18.7	low IV (Cancani); 2.2 mpu	4.13	<5.16						4.13	nomo	V	Duration, 2 min 48 s; felt gently. Warshauer notes: Before 1:00 p.m. [Nov. 15], a more severe shake [than on the 13th]; direction, south to north; duration, 10 s; rattled windows and threw pictures out of plumb again.	Not found in station HON film record; ESPHVO, v. 2, p. 250; repeated in Wood, 1915, table 1, p. 44; HH, 11/20/1914; not found in PCA.
11/25/14	12:23					ml mok?					34.4	>IV (Cancani); 2.4 mpu	4.63	<5.2						4.63	nomo		ESPHVO, v. 2, p. 261; repeated in Wood, 1915, table 1, p. 44; not perceived at HVO.	Not found in *Honolulu Station Bulletin* (Hazard, 1916); looked for but not seen on station HON film record; minimum mpu; recording pen swept from cylinder; distance, 21-22 mi.
11/25/14	14:13					ml mok?					36.8	IV (Cancani); 1.08 mpu	4.18							4.18	nomo		Duration, 4 min 38 s; not perceived at HVO.	ESPHVO, v. 2, p. 262; repeated in Wood, 1915, table 1, p. 44
12/13/14	19:40					ml mok??					32.0	IV (Cancani); 1.0 mpu	4.31							4.31	nomo		Minimum mpu; duration, 1 min 20 s; not perceived at HVO.	ESPHVO, v. 2, p. 262; repeated in Wood, 1915, table 2, p. 46
1/13/15	19:38					a3035					32.0		4.25	<5.22						4.25	nomo	II-III	Felt in Hilo. Lyman notes: Slight shock, long duration at 7:45 p.m.	Not found in Honolulu Station Bulletin (Hazard, 1918); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 267; SBHVO, v. 1, no. 1; WKC, 1992, p. 31; not found in HH or PCA.
1/25/15	15:35					ml swr?					50.0		4.16							4.16	poor		Distance calculated from Wood's catalog, using the time difference between the maximum signal and the inferred *S* arrival.	SBHVO, v. 1, no. 1.
3/28/15	8:26					kaoiki??					21.0		>5.07	6.37						6.37	hono	V; IV-V (R-F)	Shaking for 5-7 s, 6 maxima, third was strongest, pens thrown off to S and E; clock stopped in Waiohinu, where shock strongest to SW of HVO; needles thrown off to N(?) and E [inferred direction NE (SE?) or SW].	Hazard, 1918; not mentioned in WK; ESPHVO, v. 2, p. 285 ; SBHVO, v. 1, no. 2 [distance assumed from preceding and succeeding quakes].
3/28/15	9:06					kaoiki??					21.0			5.52						5.52	hono			[Aftershock(?)]; recorded in Honolulu; lost in main shock, so not noted in SBHVO, v. 1, no. 2.
5/26/15	7:26					kl sf??					31.0		5.24							5.24	nomo	felt	Felt by several at Volcano House as a slow swing; origin, SE or NW; N-S amp 32, E-W amp 101; unusually discrepant. Warshauer notes: Another quiver felt in Hilo at about 7:30 a.m. [mag high?].	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 314; SBHVO, v. 1, no. 3; HH, 5/28/1914; HT, 6/1/1915; not found in PCA or HSB.
8/15/15	5:15					a2025					22.0		4.79	<5.2						4.79	nomo	felt	About 5:20; felt at the Volcano House and generally in the vicinity of HVO. Warshauer notes: Sharp shock felt in Hilo near 5:15 a.m.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 347; SBHVO, v. 1, no. 4; HH, 8/20/1915.
8/16/15	13:56					a2025					21.0		4.10							4.10	nomo			SBHVO, v. 1, no. 4.
8/31/15	4:58					a2025					21.0		4.92	<5.2						4.92	nomo	felt	During week ending 9/1/15, 6 shocks, 3 in one day, one felt locally, two felt in Hilo; felt generally in the vicinity of HVO [and in Hilo, from ESPHVO note].	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 354; SBHVO, v. 1, no. 4; not found in HH
9/25/15	13:24					mauna kea?					47.0		4.20							4.20	nomo	felt	Warshauer notes: Several rather severe shocks during the past week, and one on Sunday last [Sept. 25] was rather strenuous. It was felt at Honokaa and Kukuihaele more than near Hilo. Other quakes have been felt along the coast and all over the island.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); HH, 10/1/1915.
9/25/15	13:52					mauna kea?					40.0		4.09							4.09	nomo	felt	Felt(?)—see above.	SBHVO (Wood, unpub.).

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
9/25/15	16:25					kl sf?					21.0	off scale	>4.56	<5.2						4.60	poor	felt	Felt-volcano; amplitude assumed.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); not found in HH.
10/21/15	3:58					a2025					21.0		4.22							4.22	nomo	felt	Morning; probably felt locally.	ESPHVO, v. 2, p. 369; SBHVO (Wood, unpub.).
11/7/15	15:01					a3035					32.0		4.02							4.02	nomo			SBHVO (Wood, unpub.).
11/20/15	12:04					kona?					73.0		4.07							4.07	nomo			Do.
12/5/15	5:25					a3035					32.0		4.86							4.86	nomo	II?	Felt at volcano house—see below.	Do.
12/8/15	1:09					a3035					32.0		4.51							4.51	nomo			Do.
1/4/16	23:15					a2025					21.0		4.06							4.06	nomo			Do.
1/10/16	17:24					a2025					21.0		4.33							4.33	nomo	felt	Early evening, January 10; two felt in Hilo.	ESPHVO, v. 2, p. 385; SBHVO (Wood, unpub.).
1/10/16	18:46					a2025					21.0		4.19							4.19	nomo	felt	Early evening, January 10; two felt in Hilo, not locally.	SBHVO (Wood, unpub.).
4/9/16	22:00					ml mok?					35.0		4.91	5.16						5.16	desp	III	Warshauer notes: Earthquakes shook the district severely last night and dismantled the instruments in the Volcano Observatory [Tom-get original newspaper].	Time assumed; not reported in SBHVO (Wood, unpub.) or in *Honolulu Station Bulletin* (Hazard, 1918); event on station HON film record at 14:53, 4/08 [differs from newspaper account]; HT, 4/10/1916; not found in PCA, HG, MN, or HH.
4/28/16	7:34					kaoiki?					20.0		4.14							4.14	nomo	felt	Felt in Hilo, not locally.	SBHVO (Wood, unpub.).
5/20/16	8:39					ml swr?					47.0		4.22							4.22	nomo	felt	The first fairly strong shock of the spasm, followed by a brief lull; felt-Hilea.	Do.
5/20/16	16:40					ml swr?					40.0		4.14							4.14	nomo	felt	Felt-Hilea.	Do.
5/20/16	17:07					hilea?					47.0		4.57							4.57	nomo	felt	Do.	Do.
5/21/16	8:21					hilea?					45.0		5.24	<5.2						5.24	nomo	felt	Felt; presumed felt HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453, 456; not found in PCA, HSB, or MN.
5/21/16	8:33					hilea?					46.0		4.70	<5.2						4.70	nomo	felt	Felt; presumed felt S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453, 456; not found in PCA, HSB, or MN.
5/21/16	17:51					hilea?					47.0		4.37							4.37	nomo	felt	Felt.	SBHVO (Wood, unpub.).
5/22/16	0:02					ml wf??					58.0		>5.06	<5.2						5.10	nomo	felt	Minimum amplitude; pens swept off cylinders; presumed felt at HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/22/16	7:40					hilea?					55.0		4.42							4.42	nomo			SBHVO (Wood, unpub.).
5/22/16	7:42					hilea?					48.0		5.07	<5.2						5.07	nomo	felt	Presumed felt HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); SBHVO (Wood, unpub.); record being changed; ESPHVO, v. 2, p. 453.
5/22/16	8:14					hilea?					50.0		5.16	<5.2						5.16	nomo	felt	Minimum amplitude; pens swept off cylinders; presumed felt HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/22/16	13:27					hilea?					48.0		4.70	<5.2						4.70	nomo	felt	Presumed felt-S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/22/16	14:26					hilea?					50.0		4.53							4.53	nomo	felt	Do.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
5/22/16	16:05					hilea?					52.0		4.48							4.48	nomo			Not found in *Honolulu Station Bulletin* (Hazard, 1918); SBHVO (Wood, unpub.).
5/22/16	16:52					ml wf??					66.0		5.44							5.44	nomo	felt	Pens swept off cylinders; presumed felt HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/22/16	20:21					ml wf??					55.0		4.75	<5.2						4.75	nomo	felt	Presumed felt-S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/22/16	21:36					ml swr?					46.0		4.34							4.34	nomo			SBHVO (Wood, unpub.).
5/22/16	21:44					ml swr?					45.0		4.42							4.42	nomo			SBHVO (Wood, unpub.).
5/23/16	4:59					ml wf?					65.0		4.71	<5.2						4.71	nomo	felt	Presumed felt-S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/23/16	5:37					hilea?					48.0		4.76	<5.2						4.76	nomo	felt	Presumed felt-S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/23/16	5:53					ml wf?					57.5		5.50	5.16						5.16	aver	felt	Preferred magnitude calculated as average of nomogram and Honolulu; presumed felt-HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); event seen on station HON film record at 05:50, amp 0.2 mm [Wood time off?]; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/23/16	7:13					ml swr?					48.0		4.09							4.09	nomo			SBHVO (Wood, unpub.).
5/23/16	7:48					hilea?					55.0		4.37							4.37	nomo			Do.
5/23/16	9:07					ml swr?					55.0		4.34							4.34	nomo			Do.
5/23/16	13:48					ml wf?					62.0		4.02							4.02	nomo			Do.
5/23/16	17:02					ml swr?					55.0		4.12							4.12	nomo			Do.
5/23/16	23:37					ml wf?					65.0		4.13							4.13	nomo			Do.
5/24/16	6:04					ml wf?					63.0		5.50	<5.2						5.00	aver	felt	Preferred magnitude calculated as average of nomogram and Honolulu; presumed felt-HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/24/16	6:51					hilea?					50.0			5.71						5.71	hono	felt	Pens swept off cylinder; the strongest shock of the series, up to this time, accompanying the eruption; presumed felt-HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/24/16	12:37					hilea?					46.0		4.51							4.51	nomo	felt	Presumed felt-S Hawaii.	SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/24/16	13:42					ml swr?					48.0		4.06							4.06	nomo			SBHVO (Wood, unpub.).
5/24/16	16:09					ml swr?					48.0		4.09							4.09	nomo			Do.
5/24/16	19:29					hilea?					49.0		5.32	5.08						5.08	aver	felt	Preferred magnitude calculated as average of nomogram and Honolulu; presumed felt-HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453.
5/25/16	13:41					ml wf?					58.0		5.45	<5.2						5.00	aver	felt	Presumed felt-HVO, S Hawaii.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453
5/25/16	17:36					hilea?					50.0		4.49							4.49	nomo			SBHVO (Wood, unpub.).
5/25/16	21:50					kaoiki?					26.0		4.23							4.23	nomo			Do.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
5/25/16	23:44					ml swr?					40.0		5.02							5.02	nomo	felt	Presumed felt-HVO, S Hawaii.	SBHVO (Wood, unpub.); ESPHVO, v. 2, p. 453
5/26/16	9:19					ml swr?					43.0		4.03							4.03	nomo			SBHVO (Wood, unpub.).
5/26/16	9:26					hilea?								5.08						5.08	hono	V; V (R-F)	Felt distinctly by nearly all, but without stopping pendulum clocks or producing alarm.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); seen on station HON film record; SBHVO (Wood, unpub.).
5/30/16	20:40					hilea					48.0		4.57	<5.2						4.57	nomo	V	Very sharp shock felt in Kau; time given as about 20:15; felt outdoors at flow-source [Mauna Loa southwest rift] but stronger at Waiohinu. Warshauer notes: One very sharp shock felt in Kau about 8:15 p.m.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 459; SBHVO (Wood, unpub.); HT, 6/7/1916; not found in PCA or HSB.
6/5/16	0:25					kl sf?					24.0		4.05							4.05	nomo			SBHVO (Wood, unpub.).
6/5/16	0:36					kl sf?					23.0		4.49							4.49	nomo			Do.
6/5/16	6:55					kl sf?					26.0		4.00							4.00	nomo			Do.
6/5/16	8:05					kl sf?					24.0		4.05							4.05	nomo			Do.
6/5/16	8:59					kl sf?					24.0	offscale	>4.7	<5.2						4.80	poor		Pens flung off; amplitude assumed.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.).
6/5/16	9:40					hualalai?					80.0		4.70							4.70	nomo		Near shock; fairly energetic.	SBHVO (Wood, unpub.).
6/5/16	10:16					kl sf?					27.0		4.42							4.42	nomo			Do.
6/5/16	11:32					kl sf?					32.0		4.37							4.37	nomo		Here followed continuous vibration for several minutes [earthquake coda? harmonic tremor?].	Do.
6/5/16	11:46					kl sf?					22.0		4.29							4.29	nomo			Do.
6/5/16	12:13					kl sf?					22.5		4.23							4.23	nomo			Do.
6/5/16	12:14					kl sf?					23.0		4.85							4.85	nomo			Do.
6/5/16	12:16					kl sf?					26.0		4.08							4.08	nomo			Do.
6/5/16	13:15					kl sf?					23.0		4.62							4.62	nomo			Do.
6/5/16	13:19					kl sf?					23.0		4.40							4.40	nomo			Do.
6/5/16	20:03					kl sf?					23		4.22							4.22	nomo			Do.
6/6/16	10:28					kl sf?					22.0		4.73							4.73	nomo			Do.
6/6/16	13:02					molokai?					150.0		4.28							4.28	nomo		Near shock.	Do.
6/6/16	19:26					molokai?					200.0		4.24							4.24	nomo		Do.	Do.
6/7/16	14:34					kl sf?					23.0		4.59							4.59	nomo			Do.
6/7/16	16:55					kl cal deep?					31.0		4.26							4.26	poor		Distance calculated from Wood's catalog, using the time difference between the maximum signal and the inferred *P* arrival.	Do.
6/9/16	9:50					kl sf?					26.0		>4.9	<5.2						5.00	nomo		Pens swept off cylinder; minimum amplitude.	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); not found in HH.
6/12/16	6:45					kl sf?						off scale		5.41						5.41	hono	V; low VI (R-F)	HON notes: Apparently local. Lyman notes: 2 shocks at 6:45 a.m. Warshauer notes: Severe in Hilo although less than last year's quake [Mar. 28, 1915], animals alarmed, pictures swung, crockery rattled; duration, 10-15 s; direction, south to north.	Hazard, 1918; WKC, 1992, p. 31 [this is the last Lyman entry-time agrees with the *Honolulu Station Bulletin*]; HH, 6/16/1916.
6/24/16	8:01					kl sf?					21.0		4.30							4.30	nomo	felt	Felt at HVO.	ESPHVO, v. 2, p. 479; SBHVO (Wood, unpub.).
7/11/16	21:41					kl sf?					42.0		5.04	<5.2						5.04	nomo	felt	Pens swept off cylinder; distance from 4 s s-p; amplitude assumed; severe shock felt in Hilo at 9:55 p.m.; duration almost 1 minute [wood time assumed to be 12 hours off for consistency with note about the preceding quake being lost in next].	Not found in *Honolulu Station Bulletin* (Hazard, 1918); looked for but not seen on station HON film record; SBHVO (Wood, unpub.); HH, 7/14/1916 [wood time G.m.t. 20:11 7/12-see note to right].
7/21/16	8:00					a2025					24.0		4.35							4.35	nomo			SBHVO (Wood, unpub.).
9/4/16	10:50					kaoiki?					21.0		4.02							4.02	nomo			Do.
9/28/16	11:46					ml mok?					34.0		4.51							4.51	nomo			Do.
11/12/16	6:22					a2025					23.5		4.18							4.18	nomo			Do.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
11/12/16	13:26					a2025					22.0		4.25							4.25	nomo	felt	Felt locally, more strongly in Hilo.	ESPHVO, v. 2, p. 529; SBHVO (Wood, unpub.); not found in HH or HT
12/5/16	13:15					hilea?					40.0		4.12							4.12	nomo	III	Rattled windows at HVO; not perceived.	ESPHVO, v. 2, p. 539; SBHVO (Wood, unpub.); not found in HH.
1/31/17	18:04					a3035					34.0		4.03							4.03	nomo			SBHVO (Wood, unpub.).
3/10/17	23:46					a2025					22.0		4.46							4.46	nomo	felt	Felt locally, quite sharply.	SBHVO (Wood, unpub.); not found in HH or HT.
3/14/17	4:57					kona?					72.0		4.09							4.09	nomo	felt	Felt locally, rattled windows(?).	Do.
6/27/17	3:08					a3035					32.0		4.11							4.11	nomo		This is the last earthquake recorded in the Wood unpublished archive.	SBHVO (Wood, unpub.).
7/28/17	20:05					kl sf?								<5.2						5.20	poor	VI	Warshauer notes: Earthquake shook Hilo shortly after 8 p.m. [Jul. 28], swaying buildings, sending people into the streets; began with a long tremble gradually augmenting in force until windows rattled; generally felt over island; severest in many years.	Not found in *Honolulu Station Bulletin* (Hazard, 1920); looked for but not seen on station HON film record; PCA, 8/1/1917; HH, 8/3/1917.
7/29/17	2:05					kl sf?								<5.2						5.20	poor	V-VI	Warshauer notes: A second quake followed 6 hours later, and again buildings shook and people ran into the streets. No damage is reported except near Laupahoehoe, where a huge stone rolled down and tore up the road.	Not found in *Honolulu Station Bulletin* (Hazard, 1920); looked for but not seen on station HON film record; PCA, 8/1/1917; not found in HH.
5/21/18	15:30					kl cal deep?								5.14						5.14	hono	IV	Generally felt on the Island of Hawaii; felt at HVO as a prolonged N-S rocking.	Not found in *Honolulu Station Bulletin* (Hazard, 1920); seen on station HON film record; ESPHVO, v. 2, p. 777.
5/21/18	19:27					kl cal deep?					25.0		4.3							4.27	desp		Moderate.	ESPHVO, v. 2, p. 777
5/22/18	15:30					kl cal deep?					25.0		4.27							4.27	desp		Do.	Do.
6/7/18	11:21					hawaii?								5.16						5.16	hono		Time differences and seismogram consistent with local shock or part of a teleseism; magnitude calculated assumes Hawaii origin.	*Honolulu Station Bulletin* (Hazard, 1920); not mentioned in ESPHVO; not found in PCA, HSB, HDT, HH, or DPH.
6/14/18	11:13					ml wf?						off scale		5.76						5.76	hono	V-VI (naalehu)	HON notes: Local shock, very irregular; generally felt, seismograph pens flung in S. 80° E. direction, near shock of great intensity, items thrown from shelves in Naalehu in westerly direction (ground displaced to E); long, slow swaying; duration, 45 min.	*Honolulu Station Bulletin* (Hazard, 1920); ESPHVO v. 2, p. 785, 787.
11/1/18	23:33	19	24	155	27	kaoiki						st		6.40				6.2	W&K	6.40	aver	VII (W&K)	HON notes: Sharp earthquake from the Island of Hawaii, with renewed activity at Kilauea; felt-all island of Hawaii, most strongly in Kau with damage at Kapapala; first movement WNW, toward Mokuaweoweo; duration, 53 min.	Isoseismal map in W&K [wrong date given]; *Honolulu Station Bulletin* (Hazard, 1920); ESPHVO v. 2, p. 840, 843; preferred mag calculated as average of HON and W&K; Hilea observer recorded time as 11:36 p.m.
11/1/18	23:38					kaoiki?					22.1	s?	4.2							4.19	poor	felt	Felt-Hilea; lost in main shock(?).	Aftershock; ESPHVO, v. 2, p. 840, 843.
11/1/18	23:44					kaoiki?					22.1	s?	4.19							4.19	poor	felt	Recorded instrumentally; felt Hilea, time recorded as 11:46.	Do.
11/1/18	23:52					kaoiki?					22.1	s?	4.19							4.19	poor	felt	Recorded instrumentally; felt Hilea, time recorded as midnight.	Aftershock; ESPHVO, v. 2, p. 843.
11/2/18	5:00					kaoiki?					22.1	s?	4.19							4.19	poor	felt	Pronounced; felt Hilea.	Do.
1/27/19	16:53					molokai?								4.77						4.77	hono	V (W&K) II-III (Hon)	HON & USEQ notes: Felt by many persons in the islands. Warshauer notes: A very brief but sharp earthquake shock was felt on Maui by many persons in different parts of the island; also felt on Oahu; Romberg says local to Oahu within 20 mi of Honolulu.	*Honolulu Station Bulletin (Hazard, 1922) [1/28—Jan. 27 in newspaper accounts; seismogram appears too short for the Island of Hawaii; intensity 5 not substantiated]; PCA, 2/2/1919; MN, 1/31/1919; not found in HH or DPH.*

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
2/25/19	21:25					kl sf?								5.20						5.20	hono	felt	Strongly felt. Warshauer notes: A sharp, grinding, abrupt earthquake felt in Hilo, the Volcano House, Puna district generally, and even in the Kohalas. Kawaihae noted that it was strongly felt at the wireless station; quake product of upward pressure.	Not reported in *Honolulu Station Bulletin* ; seen on station HON film record; duration 7 min; ESPHVO, v. 2, p. 899, 903; PCA, 2/26/1919; HDT, 2/26; 27/1919; MN, 2/28/1919; not found in HSB or DPH.
6/2/19	16:14					hilea?					38.0	s?	4.1	<5.2						4.08	desp	IV?	Large amplitude; felt strongly in Kau district, not locally.	Not found on station HON film record; ESPHVO, v. 2, p. 951; HDT, 6/10/1919 [repeats ESPHVO]; not found in HH or DPH; distance and amplitude assumed.
8/26/19	2:04					kl cal deep?								<5.2						5.00	desp	V (W&K)	Moderate shock; strongly felt in Hilo and Kona.	Not reported in *Honolulu Station Bulletin* (Hazard, 1922); not found on station HON film record; ESPHVO, v. 2, p. 994-995; not found in HH.
9/14/19	17:20	19	12	155	33	hilea?						st		5.99				6.1	W&K	5.99	aver	VII (Kau)	HON notes: Volcanic disturbance on Mauna Loa, Hawaii; recorded on all three variometers of the magnetograph; a strong quake felt generally on Hawaii Island and slightly on Maui and Oahu; two aftershocks within 1 hour; duration, >1 hour.	Isoseismal map in W&K; Honolulu Station Bulletin (Hazard, 1922); ESPHVO, v. 2, p. 1001, 1002; damage report in ESPHVO; HSB, 9/15; 16/1919. Warshauer notes: Severe shock recorded on UH seismometer.
9/18/19	3:37					hilea?						st		5.46						5.46	hono		HON notes: Local, recorded on magnetograph; a second strong local shock was registered at HVO; there was another strong local shock and two others in the course of 30 s. Warshauer notes: Another shock took place on September 18.	*Honolulu Station Bulletin* (Hazard, 1922); ESPHVO, v. 2, p. 1001, 1005; PCA, 9/28/1919; not found in HSB, HH, DPH, or MN.
9/26/19	14:20					ml swr?					38.0	s	4.3							4.31	nomo		Slight.	ESPHVO, v. 2, p. 1008.
9/26/19	14:34					ml swr?					38.0	f	3.76							4.40	calc		5 additional very slight shocks; times not given; preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Do.
9/30/19	4:35					ml swr?					52.0	s	4.5							4.52	nomo		Slight.	ESPHVO, v. 2, p. 1025.
10/5/19	7:48					hilea?					47.0	m-st	5	<5.16						4.99	nomo		Local seismic movements in unusual number registered beginning October 5; 14 shocks recorded in 6 days, all but 2 were feeble [disagrees with tabulation on p. 1025].	Not found on sta. HON film record; 43.2-51.2 km; ESPHVO, v. 2, p. 1017, 1025 [Note: During this period m-st amplitude assumed to be 40 mm, corresponding to moderate, to agree with HON magnitudes]; not found in PCA, HDT, HH, DPH, or MN; see note for 9/29.
10/6/19	4:13					hilea?					47.0	s	4.45							4.45	nomo			ESPHVO, v. 2, p. 1025.
10/7/19	13:46					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/9/19	4:25					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/9/19	6:40					hilea?					47.0	m	4.95	<5.0						4.95	nomo			Not found on station HON film record; ESPHVO, v. 2, p. 1025.
10/9/19	11:28					hilea?					47.0	m	4.95	5.16						5.16	hono			Event [teleseism?] on station HON film record at 11:28; [accepted as local; HVO time of 10:26 one hour off(?)]; ESPHVO, v. 2, p. 1025.
10/9/19	12:30					hilea?					47.0	s	4.45							4.45	nomo		And two other slight quakes.	Do.
10/11/19	18:06					hilea?					47.0	s	4.45							4.45	nomo	III (R-F)?	Slight[ly felt?] at Hilea [time given as 10/11, 19:45, not consistent with Whitney record. We assign the felt report to the nearest m-st event].	ESPHVO, v. 2, p. 1031.
10/12/19	10:50					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/13/19	16:00					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/13/19	18:15					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/13/19	18:30					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/14/19	0:15					hilea?					47.0	s	4.45							4.45	nomo	felt	Culmination of eqs with 18 shocks registered on Oct. 14; 7-14 shocks per day thereafter, mostly slight; distances accord with Kahuku rift; no strong shocks since September; 4 shocks reported as felt at Hilea between Oct. 11 and 17, dur 1-3 s, II-IV (R-F).	ESPHVO, v. 2, p. 1026, 1031; HDT, 10/16/1919.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
10/14/19	6:52					hilea?					47.0	m-st	4.99	<5.0						4.99	nomo	IV (R-F)?	Moderate[ly felt?] at Hilea [time given as 10/13, 7:15, not consistent with Whitney record. We assign the felt report to the nearest m-st event].	Looked for but not seen on station HON film record; ESPHVO, v. 2, p. 1031; see note for 10/5/19.
10/14/19	13:52					hilea?					47.0	s	4.45							4.45	nomo			ESPHVO, v. 2, p. 1031.
10/14/19	23:06					hilea?					47.0	s	4.45							4.45	nomo		And three other small disturbances.	Do.
10/15/19	8:28					hilea?					47.0	m-st	4.99	<5.0						4.99	nomo	IV (R-F)?	Moderate[ly felt?] at Hilea [time given as 10/15, 0:00, not consistent with Whitney record. We assign the felt report to the nearest m-st event]. Warshauer notes: Recurrence of earthquakes yesterday.	Not found on station HON film record; 43.2-51.2 km; ESPHVO, v. 2, p. 1031; PCA, 10/16/1919; HDT, 10/16/1919; see note for 10/5/19.
10/15/19	10:20					hilea?					47.0	s	4.45							4.45	nomo			ESPHVO, v. 2, p. 1031.
10/15/19	15:40					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/16/19	9:00					hilea?					47.0	st	5.23	<5.16						5.23	nomo		None of the four strong ones registered October 16-18 was reported at Hilea.	Not found on station HON film record; 43.2-51.2 km; 43.2-51.2 km; ESPHVO, v. 2, p. 1030, 1031.
10/16/19	9:05					hilea?					47.0	s	4.45							4.45	nomo			ESPHVO, v. 2, p. 1031.
10/16/19	15:35					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/16/19	20:20					hilea?					47.0	m-st	4.99	<5.0						4.99	nomo		None of the four strong ones registered October 16-18 was reported at Hilea.	Not found on station HON film record; 43.2-51.2 km; 43.2-51.2 km; ESPHVO, v. 2, p. 1030, 1031; see note for 10/5/19.
10/17/19	5:40					hilea?					47.0	s	4.45							4.45	nomo			ESPHVO, v. 2, p. 1031.
10/17/19	8:35					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/17/19	23:25					hilea?					47.0	m-st	4.99	<5.0						4.99	nomo	II (R-F)?	None of the four strong ones registered October 16-18 was reported at Hilea; and three other small disturbances; weak[ly felt?] at Hilea [time given as 10/15, 0:00, not consistent with Whitney record. We assign the felt report to the nearest m-st event].	Not found on station HON film record; 43.2-51.2 km; ESPHVO, v. 2, p. 1030, 1031; see note for 10/5/19.
10/18/19	13:14					hilea?					47.0	m-st	4.99	<5.0						4.99	nomo		None of the four strong ones registered October 16-18 was reported at Hilea.	Not found on station HON film record; 43.2-51.2 km; ESPHVO, v. 2, p. 1030, 1033; see note for 10/5/19.
10/19/19	3:50					hilea?					47.0	s	4.45							4.45	nomo			ESPHVO, v. 2, p. 1033.
10/19/19	7:10					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/19/19	12:10					hilea?					47.0	m-st	4.99	<5.0						4.99	nomo			Not found on station HON film record; ESPHVO, v. 2, p. 1033; see note for 10/5/19.
10/21/19	11:00					hilea?					47.0	s	4.45							4.45	nomo			ESPHVO, v. 2, p. 1033.
10/21/19	12:23					hilea?					47.0	m-st	4.99	<5.0						4.99	nomo			Not found on station HON film record; ESPHVO, v. 2, p. 1033; see note for 10/5/19.
10/22/19	12:40					hilea?					47.0	st	5.23	<5.0						5.23	nomo		Probably not strong.	Not found on station HON film record; ESPHVO, v. 2, p. 1033.
10/22/19	14:08					hilea?					47.0	vst	5.53	5.57						5.57	hono	felt	HON notes: Local shock; very strong, felt.	*Honolulu Station Bulletin* (Hazard, 1922); ESPHVO, v. 2, p. 1034.
10/23/19	0:20					hilea?					47.0	m-st	4.99	<5.0						4.99	nomo			Not found on station HON film record; ESPHVO, v. 2, p. 1034; see note for 10/5/19.
10/23/19	16:35					hilea?					47.0	m-st	4.99	<5.0						4.99	nomo		And one other small disturbance.	Not found on station HON film record; ESPHVO, v. 2, p. 1034; see note for 10/5/19.
10/24/19	12:30					hilea?					47.0	s	4.45							4.45	nomo			ESPHVO, v. 2, p. 1034.
10/24/19	13:12					hilea?					47.0	vst	5.23	<5.0						5.23	nomo		Cannot be very strong.	Not found on station HON film record; ESPHVO, v. 2, p. 1034.
10/25/19	16:30					hilea?					47.0	s	4.45							4.45	nomo			ESPHVO, v. 2, p. 1043.
10/25/19	20:00					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/26/19	4:18					hilea?					47.0	s	4.45							4.45	nomo	felt	Felt at Hilea; none on this day felt at eruption site.	Do.
10/26/19	7:15					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/26/19	9:58					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/26/19	10:49					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/26/19	12:48					hilea?					47.0	s	4.45							4.45	nomo		Listed in error as AM.	Do.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
10/26/19	19:02					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/26/19	20:10					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/26/19	20:43					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/27/19	1:30					hilea?					47.0	s	4.45							4.45	nomo			Do.
10/27/19	5:17					hilea?					47.0	m-st	4.99	<5.2						4.99	nomo			Not found on station HON film record; ESPHVO, v. 2, p. 1043; see note for 10/5/19.
10/29/19	5:00					hilea?					47.0	m-st	4.99	<5.2						4.99	nomo	felt	Felt in Kona.	Do.
10/31/19	5:12					hilea?					47.0	m-st	4.99	<5.27						4.99	nomo			Do.
11/11/19	8:42					hilea?					47.0	s	4.45							4.45	nomo	IV (R-F) at Hilea	Felt at Hilea.	10 s duration; ESPHVO, v. 2, p. 1050; time of felt report 9:00-assigned to this quake.
11/13/19	11:52					hilea?					47.0	s	4.45							4.45	nomo	V (R-F) at Hilea	Do.	15 s duration; ESPHVO, v. 2, p. 1050; time of felt report 12:00-assigned to this quake.
11/25/19	21:58					maui?					176.0			4.87						4.87	hono	IV	HON notes: Amp 0.2; strongly felt in Maui. Warshauer notes: Sharply felt in Maui at 10:03 p.m., rattled doors and windows; duration, several seconds; no damage; shook upper floors of frame buildings.	*Honolulu Station Bulletin* (Hazard, 1922); ESPHVO, v. 2, p. 1059; HSB, 11/26/1919; MN, 11/28/1919; not found in PCA, HDT, HH, or DPH.
1/18/20	8:10					kl sf?				19.5	21.5	s?	4.17							4.17	desp	felt	Felt at Hilea.	ESPHVO, v. 2, p. 1100.
1/24/20	15:15					kl sf?				19.5	21.5	m-st	4.44							4.44	nomo	felt	Recorded at Hilo; strongly felt at Hilea as a double jolt accompanied by a loud rumbling.	Not reported in *Honolulu Station Bulletin* (Hazard, 1922); looked for but not seen on station HON film record-possible event at 14:28, amp 0.3 mm; possible teleseism; ESPHVO, v. 2, p. 1103; see note for 10/5/19; not found in HDT, HH, or DPH.
3/26/20	5:35					hilea?					48.0	s	4.469							4.47	nomo			ESPHVO, v. 2, p. 1137.
5/15/20	2:20					maui?					190.0	m?	5.683							5.68	int	III-IV (Honolulu); 3, III (R-F) (Hilea); V (Maui)	Felt in Honolulu as a very perceptible shock; felt in Hilea. Warshauer notes: Sharpest shock on Maui in years, sleepers awakened; duration, several seconds; no damage; felt in Honolulu as two distinct shocks.	Not reported in *Honolulu Station Bulletin* (Hazard, 1922); looked for but not seen on station HON film record [disturbed instrument-working?]; ESPHVO, v. 2, p. 1158; MN, 5/21/1920; not found in HDT, HSB, or PCA.
5/24/20	6:00					hilea?					48.0	m	4.96	5.08						5.08	hono	IV-V; IV (R-F) at Hilea	Felt in Hilea.	Not reported in *Honolulu Station Bulletin* (Hazard, 1922); event seen on station HON film record at 05:55, amp 0.15 mm [HVO time wrong?]; ; ESPHVO, v. 2, p. 1162; not found in PCA, HSB, HDT, HH, DPH, or MN.
5/26/20	1:55					hilea?					48.0	m	4.96	<5.16						4.96	nomo	IV-V; IV (R-F) at Hilea	Do.	Not reported in *Honolulu Station Bulletin* (Hazard, 1922); looked for but not seen on station HON film record; ESPHVO, v. 2, p. 1162; not found in PCA, HSB, HDT, HH, DPH, or MN.
8/16/20	19:20					hilea?					40.0	m-st	4.9							4.88	nomo	felt	Felt at HVO and Hilea.	Not found on station HON film record; ESPHVO, v. 2, p. 1195; see note for 10/5/19; not found in PCA, HSB, HDT, HH, DPH, or MN.
9/9/20	23:59					hilea?					43.2	s	4.396							4.40	nomo			ESPHVO, v. 2, p. 1204
10/27/20	5:33					kl sf?					16.0	m?	4.201					5.3	int	4.20	aver	V	Felt locally; NW or SE from Whitney. Warshauer notes: At 5:35 a.m., a pronounced earthquake shock, three distinct rocking motions followed by lengthy shivering. Houses tipped back and forth, and sleepers awakened; felt in all districts of Hilo.	Not reported in *Honolulu Station Bulletin* (Hazard, 1922); looked for but not seen on sta. HON film record; ESPHVO, v. 2, p. 1232; DPH, 10/27/1920; HH, 10/29/1920; not found in PCA; dist assumed >5 mi to fit felt rpt; pref mag avg of int mag and nomo mag.
3/8/21	16:24					a2530					28.8	s	4.11							4.11	nomo		Azimuth NE-SW.	ESPHVO, v. 3, p. 79.
3/17/21	13:27					kona?					66.0	f	4.15							4.15	nomo	felt	Probably felt in Kona.	Do.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
3/19/21	15:44					kaoiki?					28.8	m	4.61							4.61	nomo	felt	Felt in Hilea and probably in Pahala.	*Bulletin* (Hazard, 1924); station HON film record not available; ESPHVO, v. 3, p. 79.
4/1/21	5:26					a3035					33.6	m	4.72							4.72	nomo	felt	Azimuth NE-SW; felt generally on Hawaii.	Not reported in *Honolulu Station Bulletin* (Hazard, 1924); station HON film record not available; ESPHVO, v. 3, p. 96; not in HH.
5/6/21	16:55					a3035					32.0	s	4.19							4.19	nomo	felt	Azimuth NW-SE; felt locally.	ESPHVO, v. 3, p. 117.
5/19/21	21:21					south hawaii?					25.0	m	4.51							4.50	nomo	felt	Felt over most of Hawaii; distance assumed to agree with felt report (M range 4-5).	Not reported in *Honolulu Station Bulletin* (Hazard, 1924); station HON film record not available; ESPHVO, v. 3, p. 117; not in HH.
6/24/21	12:24					a2530					28.8	m	4.61							4.61	nomo	felt	Azimuth NW-SE; felt locally and in Hilo.	Not reported in *Honolulu Station Bulletin* (Hazard, 1924); station HON film record not available; ESPHVO, v. 3, p. 133.
7/29/21	19:01					mauna kea?					59.2	f	4.07							4.07	nomo	felt	Felt strongly in Waimea.	ESPHVO, v. 3, p. 154.
9/30/21	0:39					a2530					28.8	s	4.11							4.11	nomo			ESPHVO, v. 3, p. 187.
11/7/21	12:59					a2530					27.2	s	4.07							4.07	nomo			ESPHVO, v. 3, p. 217.
1/26/22	8:35					mauna kea?					64.0	s	4.67							4.67	nomo	felt	Felt in Kohala.	Not reported in *Honolulu Station Bulletin* (Hazard, 1924); ESPHVO, v. 3, p. 234.
2/3/22	0:33					a2530					28.8	s	4.11							4.11	nomo		Azimuth SW-NE.	ESPHVO, v. 3, p. 241.
2/21/22	7:55					kl sf?					32.0	m [st?]	4.68	5.78	5.65					5.72	hono	VI	HON notes: (Local shock; strongly felt and prolonged earthquake causing avalanches at Uwekahuna; azimuth WNW-ESE. Felt over E half of Hawaii). Warshauer notes: Felt in Hilo, clothes pole and construction pole swayed wildly, one person fell down stairs.	*Honolulu Station Bulletin* (Hazard, 1924); ESPHVO, v. 3, p. 239, 241 [listed as moderate, must be strong]; DPH, 2/21/1922; not in HA or HSB.
2/21/22	14:56					kl sf?					32.0	s	4.19							4.19	nomo	felt	Aftershock(?); felt locally.	ESPHVO, v. 3, p. 241.
3/12/22	14:33					kl cal deep??					32.0	m	4.68							4.68	nomo	V	Azimuth, ESE; felt locally and in Hilo; dismantled instruments. Warshauer notes: On Sunday afternoon, an earthquake shock, slightly more severe than [last month's], shook Hilo for possibly 30 s. Some crashes of china on plate rails; no other damage.	Not reported in Honolulu Station Bulletin (Hazard, 1924); HVO, v. 3, p. 252; HDT, 3/14/1922. Warshauer notes—con.: Houses and buildings quivered and shimmied.
3/12/22	16:55					kl cal deep??					32.0	s	4.19							4.19	nomo		Aftershock(?).	ESPHVO, v. 3, p. 252.
5/21/22	10:13					kl sf?					16.0	m	4.20							4.20	nomo	felt	Felt locally.	ESPHVO, v. 3, p. 288, 290.
5/22/22	16:53					kl sf??					16.0	m [st?]	4.20	5.98	6.08					6.03	hono	felt	Hilo, Honomu, and Waiohinu. Warshauer notes: Several papers note earthquakes; DPH says "earthquakes are frequent in all the region," "earthquakes felt in Hilo for a fortnight."	*Honolulu Station Bulletin* (Hazard, 1924); ESPHVO, v. 3, p. 275, 288, 290; DPH, 5/27, 29/1922; HDT, 5/30, 31/1922; HSB, 5/30/1922 [quotes Jaggar]; not found in HA or MN.
5/22/22	22:24					kl sf?					16.0	m	4.48							4.48	nomo	III	Dismantled instruments; felt locally.	ESPHVO, v. 3, p. 288, 290; distance assumed.
5/24/22	21:58					kl sf?					16.0	m	4.20							4.20	nomo	felt	Felt locally; and at Hilo, and?	ESPHVO, v. 3, p. 275, 288, 290; distance assumed.
5/25/22	0:43					kl sf?					16.0	m	4.20							4.20	nomo	felt	Do.	ESPHVO, v. 3, p. 288, 290; distance assumed.
5/25/22	2:00					kl sf?					16.0	m	4.20							4.20	nomo	felt	Do.	Do.
5/25/22	6:15					kl sf					16.0	m	4.48							4.48	nomo	III	Instruments dismantled; felt locally; and at Hilo, and?	ESPHVO, v. 3, p. 288, 290.
5/25/22	21:36					kl sf?					16.0	m	4.48	5.15	5.27					5.21	hono	felt	Dismantled instruments; felt locally and at Hilo, Honomu, and Waiohinu(?).	ESPHVO, v. 3, p. 288; distance assumed.
5/25/22	23:24					kl sf					14.4	m	4.40							4.40	nomo	III	Do.	ESPHVO, v. 3, p. 289, 290.
5/25/22	23:26					kl sf?					16.0	m	4.20							4.20	nomo	felt	Felt locally, and at Hilo, Honomu, and Waiohinu(?).	ESPHVO, v. 3, p. 289, 290; distance assumed.
5/25/22	23:43					kl sf					17.6	m	4.27							4.27	nomo	felt	Do.	ESPHVO, v. 3, p. 289, 290.
5/27/22	18:54					kl sf?					16.0	m	4.48							4.48	nomo	III	Dismantled instruments; felt locally.	ESPHVO, v. 3, p. 289; distance assumed.
5/27/22	20:04					kl uer?					8.0	m	4.00							4.00	nomo	III	Do.	ESPHVO, v. 3, p. 289.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
5/28/22	15:40					kl sf?					17.6	m	4.54							4.54	nomo	III	Do.	Do.
5/28/22	19:57					kl mer?		5	12		13.0	m	4.33							4.33	nomo	III	instruments; felt locally. Warshauer notes: Precursory earthquake created rift through which eruption could take place [implies the creation of a fracture associated with a rift earthquake].	ESPHVO, v. 3, p. 284, 289; distance assumed; HA, 5/30/1922; HSB, 5/29; 30/1922; DPH, 5/29/1922; HDT, 5/30; 31/1922; HH, 6/1 missing.
6/2/22	6:21					kl uer?					9.6	m	4.12							4.12	nomo	III	Do.; dismantled instruments; felt locally.	ESPHVO, v. 3, p. 302; distance assumed.
7/20/22	19:58					hilea??					40.0	s	4.34							4.34	nomo			Not found in *Honolulu Station Bulletin* (Hazard, 1924); ESPHVO, v. 3, p. 319.
7/24/22	16:59					hilea??					38.4	s	4.31							4.31	nomo	felt	Felt locally. Warshauer notes: There was a sharp shock of earthquake yesterday afternoon at exactly 5 o'clock, and it was more especially noticeable in the center of the city [Hilo], although no damage was done; not felt at Volcano House.	Not found in *Honolulu Station Bulletin* (Hazard, 1924); ESPHVO, v. 3, p. 319; HDT, 7/25/1922.
10/13/22	23:08					mauna kea?					64.0	s	4.67							4.67	nomo	felt	Felt in Hilo and strongly in Kohala.	Not found in *Honolulu Station Bulletin* (Hazard, 1924); ESPHVO, v. 3, p. 354.
10/18/22	11:13					a3035					32.0	s	4.19							4.19	nomo			Not found in *Honolulu Station Bulletin* (Hazard, 1924); ESPHVO, v. 3, p. 354.
10/29/22	22:13					a2530					25.6	s	4.03							4.03	nomo	felt	Felt in Hilo.	ESPHVO, v. 3, p. 354
11/21/22	3:27					kl sf??								5.32	5.67					5.50	hono	VI	Felt over island; heavy shaking in Kona, Kau, Hamakua, also locally, Hilea, Hilo; dur 10-15 s; dismantled inst. Warshauer notes: Strongly felt-Hilo, Volcano; cracked houses and broke mirrors; two distinct shocks, 1st slight, 2d felt in six separate waves.	*Honolulu Station Bulletin* (Hazard, 1924); not mentioned in WK; ESPHVO, v. 3, p. 357, 358, 359, 363; DPH, 11/21/1922; HH, 11/23/1922; HDT, 11/21; 23/1922; HA, 11/22/1922; duration, 5 minutes on Hilo seismograph; see references.
11/22/22	0:15					kl sf??					14.4	m	4.13	nomo						4.13	nomo	V	E-W component dismantled. Warshauer notes: Slight earthquake sufficient to awaken light sleepers felt in Hilo; two separate shocks at 12:20 a.m., with a slight interval between.	Aftershock; not in *Honolulu Station Bulletin* (Hazard, 1924); ESPHVO, v. 3, p. 358, 363; DPH, 11/22/1922; HDT, 11/23/1922; duration, 5 minutes on Hilo seismograph,
12/16/22	5:00					ml mok??					35.2	s	4.25	nomo						4.25	nomo			Not found in *Honolulu Station Bulletin* (Hazard, 1924); ESPHVO, v. 3, p. 374.
1/14/23	1:00					hilea??														4.00	felt	IV?	Foreshock(?). Warshauer notes: Reports of an earlier temblor at about 1 o'clock are also heard from several persons.	MN, 1/15/1923.
1/14/23	2:28					hilea?						st		6.01	5.91					5.95	hono	IV (oahu); V-VI (hilea)	HON notes: Local shock; felt locally and in all parts of Oahu; felt over Hawaii; slight damage, stone walls down in Hilea. Cox notes: Felt-all Oahu, Hawaii.	*Honolulu Station Bulletin* (McFarland, 1929); Cox, 1986 [awakened thousands implies int 5, more typically 4]; ESPHVO, v. 3, p. 378, 381, 386.
1/24/23	2:29					hilea??					38.4	m	4.57							4.57	nomo			Not reported in *Honolulu Station Bulletin* (McFarland, 1929); aftershock(?); ESPHVO, v. 3, p. 386; not in HA or HSB.
2/9/23	20:41					hilea??					45.0	m	4.68	4.50	4.50					4.50	hono	IV-V	HON notes: An irregularity in the microseisms; quake felt [at HVO]; dismantled instruments, felt over Island of Hawaii. Warshauer notes: Quake last night felt all along this line of territory but not at volcano; slight quake caused rockslide at Kilauea.	*Honolulu Station Bulletin* (McFarland, 1929) [no amplitude reported; assume 2 mm]; ESPHVO, v. 3, p. 390, 393; DPH, 2/10/1923; HA, 2/11/1923; not in HH.
3/3/23	23:46					a1320					19.2	m	4.09							4.09	nomo	felt	Felt in Hilo.	ESPHVO, v. 3, p. 401.
4/1/23	10:45					mauna kea??					36.8	s	4.28							4.28	nomo		NW-SE.	Not found in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 413; not in HTH.
5/30/23	12:06					a2530					28.8	s	4.11							4.11	nomo		SE-NW.	ESPHVO, v. 3, p. 429.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
11/15/23	10:40					a3035					35.2	s	4.25							4.25	nomo			Not in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 488.
12/14/23	5:34					ml mok??					36.8	s	4.28							4.28	nomo	felt	Felt in Hilo, Kona, and Kau.	Not in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 497.
12/25/23	18:46					molokai?					260.0	vf	4.83							4.83	nomo	IV (oahu)	Felt-Oahu, Molokai, and Lanai. Cox notes: UH seismograph out of commission, felt-Oahu, Molokai, Maui, and Lanai (not Hawaii). Warshauer notes: Felt as sharp but short on Maui, no damage; not felt at Hilo, but felt on Oahu.	Not reported in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 497; Cox, 1986; MN, 12/28/1923.
12/28/23	16:37					mauna kea??					43.2	m	4.65							4.65	nomo	III	Instruments dismantled; felt over E Hawaii. Warshauer notes: Quake exceptionally severe in Kau district; felt at HVO and along the Hamakua coast as far as Honomu.	Not reported in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 497; HTH, 12/31/1923.
1/8/24	10:46					ml wf??					45.0	s	4.20							4.20	nomo	felt	Felt in Kona.	Not reported in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 504; distance assumed.
3/10/24	17:45					kl sf?					28.8	s	4.11							4.11	nomo			ESPHVO, v. 3, p. 512, 513.
3/29/24	1:27					kl sf?					43.2	s	4.40							4.40	nomo	IV	Felt-Hilo. Warshauer notes: Hilo felt a pretty strong quake at 1:35 a.m. today. Houses in several parts of the town rocked, but no damage was done.	Not reported in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 512, 513; HTH, 3/29/1924.
4/10/24	22:46					kl sf?					30.4	s	4.15							4.15	nomo	V?	Strongish earthquake in Puna, felt in Hilo and reported quite severe in some districts; felt locally, and in Hilo; [distance of 9 mi actually 19? (assume sf from felt reports); east rift traversed on 4/11 and again on 4/16, no new cracks observed].	Not reported in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 516, 525.
4/19/24	7:23					kl ler?					40.0	s	4.34							4.34	nomo			ESPHVO, v. 3, p. 525; distance assumed.
4/28/24	11:35					kl ler					43.2	s	4.40							4.40	nomo			Not reported in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 527.
5/10/24	23:59					kl cal 0-5?					4.0	f	2.20							4.01	nomo		See note for 5/1/24; untabulated feeble = 98.	Phreatic explosions begin evening of 5/10, lasting through 5/27; ESPHVO, v. 3, p. 529-560; 101 earthquakes, 3 felt; 2 explosions; ESPHVO, v. 3, p. 557, table.
5/11/24	23:59					kl cal 0-5?					4.0	f	2.20							4.04	nomo		See note for May 1, 1924; untabulated feeble = 107; beginning of diary of observations made during 1924 crisis; no earthquakes mentioned.	111 earthquakes, 3 felt; 1 explosions; ESPHVO, v. 3, p. 557, table; Jaggar, 1947, p. 214.
5/14/24	23:59					kl cal 0-5?					4.0	f	2.20							4.00	nomo		See note for 5/1/24; untabulated feeble = 96.	113 earthquakes, 17 felt; 3 explosions; ESPHVO, v. 3, p. 557, table.
5/15/24	23:59					kl cal 0-5?					4.0	f	2.20							4.07	nomo		See note for 5/1/24; untabulated feeble = 116.	132 earthquakes, 15 felt; 2 explosions; ESPHVO, v. 3, p. 557, table.
5/16/24	17:33					kl cal deep?					31.0	st?	4.94	5.04	5.38					5.21	hono		HON notes: Timing very similar to quake of May 30.	*Honolulu Station Bulletin* (McFarland, 1929); not reported in Jaggar, 1947, p. 218; not found in MN.
5/16/24	23:59					kl cal 0-5?					4.0	f	2.20							4.35	nomo		See note for 5/1/24; untabulated feeble = 231.	276 earthquakes, 45 felt; 4 explosions; ESPHVO, v. 3, p. 557, table.
5/16/24	23:59					kl cal 0-5?					4.0	s	2.74							4.22	nomo		See note for 5/1/24; untabulated slight = 42.	Do.
5/17/24	23:59					kl cal 0-5?					4.0	s	2.74							4.10	nomo		See note for 5/1/24; untabulated slight = 31.	150 earthquakes, 30 felt; 3 explosions; ESPHVO, v. 3, p. 557, table.
5/17/24	23:59					kl cal 0-5?					4.0	f	2.20							4.07	nomo		See note for 5/1/24; untabulated feeble = 115.	Do.
5/18/24	23:59					kl cal 0-5?					4.0	f	2.20							4.14	nomo		See note for 5/1/24; untabulated feeble = 138.	165 earthquakes, 25 felt; 3 explosions; ESPHVO, v. 3, p. 557, table.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
5/19/24	21:23					a0513					10.0	m-st	4.04							4.04	nomo	IV	A heavy quake, N-S component dismantled, felt strongly at Glenwood.	Jaggar, 1947, p. 227 [for quakes felt away from Kilauea caldera, we assign a 10-km slant distance and region "a0513"; calc magnitudes are constrained by lack of recognition in the *Honolulu Station Bulletin* (McFarland, 1929); film records unavailable].
5/19/24	23:59					kl cal 0-5?					4.0	f	2.20							4.18	nomo		See note for 5/1/24; untabulated feeble = 150.	180 earthquakes, 21 felt; 3 explosions; ESPHVO, v. 3, p. 557, table.
5/20/24	6:17					kaoiki?			19	19.00	21.0	m-st	4.56							4.56	nomo	III	Moderate, sharp; instruments dismantled. Warshauer notes: Four heavy quakes felt at Hilea during the day [5/20].	ESPHVO, v. 3, p. 552; Jaggar, 1947, p. 230; HA, 5/21/1924.
5/20/24	7:03					kaoiki?			19	19.00	21.0	st	4.67							4.67	nomo		Strong; instruments not operating; a very heavy quake. Warshauer notes: Four heavy quakes felt at Hilea during the day [5/20].	ESPHVO, v. 3, p. 552; Jaggar, 1947, p. 230; HA, 5/21/1924.
5/20/24	14:40					kaoiki			19	19.00	21.0	m-st	4.56							4.56	nomo	III	A moderate quake, dismantled both pens; origin more distant than Halemaumau, thought to be in Kau. Warshauer notes: Four heavy earthquakes felt at Hilea during this day [May 20].	Distance of 19 km in Kau direction assumed from report of road cracks (ESPHVO, v. 3, p. 576); not reported in *Honolulu Station Bulletin* (McFarland, 1929); see ESPHVO, v. 3, p. 576; Jaggar, 1947, p. 231; HA, 5/21/1924.
5/20/24	20:46					kaoiki?			19	19.00	21.0	m-st	4.56							4.56	nomo	III	Heavy shock dismantles pen. Warshauer notes: Four heavy quakes felt at Hilea during the day [5/20].	Jaggar, 1947, p. 232; HA, 5/21/1924.
5/20/24	23:59					kl cal 0-5?					4.0	f	2.20							4.21	nomo		See note for 5/1/24; untabulated feeble = 164.	201 earthquakes, 41 felt; 3 explosions; ESPHVO, v. 3, p. 557, table.
5/21/24	23:59					kl cal 0-5?					4.0	f	2.20							4.34	nomo		See note for May 1, 1924; untabulated feeble = 225. Warshauer notes: Almost continual quakes have been recorded during the past 2 days [May 19-20] at Hilea.	275 earthquakes, 50 felt; 4 explosions; ESPHVO, v. 3, p. 557, table; HA, 5/22/1924.
5/21/24	23:59					kl cal 0-5?					4.0	s	2.74							4.19	nomo		See note for May 1, 1924; untabulated slight = 39. Warshauer notes: Almost continual quakes have been recorded during the past 2 days [May 19-20] at Hilea.	Do.
5/22/24	23:59					kl cal 0-5?					4.0	f	2.20							4.38	nomo		See note for May 1, 1924; untabulated feeble = 255. Warshauer notes: Visit to Kau found no new cracks [but see ESPHVO, v. 3, p. 576]; Kapoho area continues to experience slight earthquakes.	339 earthquakes, 75 felt; 3 explosions; ESPHVO, v. 3, p. 557, table; HA. 5/23/1924.
5/22/24	23:59					kl cal 0-5?					4.0	s	2.74							4.13	nomo		See note for May 1, 1924; untabulated slight = 34. Warshauer notes: Visit to Kau found no new cracks [but see ESPHVO, v. 3, p. 576]; Kapoho area continues to experience slight earthquakes.	Do.
5/23/24	23:59					kl cal 0-5?					4.0	f	2.20							4.28	nomo		See note for May 1, 1924; untabulated feeble = 198. Warshauer notes: Hilea is recording an almost continuous tremble on the seismograph, but no perceptible earthquakes; no activity in Hilo, other than a few scattered and inconsiderable earthquakes.	257 earthquakes, 59 felt; 3 explosions; ESPHVO, v. 3, p. 557, table; HA, 5/24/1924, p. 2.
5/23/24	23:59					kl cal 0-5?					4.0	s	2.74							4.22	nomo		See note for May 1, 1924; untabulated slight = 42. Warshauer notes: Hilea is recording an almost continuous tremble on the seismograph, but no perceptible earthquakes; no activity in Hilo, other than a few scattered and inconsiderable earthquakes.	257 earthquakes, 59 felt; 3 explosions; ESPHVO, v. 3, p. 557, table; HA, 5/24/1924, p. 2.
5/24/24	3:48					a0513					10.0	m-st	4.04							4.04	nomo	IV	This quake, as with many others, caused the E or SE part of the building to creak first, followed by windows rattling on W side. Warshauer notes: Quakes shake Hilo Saturday morning; a rather strong earthquake shock was felt [in Pahala] early this morning.	See note for May 19, 1924; time 11:23; Jaggar, 1947, p. 246; HA, 5/24, 27/1924.

Table 13. All earthquakes of *M*≥4.0 during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
5/24/24	5:51					a0513					10.0	m-st	4.04							4.04	nomo	III	Both components dismantled. Warshauer notes: Quakes shake Hilo Saturday morning.	See note for May 19, 1924; time 11:23; Jaggar, 1947, p. 246; HA, 5/24/1924.
5/24/24	23:59					kl cal 0-5?					4.0	f	2.20							4.56	nomo	felt	See note for May 1, 1924; untabulated feeble = 400. Warshauer notes: Earthquakes were distinctly felt in Hilo last night [May 23-24], but no tremors were reported from any section today.	467 earthquakes, 67 felt; 2 explosions; ESPHVO, v. 3, p. 557, table; HA, 5/25/1924.
5/24/24	23:59					kl cal 0-5?					4.0	s	2.74							4.23	nomo	felt	See note for May 1, 1924; untabulated slight = 43. Warshauer notes: Earthquakes were distinctly felt in Hilo last night [May 23-24], but no tremors were reported from any section today.	467 earthquakes, 67 felt; 2 explosions; ESPHVO, v. 3, p. 557, table; HA, 5/25/1924.
5/25/24	23:59					kl cal 0-5?					4.0	f	2.20							4.29	nomo		See note for 5/1/24; untabulated feeble = 202.	248 earthquakes, 45 felt; 2 explosions; ESPHVO, v. 3, p. 557, table.
5/25/24	23:59					kl cal 0-5?					4.0	s	2.74							4.10	nomo		See note for 5/1/24; untabulated slight = 31.	Do.
5/26/24	8:06					a0513					10.0	m-st	4.04							4.04	nomo	IV	A moderate quake; dismantled both instruments. Warshauer notes: A strong earthquake shook the entire Kilauea district at 9 o'clock [time wrong?].	See note for May 19, 1924; time 11:23; Jaggar, 1947, p. 253; HA, 5/27/1924.
5/26/24	23:59					kl cal 0-5?					4.0	f	2.20							4.14	nomo		See note for 5/1/24; untabulated feeble = 137.	156 earthquakes, 19 felt; 1 explosion; ESPHVO, v. 3, p. 557, table.
5/27/24	23:59					kl cal 0-5?					4.0	s	2.74							4.74	nomo		See note for 5/1/24; untabulated slight = 17.	195 earthquakes, 36 felt; 1 explosion; ESPHVO, v. 3, p. 557, table.
5/27/24	23:59					kl cal 0-5?					4.0	f	2.20							4.20	nomo		See note for 5/1/24; untabulated feeble = 158.	Do.
5/28/24	23:59					kl cal 0-5?					4.0	f	2.20							4.06	nomo		See note for 5/1/24; untabulated feeble = 111.	130 earthquakes; ESPHVO, v. 3, p. 560, table.
5/30/24	8:42					kl cal deep?					10.0	st	4.15	5.78	5.91					5.85	hono	V	HON notes: Evidently not far away; unusually strong; both instruments dismantled; raised dustcloud at pit; N-S component set back 0.5 in. on drum; tilt strong NE; strongest quake felt here in a long time.	*Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 556; Jaggar, 1947, p. 259.
7/20/24	13:25					hilo					43.2	s	4.40							4.40	nomo	VI	Felt locally. Warshauer notes: Quake duration several seconds, severe, rocked Hilo, knocked pictures and vases down; seemed to come in a wave, which shook their houses in sections at a time as the wave seemed to pass on.	ESPHVO, v. 3, p. 586; not in *Honolulu Station Bulletin* ; HTH, 7/21/1924.
8/20/24	6:20					kaoiki					25.6	m	4.80					5	W&K	5.00	nomo	V (Kau)	Earthquake centering near Kapapala, felt-HVO, Hilo, Pahala, and Kona, but not Kapoho; distance, 16 mi, felt all over Hawaii; isoseismal map in W&K, who suggest a Hilea epicenter.	ESPHVO, v. 3, p. 590, 592, 595; [*M* ~5.0 predicts an amp of 4 mm on Milne-Shaw, which was not reported in *Honolulu Station Bulletin*]; HTH, 8/20/1924; see references.
8/20/24	22:48					kaoiki?					25.6	s	4.03							4.03	nomo			Aftershocks(?)-distance and region assumed; ESPHVO, v. 3, p. 595.
8/23/24	0:10					ml mok					32.0	s	4.19							4.19	nomo	V?	Sharply felt at HVO; felt very severe at Mokuaweoweo.	[Distance of 2 mi inconsistent with felt report; misprint for 20?] ESPHVO, v. 3, p. 590, 592, 595.
8/23/24	0:13					ml mok					32.0	m	4.68		5.59					5.59	hono	V-VI	Sharply felt at HVO; felt very severe, and stone monuments shaken down and ground cracked open at Mokuaweoweo; seismographs dismantled; distance, 20 mi. HON notes: Onset to max 1 min 10 s; 1-s period.	*Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 590, 592, 595; [probably larger than 8/20/24 *M* =5.0 at Hilea, which was not reported in *Honolulu Station Bulletin*]; not in HTH.
8/24/24	7:48					ml mok?					32.0	s	4.19							4.19	nomo	felt	Presumed felt more strongly in Kau than Puna.	[Distance of 2 mi inconsistent with statement on p. 590; misprint for 20?] ESPHVO, v. 3, p. 590, 595.
9/8/24	22:07					kona					57.6	s	4.37							4.37	nomo	felt	Felt in Kona.	Not found in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 600, 602.
9/10/24	17:03					mauna kea?					40.0	s	4.12							4.12	nomo	felt	ESPHVO v. 3, p. 604, notes: (Felt in Hilo and Honokaa).	Not found in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 604.
10/10/24	0:21					ml swr?					51.2	s	4.29							4.29	nomo	felt	Felt in Hilea.	Not found in *Honolulu Station Bulletin* (McFarland, 1929); ESPHVO, v. 3, p. 615.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
10/18/24	14:10					hilea??					40.0	m	4.60							4.60	nomo	felt	Felt locally.	Do.
2/18/25	10:18					kohala?					90	f	4.09							4.09	nomo	felt	Probably in Kohala; felt in Kohala.	Not in *Honolulu Station Bulletin* (Neumann, 1926); ESPHVO, v. 3, p. 661, 669; VL 9.
2/23/25	10:20					a2025					20.77	m	4.15							4.15	nomo	III	Dismantled instruments.	Not in *Honolulu Station Bulletin* (Neumann, 1926); ESPHVO, v. 3, p. 661, 669; VL 9.
4/15/25	5:28					a3035					30.35	s	4.15							4.15	nomo	IV	Awakened a few at Volcano House.	ESPHVO, v. 3, p. 687, 689; VL 16.
4/20/25	20:52					ml mok?					33.55	s	4.22							4.22	nomo	felt	Felt locally; gave the appearance of a Mauna Loa shake.	ESPHVO, v. 3, p. 687, 689; VL 17.
5/17/25	2:02					kaoiki?					28.75	s	4.11							4.11	nomo	IV	Felt locally, strong at Hilea.	ESPHVO, v. 3, p. 695, 696; VL 21.
7/4/25	19:55					ml mok?					35.14	s	4.25							4.25	nomo	felt	Felt locally and in Hilo (VL).	ESPHVO, v. 3, p. 719; VL 28.
7/6/25	13:47					a1320					17.57	m	4.27							4.27	nomo	III	Dismantled instruments; felt locally.	ESPHVO, v. 3, p. 719.
7/8/25	5:45					a1320					17.6	s	4.03							4.03	nomo	IV (USE)	Felt all over Hawaii (moderate or strong?, or greater distance?); VL 28 has incorrect(?) time of 0645. HON notes: Not registered but felt report received—time 16:20, felt by several at Kapaau; rapid bump; sounds faint rattle; two shocks.	*Honolulu Station Bulletin* (Neumann, 1926c); ESPHVO, v. 3, p. 719; VL 29.
7/14/25	3:23					hilea?					43.13	s	4.17							4.17	nomo	felt	Felt at Pahala (VL).	ESPHVO, v. 3, p. 713, 719; VL 29.
7/27/25	2:42					a3035					30.35	s	4.15							4.15	nomo	felt	Felt locally.	ESPHVO, v. 3, p. 714, 720; VL 31.
8/19/25	11:32					mauna kea?					65.5	s	4.46							4.46	nomo	IV (Kohala)	Felt in Hilo and Kohala. HON notes: Not recorded; felt report from Kohala, time 10:35, "felt by sev; rpd bump rkg trm ls; sounds ld rmb rtl bef."	ESPHVO, v. 3, p. 723, 725; VL 35; *Seismological Report* (Honolulu Magnetic Observatory), July-September 1925 (Neumannn, 1926).
8/19/25	15:48					mauna kea?					63.9	s	4.44							4.44	nomo			ESPHVO, v. 3, p. 725.
8/28/25	21:03					mauna kea?					68.69	f	4.17							4.17	nomo	V; IV (Kohala)	Felt at Kona and Honokaa; plainly felt Kealakekua; not felt HVO. HON notes: Not registered; felt report from Kohala: "felt by sev; doors mvd; rapid trm short dur; sounds rtl." USEQ notes: Time 07:36; felt by several in Kohala; doors moved; short duration.	ESPHVO, v. 3, p. 723, 725; VL 36; *Seismological Report* (Honolulu Magnetic Observatory), July-September 1925 (Neumannn, 1926).
9/5/25	15:34					mauna kea?					62.3	s	4.43							4.43	nomo	felt	Felt locally.	Not in *Honolulu Station Bulletin* (Neumann, 1926c); ESPHVO, v. 3, p. 734; VL 37.
10/28/25	16:52					a2530					28.75	s	4.11							4.11	nomo	felt	Felt locally (VL), 8 mi (18?) to SE.	ESPHVO, v. 3, p. 750; VL 45.
12/8/25	22:16					hilea?					30.4	s	4.15							4.15	nomo	V-VI	Around 10:14 p.m. a prolonged quake, pheasants squawked much during and after main shock, and a dog jumped up and showed alarm; felt locally; felt locally and in Hilo. Warshauer notes: Knocked down books and dishes in Pahala, sent furniture across floor.	Distance given as 9 mi, 19 mi more consistent with felt report; not in *Honolulu Station Bulletin* (Neumann, 1927a); ESPHVO, v. 3, p. 762, 767, 768; VL 50; HTH, 12/9/1925. See references.
1/16/26	12:33					kaoiki?					22.36	s	4.20							4.20	nomo	felt	Felt in Hilo and Kona; plainly felt in Hilo.	ESPHVO, v. 3, p. 772, 782; VL 56.
2/7/26	11:28					maui?								4.30	4.29					4.30	hono	IV (Maui); III (Honolulu)	Felt-Honolulu and Maui. Cox notes: 124 mi from Kilauea. Warshauer notes: Sharp shock on Maui (like an explosion) and Honolulu; two shocks on Maui 2 minutes apart, second one at 11:30 brought people out doors; also felt on Oahu.	ESPHVO, v. 3, p. 785, 793 [time given as 11:30 in table]; VL 59; Cox, 1986, p. 64; HTH, 2/8/1926; MN, 2/10/1926
2/28/26	6:41					kaoiki?					19.17	m	4.33							4.33	nomo	V (W&K)	ESPHVO, v. 3, p. 786—con.: Strongest eq felt on Kapapala Ranch within past 2 years; also felt at Puu Oo on S slope of Mauna Kea; epicenter estimated under Mauna Loa NE rift; VL 62 notes repeats ESPHVO. USEQ notes: (Felt by many standing); see references.	ESPHVO, v. 3, p. 786, 793 notes: quake centered under Mauna Loa; felt generally throughout the Island of Hawaii, duration more than 10 s at Kilauea; dismantled seismographs at HVO and Kona; dislodged rock and broke pipe at Kapapala; HTH, 3/1/1926.
3/19/26	22:33					alenuihaha					118.2	m	5.59		5.52			≥6	W&K	5.52	hono	V (Kohala); IV-V (Honolulu)	HON notes: Heeia (Oahu)—felt tremor, dur 1.5 s; Ewa (Oahu)—distinctly felt by sev, Haiku (Maui)—felt abt 1 min, E to NW; Kohala—felt by many; rpd trm 1m; rtl sounds; Honomu—felt by many; grd rkg S abt 20 m.; Volcano House—felt distinctly by all.	Intensity map in W&K; *Seismological Report* (Honolulu Magnetic Observatory), January-March 1926 (Neumann and Service, 1927).

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
3/20/26	7:27					alenuihaha					118.2	s	4.87		4.10					4.10	hono	felt	HON notes: felt; aftershock felt at Kohala, felt locally; recorded at Hilo, Kona, Hilea and HVO. Warshauer notes: Felt at Kohala 7:30 a.m., not as strong as last night's shock; a very light quake was felt in Hilo shortly after 7.	Neumann and Service, 1927a; ESPHVO, v. 3, p. 796, 798, 803; VL 65; HTH, 3/20/1926; HSB, 3/20/1926; HA, 3/21; 27/1926; MN, 3/24/1926
3/29/26	0:34					ml ner?					30.35	m	4.41							4.41	nomo	III	Dismantled one seismograph component.	Not in *Honolulu Station Bulletin* (Neumann and Service, 1927); ESPHVO, v. 3, p. 796, 803; VL 66.
4/1/26	23:59					ml mok?					35	f-s	4.03							4.66	nomo		Preferred magnitude calculated as Richter distribution assuming b =1.8 and 76 events of M >3.25 apportioned over the month.	Distance and region assumed; 5 shakes; ESPHVO, v. 3, p. 836, table.
4/2/26	23:59					ml mok?					35	f-s	4.03							4.30	nomo		Do.	Distance and region assumed; 2 shakes; ESPHVO, v. 3, p. 836, table.
4/4/26	23:59					ml mok?					35	f-s	4.03							4.79	nomo		Do.	Distance and region assumed; 7 shakes; ESPHVO, v. 3, p. 836, table.
4/5/26	23:59					ml mok?					35	f-s	4.03							4.30	nomo		Do.	2 shakes; ESPHVO, v. 3, p. 836, table.
4/7/26	23:59					ml mok?					35	f-s	4.03							4.03	nomo		Do.	Distance and region assumed; 1 shake; ESPHVO, v. 3, p. 836, table.
4/8/26	23:59					ml mok?					35	f-s	4.03							4.57	nomo		See note for April 1, 1926.	Distance and region assumed; 4 shakes; ESPHVO, v. 3, p. 836, table.
4/9/26	16:30					ml mok?					35	s-m	4.51							4.51	nomo	felt	Not registered; felt report from the Island of Hawaii: several shocks preceded eruption of Mauna Loa. "Shocks almost incessant until 20th."	*Seismological Report* (Honolulu Magnetic Observatory), April-June 1926 (Neumann, 1928).
4/9/26	23:59					ml mok?					35	f-s	4.03							4.30	nomo		2 shocks not reported.	Distance and region assumed; 3 shakes; ESPHVO, v. 3, p. 836, table.
4/10/26	1:50					ml mok?					35	s-m	4.51							4.51	nomo	felt	Felt widely on E half of the Island of Hawaii; epicenter at upper end of Mauna Loa southwest rift to east of Mokuaweoweo. Warshauer notes: Felt widely on east half of island.	Not reported at Honolulu Magnetic Observatory (Neumann, 1928); ESPHVO, v. 3, p. 807, 812; VL 68; HTH, 04/15.
4/10/26	2:04					ml mok?					35	s-m	4.51							4.51	nomo		Do.; small tidal waves noted at Hilo and Kona [HA] following these two quakes.	Not reported at Honolulu Magnetic Observatory (Neumann, 1928); ESPHVO, v. 3, p. 807, 812; VL 68; HA, 04/10; HTH, 04/15.
4/10/26	23:59					ml mok?					35	f-s	4.03							5.71	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/10/26	23:59					ml mok?					35	m	4.91							4.96	nomo	felt	4 felt at HVO; local earthquakes during the last few months with origin distance about 19 mi (30.4 km) and line of direction suggesting the northeast summit region of Mauna Loa; additional notes on the eruption in VL 68-72; see note for April 1, 1926.	75 earthquakes; ESPHVO, v. 3, p. 811, table, p. 813 [seismic prelude to Mauna Loa southwest rift eruption]; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/10/26	23:59					ml mok?					35	s-m	4.51							4.45	nomo		Do.	Do.; 0.872 quakes felt at HVO, not reported separately.
4/11/26	23:59					ml swr?					47.3	f-s	4.24							5.63	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/11/26	23:59					ml swr?					47.3	m	5.12							4.62	nomo	felt	1 felt at HVO; see note for April 1, 1926.	35 earthquakes; ESPHVO, v. 3, p. 811, table; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/11/26	23:59					ml swr?					47.3	s-m	4.72							4.59	nomo		Do.	Do.; 0.872 quakes felt at HVO, not reported separately.
4/12/26	11:41					ml swr?					48	s-m	4.73							4.73	nomo	felt	Swaying eq, producing the effect of E-W rocking; felt-Pahala and HVO.	ESPHVO, v. 3, p. 812.
4/12/26	11:48					ml ner?					25	s-m	4.27							4.27	nomo	III (Honomu)	Felt by many at Honomu, rpd trm; 2 s, val. USEQ notes: 22:25, felt by many (int III); stronger than 11:41 quake; not individually listed in table; felt-Pahala and HVO; most shakes from extension of mlswr; some from mok and mlner.	Neumann, 1928; ESPHVO, v. 3, p. 812; VL 68.
4/12/26	23:59					ml swr?					47.3	f-s	4.24							5.95	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
4/12/26	23:59					ml swr?					47.3	m	5.12							5.26	nomo	felt	5 felt at HVO, many felt at Pahala in forenoon; earthquakes felt at MLO camp during the day; see note for April 1, 1926.	81 earthquakes; ESPHVO, v. 3, p. 811, table, p. 812, 816; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/12/26	23:59					ml swr?					47.3	s-m	4.72							4.90	nomo		Do.	do; 0.872 quakes felt at HVO, not reported separately
4/13/26	4:30					ml swr?		5	47		47.27	s-m	4.72							4.72	nomo		One of 2 strongest shakes of series [confused with quake at 19:46?]; Waiohinu telephone operator timed shock Tuesday morning [Apr. 13], dur 1 min.	Not reported by Honolulu Magnetic Observatory; ESPHVO, v. 3, p. 812; HSB, 4/14/26.
4/13/26	7:30					ml swr?		5	47		47.27	s-m	4.72							4.72	nomo	felt	Felt at HVO.	ESPHVO, v. 3, p. 812.
4/13/26	14:30					ml swr?		5	47		47.27	s-m	4.72							4.72	nomo	felt	Sharp shock felt at HVO.	Do.
4/13/26	19:46					hilea			45		45.89	m	5.10	5.21	5.05					5.13	hono	felt	Unusually sharp quake felt on Mauna Loa this evening; quake with strong, twisting motion felt at HVO, dur >30 s (Whitney); alarming shock at 7:45 p.m. with wrenching movement and creaking of rocks; Honolulu time, 19:41. Warshauer notes: hm crack widened.	Neumann, 1928; ESPHVO, v. 3, p. 807, 813, 817; HTH, 4/15/1926.
4/13/26	23:59					ml swr?					47.3	f-s	4.24							5.94	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/13/26	23:59					ml swr?					47.3	m	5.12							5.21	nomo	felt	9 felt at HVO; see note for April 1, 1926. Warshauer notes: 50 slight shocks between 3 and 4 p.m.; 150 recorded at HVO, 12 felt, 6 severe; earthquakes felt on higher slopes of Mauna Loa, including rift cones.	83 earthquakes; ESPHVO, v. 3, p. 811, table; HSB, 4/14/26; HA, 4/14/1926; HTH, 4/15/1926; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/13/26	23:59					ml swr?					47.3	s-m	4.72							5.12	nomo		Do.	Do.; 0.872 quakes felt at HVO, not reported separately.
4/14/26	2:45					ml swr?					47	s-m	4.71							4.71	nomo	felt	Earthquake with E-W motion felt at Wingate camp.	ESPHVO, v. 3, p. 817.
4/14/26	3:50					ml swr?					47	s-m	4.71							4.71	nomo	felt	Vertical jolt followed by N-S motion felt at Wingate camp.	ESPHVO, v. 3, p. 817.
4/14/26	8:30					ml swr?					47	s-m	4.71							4.71	nomo	felt	Light earthquake felt at Wingate camp. Warshauer notes: Vigorous fountains in the Alika source about 8:30 a.m. April 14.	ESPHVO, v. 3, p. 817; HTH, 4/15/1926 [beginning of Mauna Loa's lower southwest rift eruption].
4/14/26	12:00					ml swr?					47	s-m	4.71							4.71	nomo	felt	Felt (at Wingate camp?).	ESPHVO, v. 3, p. 818.
4/14/26	15:30					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/14/26	15:45					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/14/26	21:45					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/14/26	23:59					ml swr?					47.3	f-s	4.24							5.79	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/14/26	23:59					ml swr?					47.3	m	5.12							5.49	nomo	felt	9 felt at HVO; see note for April 1, 1926.	60 earthquakes; ESPHVO, v. 3, p. 811, table; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/14/26	23:59					ml swr?					47.3	s-m	4.72							5.07	nomo		Do.	Do.; 0.872 quakes felt at HVO, not reported separately.
4/15/26	5:45					ml swr?								4.99	4.69					4.85	hono	felt	Felt (at Wingate camp?); Honolulu time, 5:46.	ESPHVO, v. 3, p. 818.
4/15/26	7:50					ml swr?					47	s-m	4.71							4.71	nomo	felt	Felt (at Wingate camp?).	Do.
4/15/26	12:12					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/15/26	14:05					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/15/26	15:20					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/15/26	17:21					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/15/26	19:15					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/15/26	21:09					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/15/26	21:15					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/15/26	21:45					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/15/26	23:59					ml swr?					47.3	f-s	4.24							5.92	nomo		Do.	do; 71 quakes not felt at HVO, not reported separately
4/15/26	23:59					ml swr?					47.3	m	5.12							5.64	nomo	felt	13 felt at HVO; see note for April 1, 1926	86 earthquakes; ESPHVO, v. 3, p. 811, table; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926
4/16/26	1:15					ml swr?					47	s-m	4.71							4.71	nomo	felt	Felt (at Wingate camp?).	ESPHVO, v. 3, p. 818.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
4/16/26	1:17					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	6:16					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	9:30					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	10:10					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	11:00					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	11:58					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	12:03					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	13:10					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	13:18					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	13:34					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	13:59					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	16:10					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	17:27					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	19:56					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	20:08					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/16/26	21:59					ml swr?					47	s-m	4.71	4.42	4.51					4.46	hono			Not specifically mentioned in ESPHVO or VL.
4/16/26	23:08					ml swr?					47	s-m	4.71							4.71	nomo	felt	Felt (at Wingate camp?).	ESPHVO, v. 3, p. 818.
4/16/26	23:59					ml swr?					47.3	f-s	4.24							5.73	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/17/26	1:16					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	ESPHVO, v. 3, p. 818
4/17/26	7:26					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/17/26	12:06					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/17/26	12:12					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/17/26	15:44					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/17/26	15:45					ml swr?					47	s-m	4.71							4.71	nomo	felt	Do.	Do.
4/17/26	23:59					ml swr?					47.3	f-s	4.24							5.72	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/17/26	23:59					ml swr?					47.3	m	5.12							5.39	nomo	felt	7 felt at HVO; see note for April 1, 1926.	53 earthquakes; ESPHVO, v. 3, p. 811, table; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/18/26	2:35					ml swr?					47	s-m	4.71	4.42	4.69					4.55	hono	felt	Felt (at Wingate camp?); Honolulu time, 2:45.	ESPHVO, v. 3, p. 818.
4/18/26	3:50					ml swr?					47	s-m	4.71							4.71	nomo	felt	Felt (at Wingate camp?).	Do.
4/18/26	4:22					ml swr?					47	s-m	4.71	4.50	4.51					4.50	hono	felt	Felt (at Wingate camp?); Honolulu time, 4:33.	Do.
4/18/26	11:03					ml swr?					47	s-m	4.71							4.71	nomo	felt	Felt (at Wingate camp?).	Do.
4/18/26	11:09					ml swr?					47	s-m	4.71							4.71	nomo	felt	Felt (at Wingate camp?). Warshauer notes: 250 quakes recorded at HVO from 4/14 to 4/18 a.m., none of great strength.	ESPHVO, v. 3, p. 818; HSB, 4/20/1926.
4/18/26	12:27					ml swr?					47	s-m	4.71							4.71	nomo	felt	Felt (at Wingate camp?).	ESPHVO, v. 3, p. 818.
4/18/26	13:58					ml swr?			45		45.89	m	5.10	5.16	5.21					5.18	hono	felt	HON notes: Origin time accepted over HVO felt times; sharp earthquake felt at HVO and elsewhere at 14:05; felt (at Wingate camp?) at 13:45. USEQ notes: Strong shock; Honolulu time, 13:57; distance, 325 km.	Neumann, 1928, has earthquake at 14:00, 325 km distant; ESPHVO, v. 3, p. 813, 818, 831.
4/18/26	23:59					ml swr?					47.3	m	5.12							5.36	nomo	felt	10 felt at HVO; see note for April 1, 1926.	26 earthquakes; ESPHVO, v. 3, p. 811, table; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/18/26	23:59					ml swr?					47.3	f-s	4.24							5.33	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/18/26	23:59					ml swr?					47.3	s-m	4.72							4.78	nomo		Do.	Do.; 0.872 quakes felt at HVO, not reported separately.
4/19/26	9:13					ml swr?		5	47		47.27	s-m	4.72							4.72	nomo	III	Dismantled seismographs at Hilea, Hilo, and Kealakekua; felt at, said to be the strongest yet. Warshauer notes: Severe earthquakes at 9:06 and 9:46 this morning were reported from, but were not felt at, Kau; felt locally.	Not reported at Honolulu Magnetic Observatory; ESPHVO, v. 3, p. 831; HSB, 4/19/1926; HTH, 4/25/1926.
4/19/26	23:59					ml swr?					47.3	f-s	4.24							5.33	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
4/19/26	23:59					ml swr?					47.3	m	5.12							5.17	nomo	felt	4 felt at HVO.	20 earthquakes; ESPHVO, v. 3, p. 811, table; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/19/26	23:59					ml swr?					47.3	s-m	4.72							4.96	nomo		Do.	Do.; 0.872 quakes felt at HVO, not reported separately.
4/20/26	17:00					ml swr?					47	s-m	4.71							4.71	nomo	felt	Strong, swaying earthquake, with displacement to N and E, felt at HVO. Warshauer notes: Terrific earthquakes shook the Kilauea section at 5:05 o'clock this afternoon, causing enormous avalanches in Halemaumau pit and frightening guests at Volcano House.	ESPHVO, v. 3, p. 813; HA, 4/21/1926.
4/20/26	23:59					ml swr?					47.3	f-s	4.24							5.44	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/20/26	23:59					ml swr?					47.3	m	5.12							4.90	nomo	felt	2 felt at HVO; see note for April 1, 1926	23 earthquakes; ESPHVO, v. 3, p. 811, table; VL 69; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/20/26	23:59					ml swr?					47.3	s-m	4.72							4.39	nomo		Do.	Do.; 0.872 quakes felt at HVO, not reported separately.
4/21/26	21:30					ml swr?					47	s-m	4.71							4.71	nomo	felt	Small earthquake felt at Kahuku ranch.	ESPHVO, v. 3, p. 833.
4/21/26	23:59					ml swr?					47.3	f-s	4.24							5.33	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/21/26	23:59					ml swr?					47.3	m	5.12							4.62	nomo	felt	1 felt at HVO; see note for April 1, 1926	17 earthquakes; ESPHVO, v. 3, p. 811, table; 1.128 quakes assumed to have dismantled seismograph; see note for May 1, 1926.
4/21/26	23:59					ml swr?					47.3	s-m	4.72							4.59	nomo		Do.	Do.; 0.872 quakes felt at HVO, not reported separately.
4/22/26	4:32					kaoiki deep?					40	m	5.01	4.17	4.47			5.3	maxi-mum intensity	5.30	inten-sity	V (W&K); III (Honolulu)	Felt reports from Hilo and Honolulu: Hilo—P. one building shaken 6 in. from foundation; heavy tremors caused by Mauna Loa Volcano; Honolulu—felt by many; rpd rkg, E-W, 3 s, mts and val. USEQ notes: Repeats Neumann, 1928.	*Seismological Report* (Honolulu Magnetic Observatory), April-June 1926 (Neumann, 1928); [station HON record almost obscured by microseisms; HON amp & mag are low; preferred mag based on intensity].
4/22/26	23:05					kaoiki?					19.2	s-m	4.09							4.09	nomo		No list of separate events.	ESPHVO, v. 3, p. 806.
4/22/26	23:59					kaoiki??					19.2	f-s	3.61							4.43	nomo		Do.	Do.; 71 quakes not felt at HVO, not reported separately.
4/22/26	23:59					kaoiki??					19.2	s-m	4.09							4.34	nomo		Do.	Do.; 0.872 quakes felt at HVO, not reported separately.
4/23/26	23:59					kaoiki??					19.2	f-s	3.61							4.72	nomo		See note for April 1, 1926.	6 earthquakes; ESPHVO, v. 3, p. 811, table.
4/24/26	23:59					kaoiki??					19.2	f-s	3.61							4.56	nomo	felt	See note for April 1, 1926. Warshauer notes: two probably felt in Hilo.	4 earthquakes; ESPHVO, v. 3, p. 811, table; HSB, 4/24/1926
4/25/26	23:59					kaoiki??					19.2	f-s	3.61							4.28	nomo		See note for April 1, 1926.	2 earthquakes; ESPHVO, v. 3, p. 811, table.
4/26/26	23:59					kaoiki??					19.2	f-s	3.61							4.01	nomo		Do.	1 earthquake; ESPHVO, v. 3, p. 811, table.
4/27/26	23:59					kaoiki??					19.2	f-s	3.61							4.01	nomo		Do.	Do.
4/28/26	23:59					kaoiki??					19.2	f-s	3.61							4.01	nomo		See note for April 1, 1926.	Do.
5/31/26	19:10					hilea?					35.14	s	4.25							4.25	nomo	III (Waiohinu)	Felt locally and Hilo. HON notes: Not recorded; felt by many sitting; abr prolonged but not severe, finished trm; dishes rtl; pln rky. USEQ notes: Repeats Neumann, 1928.	ESPHVO, v. 3, p. 854; VL 75; *Seismological Report* (Honolulu Magnetic Observatory), April-June 1926 (Neuman, 1928).
6/4/26	1:53					east hawaii						s			4.40					4.40	hono	IV; II (USE)	Slightly felt in Hilo (VL). HON notes: Felt by sev lying down [Honomu]; grd trm, N-S; 2 shocks abt 2 s each. USEQ notes: Repeats Neumann, 1928.	ESPHVO, v. 3, p. 858; VL 76; *Seismological Report* (Honolulu Magnetic Observatory), April-June 1926 (Neuman, 1928); not found in MN.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
6/9/26	9:34					kaoiki					25.6	m	4.53					5.3	intensity	4.90	nomo	V (W&K); IV-V Kapapala. USEQ notes: IV Waiohinu; IV Pahala; III Pepeekeo	Dismantled seismographs; distance, 16 mi to the SW; felt locally and stronger at Kapapala; widely felt over island, shook items from shelves at Kapapala; felt reports from Waiohinu, Pahala, and Pepeekeo. Warshauer notes: Repeats info.	Neumann, 1928; ESPHVO, v. 3, p. 856, 858; VL 76; HTH, 6/9/1926; preferred magnitude calculated as average of intensity and nomogram.
10/25/26	21:26					ml swr?					39.94	m	4.84							4.84	nomo	IV Waiohinu	Widely felt, felt locally; felt Hilo & Waiohinu; 46 mi from Hilo; probably near Mauna Loa summit; time 21:00; Waiohinu—felt by many; rpd trm appeared to be from N to S; pln rky. USEQ notes: Repeats Neumann, 1928.	ESPHVO, v. 3, p. 912, 913; VL 105; *Seismological Report* (Honolulu Magnetic Observatory), October-December 1926 (Neumann, 1928); not registered on Oahu.
2/2/27	23:26					kona					71.88	f	4.20							4.20	nomo	felt	Felt locally.	ESPHVO, v. 3, p. 934.
3/20/27	4:52					mauna kea os deep?		30			80	m	5.32	>6.43	6.77	>6.43		6	W&K	6.77	hono	V (Kukuihaele); IV (Haiku, Hamakua, Kohala, Waiohinu, Honolulu, Waimanalo); III (Hilo)	HON notes: Felt throughout Hawaiian Islands; felt times, 4:45-5:00; Haiku, Maui-felt by many; rpd trm; pln. Hamakua-1 shock; grd trm N-S; felt by many; made loud sounds; hls sandy. Hilo-felt by sev; grd trm; 3 clocks on higher levels stopped; pln rocky.	*Seismological Report* (Honolulu Magnetic Observatory), Jan.-3/1927 (Neumann, 1929): probably submarine origin; On NS the motion of the light spot was too rapid to register the maximum amplitude. Recorded on the D and H variometers at Ewa.
4/30/27	13:34					mauna kea					63.9	s	4.44							4.44	nomo	IV (Haina)	Not recorded; HVO time, 14:43 [wrong?]; Haina—felt by part of pop; many alarmed; windows rtl; rpd trm, then bmp, then trm: 15 s; 1d thn sounds; hls, rky; felt locally; felt by a few in HVO and Hilo; Hilo dist, 34 mi; followed by vf aftershocks.	Neumann, 1930; ESPHVO, v. 3, p. 962; VL 123 [max accel, 11.0 mm/s^2, minimum slight?].
7/7/27	3:21					mauna loa deep?					55.91	m	5.07		>5.1?					5.07	nomo	IV-V HVO; IV at Haina & Honomu & Kohala	HON notes: det, no amp; very rapid; Haina-felt by majority; rpd bmp EW about 10 s; 2d shock about 1/2 m; Honomu-felt by many; rpd rkg SW; Kohala-felt by many; rpd bmp; 2 shocks each 2 or 3 s; hls; felt all island; wakened persons at summer camp [hnp].	Neumann, 1930; ESPHVO, v. 3, p. 991, 993, 1002; VL 133 [sugg. high freq. deep event; hotspot activation(?)].
7/24/27	6:05					a3540					40	s	4.34							4.34	nomo	felt	Felt locally.	ESPHVO, v. 3, p. 1002; VL 135.
7/25/27	2:07					ml nf??					39.94	s	4.34							4.34	nomo	II (Honomu)	Felt locally; felt Volcano & Hilo, possibly elsewhere. HON notes: Time, 2:10; Honomu-felt by sev; grd rkg NS; mts. USEQ notes: Repeats Neumann, 1930. Warshauer notes: Two quakes, 2:07 and 6:13 a.m., felt at Hilo and volcano districts.	ESPHVO, v. 3, p. 1002; VL 135; *Seismological Report* (Honolulu Magnetic Observatory), July-September 1927 (Neumann, 1930); HTH, 7/25/1927.
7/25/27	6:13					hilea?					44.73	s	4.42							4.42	nomo	III (Waiohinu)	Waiohinu-felt by many; grd sway N-S; rky; felt locally; felt Volcano & Hilo, possibly elsewhere. Warshauer notes: Two quakes, 2:07 and 6:13 a.m., felt at Hilo and volcano districts.	*Seismological Report (Honolulu Magnetic Observatory), July-September 1927 (Neumann, 1930) [time given as 7/26 at 6:02—date wrong?]; ESPHVO, v. 3, p. 1002; VL 135; HTH, 7/25/1927.*
7/29/27	11:31					west hawaii					62.3	s	4.65							4.65	nomo	felt	Felt locally.	ESPHVO, v. 3, p. 1002; VL 136
7/31/27	2:14					kl cal deep??					25.56	f	3.81		4.58					4.58	hono	II (Kohala and Honomu)	Felt locally; felt; barely perceptible (I = II); time, 02:20; Honomu-felt by sev; rpd tws; val. Kohala-felt by sev; grd trm; fnt sounds before and during shock. HON notes: Local shock; misinterpreted as quarry blast(?). USEQ notes: Repeats Neumann, 1930.	ESPHVO, v. 3, p. 1002, 1044 [narrative suggests that this event and those in early August could be Kilauea events responding to the collapse of the lava column]; VL 136; *Seismological Report* , July-September 1927 (Neumann, 1930).
8/3/27	9:42					hilea?					25.6	m [st?]	4.80	5.86						5.86	hono	VI (W&K); V (kona)	Seismometer dismantled, felt-Kona & Hilo; seis dismantled, felt by nearly everyone, strongly felt-Hilo, items off shelves. Warshauer notes: Recorded equally at Kona, Hilo, and HVO; felt strongly-Hilo, no damage; Kona, dishes off shelves; lighter locally.	ESPHVO, v. 3, p. 1002; VL 136; [34 mi from Hilo, 16 mi from HVO, suggests Kaoiki; max accel, 90 mm/s^2]c; [intensity pattern matches M =5.0 8/20/24 & suggests Hilea]; HA, 8/6/1927; HTH, 8/3/1927; HSB, 8/5/1927; not found in MN.
10/28/27	2:38	19	37	155	56.0	kona			73.16	73.2	73.71	f	4.25							4.25	nomo	felt	sec tremble accompanied by rumbling; recorded at Kealakekua and Hilo with origin indicated 4 mi E of Kailua on the SW slope of Hualalai.	ESPHVO, v. 3, p. 1031; VL 149.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
1/4/28	13:07					a3035					33.55	m	4.48							4.48	nomo	felt	Felt locally; felt locally and in south Kau, Hilo, and other places; not listed in *Honolulu Station Bulletin* .	ESPHVO, v. 3, p. 1066; VL 159; not found in HTH or HA.
4/27/28	17:16					hualalai?					84.66	f	4.32							4.32	nomo	felt	Time given as 5:01 p.m., might have been felt (VL).	ESPHVO, v. 3, p. 1100; VL 175.
2/5/29	2:25					kl cal deep		30	5	5	30.41	st	4.92	5.36	5.36					5.36	hono	V (W&K); IV (R-F)	HON notes: Felt-Mauna Loa section of Honolulu; local to Kilauea; deep quake under E side of island, S Kilauea; dismantled seis, waked people all Island of Hawaii, fel hnp, Hilo, Kohala. Warshauer notes: Strongly felt eq; felt as far as Kona and Kohala.	Peters, 1929; ESPHVO, v. 3, p. 1184, 1185, 1189; VL 215, 216; HA, 2/11/1929; HSB, 2/5/1929; not found in HTH or MN.
3/2/29	10:24					kaoiki			27	27	28.46	m?	4.60	5.26	5.31					5.28	hono	IV; III R-F (VL)	HON notes: Registered; small landslide in Halemaumau; 17 mi from HVO in Kapapala direction, felt-hnp, strong eq caused small landslide on E side of Halemaumau.	1194; VL 219; moderate(?) (see reference to amplitudes of slight earthquakes in VL 251, col 2, paragraph 3!)
6/18/29	8:42:00					kaoiki?			17.6	17.6	19.77	s (m)	4.62	4.87	4.90					4.88	hono	IV	HON notes: Local; very short period; slides at Halemaumau and W wall of Kilauea crater, strongly felt at hnp, dismantled seismograph. Warshauer notes: The first of three tremors was barely noticeable in Hilo.	Peters, 1929; ESPHVO, v. 3, p. 1205, 1206; VL 234; HTH, 6/18/1929; HSB, 6/18/1929; not found in HA or MN.
6/18/29	9:31:00					kona?			40	40	41	m	5.13	5.83	5.95					5.89	hono	VI	HON notes: Local shock; not rep felt; strongly felt at hnp, buildings creaked, prolonged E-W swaying, dismantled seismograph; felt at halfway house (Kau), acc by rumble, trees set in motion; felt at Hilo-articles displaced from shelves.	Peters, 1929; ESPHVO, v. 3, p. 1206; VL 234 [distance of 44 mi doesn't match felt reports; intensity map suggests Hilea, as do newspaper reports of 20-30 mi].
9/18/29	23:59					hualalai			22	22	23.77	vf; m (kona)	4.24							5.11	nomo	V? (W&K)	Seismic crisis on Hualalai begins after noon; many more events reported locally on Hualalai than the 221 events recorded on the Kona seismometer; details given in VL 248; additional analysis and statistics given in VL 309, p. 1-2.	Eqs; 9 [8?-see VL 247] events (very feeble at Whitney, moderate at Kona) occurred 9/12-18 inclusive (VL 251 list, col. 2, 3d paragraph from bottom); not recorded in Honolulu; minimum nomogram mag assumed.
9/22/29	18:34:00					hualalai			22	22	23.77	m (kona)	4.48	4.65	4.65					4.65	hono		The following shocks with origin in the volcano district on Hawaii Island were recorded. The period is short, between 1 and 2 s, and only the "P" phase is definitely distinguishable	Peters, 1929; VL 248: 79 seismic spells in 22 hours felt at Puu Waawaa.
9/22/29	21:28:00					hualalai			22	22	23.77	m (kona)	4.48	4.95	4.95					4.95	hono	V?	Time from Hon record. HON notes: The following shocks with origin in the volcano district on Hawaii Island were recorded. The period is short, between 1 and 2 s, and only the "P" phase is definitely distinguishable.	Peters, 1929; VL 248: 79 seismic spells in 22 hours felt at Puu Waawaa; WK table shows 9/23 night; should be 9/22.
9/24/29	7:44:40					hualalai			22	22	23.77	m (kona)	4.48	5.25	5.12					5.19	hono	V? (BSSA, 1929)	Warshauer notes: The hardest tremor in this city [Hilo] was felt at 7:45 this morning.	Time from Honolulu record-10.5 hours subtracted; HTH, 9/25/1929.
9/24/29	13:59:30					hualalai			22	22	23.77	st (kona)?	4.75	4.87	5.25					5.06	hono	V? (W&K)	hnp(?)-time 1:50 p.m., strong shock, swayed ferns and rocked house, E-W vibration.	Time from Honolulu record-10.5 hours subtracted; HVO, unpub.
9/25/29	18:20:56	19	42.0	155	54.0	hualalai			22	22	23.8	st (kona)	4.75	6.12	6.19			5.6; 6.1	GUTE; WK	6.15	hono	VIII (VL; USE?)	Felt generally-Hawaiian island chain; damage rpt in VL 249. Warshauer notes: Ship captain in Kealakekua Bay felt quake as quivering, watched landslide into bay; time given as 6:23 p.m.; Kona Inn twisted on its foundations; also severe in Kohala and Hilo.	Isoseismal map in W&K—magnitude 6.1 assumes subcrustal depth based on intensity distribution and teleseismic magnitude; HA, 9/26/1929; HTH, 9/29/1929; MN, 10/2/1929.
9/25/29	23:59:00					hualalai			22	22	23.77	s (kona)	3.98							5.30	nomo		Do.	Eqs; 28 events (slight at Kona) assumed for week of 9/19-25/1929; total event count of 221 reported in VL 251 list, col. 2, 3d paragraph from bottom.
9/25/29	23:59:00					hualalai			22	22	23.77	m (kona)	4.24							5.11	nomo		Seismic crisis on Hualalai begins after noon; many more events reported locally on Hualalai than the 221 events recorded on the Kona seismometer; details given in VL 248; preferred mag calculated as nomogram magnitude multiplied by number of events.	Eqs; 9 events (moderate at Kona) occurred 9/19-25/1929 inclusive (VL 251 list, col. 2, 3d paragraph from bottom); not recorded in Honolulu; minimum nomogram mag assumed.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
9/25/29	23:59:00					hualalai			22	22	23.77	f (kona)	3.44							5.04	nomo		Do.	Eqs; 58 events (feeble at Kona) assumed for week of 9/19-25/1929; total event count of 221 reported in VL 251, list, col. 2, 3d paragraph from bottom.
9/25/29	23:59:00					hualalai			22	22	23.77	vf (kona)	2.42							4.31	nomo		Do.	Eqs; 121 events (very feeble at Kona) assumed for week of 9/19-25/1929; total event count of 221 reported in VL 251, list, col. 2, 3d paragraph from bottom.
9/25/29	23:59:00					hualalai			22	22	23.77	vf? (kona)	2.42							4.06	nomo		Warshauer notes: 63 shocks recorded at HVO at distances of 14-46 mi, dominantly 23-32 mi.	HA, 10/2/1929.
9/26/29	10:23:30					hualalai			22	22	23.77	st (kona)	4.75	4.77	4.95					4.86	hono			
9/27/29	22:19:50					hualalai			22	22	23.77	st (kona)	4.75	4.95	5.07					5.01	hono	VI (HTH)		VL 249 lists time 10:50 a.m.; WK lists time 11:20 a.m.; neither fits Honolulu record.
9/27/29	22:27:35					hualalai			22	22	23.77	st (kona)	4.75		4.77					4.77	hono			
9/27/29	22:45:30					hualalai								5.07	5.17					5.12	hono			Not in VL; time from station HON record.
9/28/29	7:10:15					hualalai			22	22	65	vst (kona)	5.75	5.62	5.65					5.63	hono	VII (HTH; USE)	*Bull. Seis. Soc. Am.* (1929, v. 119, p. 185) gives location "15 mi E of Hilo in the Puu Oo district." Warshauer notes: The Hilo district experienced several heavy shocks during the day; strongest shocks at 7 a.m. and 2 p.m.; distances, 14-35 mi from HVO.	VL time 7:08; HA, 9/29/1929.
9/28/29	15:17:35					hualalai			22	22	23.77	st (kona)	4.75	5.62	5.55					5.58	hono	VI (HTH)	Warshauer notes: The Hilo district experienced several heavy shocks during the day; strongest shocks at 7 a.m. and 2 p.m. [3? p.m.]; distances, 14-35 mi from HVO.	VL time 15:18; HA, 9/29/1929.
9/28/29	17:46:10					hualalai			22	22	23.77	st (kona)	4.75	5.51	5.32					5.41	hono			Time from Honolulu record, 10.5 hours subtracted; not listed in WK.
9/29/29	5:31:15					hualalai			22	22	23.77	st (kona)	4.75	5.25	5.25					5.25	hono			Do.
9/29/29	22:49:00					hualalai			22	22	23.77	st (kona)	4.75	5.17	5.17					5.17	hono			Time from Honolulu record, 10.5 hrs subtracted.
9/30/29	11:54:00					hualalai			22	22	23.77	st (kona)	4.75	5.37	5.32					5.35	hono	VI (HTH)	Warshauer notes: Two severe shocks were felt in Hilo and Kona today. One of these, occurring at 11:55 a.m., was extremely heavy, destroying several stone fences on the slopes of Hualalai.	VL time 11:55; HA, 10/1/1929
10/2/29	18:37:40					hualalai			22	22	23.77	st (kona)	4.75	4.54	4.54					4.54	hono			Time from Honolulu record, 10.5 hrs subtracted; not listed in WK.
10/2/29	23:59:00					hualalai			22	22	23.77	st (kona)	4.75							5.39	nomo		Preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Eqs; 5 events (strong at Kona), 9/26-10/2/29, cited in VL 251 list, col. 2, 3d paragraph from bottom, are not accounted for in Honolulu records; minimum magnitude preferred; magnitude fit improved if closer to Kealakekua.
10/2/29	23:59:00					hualalai			22	22	23.77	m (kona)	4.24							5.38	nomo		Do.	Eqs; 18 events (moderate at Kona), 9/26-10/2/29, cited in VL 251 list, col. 2, 3d paragraph from bottom, are not accounted for in Honolulu records; minimum magnitude preferred.
10/2/29	23:59:00					hualalai			22	22	23.77	s (kona)	3.98							5.37	nomo		Do.	Eqs; 34 events (slight at Kona) assumed for week of 9/26-10/2/1929; total event count of 244 reported in VL 251 list, col. 2, 3d paragraph from bottom.
10/2/29	23:59:00					hualalai			22	22	23.77	f (kona)	3.44							5.09	nomo		Do.	Eqs; 65 events (feeble at Kona) assumed for week of 9/26-10/2/1929; total event count of 244 reported in VL 251 list, col. 2, 3d paragraph from bottom.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
10/2/29	23:59:00					hualalai			22	22	23.77	vf (kona)	2.42							4.29	nomo		Do.	Eqs; 114 events (very feeble at Kona) assumed for week of 9/26-10/2/1929; total event count of 244 reported in VL 251 list, col. 2, 3d paragraph from bottom.
10/3/29	9:42:43					hualalai			22	22	23.77	st (kona)	4.75	5.04	4.54					4.79	hono			Time from Honolulu record, 10.5 hours subtracted; time not listed in W&K.
10/5/29	21:22:31					hualalai			74	75.5	76.01	st; vst (kona)	5.56	seis-mom-eter dis-mantled	seis-mom-eter dis-mantled			6.5	GUTE	6.50	gute	VIII (VL; USE?)	Felt generally-Hawaiian Island chain; damage report in VL 250. Warshauer notes: See references.	Isoseismal map in W&K, who accept GUTE magnitude 6.5; a crustal depth is consistent with isoseismal gradients; HA, 10/6-9/1929.
10/8/29	0:37:45					hualalai			22	22	23.77	st (kona)	4.75	5.20	5.51					5.35	hono			
10/9/29	23:59:00					hualalai			22	22	23.77	m (kona)	4.24							5.11	nomo		Do.	Eqs; 9 events (moderate at Kona), 10/3-9/1929, cited in VL 251 list, col. 2, 3d paragraph from bottom, are not accounted for in Honolulu records; minimum magnitude preferred.
10/9/29	23:59:00					hualalai			22	22	23.77	s (kona)	3.98							5.10	nomo		Do.	Eqs; 17 events (slight at Kona) assumed for week of 10/3-9/1929; total event count of 129 reported in VL 251 list, col. 2, 3d paragraph from bottom.
10/9/29	23:59:00					hualalai			22	22	23.77	f (kona)	3.44							4.87	nomo		Do.	Eqs; 32 events (feeble at Kona) assumed for week of 10/3-9/1929; total event count of 129 reported in VL 251 list, col. 2, 3d paragraph from bottom.
10/9/29	23:59:00					hualalai			22	22	23.77	st (kona)	4.75							4.75	nomo		Preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Eqs; 1 event (strong at Kona), 10/3-9/29, cited in VL 251 list, col. 2, 3d paragraph from bottom, are not accounted for in Honolulu records; minimum magnitude preferred; magnitude fit improved if closer to Kealakekua.
10/9/29	23:59:00					hualalai			22	22	23.77	vf (kona)	2.42							4.07	nomo		Do.	Eqs; 66 events (very feeble at Kona) assumed for week of 10/3-9/1929; total event count of 129 reported in VL 251 list, col. 2, 3d paragraph from bottom.
10/14/29	23:35:00					hualalai			22	22	23.77	m; st (kona)	4.75							4.75	nomo	felt	Felt-Kona; barely felt-hnp.	Assume this event is the one strong event cited in VL 251 list, col. 2, 2d paragraph from top and 3d paragraph from bottom; not recorded in Honolulu.
10/15/29	9:59:00					hualalai			22	22	23.77	s?; m (kona)	4.24							4.24	nomo		(The next four earthquakes) registered with 3- to 4-cm amplitude on the seismograms of about 120-times magnification (ed. note: Whitney is 115). They would rank as slight earthquakes.	Slight class conflicts with later amplitude ranges which define "moderate" as 2.5-6 cm amplitude; conflict resolved if amplitudes refer to Kona seismometer.
10/15/29	13:04:00					hualalai			22	22	23.77	s?; m (kona)	4.24							4.24	nomo		Do.	
10/15/29	17:41:00					hualalai			22	22	23.77	s?; m (kona)	4.24							4.24	nomo		Do.	
10/15/29	22:05:00					hualalai			22	22	23.77	s?; m (kona)	4.24							4.24	nomo		Do.	
10/16/29	23:59:00					hualalai			22	22	23.77	s (kona)	3.98							4.96	nomo		Do.	Eqs; 12 events (slight at Kona) assumed for week of 10/10-16/1929; total event count of 97 reported in VL 251 list, col. 2, 3d paragraph from bottom.
10/16/29	23:59:00					hualalai			22	22	23.77	f (kona)	3.44							4.71	nomo		Do.	Eqs; 25 events (feeble at Kona) assumed for week of 10/10-16/1929; total event count of 97 reported in VL 251 list, col. 2, 3d paragraph from bottom.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
10/16/29	23:59:00					hualalai			22	22	23.77	m (kona)	4.24							4.24	nomo		Preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Eqs; 1 event (moderate at Kona), 10/10-16/1929, cited in VL 251 list, col. 2, 3d paragraph from bottom, are not accounted for in Honolulu records; minimum magnitude preferred.
10/21/29	12:00:00					hualalai			22	22	23.77	f?; m? (kona)	4.24							4.24	nomo	felt	Felt strongly-Kona; strongest of a swarm of 36 lasting 1 hr 45 m (BSSA, v. 19, p. 235-237); Holualoa felt 6 (10/20), 69 (10/21), 5 (10/22), 2 (10/23), 8 (10/24), 2 (10/25), and 1 (10/26).	Hu swarm continues; Whitney shocks vf (M3.22); f (M4.23): 10/17-23, 3f, 6 vf; 10/24-30, 12 vf, 1f; 10/31-11/6, 9 vf; 11/7-13, 14 vf; 11/14-20, 5 vf; 11/21-27, 5 vf; 11/28-12/4, 1f, 6 vf; 12/5-11, 5 vf; 12/12-18, 3 vf?, 2f?; 12/19-25, 1 vf, 12/26-1/1/30, 5
10/21/29	23:59:00					hualalai														4.67	calcu-lated	felt	69 shocks felt at Holualoa; 41 registered; assume average M =3; preferred magnitude calculated as M =3 multiplied by number of events, yielding a minimum moment magnitude.	VL 253.
11/10/29	20:19:00					south hawaii			54.4	54.4	55.14	f	4.02							4.02	nomo	felt	Felt-generally Island of Hawaii.	VL 255.
11/24/29	6:59:00					kona?			64	64	64.63	f	4.13							4.13	nomo	felt	40 mi from HVO; felt strongly-Kona.	Hualalai(?)-most distances are greater for the Hualalai swarm; not noted in *Honolulu Station Bulletin* ; VL 257.
12/1/29	14:06:00					kona?			67.2	67.2	67.8	f	4.16							4.16	nomo	felt	42 mi from HVO; felt-Kona.	Hualalai(?)-most distances are greater for the Hualalai swarm; not noted in *Honolulu Station Bulletin* ; VL 258.
1/29/30	18:42:00					hualalai?					76.8	s	4.80							4.80	nomo	felt	shock [no amplitude given]; felt locally, probably felt generally on the Island of Hawaii. [Magnitude fits if referenced to Whitney rather than Kona.]	Peters, 1930; VL 267, p. 3-4; not found in MN.
2/9/30	9:43:00					kona?					64	f	4.12							4.12	nomo	felt	Felt in some places on the island.	VL 268, p. 3
2/19/30	17:42:00					hilea?					43.2	s	4.40							4.40	nomo	felt	Felt strongest in Kau district.	Not registered on Oahu; VL 270, p. 4.
5/20/30	2:47:00					hualalai os?					169.6	f	4.80							4.80	nomo	felt	Felt locally, more strongly in N Hilo; period slow on E side of island, quicker in N Kona, suggesting a Hualalai source. Warshauer notes: [Shocks at 2:47 a.m. and 6:52 p.m.] were strongly felt at Puu Waawaa and, also noticed in Hilo at Puueo.	Peters, 1930. HON notes: Registered at 13:18 G.m.t.; sharp local shock, no amplitude given, dur 6.2 min; VL 283, p. 3-4; HTH, 5/21/1930. Warshauer notes—con.: Similar felt pattern to Hualalai eqs of Sept.-Oct./1929.
5/20/30	18:52:00					hualalai os?			97.6	97.6	98.01	f	4.42							4.42	nomo	V (HTH; USE)	HON notes: Registered at 5:23, 5/21/30 (Gm.t.); local shock, no amplitude given, dur 3.7 min; felt locally, more strongly in N Hilo; period slow on E side of island, quicker in N Kona, suggesting a Hualalai source.	Peters, 1930; VL 283, p. 3-4; HTH, 5/21/1930.
5/25/30	20:17:00	19	26.0	155	25.0	kl sf?				25	26.57	m	4.55					4.7	WK	4.55	nomo	V (USE)	Felt-all Hawaii Island, no objects overturned; stronger motion in Kau & Puna (strong at Keaau beach) than in Kona or Kohala; seismographs dismantled; WK M =4.7 based on intensity distribution; VL 283, p. 4 suggests deep origin beneath Kilauea or Mauna Loa.	VL 283—cont.: Whitney-first motion down to S and E; Hilo-began W swaying, then strong jerks that quickly ended, first to NE, then to SW; Puu Waawaa-vibration long, not strong; Honokahau-a moderate shock with thunderous noise; Kealakekua-alarmingly sudden.
6/3/30	4:54:00					north hawaii					107.2	f	4.48							4.48	nomo	felt	Felt on both east and west sides of island.	Not registered on Oahu; VL 285. p. 3.
6/14/30	0:25:00					kl sf?					19.2	s	4.09							4.09	nomo	IV	HON notes: Registered at 0:26; nearby type, no amplitude given; generally felt on E side of island; movement prolonged and moderate at Kilauea, shorter and ending in a sharp jerk at Hilo; vertical component pronounced on Kilauea seismogram; [moderate?].	Peters, 1930; VL 286. p. 3.
7/22/30	13:53:00					ml nf?					56	m	5.07							5.07	nomo	V-VI	Felt generally on island of Hawaii, especially in N Kona; workmen severely jolted at halfway house on the Mauna Loa trail; shock alleged to be strongest since the Hualalai series last autumn; epicenter in saddle between Mauna Kea, Mauna Loa, and Hualalai.	VL 292, p. 3; HTH, 7/22/1930; not found in HA. Warshauer notes: Felt most strongly in Kohala (objects thrown off shelves) and Puu Waawaa. Said to be strongest at since Hualalai series; see references.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
9/28/30	20:35:00					kl cal deep?					25.6	m	4.53							4.53	nomo	III	Dismantled instruments, strong vertical movement; felt as v gentle rocking motion by few; distance given as 12 mi on some instruments, 20 mi on others; inferred deep from Kona and Hilo records; felt hnp, kona; felt by some in all parts of island.	VL 301, p. 4; VL 302, p. 4 [Powers inferred location as deep under Mokuaweoweo-distances fit Kilauea deep]; Peters, 1930. HON notes: Registered at 20:36:33; no amplitude given; not found in HTH.
10/20/30	8:25:00					kl cal deep?		30	3	3	30.15	m	4.92					5.6	intensity	5.25	nomo	V-VI; V (W&K)	Dismantled seismographs; felt-all Hawaii Island, strongest on Kilauea slopes; seismograms indicate source under Kilauea crater. Warshauer notes: Felt in Hilo, Honokaa, Puu Waawaa, Kohala, and Waiohinu. Articles off shelves in Hilo and Waiohinu.	Peters, 1930. HON notes: Registered at 8:25:24; felt sharply at Kilauea, where all instruments were dismantled; no amplitude given, dur 20.5 min; distance assumed; VL 304, p. 4; HTH, 10/20/1930; see references.
10/31/30	18:23:00					south hawaii					51.2	s	4.29							4.29	nomo	felt	Felt locally by many persons, and by a few persons in Hilo; probably felt in Kau and Kona, but not strong enough to cause comment.	Not registered on Oahu; VL 306, p. 2.
12/1/30	20:55:00					south hawaii					51.2	s?	4.29							4.29	nomo	felt	Felt from Hilo to Kona (slight?-given as vf).	VL 311, p. 3.
1/16/31	20:44:00					ml ner deep?					48	s?	4.25							4.25	nomo	felt	Felt generally, more in Hilo and Hamakua districts than elsewhere; epicenter apparently under center of island; origin deep under NE slope of Mauna Loa.	Not registered on Oahu; VL 317, p. 3; VL 319, p. 3.
1/29/31	23:39:00					kl cal deep?			22	22	30	s	4.40							4.40	nomo	V (Halemaumau); V (Waiohinu; USE)	HON notes: Registered 23:38:08, dur 10 s; reported felt in Honolulu [Hawaii?]; no amp given; felt all Hawaii Island; suggest origin beneath Mauna Loa. Warshauer notes: Felt all island; duration, 30 s; no damage; felt all Kona, Kohala, Hamakua, and Puna.	Distance of 30 km assumed to better fit data; [VL distance is 22 km]; Peters, 1931; VL 319, p. 3 [rockfalls in Halemaumau during quake]; HTH, 1/30/1931 [moderate(?) and (or) deeper(?)]; not found in MN.
3/8/31	6:53:00					east hawaii					48	s	4.47							4.47	nomo	felt	Felt in Hilo.	Not registered on Oahu; VL 324, p. 4.
6/11/31	18:51:00					ml wf?					60	s	4.88							4.88	nomo	V	Felt stronger and quicker at Honokahau, small objects overturned; felt as a slow motion at Waimea, Hilo, Kau, and hnp. Warshauer notes: Felt generally on the island, pronounced at Holualoa, definite in Hilo (Puueo).	Peters, 1931; VL 338, p. 4. HON notes: Registered at 18:52; local, dur 8 min, no amplitude given; HTH, 6/12/1931. Warshauer notes—con.: Powers quoted as saying quake 27 mi from HVO, on slopes of Mauna Loa [distance low(?)-increased to raise mag].
8/30/31	6:53:00					mauna loa					24	st?	5.00							5.00	nomo	IV	Time given [in error] as 7:53; .felt generally on Island of Hawaii; dismantled instruments in Kona, Hilo, and Kilauea; felt as slight and prolonged tremor at Kilauea, more strongly in Hilo, Olaa, and Kona; vertical seismograph indicates origin NW of HVO.	VL 349, p. 3 [15 mi from HVO; 30 mi from Hilo].
12/8/31	10:22:00					kaoiki?					22.4	m	4.43							4.43	nomo	V	HON notes: Registered at 10:22:36; local; amplitude not given; dismantled seismographs; persons near Mauna Iki reported noise seemingly from Mauna Loa progressing underfoot and heard rocks falling down cracks.	Peters, 1931; VL 364, p. 4; not found in HTH.
4/26/32	1:59:00	19	36.5	155	38.5	ml nf	8	8		44.1	46.87	f	4.23							4.23	nomo	IV-V	23 mi from Kealakekua, 32 mi from HVO, 42 mi from Hilo; saddle between Mauna Loa and Hualalai; felt-Haina, Honomu, Hilo, Kamuela, Kohala, Waikii, hnp.	VL 384, p. 3; Note: distances from three stations incompatible; lat and long at center of intersection given; Honolulu records unavailable; HVO, unpub.
6/14/32	4:51:45	19	28.0	155	22.0	kaoiki	13	13		11.2	17.13	m	4.25							4.25	nomo	V; V (W&K); III R F (VL)	Felt generally Hawaii Island, Maui. Warshauer notes: Severe earthquake recorded at 4:55 a.m.; dismantled both seismograph components, strong vertical motion; felt by practically everyone in Hilo and volcano, not felt in Kona; no damage, 9 mi from HVO.	VL 388; HTH, 6/14/1932 [kl sf better fits felt reports(?)]; not found in MN.
7/3/32	23:59:00					maui?					240	vf	4.03							4.03	nomo		Distance, 150 mi.	1 event (vf), no date or time; VL 388.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
7/7/32	22:25:00					kl sf?					16	m?	4.20							4.20	nomo	felt	Warshauer notes: An earthquake, the strongest in Hilo in many months, rocked a section of the Big Island at 10:25 p.m. last night. No damage was reported from any districts. Felt most strongly at Hilo, also felt at volcano, slight at Puu Waawaa & Kapoho.	Not in VL; HTH, 7/8/1932. Warshauer notes—con.: Apparently not felt at Hamakua, Kau, and Kohala.
7/7/32	22:30:49	19	18.8	155	15.9	kl sf	9.6	9.6	12.8	13.3	16.41	m	4.22							4.22	nomo	IV-V; V? (PCA)	8 mi s of HVO; felt generally Hawaii Island, Oahu; [kcaldeep?]. Warshauer notes: Hilo shaken Thursday night by an earthquake which lasted a full minute at 10:29 p.m.; 15 mi from HVO in the direction of Hilo; similar intensity to event of 6/13; no damage.	VL 389; HTH, 7/8/1932; not found in MN.
8/19/32	12:30:00	19	47.0	156	4.7	hualalai os	19.2	19.2		94	95.94	f	4.40							4.40	nomo	felt	3 mi N of Keahole pt and 2 mi at sea; felt-Kona, Kohala; Hawi-4; Hilo-felt lying in bed; Kukuihaele-3.	VL 390; time given by felt reports (12:25-12:41 p.m.); HVO, unpub.
8/31/32	23:59:00					kona?					72	t	2.72							4.06	nomo		Eqs: 30 tremors, 30-60 mi distance; preferred magnitude calculated a nomogram magnitude multiplied by number of events.	No specific date or time between 8/29 and 8/31/1932; VL 391.
1/11/33	12:00:00					kona os?				320.0	320.1	vf	4.23							4.23	nomo		A very feeble shock, about 200 mi west to southwest of Hawaii, preceded [the event at 12:45]. This shock was probably in the vicinity of a large submarine mountain. Note: Loihi distance about 53 km from Kilauea's summit	VL 395.
1/11/33	12:45:00	20	0.0	154	49.5	mauna kea?				78.2	78.7	f	4.00							4.00	nomo		Location uncertain; 20-30 mi NE of Hilo; preceded, during the noon hour, by four foreshocks or tremors at unknown distance.	Do.
2/4/33	6:17:00	18	42.00	155	15.00	kl kuer sf os deep?		40.0		81.3	90.6	f	4.69	4.62	no trace					4.83	aver	IV	Felt-Holualoa, Hakalau, Hilo, hnp; Honaunau-2; Hakalau-4; hnp-windows rattled, pheasants squawked; Holualoa-4; preferred magnitude calculated as average of Honolulu and nomogram.	50 mi due S of HVO; recorded at three stations; Honolulu amplitude average of two readings; VL 396; HVO, unpub.
6/29/33	0:44:00	19	40.0	155	48.0	hualalai	1	1		62.6	62.6	s	4.43	no trace	no trace					4.43	nomo	VI	Reported at three or more stations-moved furniture; damaged stone walls; Puu Ulaula-5, awakened campers; duration, 4-5 s, dishes moved; Honomu-4, long and feeble; Kealakekua-6, building shuddered violently 3-4 s; Hookena-4, objects moved, stone wall down.	VL 400; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards]; postcard data cont.; Holualoa-4, reported from north and south Kona; Hilo-3
7/31/33	11:56:00	19	20.0	155	30.0	kaoiki	16	16		27.4	31.8	s	4.44	4.76	no record					4.76	hono	IV	Felt sharply Kapapala ranch; Pahala, Naalehu, Hookena, HNP; Hookena-2, water agitated in tank;-2, slight; Naalehu-4, stone wall down(?); Paauilo-4, building shook, windows rattled; Kapapala-house shook strongly.	VL 402; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
9/2/33	12:00:00	19	2.0	155	40.0	hilea	8	8		61.5	62.0	f	4.10							4.10	nomo			VL 403
9/7/33	14:40:00	19	18.0	155	27.0	hilea	40	40		24.7	47.0	s	4.45	<4.37	<4.37					4.45	nomo	III	Felt-HVO, Hilo; Hilo-2, slight shaking and creaking of building.	looked for but not found on station HON film record; time from felt report; VL 403; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards]
9/26/33	21:15:00	19	42.0	155	23.0	ml nf	10	10		32.6	34.1	f	4.01							4.01	nomo	V	Felt-Honomu, Hakalau, Hilo, Pahala, Olaa, Papaikou. Warshauer notes: Slight quake, felt in some parts of Hilo;-4, hanging objects shook, felt all Onomea; Hakalau-6; Olaa-3, jolt, also felt in Pahala; Hilo-3, mirror swung; Honomu-6, strong.	VL 403; HTH, 9/27/1933; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards]
10/13/33	3:01:00	19	15.00	154	23.00	kl ler sf os?		10.0		94.7	95.2	m	5.20	<4.80	<4.66					4.50	hono	felt	Lightly felt; Kealakekua-prolonged gentle swaying east to west; Hilo-2, felt in Kaumana; preferred magnitude estimated from Honolulu data, consistent with felt report.	Closer(?); slight(?); VL 404; HVO, unpub.; not found in HTH.
10/19/33	5:57:00					ml nf?			28	28.0	29.4	s	4.13	<4.40	<4.32					4.13	nomo	V	Felt-Hilo, Honomu. Warshauer notes: Sharp temblor rocked Hilo; Hilo-2, III, mirror swung, building creaked slightly; duration, 15-20 s; Honomu-2-3;-3, building creaked.	Looked for but not found on station HON film record; time given as 5:37-corrected from felt reports; VL 404; HTH, 10/19/1933; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
10/21/33	9:10:00	19	21.5	155	31.5	kaoiki	3.2	3.2		29.0	29.2	m	4.62	4.76	4.76					4.76	hono	V?	Felt-all Hawaii Island. Warshauer notes: Severe shock felt all island, equally severe shock a few seconds later; felt-all Hilo, very strong at Kapapala; additional felt data in HVO, unpub.	VL 404; HTH, 10/21; 23/1933; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
10/21/33	9:11:00	19	25.0	155	30.0	kaoiki	14	14		25.2	28.9	m	4.61	4.82	4.55					4.68	hono	V?	Felt generally-Hawaii Island. Warshauer notes: See above; Honomu-5 (first), VI (second), dur 3 s, felt by everyone; Kealakekua-4, building creak, window rattle; Kapapala-4, felt 4 quakes (aftershocks at 6:30, 9:19, 10:20 p.m. 10/21 and 4:37 a.m. 10/22).	VL 404; HTH, 10/21; 23/1933; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
12/2/33	5:55:00					ml mok	13	13	34	34.0	36.4	s	4.28	<4.50	<4.32					4.28	nomo	II R-F (VL)	Eruption begins in Mokuaweoweo at 05:43; tremor accompanies earthquakes; felt-Hilo, Kona. Warshauer notes: Three strong earthquakes occurred at 6 a.m. coincident with eruption in Mokuaweoweo; felt severely at ml [Red Hill] rest house.	VL 406, p. 2; HTH, 12/2/1933
12/2/33	6:01:00	19	28.5	155	37.0	ml mok	5	5		37.8	38.1	s	4.31	<4.50	<4.32					4.31	nomo	V	West rim of Mokuaweoweo; felt with alarm, ml [Red Hill] rest house. Warshauer notes: See above; Hilo-very slight (6:03 a.m.).	VL 406, p. 2; HTH, 12/2/1933; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
12/2/33	6:06:00	19	32.0	155	35.0	ml mok	5	5		35.8	36.2	s	4.27	<4.50	<4.32					4.27	nomo	VI (USE)	3 mi NE of north end of Mokuaweoweo; felt with alarm, ml [Red Hill] rest house, lightly at Hilo. Warshauer notes: See above.	VL 406, p. 2; HTH, 12/2/1933.
1/9/34	1:59:00	19	12.5	155	44.0	hilea	5	5		55.6	55.8	s	4.35	no trace	no trace					4.35	nomo	V	Felt-Hookena, Kapapala, Pahala, HVO; Hilo-slight; duration, 15 s; Hakalau-4 (time 4 a.m.); Pahala-3, buildings shook; Hilea-sharp quake; duration, 6 s; Honaunau-3, awakened; Hookena 2 (3 a.m.).	VL 407; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
1/13/34	13:35:00	19	11.00	155	11.00	kl kuer sf os deep?	16.0	40.0	27.0	28.7	49.2	s	4.75	5.46	5.11					5.28	hono	V	Felt generally-Hawaii Island; Hakalau-6; Pahala-3, building shook/windows rattle; Holualoa-4, long double quake, felt all north and south Kona; hnp-4, window/door rattle acc by rumble, decided jolt, then 2d lesser; Honaunau-3, windows rattle.	Honolulu amplitude average of two readings; nomogram magnitude low-deeper(?) and (or) moderate(?); not mentioned in W&K; VL 407; HVO, unpub.
2/9/34	9:59:00	19	13.0	155	33.0	hilea				38.7	39.7	s	4.34	no trace	incom-plete					4.34	nomo	IV	Felt sharply-Kapapala ranch; felt-Hookena,, HVO; Pahala-3, building creak and shake, Wood valley-cane thrashing, horse disturbed; Hookena-4; duration, 6 s, building creak, hanging objects moving.	VL 408; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
2/24/34	17:31:00	19	46.0	155	42.0	mauna kea	16	16		59.5	61.6	f	4.10	<4.35	no record					4.10	nomo	IV	Felt-HVO, Hakalau,;-3, slight shock; hnp-felt at summer camp; Hakalau-4.	VL 408; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
3/1/34	22:22:00	19	33.0	155	35.0	ml nf				36.5	37.6	s	4.30	<4.55	no trace					4.30	nomo	V	Felt generally-Hawaii Island. Warshauer notes: See references; Pahala-2; Honomu-3, rocking; duration, 1 s, west to east; Hilo-felt strongly by person lying down, E-W followed by N-S; Kona-felt; Hakalau-5.	VL 408; HTH, 3/2/1934; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
4/9/34	2:06:00	20	9.0	155	53.0	kohala				103.4	103.8	vf	4.19	no trace	no trace					4.19	nomo	IV	earthquake; Kamuela and Kawaihae-felt; central Maui-felt by many; Hilo-slight;-felt; N Kohala-5 quakes between 1 and 8 a.m. (number disputed), slight, finishing sharp, severe, short;-3.	VL 410; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
4/9/34	8:21:00	20	6.0	155	43.0	kohala				88.6	89.0	f	4.08	no trace	no trace					4.08	nomo	IV	Less widely felt; Kohala-short, sharp earthquake; Kamuela and Kawaihae-felt; Honomu-felt by many, 2 shocks (9:15 a.m.), trembling; duration, 2 s;-felt; N Kohala-short, heavy shock accompanied by rumble;-4.	VL 410; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
4/14/34	19:51:00	19	37.5	154	43.0	hilo os				61.3	62.0	s	4.65	<4.92	<4.70					4.65	nomo	III?	Felt-Olaa, Hilo; Hilo (7:52:40 p.m., 7:50 p.m.)-felt by several in at least two locations, slight shock.	VL 410; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
4/14/34	19:51:00	19	37.50	154	43.00	kl ler os		5.0		61.3	61.5	s	4.64	no trace	no trace					4.64	nomo	felt	Felt-Olaa, Hilo.	Closer(?); VL 410.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
5/10/34	10:09:00	19	38.0	155	23.0	ml nf?	25	25		25.9	36.0	m-st	>5.04	5.80	5.60					5.70	hono	VI	Felt-all Hawaii Island, Maui. Warshauer notes: A strong, slow earthquake, felt severely-Hilo, people ran into streets; felt slightly at Kona; much less at Kapapala than Hilo and volcano; minor damage in N Kohala; dur 26 s, beginning light, end sharp.	Depth, 28 km in HVO catalog; VL 411 [detailed damage report given]; HTH, 5/10; 14 [see below]/1934; additional felt reports in HVO, unpub.
5/13/34	15:23:00	19	22.5	155	22.5	kaoiki	20	20		13.5	24.2	s	4.25	4.45	no trace					4.45	hono	V	Felt-HVO, Hilo. Warshauer notes: Hilo rocked by 2 shocks 3 minutes apart, 2d more feeble; generally felt, strongly in Kohala, minor damage; Hilo-3-4, building rocked, felt moderately, furniture rattled; Honokaa-4.	VL 411; HTH, 5/14/1934; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
5/13/34	15:25:00	19	13.0	155	39.0	hilea	4	4		47.4	47.6	s	4.24	det.?	over-exposed					4.24	nomo	III	Felt-HVO, Hilo. Warshauer notes: See above; Hilo-2-3, v short, hnp-felt.	Aftershock; VL 411; HTH, 5/14/1934; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
6/26/34	19:07:00	19	12.00	155	5.00	kl mer sf os?	10.0	10.0		31.8	33.3	m	4.71	4.75	4.75					4.75	hono	V	Felt-Hilo,, HVO; more detail given in HVO, unpub. Warshauer notes: Felt strongly in some parts of Hilo, and more generally on the island; no damage.	VL 412; HVO, unpub.; HTH, 6/27/1934.
9/17/34	11:56:00	19	2.0	155	13.0	loihi	17	17		44.5	47.6	f	4.24							4.24	nomo	II	Felt-HVO, Honomu; Honomu-2; duration, 1 s.	VL 415; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
10/13/34	19:14:00	19	28.0	155	30.0	mauna loa deep	65	65		25.5	69.8	m	5.22	5.22	5.18					5.20	hono	V	Felt generally-Hawaii Island. Warshauer notes: The entire island rocked by an earthquake; duration, 30 s, no damage; felt widely in Kona, also at Waimea, and the Hamakua Coast; motion gentle swaying, two parts with long intervals between.	VL 416; HTH, 10/15/1934; extensive felt reports in HVO, unpub.
10/19/34	0:20:00	19	30.0	155	40.0	mauna loa deep	60	60		43.5	74.1	f	4.22	<4.32	no record					4.22	nomo	V	Earthquake of moderate intensity rocked the Big Island, hard enough in Hilo to awaken sleepers, no damage; 3 sharp quakes felt in Waimea, followed by several of slighter intensity.	VL 416; [some aftershocks evidently not recorded at Whitney vault]; HTH, 10/19/1934; extensive felt reports in HVO, unpub. [felt reports give date as 10/19].
1/2/35	6:47:17	19	25.50	155	17.00	kl cal deep	3.0	30.0		2.4	30.1	m	4.64	4.75	4.80			5.90	W&K; S&C	5.15	aver	VI (W&K); V (C&S)	Felt generally-Hawaii Island, objects fell in Hilo, landslide at Halemaumau. Warshauer notes: Felt-all island, least in Kohala; two waves, slight, then heavy; bottles, pictures broken in Hilo; pref mag calculated as weighted average of WK(1) and Hono(2).	Isoseismal map in W&K (M =5.9 too high because intensity V in Kau and Kona incorrect); depth changed to improve magnitude agreement, consistent with felt reports; VL 419; HTH, 1/2/1935; additional felt data in HVO, unpub.
3/3/35	0:12:00					maui?					240.0	vf	4.03	4.27	4.43					4.35	hono	V	Haleakala-4, movement up and down, cement cornice of building fell off; Wailuku-not very strong; felt-all Maui, Oahu, and in Kohala.	Not separately reported in VL 420, but included in table; time from station HON film record; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards]; Maui/Molokai consistent with Hon mag and felt reports.
6/5/35	6:55:00	19	28.0	155	48.0	kona	24	24		57.0	61.8	f	4.10	<4.62	<4.55					4.10	nomo	III	Felt-HVO and Honokaa; Honokaa-felt a light shake.	VL 424; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards]; stronger trace on Kona seismograph.
6/25/35	0:45:00	19	26.50	155	16.50	kl cal 10-20	5.0	15.0		1.9	15.1	m	4.16	<4.37	<4.42					4.16	nomo	V	Awakened people generally south side Hawaii Island, dismantled seismographs; Anuhea-3, building creaked;-quite a shock; hnp-wakened many, quite hard at; Puu Ulaula-wakened party at rest house; Papaikou-felt, Hilo-many awakened.	Greater depth assumed consistent with felt reports; VL 424; HVO unpub.
6/27/35	8:14:00	19	40.0	156	0.0	hualalai				82.2	82.7	vf	4.03	<4.07	<4.07					4.03	nomo	V	Felt-north Kona, Puu Waawaa. Warshauer notes: While the Kona district yesterday morning [June 27] experienced one of the worst quakes in the past 6 years, the entire district being rocked; dishes knocked off in Kona, felt hard at Puu Waawaa.	Looked for but not found on station HON film record; VL 424; HTH, 6/28/1935.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
6/28/35	9:00:00					kl sf?	8.0	10.0		19.2	21.6	m-st	4.69	5.71	5.82			5.6; 5.7	GUTE; W&K	5.76	aver	VI; VI (W&K; S&C); V (USE)	Dismantled seismographs; some damage in Hilo; felt generally-Hawaii Island; extensive felt reports in HVO, unpub. Warshauer notes: hard in Hilo/Kapoho, less in Kona/Kohala; preferred magnitude calculated as an average of GUTE, W&K, and Honolulu.	Isoseismal map in W&K [location given in VL (19.6, 155.18-Mauna Loa NE rift) disagrees with felt reports which strongly favor kl sf]; VL 424; HVO, unpub.; HTH, 6/28/1935.
9/30/35	22:36:00	19	22.0	155	39.5	ml swr	45	45		42.5	61.9	m	4.90	4.70	4.80					4.75	hono	IV	Felt generally-Hawaii Island. Warshauer notes: Felt locally (long, swaying), one of 4 shocks felt islandwide, no damage.	Seismogram pictured in VL 444, p. 3; VL 428; HTH, 10/1/1935.
9/30/35	23:58:00	19	38.7	155	26.3	ml nf	26	26		30.3	39.9	m-st	5.61	5.46	5.79					5.62	hono	V; IV (S&C)	Felt-all Hawaii Island, some damage in Hilo. Warshauer notes: Strongest of series; felt Hilo, volcano, Kau, Kona; no damage.	Seismogram pictured in VL 444, p. 3, E-W labeled m-dismantled, p. 5, n-s labeled slight; assume drum moves at 60 mm/min, amp >142 mm E-W, 95 mm N-S [st, as measured]; VL 428; HTH, 10/1/1935; additional felt reports in HVO, unpub.
10/1/35	0:02:00	19	38.7	155	26.3	ml nf?				30.3	31.6	m	4.67	lost in ms	lost in ms					4.67	nomo	felt	Felt as a continuation of M=5.6 eq; location uncertain. Warshauer notes: Felt-Hilo, Volcano, Kau, Kona (Holualoa-light shock); Honomu-felt(?).	VL 428; HTH, 10/1/1935; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
10/1/35	0:34:00	19	38.7	155	26.3	ml nf?				30.3	31.6	s	4.18							4.18	nomo	felt	Associated with preceding two quakes. Warshauer notes: Felt-Hilo, not volcano.	VL 428; HTH, 10/1/1935.
10/1/35	10:22:00	19	38.3	155	19.2	ml ner				23.9	25.5	m	4.29	<4.63	4.15					4.15	hono	II	Felt-Hilo and HVO; felt at Pahala and Hilo (10:37); Hilo-2.	Honolulu data average of two readings; VL 428; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
11/21/35	1:11:00	19	31.0	155	31.5	ml ner	5	5		29.4	29.8	m (st?)	5.64	5.03	5.05			5.6	W&K	5.43	aver	VI; V (S&C)	Felt-Waikiki (Oahu), Hana (Maui), Kapapala ranch; duration, 90 s, items off shelves, window broke. Warshauer notes: See references; extensive felt reports in HVO, unpub.; preferred magnitude calculated as average of Honolulu, Whitney as read, and W&K.	Isoseismal map in W&K; seismogram pictured in VL 444, p. 1, assume drum moves at 60 mm/min, amp 210 mm N-S [st, as measured]; seismogram s-p agrees with VL distance; HTH, 11/21/1935; HVO, unpub.—see references.
11/21/35	18:35:00					ml ner		5	34	34.0	34.4	s	4.01							4.01	nomo		Do.	Mauna Loa eruption begins, from north bay of Mokuaweoweo to Red Hill, 4 mi down Mauna Loa northeast rift zone; VL 429.
11/21/35	18:42:00					ml ner		5	34	34.0	34.4	s	4.01							4.01	nomo		Do.	VL 429.
2/5/36	12:00:00	19	35.8	155	41.3	ml nf deep	33.6	33.6		48.7	59.1	f	4.07	<5.22	<5.22					4.07	nomo	felt	5 mi NW of Puu Koli; felt-Hilo, hnp.	VL 432, p. 2; time not given.
3/21/36	15:50:00					hualalai			77	77.0	77.5	f	4.26	<4.77	no trace					4.26	nomo		W slope Hualalai.	VL 433, p. 3.
4/15/36	8:27:00	19	24.00	155	15.00	kl cal deep	30.0	30.0		3.6	30.2	m	4.64	4.72	4.60					4.66	hono	V (USE); IV (kona)	Felt generally-Hawaii Island, specific reports from Olaa, Hookena, and Hamakua coast; felt rather strongly in volcano; E-W component dismantled; Hookena-3, building creaked.	VL 434, p. 2; HVO, unpub.
1/31/37	7:33:00	19	45.5	155	55.3	hualalai	28.8	28.8		78.6	83.7	s	4.63	<4.77	<4.77					4.63	nomo	IV	Felt-Hookena, Kamuela. Warshauer notes: The entire island was rocked by an earthquake at 7:34 a.m. Sunday; estimated to originate in Hualalai direction; Hookena-4 (7:02 a.m.—same event?), building creaked, hanging objects moved.	VL 444, p. 6; HTH, 2/1/1937; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
4/9/37	7:29:00	19	16.30	155	12.20	kl kuer sf	11.2	11.2		18.7	21.8	m	4.42	<4.65	<4.81					4.42	nomo			VL 446, p. 7.
4/18/37	4:10:00	19	41.7	155	52.3	hualalai				70.8	71.3	f	4.20	<4.35	<4.47					4.20	nomo	IV	Waawaa (strong). Warshauer notes: Felt sharply throughout island, more in Waimea and; v strong at; additional felt reports in HVO, unpub.	VL 446, p. 7; HTH, 4/19/1937; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
7/30/37	14:40:00	19	32.0	155	28.0	ml ner				24.5	26.1	m	4.30	4.28	4.20					4.24	hono		Near Puu Ulaula.	VL 449, p. 7.
1/22/38	22:03:00	21	12.0	156	6.0	maui				215.7	215.9	m-st	6.29	>6.2	>6.2			6.8	GUTE	6.80	gute	VIII; VIII (W&K; Cox); VII (S&C)	Felt throughout the Hawaiian chain. Warshauer notes: A quake, duration, 90 s, felt in every section of the big island, also on Maui, Oahu, and Kauai; channel between Maui and Kohala; maximum damage (broken dishes and rearranged furniture) in both places.	Isoseismal map in W&K; Neumann, 1940a Honolulu station dismantled]; VL 455, p. 6-7 [damage report given]; Jaggar, 1938 [damage reports from all islands]; HTH, 1/24-28/1938; extensive felt reports in HVO, unpub.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
2/17/38	2:18:00	19	33.0	155	27.0	ml ner	12.8	12.8		23.9	27.1	m	4.33	4.27	no trace					4.27	hono	IV-V	Felt strongly in Kona and hnp, slightly by many in Hilo; Kealakekua-very slight single shake; duration, 3-5 s.	VL 456, p. 3; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
3/7/38	5:56:00	19	42.0	155	32.0	mauna loa deep	44.8	44.8		41.5	61.0	m	4.89	4.91	4.28					4.60	hono	V	Felt-Hilo, Kona, hnp. Warshauer notes: rocked entire island; double shock in Hilo and volcano, both prolonged; mod strong, duration, 30 s, waking many; strong at, slight at Kohala and Puu Waawaa; prolonged at Kona; HVO seismometers dismantled.	VL 457, p. 6; HTH, 3/7/1938; additional felt reports in HVO, unpub.
5/28/38	6:35:00					kl cal deep?		30.0		5.1	30.4	s?	4.15	4.30	4.07					4.18	hono	felt	Should be feeble if kcaldeep, slight if south flank, moderate if uer; obscured by tremor(?); felt(?).	Not in VL 459; kuer sf or kcaldeep(?) to be consistent with being recorded on Oahu.
6/1/38	10:38:00	19	18.20	155	11.50	kl kuer sf	11.2	10.0		16.0	18.8	m	4.31	no record	no record					4.31	nomo		Warshauer notes: A moderate shock about 10:45 a.m. Wednesday dismantled the instruments	Station HON film record missing; VL 460, p. 3; HTH, 6/6/1938; not found in PCA.
6/2/38	15:33:00	19	21.70	155	19.50	kl cal deep	24.0	24.0		10.2	26.1	s	4.05	<4.50	<4.42					4.05	nomo			VL 460, p. 3; not found in PCA.
8/8/38	23:59:00					kl uer		3.0	5.6	5.6	6.4	s	3.06							4.42	calc		Assume uer/Koae; average depth, 3 km; average distance, 5.6 km; preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Earthquake swarm; 31 events (slight) not separately tabulated in VL 462 or recorded in Honolulu.
8/8/38	23:59:00					kl uer		3.0	5.6	5.6	6.4	f	2.52							4.02	calc		Assume uer/Koae; av depth = 3 km; average distance, 5.6 km; preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Earthquake swarm; 45 events (feeble) not separately tabulated in VL 462 or recorded in Honolulu.
10/25/38	12:18:00	19	27.80	155	9.50	kl gln deep	25.6	25.6		11.4	28.0	s	4.10	<4.2	<4.2					4.10	nomo	III	Felt-Hilo, hnp. Warshauer notes: An earthquake, classified as slight at Kilauea observatory, was sharply felt in Hilo yesterday about 12:20 p.m.	VL 462, p. 5; HTH, 10/26/1938.
10/27/38	18:11:00	19	42.0	155	50.2	hualalai	24	9		67.7	68.3	s (kona?)	4.00	<3.95	<4.07					4.00	nomo	V	Felt-Kona,; Hookena-5, sharp perpendicular shock followed by gentle side motion for 5-6 s, buildings creak, hanging objects move, water tanks slopped over; Kealakekua-telephone central reports strong shock.	Better fit if distance referenced to Kona, not Whitney; shallower(?); VL 462, p. 5; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
1/19/39	14:58:00	19	41.6	155	52.0	hualalai	25.6	25.6		20.8	33.0	s	4.21	4.35	4.16					4.25	hono	IV	Felt strongly-Kona, Kohala; lightly-Hilo, Kau. Warshauer notes: An earthquake rocked the Kona area at 2:58 p.m. today for about 15 seconds. No damage was reported; felt strongly Kona, short and sharp at, slight in Kau, not felt at Volcano or Hilo.	Magnitudes agree if amplitude referenced to distance from Kona seismometer; VL 463, p. 2; HA, 1/20/1939; HTH, 1/20/1939; see references for complete felt report.
4/12/39	4:18:00	19	27.00	155	14.00	kl gln deep	28.8	28.8		3.6	29.0	s	4.12	<4.32	<4.32					4.12	nomo	V	Felt-Hilo, Olaa, hnp; Hilo-3. Warshauer notes: felt generally on Big island; awakened sleepers in Hilo; no damage.	VL 464, p. 5; HVO unpub; HTH, 4/12/1939
5/15/39	10:28:00	19	22.00	155	8.00	kl mer sf	16.0	10.0		15.2	18.2	m-st	4.74	5.06	4.73					4.90	hono	VI; VI (S&C)	Strongly felt-all Hawaii Island except Kohala; strongest in Hilo (slight damage to masonry and plaster) and hnp. Warshauer notes: Felt strongly in all districts except Kohala; minor damage in Hilo, household articles knocked from shelves, building cracks.	[illegible] south flank (likely considering high mag and not felt in Kohala); VL 464, p. 6; additional felt reports in HVO, unpub.; HTH, 5/15/1939; see HVO, unpub., and references for complete felt report.
5/23/39	14:14:00	19	28.5	155	22.0	kaoiki	19.2	19.2		12.2	22.7	m-st	4.72	4.88	5.07			4.8	W&K	4.97	hono	VI	Felt generally-Hawaii Island; all seismographs on island dismantled. Warshauer notes: Felt in all districts except Kohala; strong like last week; Kona, Hilo, and volcano stronger than last week; Kau strong; duration, 30 s; many aftershocks.	Isoseismal map in W&K; Cox, 1986; Honolulu records suggest that quake has different source from 5/24/39 kl cal deep; mag agreement OK for Kaoiki quake at depth given; VL 464, p. 6; HTH, 5/23; 24/1939; additional felt reports in references and HVO, unpub.
5/24/39	12:59:00	19	25.00	155	14.00	kl cal deep	24.0	30.0		3.3	30.2	m-st	4.92	5.26	5.52					5.39	hono	VI	Felt-entire Hawaii Island, dismantling all instruments. Warshauer notes: Felt in all districts of Hawaii Island, also Oahu [denied, HTH, May 26]; objects knocked from shelves in volcano district; duration, 15 s (felt), 6 min (instr.); deep Kilauea origin.	Honolulu amplitude average of two readings; VL 464, p. 6; HTH, 5/24; 26/1939; see also HVO, unpub., and references for additional felt reports.
5/24/39	13:09:00	19	25.00	155	14.00	deep	32.0	32.0		3.3	32.2	s	4.19	no trace	no trace					4.19	nomo		hnp-felt, caused landslide in Halemaumau.	VL 464, p. 6; HVO, unpub.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
5/29/39	19:15:00	19	30.0	156	50.0	lanai se	40	40		166.0	170.7	vf	4.53	4.91	4.78					4.85	hono	V	Felt widely-Oahu, Maui; 20-30 mi deep, 90 mi S of Lanai. Warshauer notes: Felt sharply throughout Oahu, not felt on Hawaii; 150 mi from Honolulu, duration, 10 s (felt), 5 min (instr.); recorded at HVO; felt on Oahu, Maui, and Hawaii.	Attenuated at Whitney(?); VL 464, p. 6; HTH, 5/30/1939; HA, 5/30/1939; see additional felt reports in references and HVO, unpub.
5/31/39	15:10:00	19	18.50	155	14.50	kl kuer sf	17.6	10.0		13.8	17.0	m-st	4.52	4.71	4.63					4.67	hono	V	hnp-6.	Honolulu amplitude average of two readings; VL 464, p. 6; HVO, unpub.
5/31/39	20:38:00	19	37.5	155	15.5	ml ner	19.2	19.2		21.6	28.9	s	4.12							4.12	nomo	V	Felt-Hilo, hnp. Warshauer notes: Generally felt throughout volcano and by a few persons in Hilo; hnp-6.	VL 464, p. 6; HTH, 6/1/1939; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
5/31/39	20:51:00	19	34.0	155	10.5	kaoiki	17.6	17.6		17.6	24.9	m-st	4.78	4.45	4.60					4.52	hono	V	Felt-all Kau, Hilo, all island, strong at hnp. Warshauer notes: Very hard in volcano and all Hilo, windows and doors rattled; duration, >30 s; slight in Kohala and Kona; hnp-6; Paauhau-3, quite sharp, duration, 5 s; Hilo-slight, felt by most.	Shallower(?); VL 464, p. 6; HTH, 6/1/1939; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
6/12/39	1:11:00	19	21.00	155	17.00	kl cal deep	20.8	20.8		9.3	22.8	m-st	4.72	4.64	4.65					4.65	hono	V	Felt generally-Hawaii Island, strongest in Hilo and hnp; Kealakekua-short tremor, slight shake, short tremor; hilo-mod, wakened many; hnp-3, wakened persons. Warshauer notes: Hilo-wakened person, prolonged rattling of windows/doors; dismantled instruments	Honolulu amplitude average of two readings; possible surface waves noted on Honolulu seismogram; VL 464, p. 6; HVO, unpub.; HTH, 6/12/1939; weaker than earlier four shocks; felt duration, 30 s.
6/19/39	3:49:00	19	25.30	155	15.00	kl cal deep	24.0	24.0		1.6	24.1	m	4.25	<4.60	<4.53					4.25	nomo	III	Felt-Hilo, hnp; Hilo (time 3:38:15—same event?), 2 mild waves, slight, felt by a few. Warshauer notes: Slight to moderate quake was generally felt in the Hilo and volcano districts at 3:48:45 a.m. In Hilo, felt as a prolonged shock, not strong.	Time changed to agree with newspaper and postcard data; VL 464, p. 7; HVO, unpub.; HTH, 6/19/1939.
7/1/39	0:20:00	19	23.00	155	11.50	kl cal 10-20?	17.6	17.6		9.0	19.8	m	4.35	4.30	4.48					4.39	hono	V	Awakened many in Hilo and hnp, dism seis; hale Pohaku (Mauna Kea)-fairly sharp quake, dur 3-4 s, wakened most sleepers; hilo-3, wakened. Warshauer notes: Felt-all Hilo and volcano dist; dur ~6 min, felt ~15 s; rattled windows, awakened many, no damage.	Honolulu amplitude average of two readings; VL 464, p. 7; HVO, unpub.; HTH, 7/1/1939.
7/14/39	3:51:00	19	19.50	155	7.00	kl mer sf	8.0	8.0		19.2	20.8	m-st	4.66	4.99	5.08			5.50	W&K; S&C	5.04	hono	V; V (S&C)	Felt generally-Hawaii Island; intensity greatest in Kau, Puna; sleepers wakened in Hilo, hnp; unusually strong at Pahoa. Warshauer notes: Felt-entire island, strongest in Puna & volcano district; sleepers awakened and windows rattled, but no damage done.	Honolulu amplitude average of two readings; isoseismal map in W&K (mag too high?); VL 465, p. 5; HTH, 7/14/1939; see HVO, unpub., and references for complete felt report.
8/5/39	13:46:00	19	31.0	156	2.0	hualalai?	12.8	12.8		82.0	83.0	vf	4.03							4.03	nomo	IV	Felt-Holualoa, Hookena; Hookena-2; Kau and Kona-rather sharp and short, single shake with vertical motion; Holualoa-5.	VL 465, p. 5; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards]; not found in HTH.
8/17/39	5:57:00	19	19.50	155	6.50	kl mer sf	12.8	10.0		20.0	22.3	m	4.43	4.26	4.46					4.36	hono		No intensity reports!	Honolulu amplitude average of two readings; VL 465, p. 6; not found in HTH.
8/17/39	6:18:00	19	21.50	155	7.00	kl mer sf	6.4	6.4		17.2	18.4	m	4.30	<4.46	<4.46					4.30	nomo		Do.	VL 465, p. 6; not found in HTH.
6/11/40	17:32:00	19	26.8	155	31.6	kaoiki	28.8	28.8		28.1	40.2	s-m (f-s?)	4.12	<4.27	<4.02					4.12	nomo	V	Felt-Hookena, Kealakekua, hnp; Kealakekua-slight tremor followed by shake that dwindled away; duration, 5 s; Hookena-4, slight tremble followed by sharp shake, buildings shook, objects on shelves moved.	Feeble-slight(?); shallower(?); VL 468, p. 12; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
6/16/40	23:56:49	21	0.0	155	18.0	maui east				174.5	174.8	st	6.14	off scale	off scale			6.0	GUTE	6.00	gute	VI; V (S&C)	Felt generally-Hawaiian chain, particularly on Oahu, Maui, Hawaii. Warshauer notes: At least 2 sharp earthquakes felt in Honolulu; first lasted several seconds, windows rattled, houses creaked; also Hilo, Maui, Molokai (articles off shelves); no damage.	Isoseismal map in W&K; VL 468, p. 12 [detailed felt report given]; HSB; HTH; HA, 6/17/1940; additional felt reports in HVO, unpub.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
6/17/40	0:14:00	21	0.0	155	18.0	maui east				174.5	174.8	s	5.37	lost in ms	lost in ms					5.37	nomo	IV	Aftershock of 6/16/40 earthquake. Warshauer notes: Slight shock; duration, 2 s; second slight quake; Kealakekua-very slight and very short; Hookena-2; duration, 5 s, sort of bubbling motion; (Maui)-4, shook windows.	VL 468, p. 12; HSB; HTH, 6/17/1940; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
6/17/40	7:47:00	21	0.0	155	18.0	maui east				174.5	174.8	m (f?)	4.82	4.59	4.72					4.65	hono	V (S&C)	Aftershock of 6/16/40 earthquake; felt-Hawaii, Maui, Oahu. Warshauer notes: A moderate quake.	Honolulu data average of two readings; nomogram agrees only if earthquake is "feeble"; error in VL(?); VL 468, p. 12; HSB; HTH, 6/17/1940.
6/17/40	12:39:00	21	0.0	155	18.0	maui east				174.5	174.8	s	5.37	5.42	5.00					5.20	hono	V (S&C); III (hamakua)	Aftershock of 6/16/40 quake; felt-Hawaii, Maui, Oahu. Warshauer notes: Another aftershock bet slight and moderate; Hakalau-moderate; Kealakekua-very slight shake of 2-s dur, felt by few; Paauhau-3, 2-s med vib, 2 lighter vibs; Wailuku-3, shook windows.	VL 468, p. 12; HTH, 6/17/1940; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
7/4/40	15:55:00	20	4.9	154	42.2	mauna kea os				93.2	93.7	f	4.12	4.05	4.00					4.03	hono		40 mi NE of Hilo.	VL 469, p. 5.
7/9/40	19:30:00	20	8.6	155	9.1	mauna kea os				80.0	80.6	f	4.61	4.78	4.78					4.78	hono		Offshore 12 mi NE of Ookala.	Do.
7/15/40	16:48:00	20	54.0	155	8.0	maui east				163.9	164.2	m	5.82	5.90	5.91			5.6	GUTE	5.90	hono	V; V (S&C)	Main shock: felt-all islands exc Kauai. Warshauer notes: Strong at Kohala; duration, 30 s; slight in Hilo, felt by many; Paauhau-3, single brief very noticeable vibration; Ulupalakua (Maui)-light shock; duration, 20 s; visible bouncing of bed mattresses.	W&K report M 5.5-not derived from felt area; VL 469, p. 5; HTH, 7/16/1940; HA, 7/18/1940; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
7/15/40	21:13:00	20	54.0	155	8.0	maui east				163.9	164.2	vf	4.51	4.52	4.52					4.52	hono	II	Paauhau, Maui (Ulupalakua); Ulupalakua (Maui)-extremely slight, horizontal E-W motion, double shake with 1/2-s separation; Paauhau-2, single vibration, brief and very weak.	VL 469, p. 5; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
9/1/40	22:15:00	21	0.0	155	16.0	maui east				174.5	174.7	m	5.62	5.58	5.20			5.6	GUTE	5.39	hono	IV (S&C); V (USE)	Felt generally-Hawaii Island.	W&K report M 5.5-not derived from felt area; VL 469, p. 5; not found in HTH.
1/17/41	7:30:00	19	40.3	156	3.5	hualalai	22.4	22.4		88.2	91.0	s	4.91	4.77	3.93					4.77	hono	VI	Felt strongly-Puu Waawaa; also, Kailua, Hookena, Hilo; Puu Waawaa ranch-6, buildings shook quite hard, some objects fell off shelves; Hookena-2, building shaken; Waimea-rattled windows; duration, 15 s.	VL 471, p. 4; not found in HTH; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
1/18/41	9:34:00	20	12.3	155	13.2	mauna kea os				86.2	86.6	f	4.33	4.62	4.44					4.53	hono		15 mi N of Papaaloa near earthquakes of summer 1940.	VL 471, p. 4; not found in HTH.
2/8/41	9:19:00	20	10.2	155	0.0	mauna kea os				86.7	87.1	f	4.34	4.56	4.69					4.62	hono			Do.
2/11/41	21:56:00	20	34.0	154	49.0	kohala os				134.7	135.0	f	4.37	4.13	4.01					4.07	hono			VL 471, p. 4.
2/18/41	11:53:00	19	41.0	155	39.0	deep	48	48		49.7	69.1	s	4.72	4.56	4.56					4.56	hono			VL 471, p. 4; not found in HTH.
4/20/41	10:46:00	19	23.90	155	16.00	kl cal deep	1.6	25.0		3.7	25.3	m	4.52	4.58	4.47					4.53	hono	IV	Felt-hnp, Kau, Kona, Hilo. Warshauer notes: A moderate earthquake felt throughout East Hawaii dismantled instruments at HVO and Halemaumau; felt duration, about 30 s; occurred at 11:46 a.m. [time off?], preceded by a series of lesser quakes.	VL 472, p. 3; HTH, 4/21/1941; see HVO, unpub., for additional felt reports.
9/25/41	7:18:00	19	21.0	155	27.0	kaoiki	11.2	11.2		21.9	24.6	m-st	4.78	5.80	5.85			6.0		5.82	hono	VII; VII (S&C)	SE flank ml, 4 mi N of Kapapala ranch house; felt generally-Hawaii Island, by some in Honolulu. Warshauer notes: Felt most strongly-Pahala and Kapapala, dishes fell, bottles broken; plaster cracked in Hilo; strong at Kohala, Puna, and Kona; no damage.	Isoseismal map in W&K; strong(?); VL 473 [includes damage report; dismantled all seismographs, low mag instrument not operating], p. 3; HTH, 9/25/1941; extensive felt reports in HVO, unpub.
10/25/41	8:54:00					mauna kea		40	73	73.0	83.2	f	4.63	4.96	5.20					5.08	hono	felt	N slope Mauna Kea near; felt generally-Hawaii Island; this and subsequent quakes precursory to Mauna Kea swarm starting November 13. Warshauer notes: Felt at Hawaii National Park, Hilo, and Kohala.	Slight(?); VL 474, p. 3; HTH, 10/30/1941.
11/13/41	20:07:00	20	4.0	155	42.0	mauna kea?		43	83.2	84.5	94.8	f; s (ml)	4.40	3.99; 4.61	thick line					4.30	hono	felt	52 mi from HVO; felt-. Warshauer notes: Felt at; felt in Kohala, north Kona, Hamakua, and [probably] at Kilauea.	HON magnitude average of two readings; VL 474, p. 3; HTH, 11/15; 21/1941.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
11/15/41	6:53:00	20	4.0	155	42.0	mauna kea?	43.2	43.2	83.2	84.5	94.9	s	5.20	5.73	4.91					5.32	hono	felt	52 mi from HVO; Hilo dismantled. Warshauer notes: The strongest earthquake [in a series] was reported at 6:58 a.m. today [doesn't say whether felt!]; felt islandwide by a few and by many in Kohala, north Kona, and Hamakua.	VL 474, p. 3; HTH, 11/15; 21/1941; not found in HA.
11/15/41	18:37:00					mauna kea?		43	83.2	83.2	93.7	f	4.39	4.02	4.22					4.12	hono	felt	52 mi from HVO; felt generally-N Hawaii Island. Warshauer notes: Felt in northern part of island and by several in Hilo.	VL 474, p. 3; HTH, 11/21/1941.
11/16/41	2:31:00					mauna kea?	43.2	43.2	81.9	81.9	92.6	f	4.11	<4.10	<4.10					4.11	nomo	felt	Near 52 mi from HVO; newspaper time accepted. Warshauer notes: Felt in Hilo; felt at and perhaps other places in N Hawaii.	Do.
11/16/41	9:41:00	20	4.0	155	42.0	mauna kea?	43.2	43.2	83.2	84.5	94.9	m	5.71	5.83	5.83					5.83	hono	V; V (S&C)	Near 52 mi from HVO; felt generally Hawaii Island; slight damage. Warshauer notes: Felt by many in all parts of Hawaii; no damage reported; not felt on Oahu.	Do.
11/18/41	2:56:00	20	4.0	155	42.0	mauna kea?	43.2	43.2	83	84.5	94.9	m-st	5.71	6.07	6.17					6.12	hono	VI; V (S&C)	Near, slight damage; felt strongly-Hawaii Island, less on Maui. Warshauer notes: Dishes and bottles were broken at early this morning by an earthquake also felt strongly in Hilo; approximate time of the quake was 2:53 a.m.	VL 474, p. 3; HTH, 11/18/1941.
11/18/41	10:30:00	20	4.0	155	42.0	mauna kea?		43	83	84.5	94.8	f	4.72	5.05	4.50					4.72	hono	felt	Felt generally-Hawaii Island.	VL 474, p. 3.
11/18/41	10:33:00	20	4.0	155	42.0	mauna kea?		43	83	84.5	94.8	f	4.40	<4.22	<4.22					4.40	nomo	felt	Do.	Do.
11/19/41	7:43:00	20	4.0	155	42.0	mauna kea?		43	83.2	84.5	94.8	f	4.72	5.17	5.40					5.29	hono	felt	52 mi from HVO; felt widely.	Slight(?); VL 474, p. 3.
11/22/41	10:04:00	20	4.0	155	42.0	mauna kea?		43	83	84.5	94.8	f	4.13							4.13	nomo		Near.	VL 474, p. 4.
11/22/41	21:23:00	20	4.0	155	42.0	mauna kea?		43	83	84.5	94.8	s	5.20	5.61	5.50					5.56	hono	V (W&K)	Near; felt generally-Hawaii Island, few on Maui.	Moderate(?); VL 474, p. 4.
11/22/41	22:12:00	20	4.0	155	42.0	mauna kea?		43	83	84.5	94.8	vf	4.13							4.13	nomo	felt	Felt.	VL 474, p. 4.
1/25/42	6:13:00					kaoiki?			25.6	25.6	27.1	s	4.07							4.07	nomo	V-VI	16 mi from HVO; felt-hnp; broke dishes at KMC.	VL 475, p. 2
2/8/42	17:48:00	19	38.0	155	10.0	hilo deep	48	48	24.5	24.6	53.9	s	4.81	5.15	5.23					5.19	hono	felt	8 mi SW of Hilo; felt-Hilo, hnp; Hilo seismograph dismantled.	Farther away(?) or moderate(?); VL 475, p. 2; not found in HTH.
2/18/42	11:09:00	19	25.80	155	16.60	kl cal 10-20	12.8	12.8	2.0	1.7	12.9	m	4.05	no record	no record					4.05	nomo	V	N end Kilauea crater; felt-hnp, awakened many, dismantled HVO and mlo seismographs.	VL 475, p. 2.
2/21/42	8:11:00	19	32.0	155	28.0	ml ner	8	8	24	24.5	25.8	m	4.81	6.09	6.09					6.09	hono	VI	Felt widely. Warshauer notes: Hilo-dishes and bottles fell, plaster cracked, parked cars shook from two strong quakes; dismantled seismographs, slides in Kilauea crater; bottles broken at Volcano House.	Strong(?) or deep(?); VL 475, p. 2; HTH, 2/21; 22/1942; HSB, 2/21/1942; time given as "shortly after 9 a.m. today" [Hawaii war time, 1 hour later].
2/21/42	8:14:00	19	32.0	155	28.0	ml ner	8	8	24	24.5	25.8	m	4.81	6.14	6.09					6.11	hono	VI	Do.; felt widely; another and stronger shock occurred at about 9:14 a.m.	VL 475, p. 2; HTH, 2/21; 22/1942; HSB, 2/21/1942; time given as "shortly after 9 a.m. today" [Hawaii war time, 1 hour later].
2/21/42	8:36:00	19	32.0	155	28.0	ml ner	8	8	24	24.5	25.8	s	4.04	no trace	no trace					4.04	nomo		Warshauer notes: Then, at 9:37 there was another shake, strong enough to dismantle the east-west component of the seismograph at the Volcano House.	[Times are Hawaii war time, 1 hour later]; VL 475, p. 2; HTH, 2/22/1942.
2/22/42	14:47:00					ml ner?		8	25.6	25.6	26.8	s	4.06							4.06	nomo		16 mi from HVO.	VL 475, p. 2.
2/22/42	15:05:00					ml ner?		8	24	24.0	25.3	s	4.02							4.02	nomo		15 mi from HVO.	Do.
3/7/42	6:41:00	19	29.4	155	35.0	ml mok		8	36	34.6	35.5	s	4.04							4.04	nomo		N end of Mokuaweoweo.	Do.
3/15/42	9:35:00	19	27.2	155	35.8	ml mok		8	34	35.5	36.4	s	4.05							4.05	nomo		S end of Mokuaweoweo.	Do.
3/16/42	21:57:00	19	27.2	155	35.8	ml mok		5	34	35.5	35.8	s	4.04							4.04	nomo	felt	Do.; felt-Kona.	Do.
3/19/42	0:17:00					ml mok		5	35	35.0	35.4	s	4.03							4.03	nomo		Near Mokuaweoweo; E-W dismantled.	Do.
3/20/42	23:05:00					ml swr		5	43	43.0	43.3	m	5.17	>5.67	5.88					5.88	hono	V	SW rift; felt widely; stopped clocks in S Kona. Warshauer notes: Deep-seated earthquake felt generally in Hilo; dismantled seismic equipment; no damage.	Strong(?); must be deep to fit felt reports and HON magnitudes; VL 475, p. 2; HTH, 3/21/1942; time given as "12:04 a.m. today" [daylight saving time in effect; see VL 476, p. 2, 1st paragraph].
3/21/42	20:14:00					ml swr		5	53	53.0	53.2	f	4.00							4.00	nomo	felt	SW rift; felt-S Kona.	VL 475, p. 2.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
3/28/42	21:55:00					ml ner		5	25	25.0	25.5	s	4.03	no trace	no trace					4.03	nomo	felt	NE rift; felt-hnp, Hilo.	Do.
4/26/42	23:41:00					ml ner	5	5	34	34.0	34.4	m	4.73	4.61	4.98					4.79	hono	felt	Upper NE rift; felt-hnp, Hilo.	VL 476, p. 7.
4/27/42	0:01:00					ml ner		5	34	34.0	34.4	s	4.24							4.24	nomo		Upper NE rift.	Do.
4/27/42	4:21:00					ml ner		5	34	34.0	34.4	s	4.24							4.24	nomo		Do.	Do.
4/27/42	8:49:00					ml ner		5	34	34.0	34.4	s	4.50	4.97	4.61					4.79	hono		Do.	Deeper(?); VL 476, p. 7.
4/27/42	9:52:00					ml mok		5	35	35.0	35.4	s	4.26							4.26	nomo		Near Mokuaweoweo.	VL 476, p. 7.
4/27/42	11:53:00	19	32.5	155	28.0	ml ner		5	25	24.9	25.4	s	4.03							4.03	nomo		NE rift above Puu Ulaula.	Do.
4/27/42	14:12:00					ml ner?		5	25	25.0	25.5	s	4.03							4.03	nomo		Record confused; no location or distance given.	Do.
4/27/42	14:23:00					ml ner?		5	25	25.0	25.5	s	4.03							4.03	nomo		No location or distance given.	Do.
4/27/42	16:44:00					ml ner?		5	25	25.0	25.5	s	4.03							4.03	nomo		Do.	Do.
4/27/42	21:43:00					ml ner?		5	25	25.0	25.5	m	4.80	6.09	light trace					6.09	aver	felt	Felt strongly-Puu Ulaula; instruments dismantled.	Strong(?); VL 476, p. 7; not found in HTH.
4/29/42	11:10:00					ml ner?		5	24	24.0	24.5	s	4.00							4.00	nomo		No location or distance given.	VL 476, p. 7.
7/9/42	3:00:00					kohala os			115	115.0	115.4	s	5.34	5.92	5.50					5.71	hono	IV	In ocean N of Kohala; felt strongly-Kohala. Warshauer notes: An earthquake between slight and moderate was recorded at 3:59 a.m. [daylight saving time in effect]; dismantled seismograph, felt strongly in district, also in Hilo.	Moderate(?); VL 477, p. 3; HTH, 7/9/1942.
10/11/42	11:43:00	19	29.4	155	35.0	ml mok			34	34.6	35.8	s	4.26							4.26	nomo		N end of Mokuaweoweo.	VL 478, p. 3; not found in HTH.
12/6/42	12:08:00	19	6.0	155	41.3	ml swr			59	58.2	58.9	s	4.39	no trace	no trace					4.39	nomo	felt	SW rift near source of 1868 flow; felt-Hilo to S Kona.	Closer(?); VL 478, p. 4; not found in HTH.
12/21/42	23:59:00					kl mer?		2.0	16.0	16.0	16.1	s	3.71							4.15	calc		Preferred magnitude calculates as nomogram magnitude multiplied by number of events.	3 slight events on December 21 not separately tabulated; VL 478, p. 4.
1/9/43	20:04:00					ml swr?			59	59.0	59.7	f	4.07							4.07	nomo	felt	Felt-S Kona.	VL 479, p. 5.
1/17/43	14:08:00					ml ner			24	24.0	25.6	s	4.03							4.03	nomo	felt	NE rift; felt-hnp.	Do.
1/19/43	2:48:00					ml ner?			24	24.0	25.6	s	4.03							4.03	nomo	felt	Felt-hnp, Hilo.	Do.
5/8/43	4:10:00					ml mok			35	35.0	36.1	s	4.27	no trace	no trace					4.27	nomo	felt	[On p. 3, time given as 5:10 April 8—probably the same quake, given a daylight-saving-time correction and a misprint of the month]; near Mokuaweoweo; felt generally-E Hawaii Island.	VL 480, p. 3, 4; not found in HTH.
6/14/43	21:38:00	20	4.0	155	42.0	kohala?				84.5	85.0	s	4.64	no trace	no trace					4.64	nomo	felt	Near; felt widely-Hawaii Island.	Closer(?); calc mag accepted on the basis that there may have been high background noise on the Honolulu seismogram preventing the earthquake from being seen; VL 480, p. 4; not found in HTH.
10/16/43	2:36:00					mauna kea			45	45.0	45.9	s	4.44							4.44	nomo	felt	E slope Mauna Kea; felt-hnp, Hakalau.	VL 482, p. 2.
11/10/43	16:22:00					hilea?			43	43.0	43.9	m	4.90	4.88	4.88					4.88	hono	VI; VI (USE); V (W&K; S&C)	Felt widely-S half Hawaii Island; stone walls thrown down SW of Pahala; dismantled instruments.	VL 482, p. 2; not found in HTH.
12/22/43	19:50:00					ml swr?			45	45.0	45.9	s	4.21	no trace	no trace					4.21	nomo	felt	SW slope Mauna Loa; felt-hnp, Hilo.	Closer(?) or feeble(?); VL 482, p. 2; not found in HTH.
1/23/44	14:40:00	19	32.0	155	28.0	ml ner				24.5	26.1	s	4.05							4.05	nomo	felt	NE rift near Puu Ulaula; felt-hnp, Pahala.	VL 483, p. 3.
7/2/44	20:48:00					kohala?			90	90.0	90.4	f	4.36	4.74	4.92					4.83	hono		NW Hawaii.	Offshore(?); VL 485, p. 3.
10/2/44	17:27:00	20	1.0	155	17.0	mauna kea		40		65.2	76.5	s	4.79	<4.50	4.40					4.40	hono		Deep focus, near Ookala.	shallower(?); VL 486, p. 3; not found in HTH
10/17/44	13:54:00					mauna kea			55	55.0	55.7	f	4.03	<4.32	<4.02					4.03	nomo	felt	Mauna Kea; felt-Hilo.	VL 486, p. 3.
10/29/44	17:17:00					mauna kea			55	55.0	55.7	f	4.03							4.03	nomo	felt	Mauna Kea; felt-hnp, Hilo.	Do.
11/12/44	4:56:00	19	24.00	155	17.70	kl cal deep?	14.4	30.0	4.5	5.0	30.4	m	4.65	4.58	4.58					4.58	hono	V (W&K; USE)	SW of Halemaumau; felt widely-S half Hawaii Island, dismantled seismographs at Hilo, Kona, and HVO.	Depth increased to match HON magnitude consistent with felt reports; VL 486, p. 3; not found in HTH.
12/27/44	3:42:00	19	29.0	155	35.0	ml mok	24	24		34.5	42.0	st	5.15	light trace	5.78			5.6	GUTE	5.78	hono	VI; VI (USE; S&C)	Edge Mokuaweoweo, felt widely-Hawaii Island, plainly on Oahu; objects off shelves Pepeekeo, and stone fences down in Hilea; dismantled seismographs. Warshauer notes: Sharp quake awakened people; dur few seconds, no damage in Hilo; pronounced in hnp.	VL 486, p. 3; HTH, 12/27/1944.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
12/27/44	5:46:00	19	29.0	155	35.0	ml mok	24	24		34.5	42.0	s	4.38	no trace	no trace					4.38	nomo	III	Do.; dismantled seismographs. Warshauer notes: The earthquake [at 4 a.m. H.s.t.] was followed by two smaller quakes at 6 and 7 a.m. [daylight saving times approximate?].	VL 486, p. 3; HTH, 12/27/1944.
12/30/44	9:21:00	19	29.0	155	35.0	ml mok	24	24		34.5	42.0	m	5.15	5.36	5.50					5.43	hono	III	Do.	Deeper(?); VL 486, p. 3; not found in HTH.
12/31/44	11:10:00	19	16.2	155	28.9	hilea	20.8	20.8		29.4	36.0	m	5.04	4.93	5.08					5.00	hono	III	Wood valley; do.	VL 486, p. 3; not found in HTH.
1/9/45	18:57:00					hilea?			35	35.0	36.1	s	4.27							4.27	nomo	felt	Felt-Pahala.	VL 487, p. 5.
1/24/45	10:38:00	19	25.00	155	16.20	kl cal deep	20.0	21.0		1.9	21.1	m	4.39	4.32	4.33					4.32	hono	felt	E rim Kilauea crater; felt widely-S half Hawaii Island.	Do.
3/5/45	0:00:00					ml swr			45	45.0	45.9	m	4.93	4.91	5.04					4.97	hono	V	SW rift; felt widely-Hawaii Island; stopped clocks in S Kona.	VL 487, p. 6; VL date wrong—Honolulu record shows 3/5.
3/12/45	19:00:00	19	19.00	155	2.00	kl kuer sf?		10.0	28.0	27.2	28.9	m	4.38	<4.47	<4.32					4.38	nomo	felt	In ocean off Puna-Kau boundary; felt-hnp, dismantled seismograph.	Location onshore would be more consistent with modern catalog and give better mag agreement with HON consistent with felt report; VL 487, p. 6; not found in HTH.
5/19/45	1:48:00					kaoiki			20	20.0	21.9	m	4.70	5.22	5.37					5.30	hono	V (USE; S&C)	E slope Mauna Loa; felt generally-Hawaii Island, slightly on Oahu.	Deeper(?); VL 488, p. 3; not found in HTH.
5/29/45	18:45:00	19	31.0	155	32.4	kaoiki	20.8	20.8		30.9	37.3	s	4.29	no trace	no trace					4.29	nomo	felt	5 mi SW of Puu Ulaula; felt-hnp, Hilo, s Kona	VL 488, p. 3.
6/14/45	19:46:00	19	11.3	155	28.7	hilea				35.4	36.5	s	4.28	<4.45	4.07					4.07	hono	felt	Near Pahala; felt-hnp, Pahala.	Do.
7/13/45	2:15:00	19	20.00	155		kl mer sf	8.0	8.0		29.6	30.6	m	4.65	4.98	4.60					4.79	hono	IV	Coast SW of Kalapana; felt widely-E half Hawaii Island; dismantled E-W component. Warshauer notes: Residents in several sections of Hilo felt an earthquake that some describe as "fairly strong" at 3:15 a.m. [daylight saving time]; duration, >5 minutes.	VL 489, p. 4; HTH, 7/13/1945.
9/19/45	5:33:00					ml nf			36	36.0	37.1	s	4.29	4.38	3.89					4.14	hono	V (USE)	Between Mauna Loa and Mauna Kea; felt widely-Hawaii Island.	VL 489, p. 4; not found in HTH.
12/16/45	20:30:00					kaoiki			20	20.0	21.9	s	4.18	5.41	4.96					5.19	hono	felt	E flank of Mauna Loa; felt-hnp, Pahala, Hilo; E W component dismantled.	deeper(?), farther away(?) or moderate(?); Honolulu mag too high for felt report(?); VL 490, p. 3
2/6/46	4:45:00	19	8.0	155	28.7	hilea				40.3	41.3	s	4.36	4.76	4.76					4.76	hono	felt	Near coast below Pahala; felt-Kau, S Kona.	VL 491, p. 5.
2/8/46	6:15:00					ml ner			30	30.0	31.3	s	4.17	4.37	4.37					4.37	hono	felt	NE rift; felt-hnp, Pahala, Hilo.	Do.
2/14/46	9:03:00					ml swr			48	48.0	48.8	s	4.26	no trace	no trace					4.26	nomo		Middle SW rift.	Do.
2/23/46	22:44:00					kohala?			60	60.0	60.7	s	4.41	no trace	no trace					4.41	nomo	felt	Felt-N Kona, S Kohala.	Closer(?) or feeble(?); VL 491, p. 5.
4/8/46	8:58:00					ml mok deep?		40	35	35.0	53.2	s	4.32	no trace	no trace					4.32	nomo	felt	Deep under Mauna Loa in; felt widely.	VL 492, p. 7.
5/19/46	18:36:00					kl ler sf?		10.0		60.0	60.8	s	4.63	4.73	4.72					4.72	hono	felt	Felt-hnp, Hilo.	Honolulu amplitude average of two readings; s-p on Honolulu record, felt report, and magnitude suggests ler sf; ed assumed for mag agreement; VL 492, p. 7.
8/8/46	16:28:00					ml ner?			30	30.0	31.3	s	4.17	no trace	no trace					4.17	nomo	felt	NE slope Mauna Loa; felt-hnp.	VL 493, p. 3.
9/4/46	13:21:00					ml ner?			30	30.0	31.3	s	4.17	no trace	4.12					4.12	hono	III	NE slope Mauna Loa; felt-hnp. Warshauer notes: The strongest quake we've had in quite awhile rocked the volcano and Kau regions; felt duration, several seconds, no damage; felt in Honolulu [unlikely?].	VL 493, p. 3; HTH, 9/5; 10/6/1946.
10/8/46	23:56:00	19	29.7	155	22.5	kaoiki	16	16		14.0	21.2	s	3.90	no trace	no trace		4.06			4.06	hono	felt	NE slope Mauna Loa, 1 mi E of Mauna Loa seismograph; felt-hnp, Hilo.	VL 494, p. 7.
10/10/46	5:59:00					hualalai deep		40	90	90.0	98.5	vf	4.15	obscure trace	obscure trace		4.79			4.47	aver	felt	NW coast of Hualalai; felt-Kona, Maui. Warshauer notes: An earthquake October 10 was widely felt on Maui and scattered points on this island originated deep under the Hualalai coast.	VL 494, p. 7; HTH, 11/5/1946.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
10/29/46	18:43:00					kaoiki deep		20	20	20.0	28.3	s	4.10	<4.37	<4.27		3.59			4.10	nomo		E slope Mauna Loa. Warshauer notes: The earthquake of October 29, which rocked most of the east half of Hawaii, originated deep under the east slope of Mauna Loa.	[Not sure whether s-p horizontal has the same characteristics as the Neumann-LaBarre instrument after Nov. 1946]; station HON film time is 18:46, nomogram magnitude accepted; VL 494, p. 7; HTH, 11/5/1946.
11/30/46	1:54:00					deep		40	20	20.0	44.7	s	4.42	4.22	no trace					4.22	hono		E slope Mauna Loa.	VL VL 494, p. 7.
12/22/46	7:02:00					hilo	24	24	30	30.0	38.4	f	4.09	<4.32	<4.32		4.32			4.32	hono	felt	Felt-E Hawaii Island.	VL 494, p. 7; station HON film time is 7:04.
1/15/47	9:47:00					ml ner			30	30.0	31.3	s	4.17	4.37	<4.27		4.83			4.37	hono		NE rift; M-S magnitude accepted as preferred.	N-L high(?); VL 495, p. 6; station HON film time is 9:48.
2/26/47	18:54:00					ml ner			30	30.0	31.3	f (s?)	4.17	<4.55	no trace		<4.47			4.17	nomo	felt	NE rift; felt generally-e Hawaii Island; mag calculated assuming "slight" fits felt report better	VL 495, p. 6; not found in HTH.
3/19/47	23:06:00					ml mok deep	40	40	35	35.0	53.2	m (s?)	4.80	4.38	4.22		4.42			4.34	hono	V (USE)	Deep under Mauna Loa; felt widely-Hawaii Island; dismantled MLO seismometer. Warshauer notes: Strong quake under Mauna Loa east slope dismantled seismographs at HVO; shallower than others recently; especially strong at and Kapapala; felt in Hilo.	Shallower(?), or slight(?); VL 495, p. 6; HTH, 3/20/1947.
3/21/47	17:37:00	19	44.0	156	3.8	hualalai				91.0	91.5	f	4.37	<4.17	<4.17		4.57			4.37	nomo		Keahole pt.	N-L high(?); VL 495, p. 6; not found in HTH.
4/12/47	1:46:00					kaoiki			20	20.0	21.9	s	4.18	no trace	no trace		trace			4.18	nomo	felt	Felt-Kapapala.	VL 496, p. 3.
4/12/47	2:29:00					kaoiki			20	20.0	21.9	s	4.18	no trace	no trace		no trace			4.18	nomo	felt	Do.	Do.
6/14/47	23:00:00					kl cal 10-20?		15.0	4.0	4.0	15.5	m	4.18	<4.12	<4.2		4.48			4.18	nomo	felt	Moderate depth under Kilauea; felt locally and as far as Papaikou; MLO instrument dismantled.	N-L high(?); VL 496, p. 3
6/19/47	5:24:00					kl cal 10-20?		13.0	4.0	4.0	13.6	m	4.09	4.18	4.02		3.85			4.02	hono	felt	Shallow under Kilauea; felt locally; E-W dismantled.	VL 496, p. 3.
8/18/47	9:52:00					kl cal deep		21.0	5.0	5.0	21.6	m	4.41	4.15	4.39		no record			4.27	hono	felt	Deep under Kilauea; felt locally and at Naalehu; E-W seismograph dismantled. Warshauer notes: An earthquake at 9:52 a.m. was felt as far as Hilo.	VL 497, p. 3; HTH, 8/18; 19/1947.
8/19/47	6:44:00					kaoiki?			20	20.0	21.9	s	4.18	no trace	no trace		no record			4.18	nomo	felt	notes: Felt at and Kapapala, "much stronger" than the [Kilauea] quake at 9:52 a.m. August 18.	VL 497, p. 3; HTH, 8/19/1947.
9/21/47	5:50:00	19	42.2	155	28.0	ml nf deep	36	36		37.2	51.8	s	4.52	4.35	<4.50		4.28			4.31	hono	IV	Deep below Humuula; felt widely-Hawaii Island, few on Maui. Warshauer notes: Big Island, from to Hilo and as far west as Pahala in Kau, shook for 3.5 min early Sunday; no damage; slow swaying, intense for 20 s, acc by rumbling.	Honolulu data average of 2 readings; shallower(?); VL 497, p. 3; HTH, 9/22/1947.
9/30/47	4:04:00					kl cal deep	11.2	25.0	5.0	5.0	25.5	m	4.52	4.45	4.63		5.15			4.74	hono	V	East of Kilauea crater; felt generally-S Kona to Hilo. Warshauer notes: Roused sleepers all over island, duration, >1 min; toppled radio antenna and caused a hole to form in Hilo; movement horizontal and vertical; dismantled all seismographs on island.	N-L peak trace invisible; VL 497, p. 3; HTH, 9/30/1947.
10/17/47	0:27:00	19	16.8	155	27.2	kaoiki			26	26.3	27.8	s	4.09	no trace	no trace		4.11			4.11	hono	felt	Near Kapapala; felt generally-E Hawaii Island.	VL 498, p. 3.
10/31/47	2:13:00	19	28.5	155	35.5	ml mok				35.2	36.3	m	4.53	4.43	4.33		4.11			4.29	hono	V	Mokuaweoweo; felt widely-E half Hawaii Island; clocks stopped in S Kona.	VL 498, p. 3; not found in HTH.
12/14/47	10:10:00					kl cal deep	32.0	32.0		5.0	32.4	m	4.69	<4.27	<4.27		4.89			4.69	nomo	IV	Felt-hnp, Hilo. Warshauer notes: Deep earthquake 20 mi under Kilauea; rattled windows and dishes in the Hilo, Volcano, and Kau districts; pronounced vertical motion; felt quite plainly in hnp region, acc. by a rumble; dismantled mlo and HVO seismographs.	N-L high, M-S low; VL 498, p. 3; HTH, 12/15/1947.
12/20/47	5:18:00	19	28.5	155	35.5	ml mok				35.2	36.3	s	4.28	<4.17	<4.22		4.72			4.42	hono	felt	Mokuaweoweo; felt-E half Hawaii Island. Warshauer notes: Widely felt.	Honolulu data average of 2 readings; N-L mag high; VL 498, p. 3; HTH, 12/2/1947.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
12/24/47	6:38:00	19	21.5	155	25.6	kaoiki				19.2	21.2	s	4.16	no trace	no trace		no trace			4.16	nomo	V	E slope Mauna Loa near Ainapo; felt-hnp, Hilo. Warshauer notes: The third earthquake to originate under Mauna Loa in 5 days awakened Big Island residents at 6:38 a.m. today. It was particularly noticeable in the Puueo section of Hilo.	VL 498, p. 3; HTH, 12/24/1947.
1/8/48	16:15:00					kaoiki			20	20.0	21.9	s	4.18	no trace	no trace		4.12			4.12	hono	felt	E slope Mauna Loa; felt-hnp. Warshauer notes: Seismographs at Hawaii National Park registered a fairly deep earthquake southwest of Kilauea Volcano at 4:30 p.m. Thursday. The quake was felt in the volcano district and parts of Hilo.	VL 499, p. 3; HTH, 1/9/1948 [time differs from VL—same quake or a separate one, possibly kl cal deep, not recorded in VL 499(?)].
1/15/48	6:16:00					ml ner			30	30.0	31.3	s	4.17	<4.37	no trace		<3.27			4.17	nomo	III	NE slope Mauna Loa; felt-hnp, Hilo. Warshauer notes: a moderate [slight in] earthquake was felt at 6:16 a.m. today, lasting several seconds in the Puueo section of Hilo. It was felt, not severely, in the volcano region and other sections of the island.	VL 499, p. 3; HTH, 1/15/1948.
1/26/48	23:02:00					ml ner			30	30.0	31.3	s	4.43	no trace	no trace		4.61			4.61	hono	felt	NE rift; felt- to Hilo. Warshauer notes: A moderate earthquake, originating on the northeast slope of Mauna Loa, was registered at 11:02 p.m.; the earthquake was felt over a wide area, including the Puueo section of Hilo	N-L high(?); VL 499, p. 3; HTH, 1/27/1948.
3/9/48	15:46:00					kohala?			65	65.0	65.6	s	4.46	no trace	no trace		4.43			4.43	hono	felt	Felt from Hilo to Kona; off coast north of Hualalai. Warshauer notes: An earthquake, originating either under Hualalai or Mauna Kea, was recorded by HVO at 3:46 p.m. Tuesday. The quake was felt over a wide area, including Hilo and.	Closer(?) or feeble(?); newspaper location (approx 65 km from HVO gives better fit than location (95 km from HVO); VL 499, p. 3; HTH, 3/10/1948.
3/19/48	16:18:00					kl cal deep		25.0		3.0	25.2	m	4.52	4.16	det		4.78			4.35	hono	IV	Deep Kilauea; felt-Hilo to Naalehu. Warshauer notes: A sharp temblor shook the Big Island at 4:18 p.m. Friday, the strongest in 3 months; a vertical quake, strongly felt in the volcano area and in most areas of Hilo.	Honolulu amplitude average of two readings; N-L high; M-S E-W detected; not read because record was being changed; VL 499, p. 3; HTH, 3/20/1948.
5/22/48	11:34:00					hualalai deep		20	70	70.0	72.8	s	4.54	4.10	no trace		no record			4.10	hono	felt	Hualalai. Warshauer notes: An earthquake originated deep under Hualalai at 11:33 a.m. Saturday. The temblor was felt in the volcano district.	Closer to Kilauea(?) and/or shallower(?); VL 500, p. 4; HTH, 5/24/1948.
5/24/48	23:16:00					ml ner			30	30.0	31.3	s	4.17	no trace	no trace		trace			4.17	nomo	felt	NE rift; felt-hnp.	VL 500, p. 4.
6/28/48	1:42:00	21	12.0	157	54.0	oahu				340.8	340.9	s	5.61	seis dism.	seis dism.		seis dism.	4.8	Cox; (W&K, p. 72)	5.20	aver	VI; VI (Cox; S&C)	Oahu; felt-Hilo. Warshauer notes: felt in Hilo and recorded at HVO; 125-150 miles away, possibly in Molokai vicinity; considerable damage in Honolulu, including houses shifted on foundations, pipes broken and lots of broken plaster and window panes.	Cox, 1986; Cox mag too low(?)-even HVO location near Molokai yields M=5.4 5; wrong date—6/26/48—in VL 500, p. 4; HTH, 6/28/1948; see references for more complete damage report; preferred mag calculated as average of nomogram and Cox.
7/30/48	2:28:00					kl cal 10-20?	9.6	15.0		3.0	15.3	m	4.17	4.25	4.33		3.70			4.10	hono	V	E of Kilauea crater; felt-hnp; awakened people. Warshauer notes: Residents of the volcano district were jarred by two "fairly sharp" temblors at 2:28 and 2:31 a.m. today. Both quakes were felt generally in the volcano district. No reports from elsewhere.	N-L low; VL 501, p. 3; HTH, 7/30/1948; HTH, 8/5/1948.
7/30/48	2:31:00					kl cal 10-20?	9.6	15.0		3.0	15.3	m	4.17	4.15	4.25		3.88			4.10	hono	V	Do.	Do.
9/13/48	8:20:00					ml nf	36	36	32	32.0	48.2	m	4.97	5.15	5.23		4.88			5.09	hono	IV	SE of Mauna Kea; felt-E half Hawaii Island. Warshauer notes: A heavy earthquake, felt all the way from Hilo to, rocked the south end of the Big Island at 8:22 a.m. today. Finch said they were deep under Mauna Loa.	VL 501, p. 3; HTH, 9/13/1948.
9/15/48	9:45:00	19	28.5	155	35.5	ml mok				35.2	36.3	s	4.05	no trace	no trace		3.22			4.05	nomo		Mokuaweoweo.	N-L low(?); VL 501, p. 3.
1/6/49	15:59:00	19	28.5	155	35.5	ml mok		8		35.2	36.1	m	4.53	no trace	no trace		no trace			4.53	nomo		2 mi NE of Mokuaweoweo; one of the strongest quakes of the series.	Closer(?) or slight(?); VL 503, p. 7, 8.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
1/15/49	6:40:00					ml swr deep	36	20	25	25.0	32.0	m	4.45	4.45	no trace		4.07			4.26	hono	IV	Above wood valley. Warshauer notes: Hilo this morning was rocked by a heavy earthquake at 6:40, dismantled the E-W component of the Hilo seismograph; the temblor was felt in all parts of the island, particularly in Kona, Kau, Puna, and Hilo.	closer(?) normal Kaoiki depth(?); VL 503, p. 8; HTH, 1/15; 16/1949 [time given as 12:40 a.m.-newspaper time fits Hon time]
1/15/49	11:16:00					kohala os			110	110.0	110.4	s	4.82	4.50	4.08		4.78			4.45	hono		ocean W of Kohala.	closer(?); VL 503, p. 8
1/20/49	14:27:00	19	55.0	155	46.7	mauna kea deep		40		76.8	86.6	vf	4.06							4.06	nomo	felt	Deep; 10 mi SW of. Warshauer notes: A moderate earthquake at 2:28 p.m. Thursday originated at Kohala or the NW part of Mauna Kea; described as "very distinct" at. It was also felt at Kona and Kohala and very slightly at the volcano.	VL 503, p. 8; HTH, 1/21/1949
1/26/49	13:06:00	19	55.0	155	46.7	mauna kea deep		40		76.8	86.6	f	4.33	no trace	no trace		no trace			4.33	nomo		10 mi SW of Waimea.	VL 503, p. 8
1/26/49	23:57:00	19	24.5	155	22.7	kaoiki	8	8		12.6	14.9	m	4.15	4.16	4.18		4.38			4.24	hono	felt	Ohaikea. Warshauer notes: A slight temblor at 11:47 p.m. originated under the east slope of Mauna Loa; plainly felt at; [same as the moderate quake in at 11:57?].	Honolulu data average of two readings; VL 503, p. 8; HTH, 1/27/1949
1/28/49	15:50:00					kaoiki	8	8	20	20.0	21.5	m	4.41	<4.02	<4.20		4.28			4.28	hono		E slope Mauna Loa.	Honolulu data average of two readings; VL 503, p. 8; HTH, 2/26/1949
2/26/49	13:54:00	19	33.2	155	24.2	ml ner				20.3	22.2	st	4.70	4.85	4.71		5.13			4.90	hono	V (USE); IV	NE rift, 7,000 ft; felt strongly-Hilo to Naalehu. Warshauer notes: The large [quake] at 1:55 emanated from the northeast rift at an altitude of 7,000 ft; dismantled instruments at HVO and Hilo; felt from Naalehu to Hilo, perhaps wider.	VL 503, p. 8; HTH, 2/27; 28/1949.
4/11/49	18:40:00					kaoiki			20	20.0	21.9	m	4.42	no trace	no trace		4.46			4.46	hono	felt	Kaoiki fault; felt-	Closer(?) or slight(?); VL 504, p. 5.
5/2/49	5:02:00					kona?			15	15.0	17.5	st	4.54	4.00	det.		4.34			4.17	hono	VI; V (USE; S&C)	W slope Mauna Loa; felt-Hilo, strongly at Puu Ulaula, Holualoa to; Kona seismograph broken; many sleepers awakened, some rushed out of doors; some objects thrown from shelves-Honaunau to Kealakekua.	Honolulu data average of two readings; distance given from crude isoseismal map—assumes strong on Kona seismograph; VL 504, p. 5.
5/7/49	23:26:00	19	28.5	155	35.5	ml mok	19.2	19.2		35.2	40.1	st	5.12	no trace	no trace		4.47			4.47	hono	IV (W&K); III	Both ml seismograph components dismantled; Mokuaweoweo; felt-Holualoa, Kealakekua.	Closer(?) or moderate(?); VL 504, p. 5.
5/21/49	1:06:00					ml wf			50	50.0	50.8	f	3.96	no trace	no trace		4.14			4.14	hono	felt	W slope Mauna Loa; felt-Holualoa.	VL 504, p. 5.
5/23/49	10:24:00	19	16.8	155	27.2	kaoiki			26	26.3	27.8	m	4.35	3.97	det.		4.16			4.07	hono	V (W&K); IV	S slope ml near Kapapala; felt strongly-Pahala; also hnp, Hookena; both comp. ml seismograph dismantled. Warshauer notes: Sharp earthquake under Mauna Loa was also recorded on the Hilo seismograph; The quake was felt particularly strongly at Kapapala.	Honolulu data average of two readings; VL 504, p. 5; HTH, 5/23/1949.
6/8/49	14:12:00					ml ner	5	5	25	25.0	25.5	m	4.29	no trace	no trace		no trace			4.29	nomo	III	NE rift; both components of ml seismograph dismantled.	Closer(?) or slight(?); VL 504, p. 5.
6/25/49	19:27:00	19	15.0	155	36.5	hilea	16	16		41.8	44.7	s	4.20	no trace	no trace		no trace			4.20	nomo		Do.	VL 504, p. 5.
7/5/49	0:44:00	19	30.40	154	51.00	kl ler sf?	19.2	10.0		44.1	45.3	m	4.92	4.74	4.65		4.70			4.70	hono		E rift near Kapoho [Honolulu magnitude suggests either deep rift event or adjacent south flank].	Shallow on Honolulu seismogram; VL 505, p. 3.
8/30/49	14:27:00	19	9.20	155	8.80	kl kuer sf os deep	36.0	36.0	31.5	33.1	48.9	s	4.48	4.07	<4.17		4.87			4.47	hono	felt	8 mi SSE of Apua pt; felt-volcano.	Honolulu amplitude average of two readings; VL 505, p. 4
9/1/49	12:53:00	19	19.7	155	25.7	kaoiki				21.0	22.9	m	4.45	<4.12	<4.12		4.16			4.16	hono	IV; V (W&K)	Kaoiki fault, 3-4 mi NE of Kapapala ranch; felt strongly-Kapapala to, weakly-volcano to Hilo, pahoehoe to Holualoa. Warshauer notes: "Strong" earthquake disabled mlo seismograph [otherwise repeats info].	Honolulu data average of two readings; VL 505, p. 4; HTH, 9/2/1949
11/4/49	12:12:00	19	49.5	155	28.5	mauna kea	32	32		49.3	58.8	f	4.06	no trace	no trace		no trace			4.06	nomo	felt	Mauna Kea summit; felt-hunters at 10,000 ft on Mauna Kea. Warshauer notes: A rapid-fire series of earthquakes in a pattern often indicative of an impending eruption occurred November 4 directly under the summit of Mauna Kea at a depth of 20 mi.	VL 506, p. 4; HTH, 11/18/1949
11/4/49	13:02:00	19	49.5	155	28.5	mauna kea	32	32		49.3	58.8	f	4.06	no trace	no trace		no trace			4.06	nomo	felt	Mauna Kea summit; felt-hunters at 10,000 ft on Mauna Kea	VL 506, p. 4

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
11/25/49	7:58:00	19	28.5	155	33.0	ml mok	32	21.6		30.9	37.7	m	4.56	<4.67	<4.55	bad record	bad record			4.56	nomo	III	E slope Mauna Loa near Mokuaweoweo; felt-hnp, N Kona to Hilo. Warshauer notes: Felt over most of Big island; Finch placed the quake 12-15 mi below Mauna Loa's summit [20 mi in]; dismantled one component HVO, both components mlo seismographs.	Newspaper depth used; shallower(?), closer(?) or slight(?); VL 506, p. 4; HTH, 11/25/1949.
3/25/50	5:43:00					kaoiki	28	10	27	27.0	28.8	st	4.89	4.50	4.50	4.36	4.67			4.51	hono	V	5,000 ft, east slope Mauna Loa; felt widely-Hawaii Island; quake awakened many on Big island; particularly strong at Hilo and hnp; described as "moderate to strong"; dismantled seismographs at Mauna Loa, Hilo and HVO (one component).	Shallower(?), closer(?) or moderate; VL 507, p. 4; HTH, 3/25/1950.
5/29/50	15:17:00	19	30.0	156	0.0	kona?			70	78.3	78.8	st	5.59	no record	no record	no record	no record	6.25; 6.4	PAS; W&K	6.32	w&k	VII; VII (S&C)	Upper SW rift; widely felt; all instruments dismantled; damage to water tanks, stone walls, in Kona. Warshauer notes: Quake rocked Big Island; duration, >5 min; Hilo-broke china, lamps swung; Kona-bottles off shelves; Kona/Hilo seis dism; felt offshore.	Isoseismal map in W&K [W&K prefer Kona location, which we accept]; VL 508, p. 12; additional felt reports in HTH, 5/30; 6/1/1950.
6/2/50	20:54:00					ml swr?		5		30.0	30.4	s?	3.93	<3.97	<3.97	4.00	<3.27			4.00	hono			Seismogram pictured in VL 509, p. 4; measured amplitude fits slight, but caption gives wrong day; Honolulu data average of two readings; not separately listed in VL 508.
6/4/50	10:13:00					ml swr?		5		30.0	30.4	m?	4.41	no trace	no trace	3.92	3.42			4.04	aver		Preferred magnitude calculated as average of Honolulu and nomogram.	Not separately listed in VL 508.
6/4/50	23:59:00					ml swr?		5		30.0	30.4	s	4.15							4.43	calc		Preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Earthquake swarm; 2 events (s), not separately listed in VL 508, p. 12.
6/4/50	23:59:00					ml swr?		5		30.0	30.4	f	3.61							4.15	calc		Do.	Earthquake swarm; VL 4 events (f), not separately listed in VL 508, p. 12.
6/5/50	3:08:21					ml swr?		5		30.0	30.4	m?	4.65	4.80	5.03	4.83	4.82			4.87	hono	felt	Warshauer notes: A series of tremors recorded by HVO were punctuated sharply by a heavy earthquake at 3:09 a.m. and another at 9 a.m. yesterday. The first one was sufficient intensity to dismantle the instrument and the second was strong enough to be felt	Not separately listed in VL 508; HTH, 6/6/1950.
6/5/50	23:59:00					ml swr?		5		30.0	30.4	f	3.61							4.04	calc		Preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Earthquake swarm; 3 events (f), not separately listed in VL 508, p. 12.
6/6/50	15:27:00					ml swr?		5		30.0	30.4	m?	4.41	4.20	4.20	4.32	4.35			4.27	hono			Do.
6/6/50	16:08:00					ml swr?		5		30.0	30.4	m?	4.41	4.19	4.07	<3.92	3.87			4.04	hono			Honolulu data average of two readings; not separately listed in VL 508; should be "moderate", according to table at top of p. 12, VL 508; nomogram magnitudes high unless closer to Kona station(?)
6/6/50	23:59:00					ml swr?		5		30.0	30.4	s	4.15							4.43	calc		Preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Earthquake swarm; 2 events (s), not separately listed in VL 508, p. 12.
6/7/50	23:59:00					ml swr?		5		30.0	30.4	s	4.15							4.15	calc		Do.	Earthquake swarm; 1 events (s), not separately listed in VL 508, p. 12.
6/8/50	6:25:00					ml swr?		5		30.0	30.4	m?	4.41	4.22	no trace	no trace	no trace			4.22	hono			Not separately listed in VL 508; should be "moderate," according to table at top of p. 12, VL 508; nomogram magnitudes high unless closer to Kona station(?).
6/8/50	6:37:00					ml swr?		5		30.0	30.4	m?	4.41	4.07	no trace	no trace	no trace			4.07	hono			Do.
6/9/50	22:49:00					ml swr?		5		30.0	30.4	m?	4.41	3.97	4.20	4.32	3.87			4.09	hono			Not separately listed in VL 508; should be "moderate", according to table at top of p. 12, VL 508; nomogram magnitudes high unless closer to Kona station(?).
6/11/50	15:43:00					ml swr?		5		30.0	30.4	m?	4.41	4.40	4.40	4.40	4.27			4.37	hono		Warshauer notes: Two rather strong earthquakes were registered at the Hawaiian Volcano Observatory Sunday [June 11].	Not separately listed in VL 508; HTH, 6/13/1950.
6/11/50	23:59:00					ml swr?		5		30.0	30.4	s	4.15							4.15	calc		Preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Earthquake swarm; 1 events (s), not separately listed in VL 508, p. 12.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
6/13/50	3:01:00					ml swr?		5		30.0	30.4	m?	4.41	4.28	4.40	4.32	4.05			4.26	hono			Not in VL 508.
6/13/50	14:04:00					ml swr?		5	37	37.0	37.3	m?	4.55	4.58	4.50	4.52	4.47			4.52	hono		Warshauer notes: Two strong earthquakes were registered yesterday [June 13], one at 2:05 p.m. and a second at 7:30 p.m. both originating under the southern rim of Mokuaweoweo, the Mauna Loa summit crater	Not separately listed in VL 508; HTH, 6/14/1950.
6/13/50	19:47:47					ml swr?		5	37	37.0	37.3	st?	5.07	5.12	5.21	record dis-turbed	5.03			5.12	hono		Do.	US C&GS location given as lat 20° N., long 155.5° W; wrong(?); not separately listed in VL 508; HTH, 6/14/1950.
10/11/50	20:06:00					kaoiki deep		40	20	20.0	44.7	s	4.20	no trace	no trace	no trace	3.88			4.04	aver	felt	E slope Mauna Loa; felt widely-most of Hawaii Island; preferred magnitude calculated as average of Honolulu and nomogram.	VL 510, p. 4.
12/9/50	5:43:00					kl koae	7.2	7.2	12.0	12.0	14.0	m	4.11	<4.47	<4.47	no trace	4.40			4.40	hono	felt	E of Mauna Iki; felt widely. Warshauer notes: See above.	Calculated mag low; strong signal lost in swarm(?), or deeper(?); Honolulu amplitude average of two readings; VL 510, p. 4; HTH, 12/9/1950.
12/9/50	20:45:00	19	19.00	155	22.00	kl koae?	7.2	7.2	15.5	16.9	34.4	m	5.01	5.09	5.28	5.05	5.06			5.12	hono	felt	Near Kamakaia hills; felt widely. Warshauer notes: Dismantled seismographs at HVO, ml, and Hilo; felt in Hilo and Kau.	Calculated mag low; strong signal lost in swarm(?), or deeper(?); VL 510, p. 4; HTH, 12/11/1950.
12/9/50	23:59:00					kl koae		4.0		6.7	7.8	s	3.21							4.12	calc		Do.; preferred magnitude calculated from nomogram magnitude multiplied by number of events.	Kilauea caldera-Koae earthquake swarm; VL 510, p. 4, col. 1; 10 slight events.
12/10/50	0:42:00					kl koae?		7.2	16.0	16.0	17.5	s?	4.03	4.64	4.68	4.79	4.68			4.70	hono	IV?	If slight, must be kcaldeep. Warshauer notes: Dismantled HVO and ml seismographs; felt in Kau, most strongly at Kapapala, and probably in Hilo.	Not in VL 510; HTH, 12/11/1950.
12/10/50	5:57:00	19	19.00	155	22.00	kl koae?	7.2	7.2	15.5	16.9	18.4	m	4.30	4.44	4.74	4.85	4.78			4.70	hono	IV?	Near Kamakaia hills. Warshauer notes: Dismantled HVO and ml seismographs; felt in Kau, most strongly at Kapapala, and probably in Hilo.	Calculated mag low; strong signal lost in swarm(?), or deeper(?); VL 510, p. 4; HTH, 12/11/1950.
12/10/50	8:23:00	19	18.00	155	22.00	kl koae?	7.2	7.2	17.0	18.3	19.7	m	4.35	5.02	5.13	4.79	4.96			4.98	hono	IV?	Below Kamakaia hills. Warshauer notes: Dismantled HVO and ml seismographs; felt in Kau, most strongly at Kapapala, and probably in Hilo.	Calculated mag low; strong signal lost in swarm(?), or deeper(?); VL 510, p. 4; HTH, 12/11/1950.
12/10/50	17:29:00	19	19.00	155	22.00	kl koae?	7.2	7.2	17.0	16.9	18.4	m	4.57	4.60	4.71	4.79	4.68			4.70	hono	IV?	Kamakaia hills. Warshauer notes: Dismantled HVO and ml seismographs; felt in Kau, most strongly at Kapapala, and probably in Hilo.	Calculated mag low; strong signal lost in swarm(?), or deeper(?); VL 510, p. 4; HTH, 12/11/1950.
12/10/50	21:25:00	19	19.00	155	22.00	kl koae?	7.2	7.2	17.0	16.9	18.4	st	4.57	5.21	5.37	5.31	5.15			5.26	hono	V?	Kamakaia hills; felt widely. Warshauer notes: Strongest of series; dismantled HVO, ml, and Hilo seismographs; felt in Kau and Hilo.	Calculated mag low; strong signal lost in swarm(?), or deeper(?); VL 510, p. 4; HTH, 12/11/1950.
12/10/50	23:59:00					kl koae		4.0		6.7	7.8	s	3.21							4.22	calc		Do.; preferred magnitude calculated from nomogram magnitude multiplied by number of events.	Kilauea caldera-Koae earthquake swarm; VL 510, p. 4, col. 1; 13 slight events.
12/11/50	12:53:00	19	15.50	155	25.30	kl swr sf?	7.2	7.2		25.6	26.6	m	4.55	3.95	3.95	4.41	4.34			4.16	hono		SW rift below upper end of 1823 flow.	Honolulu amplitude average of two readings; VL 510, p. 4.
12/26/50	2:55:00	19	24.50	155	15.00	kl cal 10-20?	12.8	15.0	3.0	2.8	15.3	m	4.17	4.12	<4.32	4.20	4.85			4.16	hono	V	South of Kilauea Iki; felt widely. Warshauer notes: A plainly felt earthquake accompanied by a loud rumble and a roar startled many Hilo and volcano residents out of their sleep early this morning; preferred magnitude calculated without N-L.	N-L high; VL 510, p. 4; HTH, 12/26/1950.
1/6/51	4:58:00	19	17.0	155	43.0	ml swr			51	50.8	51.6	s	4.30	no trace	no trace	no trace	4.05			4.05	hono		SW rift, 8,000 ft. Warshauer notes: Felt in Hilo and, no report from Volcano, probably deep.	VL 511, p. 4; HTH, 1/6/51.
2/16/51	7:26:00	19	32.0	155	28.0	ml ner deep	24	24	24.5	24.5	34.3	s; m (ml)	4.01	<4.07	<4.07		<3.27			4.01	nomo	felt	NE rift near Puu Ulaula; felt-Hilo to.	ml mag VL 4.0-4. 5; VL 511, p. 4.
4/22/51	4:53:53	19	24.50	155	6.80	kl cal deep	33.6	33.6	9.0	15.8	37.1	m	4.55	<4.20	<4.27	no trace	4.21			4.21	hono	III	E rift 7 mi S15E from Glenwood; felt-Kapapala, volcano to Hilo. Warshauer notes: A moderate earthquake that originated on the east rift of Kilauea about 5 mi south of Glenwood and at a depth of 31 mi; Hilo-3.	Honolulu amplitude average of two readings; mag agreement improved if shallower (20 km or less); epicenter estimated noninstrumentally, its location only approximate; VL 512, p. 2, 4; HSB, 4/24/1951; HVO unpub.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
4/22/51	14:52:00	19	24.50	155	13.30	kl cal deep	44.0	35.0	4.0	4.9	35.3	vst	6.27	6.31	5.95	5.72	5.79	6.5; 6.0; 6.3	Pasadena; Berkeley; W&K	6.23	aver	VII; VII (USE; S&C)	Felt-entire island, Maui, Oahu; Hilo-5, N-S, objects onto floor, clock stopped. Warshauer notes: Little damage, Hilo-buildings swayed/dishes broke, glass cracked, water main broke; hnp-damage to roads, new cracks, some subsidence, landslides in Halemaumau	Isoseismal map in W&K; E rift near Kilauea crater; VL 512, p. 4, damage report on p. 1-3; HVO unpub.; HTH, 4/23/1951; HA, 4/23/1951; HSB, 4/24/1951; preferred mag calculated as weighted average of Milne-Shaw avg (1), Berkeley, Pasadena, and W&K (all 1).
4/26/51	3:58:00	19	23.40	155	8.30	kl mer	19.2	10.0	11.5	13.7	17.0	st (m?); s (hilo)	4.00	<4.47	<4.47	<3.90	<3.85			4.00	nomo	felt	E rift near Makaopuhi crater; felt-volcano. Warshauer notes: An earthquake described as "strong" was recorded on HVO and Hilo [slight] seismographs at 3:57:44 this morning.	Strong classification inconsistent with indicated hypocenter, absence of a record in Honolulu, and limited felt reports; Hilo (s) yields calculated mag 3.90-4.38; error in VL 512, p. 5(?); HTH, 4/26/1951.
6/11/51	8:33:00	19	29.80	155	2.10	kl gln	11.2	10.0		24.9	26.9	s	4.07	no trace	no trace	no trace	no trace			4.07	nomo	III	6 mi w of Pahoa; felt-Hilo to volcano; Hilo-2, typical local quake, one short quick jerk	VL 512, p. 5; HVO, unpub.
8/21/51	0:57:00	19	30.0	155	57.0	kona			72	73.0	73.6	st	5.54	5.87	5.90	6.35	5.68	6.75; 7.0; 6.9	PAS; BERK; GUTE	6.90	gute	VIII; VIII (W&K; S&C)	3 mi WNW of Napoopoo-prob on Kealakekua Fault; strong-all Hawaii Island, also Maui, Oahu, much damage on W side Hawaii. Warshauer notes: See refs; Kapapala-severe quake followed by smaller shocks, last at 6:16 am, phone service disrupted, no major damage.	Isoseismal map in W&K; depth 10 km; location, lat 19°29.5′ N., long 155°58.3′ W., offshore; VL 513, p. 6; HTH, 8/21/1951; HVO, unpub.; see references for detailed felt reports.
8/21/51	8:03:00					kona			10	10.0	13.5	m (kona)	4.08	4.40	4.48	4.24	3.84			4.24	hono			Closer(?) or moderate at Kona; VL 513, p. 6.
8/21/51	9:57:00					kona			10	10.0	13.5	st (kona)	4.36	4.24	4.10	3.97	3.92			4.06	hono	felt	Felt-Kona to volcano; Kapapala ranch (10:00 a.m.)-slight earthquake.	VL 513, p. 6; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
8/21/51	10:12:00					kona			10	10.0	13.5	st (kona)	4.36	4.18	4.24	4.27	4.44			4.28	hono	felt	Felt(?); Kapapala ranch (11:15 a.m.—time off by 1 hour?)-slight earthquake.	VL 513, p. 6; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
8/21/51	18:32:00					kona			10	10.0	13.5	st (kona)	4.36	4.30	4.30	4.39	4.44			4.36	hono			VL 513, p. 6.
8/21/51	22:48:00					kona			10	10.0	13.5	st (kona)	4.36	4.78	4.70	4.87	5.01			4.84	hono	V?	Felt-Kona to volcano; Capt. Cook (Greenwell diary)-big shaker.	VL 513, p. 6; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
8/22/51	6:38:00					kona			10	10.0	13.5	m (kona)	4.08	4.40	4.24	4.09	4.22			4.24	hono	III	Felt-Kona to Kapapala; Kapapala ranch (6:20 a.m.)-slight earthquake; Capt. Cook (Greenwell diary)-0630, good one.	Closer(?) or moderate at Kona; VL 513, p. 6; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
8/22/51	17:15:00					kona			10	10.0	13.5	st (kona)	4.36	4.74	4.70	4.49	4.76			4.67	hono	IV	Felt-Kona to volcano; Kapapala ranch (5:18 p.m.)-medium earthquake.	VL 513, p. 6; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
9/1/51	12:29:00					kona			60	60.0	60.7	f; s (kona)	4.09							4.09	nomo	III	Kealakekua fault; Capt. Cook (Greenwell diary)-PM, fair one.	Kona mag 3.8-4.3 if S part of fault; VL 513, p. 6; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
9/16/51	1:43:00	19	19.0	155	25.9	kaoiki			21.5	22.0	23.8	st	4.75	4.87	5.22	4.94	4.93	5.0		4.99	hono	V (VL; S&C)	Kaoiki fault, 3 mi NE of Kapapala; felt-Kona to Hilo; felt-Hilo-3 to IV; Hilo-3 to IV [date given as 9/15]. Warshauer notes: Shook the Big Island; dismantled HVO and ML seismographs; strong in Hilo, Volcano. Pahala, and Kona; no serious damage.	VL 513, p. 6; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards]; HTH, 9/17/1951.
9/25/51	1:23:00	19	43.6	155	55.8	hualalai			77	77.8	78.3	s; m (kona)	4.59	no trace	no trace	3.58	4.07			4.17	aver	felt	Do.; felt generally-N Kona. Warshauer notes: See above; preferred magnitude calculated as average of Honolulu and nomogram.	Kona mag VL 4.3-4.8; closer to Kona(?); preferred magnitude averages Whitney, Kona and two Honolulu magnitudes; VL 513, p. 6; HTH, 9/25/1951.
10/9/51	4:45:00					kona			60	60.0	60.7	s	4.63	no trace	no trace	no trace	3.62			4.12	aver	IV	Central Kona; assume 10 km from Kona; felt-Kona to Hilo; Kealakekua-strong and short; Hilo-2, very light; preferred magnitude calculated as average of Honolulu and nomogram.	VL 514, p. 4; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
10/17/51	21:12:00	19	33.6	155	12.1	hilo			17	15.6	18.1	s; m-ml	4.05	no trace	no trace	no trace	no trace			4.05	nomo	felt	3,000 ft, NE rift; felt-volcano, Hilo.	ml mag 3.9-4. 4; VL 514, p. 4.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
11/8/51	9:34:00	19	9.0	155	44.0	ml swr			60	58.8	59.5	st	5.39	5.62	5.63	5.66	5.61			5.63	hono	VI; VI [USE; S&C]	4,500 ft, SW rift; felt-S Hawaii Island. Warshauer notes: "Strong" quake shook the Big Island; no damage; felt-all island; Kona dur 30 s; Kahuku Ranch-stone fences down, concrete sidewalks cracked, few dishes broken; additional felt reports in HVO, unpub.	VL 514, p. 5; HTH, 11/8; 9/1951; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
11/23/51	8:22:00	19	28.5	155	59.8	kona			75	77.7	78.2	s; m (kona)	4.59	no trace	no trace	no trace	no trace			4.00	nomo	felt	Kealakekua fault, 5 mi W of Napoopoo; felt-central Kona to Kahuku.	Kona mag 3.8-4.3; location wrong-SE of Napoopoo(?); or feeble at Whitney(?); Kona magnitude preferred; VL 514, p. 5.
12/6/51	20:19:00	19	25.00	155	1.00	kl mer sf?		5.0		25.8	26.3	st (m?)	4.55	<4.52	<4.52	<4.0	4.53			4.53	hono	IV	E rift, 7 mi SW of Pahoa; felt-Kapapala to Hilo and east Puna. Warshauer notes: A strong earthquake was felt all over the Hilo and Volcano districts at 8:19 last night.	Honolulu amplitude average of two readings; [moderate(?), or closer to summit(?); probably kl sf rather than rift]; VL 514, p. 5; additional felt data in HVO unpub; HTH, 12/7/1951
2/2/52	1:16:00					hilo deep	48	48	31	31.0	57.1	m	4.85	4.90	4.45	4.56	4.76			4.67	hono	V	Nearly under Kaumana [Hilo]; felt-most of Hawaii Island, strongly at Hilo. Warshauer notes: A short strong earthquake jerked some Hiloans awake at 1:16 this morning, but no damage reported; Captain Cook-4; Hilo-2 to III, rattled windows; Kukuihaele-5.	Location reasonable(?); VL 515, p. 6; HTH, 2/2/1952; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
3/13/52	11:38:00	19	2.40	155	6.20	kl mer sf os		10.0		46.5	47.6	st	5.23	5.37	5.35	5.21	5.23			5.29	hono	felt	Off south shore; felt-volcano to Naalehu.	VL 515, p. 6.
3/14/52	18:21:00	19	2.80	155	4.80	kl mer sf os		10.0		46.8	47.9	st	5.24	5.25	5.07	5.21	5.23			5.19	hono	felt	Off south shore; felt-Hilo to Kapapala.	Do.
3/17/52	17:58:00	19	7.50	155	2.00	kl mer sf os?		10.0		41.6	42.8	st	5.16	5.88	no record	5.50	5.63	5.00	USE?	5.67	hono	V; V (USE; S&C)	Felt-Naalehu; small tsunami at Kalapana. Warshauer notes: Tsunami at Kalapana; earthquake not felt there.	VL 515, p. 7; HTH, 3/18/1952; see references; coverage of the earthquake swarm continues daily through 3/28.
3/18/52	9:02:00					kl kuer sf os								<4.27	<4.27	<4.05	4.28			4.28	hono		Off south shore.	Not in VL 515.
3/18/52	10:53:00	19	0.10	155	19.80	kl kuer sf os		10.0		48.3	49.3	m	4.75	4.78	4.65	4.75	4.65			4.71	hono	felt	Off south shore; felt-Naalehu.	VL 515, p. 7.
3/18/52	13:01:00	19	6.10	155	20.50	kl kuer sf os		10.0		37.6	38.9	m	4.58	<4.27	<4.27	<4.05	4.30			4.30	hono		Off south shore.	Honolulu amplitude average of two readings; VL 515, p. 7.
3/18/52	14:18:00	19	4.60	155	24.70	kl swr sf os		10.0		42.5	43.6	st	5.17	5.57	5.73	5.43	5.51			5.56	hono		Do.	VL 515, p. 7.
3/19/52	2:55:00	19	6.50	155	1.80	kl mer sf os?		10.0		43.4	44.5	st	5.19	5.48	5.68	5.40	5.43			5.50	hono	felt	Off south shore; felt-Naalehu.	Do.
3/19/52	14:15:00					kl kuer sf os		10.0	47.0	47.0	48.1	s?	4.73	4.60	no record	4.65	4.48			4.58	hono		Off south shore.	Not in VL 515.
3/19/52	15:51:00	19	2.00	155	20.10	kl swr sf os		10.0		44.9	46.0	st	5.21	5.52	no record	5.36	5.29			5.39	hono		Do.	VL 515, p. 7.
3/20/52	1:22:00	19	2.30	155	18.50	kl kuer sf os		10.0		43.9	45.1	st	5.20	5.52	no record	5.25	5.30			5.36	hono		Do.	Do.
3/20/52	9:51:00	19	3.20	155	14.70	kl kuer sf os		10.0		42.0	43.2	st	5.17	5.50	5.45	5.25	5.28			5.37	hono	felt	Off south shore; felt-Naalehu.	Do.
3/20/52	20:16:00	19	3.50	155	23.70	kl swr sf os		10.0		43.8	44.9	m	4.68	4.49	4.49	4.60	4.49			4.52	hono	felt	Do.	Do.
3/20/52	23:48:00	19	2.20	155	23.60	kl swr sf os		10.0		46.0	47.1	m	4.71	4.49	4.43	4.70	4.43			4.51	hono	felt	Do.	Do.
3/21/52	4:35:00	19	2.70	155	13.90	kl kuer sf os		10.0		43.0	44.2	st	5.18	4.78	4.78	4.83	4.78			4.79	hono	felt	Do.	Mag agreement improved if moderate rather than strong; VL 515, p. 7.
3/21/52	10:55:00					kl kuer sf os		10.0	40.0	40.0	41.2	s?	4.62	4.56	4.54	4.70	4.40			4.55	hono		Off south shore.	Honolulu amplitude average of two readings; not in VL 515.
3/21/52	14:25:00	19	4.30	155	14.30	kl kuer sf os		10.0		40.0	41.3	m	4.62	4.40	4.40	4.35	4.30			4.36	hono		Do.	Mag agreement improved if closer to shore; VL 515, p. 7.
3/22/52	2:02:00	19	2.50	155	12.10	kl kuer sf os		10.0		43.7	44.9	st	5.19	5.04	5.22	5.09	4.90			5.06	hono	felt	Off south shore; felt-Naalehu.	VL 515, p. 7.
3/22/52	6:19:00	19	7.80	155	0.40	kl mer sf os?		10.0		42.9	44.0	m	4.67	4.35	4.35	4.70	4.53			4.48	hono		Off south shore.	Do.
3/22/52	19:20:00	19	6.40	155	3.90	kl mer sf os?		10.0		41.6	42.8	m	4.65	4.70	4.75	4.70	4.70			4.71	hono	felt	Off south shore; felt-Naalehu.	Do.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
3/22/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	s	4.40							6.12	calc		sf offshore; preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Reconciliation of the weekly tabulation (VL 515, p. 5) with the earthquake list on p. 7 (including those identified at Honolulu) shows 79 (s) unaccounted for between 3/16 and 22/1952, assuming that all belong to the swarm.
3/22/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	f	3.85							5.71	calc		Do.	Reconciliation of the weekly tabulation (VL 515, p. 5) with the earthquake list on p. 7 (including those identified at Honolulu) shows 111 (f) unaccounted for between 3/16 and 22/1952, assuming that all belong to the swarm.
3/22/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	vf	2.83							5.27	calc		Do.	Reconciliation of the weekly tabulation (VL 515, p. 5) with the earthquake list on p. 7 (including those identified at Honolulu) shows 483 (vf) unaccounted for between 3/16 and 22/1952, assuming that all belong to the swarm.
3/23/52	6:52:00	19	11.70	154	55.00	kl mer sf os?		10.0		44.8	45.9	m	4.70	4.70	4.70	4.80	4.70			4.73	hono	V	Off south shore; felt-Naalehu and Pahala; Pahala-3 to V, shook house, rattled windows, house and bed moved.	VL 515, p. 7; HVO, unpub.
3/23/52	15:05:00	19	2.80	155	14.40	kl kuer sf os		10.0		42.8	43.9	m	4.67	4.48	4.65	4.65	4.60			4.60	hono	felt	Off south shore; felt-Naalehu and Pahala.	VL 515, p. 7.
3/24/52	2:02:00	19	8.00	155	1.70	kl mer sf os?		10.0		41.2	42.4	m	4.64	4.53	4.53	4.80	4.70			4.64	hono	felt	Off south shore; felt-Naalehu.	Do.
3/24/52	13:29:00	19	6.30	155	2.40	kl mer sf os?		10.0		43.1	44.2	st	5.18	4.83	4.92	4.88	no record			4.88	hono	felt	Do.	Do.
3/25/52	0:30:00	19	1.30	155	17.00	kl kuer sf os		10.0		45.6	46.7	m	4.71	<4.27	3.70	4.59	no record			4.25	hono		Off south shore.	Honolulu amplitude average of two readings; VL 515, p. 7.
3/25/52	7:04:00	19	4.30	155	5.80	kl kuer sf os		10.0		43.6	44.7	st	5.19	4.70	4.78	4.68	no record			4.72	hono	felt	Off south shore; felt-Naalehu.	Do.
3/25/52	9:17:00	19	5.20	155	5.10	kl kuer sf os		10.0		42.5	43.7	st	5.18	5.19	5.20	5.20	5.18			5.19	hono	felt	Do.	VL 515, p. 7.
3/26/52	4:40:00	19	3.30	155	13.80	kl kuer sf os		10.0		41.9	43.1	m	4.65	<4.47	<4.47	<3.95	4.10			4.10	hono	felt	Off south shore; felt-Naalehu.	Honolulu amplitude average of two readings; VL 515, p. 7.
3/27/52	4:31:00	19	3.10	155	12.60	kl kuer sf os		10.0		42.5	43.7	m	4.66	4.70	4.60	4.75	4.60			4.66	hono	felt	Do.	VL 515, p. 7.
3/27/52	22:44:00	19	2.20	155	13.90	kl kuer sf os		10.0		44.0	45.1	m	4.68	4.78	4.60	no trace	4.48			4.68	hono	IV	Off south shore; felt-Naalehu, Pahala; Pahala-shook house, rattled windows; 4, shook bed. Warshauer notes: The quake at 10:43 p.m. was reported by a Naalehu resident as "quite strong" and was felt rather longer than usual.	VL 515, p. 7; HVO unpub; HTH, 3/28/1952
3/28/52	11:57:00	19	3.30	155	11.50	kl kuer sf os		10.0		42.4	43.6	m	4.66	<4.47	<4.42	4.48	4.28			4.38	hono	felt	Off south shore; felt-Naalehu.	Honolulu amplitude average of two readings; VL 515, p. 7.
3/29/52	2:42:00					kl kuer sf os?		10.0	42.0	42.0	43.2	m	4.65	4.65	4.74	det	4.78			4.72	hono	felt	Do.	VL 515, p. 7.
3/29/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	s	4.40							6.17	calc		sf offshore; preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Reconciliation of weekly tabulation (VL 515, p. 5) with earthquake list on p. 7 (including those identified at Honolulu) shows 90 (s) unaccounted for between 3/23 and 29/1952, assuming all belong to the swarm.
3/29/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	f	3.85							5.50	calc		Do.	Reconciliation of weekly tabulation (VL 515, p. 5) with earthquake list on p. 7 (including those identified at Honolulu) shows 66 (f) unaccounted for between 3/23 and 29/1952, assuming all belong to the swarm.
3/29/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	vf	2.83							5.10	calc		Do.	Reconciliation of weekly tabulation (VL 515, p. 5) with earthquake list on p. 7 (including those identified at Honolulu) shows 313 (vf) unaccounted for between 3/23 and 29/1952, assuming all belong to the swarm.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
3/30/52	13:53:00					kl kuer sf os?		10.0	42.0	42.0	43.2	st	5.17	4.84	4.87	4.75	4.78			4.81	hono	IV	Off south shore. Warshauer notes: Quakes off south coast total 2,995. The only heavy earthquake in the past 24 hours came at 1:53 p.m. Sunday.	VL 515, p. 7; HTH, 3/31/1952.
3/30/52	16:03:00					kl sf os		10.0	42.0	42.0	43.2	m?	4.65	4.40	4.30	no trace	4.30			4.33	hono		Off south shore.	Not in VL 515.
3/31/52	22:00:00	19	2.20	155	13.40	kl kuer sf os		10.0		44.0	45.2	st	5.20	4.78	4.78	4.75	4.81			4.78	hono	felt	Off south shore; felt-Naalehu.	VL 515, p. 7.
4/5/52	11:23:00	19	22.00	155	10.50	kl mer	20.8		11.5	11.5	14.6	m	4.14	no trace	no trace	no trace	no trace			4.14	nomo		E rift near Makaopuhi crater.	Could be shallow; VL 516, p. 7.
4/5/52	14:16:00					kl kuer sf os		10.0	42.0	42.0	43.2	m	4.65	4.40	4.40	no trace	4.40			4.40	hono		Off south shore.	Closer to shore(?); VL 516, p. 7.
4/5/52	21:04:00	19	22.60	155	8.80	kl mer		5.0	13.5	13.5	14.4	m	4.40	4.60	4.60	4.60	4.43			4.56	hono		East rift near Napau crater.	Could be deeper; VL 516, p. 7.
4/5/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	s	4.40							5.82	calc		sf offshore; preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Reconciliation of weekly tabulation (VL 515, p. 5) with earthquake list on p. 7 (including those identified at Honolulu) shows 37 (s) unaccounted for between 3/30 and 4/5/1952, assuming all belong to the swarm.
4/5/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	f	3.85							5.25	calc		Do.	Reconciliation of weekly tabulation (VL 515, p. 5) with earthquake list on p. 7 (including those identified at Honolulu) shows 55 (f) unaccounted for between 3/30 and 4/5/1952, assuming all belong to the swarm.
4/5/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	vf	2.83							5.00	calc		Do.	Reconciliation of weekly tabulation (VL 515, p. 5) with earthquake list on p. 7 (including those identified at Honolulu) shows 242 (vf) unaccounted for between 3/30 and 4/5/1952, assuming all belong to the swarm.
4/6/52	14:57:00					kl kuer sf os		10.0	42.0	42.0	43.2	s?	4.40	4.44	<4.57	<4.05	4.20			4.32	hono		Off south shore.	Honolulu amplitude average of two readings; not in VL 516.
4/6/52	15:10:00					kl kuer sf os		10.0	42.0	42.0	43.2	m	4.65	4.40	4.48	4.65	4.40			4.48	hono		Do.	VL 516, p. 7.
4/6/52	15:36:00					kl kuer sf os?		10.0	42.0	42.0	43.2	s?	4.40	4.40	4.40	det	4.30			4.37	hono	III	Off south shore; Kealakekua (Greenwell diary-3:30 p.m.)-4, very good shake.	Not in VL 516; HVO, unpub.
4/6/52	21:20:00					oahu?								4.33	4.56	off scale	off scale			4.45	hono	IV (Cox; S&C); V (USE)	Offshore between Molokai and lanai; felt widely on Oahu, houses creaked, windows rattled, fixtures rocked; short quake centered on Oahu or offshore was felt widely in Honolulu, also felt lightly on Maui and Kauai. Rated as intensity IV and not damaging.	Cox, 1986; not recorded at Whitney vault; VL 516, p. 7; HTH, 4/7/1952.
4/7/52	12:53:00	19	22.00	155	10.50	kl mer sf?	19.2	10.0	11.5	11.5	15.3	st	4.44	4.69	4.65	4.63	4.90			4.72	hono	III	East rift near Makaopuhi crater; felt-Naalehu to volcano. Warshauer notes: A quake at 12:54 p.m. was lightly felt in the national park area.	VL 516, p. 7; HTH, 4/8/1952.
4/7/52	13:00:00					kl kuer sf os		10.0	42.0	42.0	43.2	m	4.65	4.30	4.48	<4.20	4.40			4.39	hono		Off south shore.	Honolulu amplitude average of two readings; VL 516, p. 7.
4/7/52	23:55:00	19	22.10	155	12.00	kl uer	11.2	11.2	9.0	9.5	14.7	m	4.14	no trace	no trace	no trace	no trace			4.14	nomo		East rift near Alae crater.	VL 516, p. 7.
4/10/52	16:56:00	19	18.80	155	10.10	kl kuer sf		10.0	15.5	16.3	19.1	m	4.33	4.20	4.20	no trace	4.20			4.20	hono	felt	Hilina fault at Poliokeawe pali 3.5 mi N45W of Kaena pt; felt-Naalehu	Do.
4/12/52	5:53:00	19	23.30	155	14.60	kl cal 10-20	20.8	15.0	5.0	5.1	15.8	st	4.47	4.59	4.55	4.53	4.40			4.52	hono	felt	East rift 1 mi NW of Heake; felt-Naalehu, Kapapala.	Moderate(?) or shallower(?); VL 516, p. 7.
4/12/52	6:22:00					kl kuer sf os		10.0	44.7	44.7	45.8	m	4.69	4.40	4.40	det	4.40			4.40	hono		Off south shore.	VL 516, p. 7.
4/12/52	19:40:00	19	22.50	155	12.50	kl cal deep?		30.0	8.5	8.3	31.1	s	4.17							4.17	nomo	III	East rift near Puu Huluhulu; felt-volcano; Kealakekua (Greenwell diary-7:45 p.m.)-slight, long jiggle; Honokaa-5. Warshauer notes: A quake at 7:50 p.m. Saturday was felt in the Hilo and Volcano areas.	Depth assumed consistent with felt reports; VL 516, p. 7; HVO, unpub.; HTH, 4/14/1952.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
4/12/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	s	4.40							5.30	calc		sf offshore; preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Reconciliation of weekly tabulation (VL 516, p. 7) with earthquake list on p. 7 (including those identified at Honolulu) shows 10 (s) unaccounted for between 4/6 and 12/1952, assuming all belong to the swarm.
4/12/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	f	3.85							4.80	calc		Do.	Reconciliation of weekly tabulation (VL 516, p. 7) with earthquake list on p. 7 (including those identified at Honolulu) shows 11 (f) unaccounted for between 4/6 and 12/1952, assuming all belong to the swarm.
4/12/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	vf	2.83							4.61	calc		Do.	Reconciliation of weekly tabulation (VL 516, p. 7) with earthquake list on p. 7 (including those identified at Honolulu) shows 90 (vf) unaccounted for between 4/6 and 12/1952, assuming all belong to the swarm.
4/16/52	7:08:00					kl kuer sf os		10.0	42.0	42.0	43.2	m	4.65	4.40	4.48	4.53	4.40			4.45	hono		Off south shore.	VL 516, p. 7.
4/19/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	s	4.40							4.94	calc		sf offshore; preferred magnitude calculated as nomogram magnitude multiplied by number of events.	Reconciliation of weekly tabulation (VL 516, p. 7) with earthquake list on p. 7 (including those identified at Honolulu) shows 4 (s) unaccounted for between 4/13 and 19/1952, assuming all belong to the swarm.
4/19/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	vf	2.83							4.24	calc		Do.	Reconciliation of weekly tabulation (VL 516, p. 7) with earthquake list on p. 7 (including those identified at Honolulu) shows 35 (vf) unaccounted for between 4/13 and 19/1952, assuming all belong to the swarm.
4/19/52	23:59:00					kl kuer sf os?		10.0	42.0	42.0	43.2	f	3.85							4.12	calc		Do.	Reconciliation of weekly tabulation (VL 516, p. 7) with earthquake list on p. 7 (including those identified at Honolulu) shows 2 (f) unaccounted for between 4/13 and 19/1952, assuming all belong to the swarm.
4/21/52	17:45:00	19	1.90	155	13.70	kl kuer sf os		10.0		44.5	45.6	m	4.69	4.54	4.65	det	4.54			4.58	hono		Off south shore, 16 mi S. 10° W. of Apua pt.	VL 516, p. 7.
5/3/52	18:16:00	19	12.50	155	20.80	kl swr sf os		10.0		26.4	28.2	m	4.59	4.43	4.43	no trace	4.55			4.47	hono		Off south shore.	Do.
5/10/52	19:14:00					kl cal 05-10	11.2	8.0	3.0	3.0	8.5	st	4.04	<4.12	<4.20	<3.98	<3.70			4.04	nomo	felt	Kilauea crater; felt(?).	Do.
5/19/52	1:16:00	19	2.70	155	7.20	kl kuer sf os		10.0		45.4	46.5	s	4.22	<4.17	<4.27	<4.30	<3.78			4.22	nomo		Off south shore.	Do.
5/19/52	4:08:00	19	20.2	155	28.9	kaoiki			20	25.5	27.1	s	4.07	4.32	4.19	<3.71	<3.24			4.19	hono		SE slope Mauna Loa.	Do.
5/21/52	17:13:00	19	18.1	155	28.3	kaoiki			20	26.5	27.9	m	4.35	4.33	4.25	4.11	3.94			4.16	hono	II	SE slope Mauna Loa; Kapapala ranch-2.	VL 516, p. 7; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
5/23/52	12:13:00	19	29.0	155	59.0	kona	9.6	9.6		76.4	77.0	st	5.57	5.61	5.45	5.49	5.23	6.0	S&C (Pas)	5.69	aver	VI; VI (S&C)	Felt-all Hawaii Island, some on Maui. Warshauer notes: "Strong" quake felt Kona to Hilo, dur 23 min at HVO; landslides, road damage, water-tank breaks, and merchandise swept off shelves in Kona; preferred mag calculated as average of M-S (2) and Pas (1).	Isoseismal map in W&K; Kealakekua Fault 3.5 mi w of Napoopoo; VL 516, p. 8 [damage report on p. 6]; HTH, 5/24/1952; additional felt reports in HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
6/11/52	8:01:00	19	0.70	155	16.30	kl kuer sf os	10.0	5.0		46.6	46.9	s	4.23	<4.17	<4.27	<4.05	<3.70			4.23	nomo		Off south shore.	VL 516, p. 8.
6/18/52	5:17:00	19	2.10	155	19.80	kl kuer sf os		10.0		44.6	45.7	s	4.44	4.37	4.40	4.35	4.20			4.33	hono		Do.	Do.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
6/19/52	16:03:00	19	21.30	155	21.20	kl cal deep?	2.0	25.0	12.5	12.9	28.1	st	4.87	4.83	4.96	4.86	4.79			4.86	hono		SW rift 0.5 mi NE of Mauna Iki; shallow.	Honolulu amplitude average of two readings; "shallow" designation in VL 516 unlikely; Honolulu records consistent with deep origin; Honolulu amplitude average of two readings; VL 516, p. 8.
6/19/52	16:27:00	19	19.00	155	22.00	kl swr		5.0	17.0	16.9	17.6	m	4.03	<4.12	<4.12	<4.10	<3.75			4.03	nomo		SW rift near Kamakaia hills.	VL 516, p. 8.
7/6/52	22:56:00					mauna kea?			67	67.0	67.6	f	4.16	4.17	4.17	3.87	4.00			4.05	hono	IV	Do.; assume epicenter between Kukuihaele and Hilo. Warshauer notes: 2 quakes were recorded last night, one at 10:56 p.m., and the other at 4:42 a.m. Both were felt in Hilo; Kukuihaele-5, rumbling noise followed by quake, buildings shook, objects rattled.	VL 517, p. 6; HTH, 7/7/1952; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
7/7/52	4:43:00					mauna kea?			67	67.0	67.6	s	4.48	4.45	4.25	4.57	4.62			4.47	hono	V	Felt-Kukuihaele, Hilo; assume epicenter bet Kukuihaele and Hilo. Warshauer notes: See above; Kukuihaele-5, buildings shook, awakened persons.	VL 517, p. 6; HTH, 7/7/1952; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
7/12/52	13:38:00					kona			60	60.0	60.7	m; st (kona)	4.89	3.97	4.05	3.87	4.36			4.38	aver	V	Central Kona; assume 15 km from Kona; felt-Kona to Hilo; preferred magnitude calculated as average of Honolulu and nomogram; Kealakekua-5, strong all over Kona, strong and hard, not long, came from south, sounded like a blast.	Honolulu data average of two readings; VL 517 time 13:53; Honolulu records record event at 13:38; our calculated mags are 4.9 (Whitney), 4.5 (Kona); VL 517, p. 6; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
8/9/52	10:31:00					mauna kea?			48	48.0	48.8	f; s (ml; hilo)	4.07							4.07	nomo		Assume mk summit; 37 km from ml, 43 km from Hilo, 48 km from Whitney.	Hilo mag, 3.9-4. 4; ml mag, 3.8-4.2; VL 517, p. 6.
8/14/52	14:08:00					kl kuer sf os		10.0	44.7	44.7	45.8	s	4.44	<4.17	<4.17	<4.25	4.88			4.44	nomo	felt	Off south shore; felt-volcano, Kapapala, Naalehu.	Honolulu amplitude average of two readings; N-L high; VL 517, p. 6.
8/16/52	21:07:00					kl kuer sf os	10.0	10.0	44.7	44.7	45.8	m	4.69	4.30	4.30	4.35	4.40			4.34	hono		Off south shore.	VL 517, p. 6.
9/2/52	4:45:00					kl cal deep?		30.0	4.0	4.0	30.3	f	3.60	<4.20	<4.02	<3.8	4.63			4.10	aver	IV	Kilauea crater; felt-Glenwood, volcano, Naalehu, Hilo; Capt. Cook-3, slight rattle of windows; preferred magnitude calculated as average of Honolulu and nomogram.	N-L high; VL 517, p. 7; HVO, unpub.
11/16/52	2:41:00					kl kuer sf os		10.0		44.7	45.8	s	4.21	4.27	<4.17	<4.25	<3.85			4.27	hono		Off south coast.	VL 518, p. 12.
11/27/52	22:14:00	19	29.0	155	38.0	ml mok				39.7	40.7	s	4.13	no trace	no trace	no trace	no trace			4.13	nomo	III	Felt-Kona; Capt. Cook-2, rumble preceded quake, appeared to come from Mauka, longish tremor as though a wave passed through the house, soft noise acc quake, dog disturbed and anxious before and during quake.	VL 518, p. 12; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
1/9/53	16:42:00					kona			15	15.0	17.5	vf (kona)	2.95							4.24	aver	felt	Central Kona; assume 15 km from Kona; felt-Kona.	VL 519, p. 6
1/12/53	3:27:00					kona			15	15.0	17.5	t; vf (kona)	2.21							4.35	nomo		Central Kona; assume 15 km from Kona.	Do.
1/13/53	7:29:00					kaoiki?			25	25.0	26.6	vf	3.24							5.45	hono	felt	Felt strongly-Kapapala.	Do.
3/25/53	10:50:00	19	30.4	155	33.4	ml ner			33	32.3	33.5	vf; s (ml)	3.40							4.41	aver		Near Mauna Loa summit, probably on NE rift zone.	ml mag 3.3-3.8; closer to ml(?); VL 519, p. 6.
4/16/53	14:36:00					kona			10	10.0	13.5	vf (kona)	2.02							4.04	nomo		Assume 10 km from Kona.	VL 520, p. 4.
5/22/53	23:22:00					kona			60	60.0	60.7	vf; f (kona)	3.07							4.50	hono	V	Kealakekua Fault(?); assume 15 km from Kona; felt-central Kona; Capt. Cook-3 to IV, came suddenly with very rapid vibrations, objects on shelves vibrated, a few fell to floor; strong jolt in Kealakekua.	Kona mag, 3.0-3. 5; VL 520, p. 4; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
5/27/53	19:33:00					kaoiki?			20	20.0	21.9	t	1.89							4.12	aver	felt	Felt-Kapapala.	VL 520, p. 4.
8/21/53	17:00:00					kona?														5.06	hono	II	Capt. Cook-felt as quiver at Kealakekua by several.	Not in VL 521-date and time from felt report; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
8/22/53	2:00:00					hualalai?														4.17	hono	III	Capt. Cook-3, duration, 20 s; gentle continuous tremors, felt at Kalahiki, mauka to makai movement.	Do.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
10/2/53	22:06:00					kona			15	15.0	17.5	vf (kona)	2.95							4.31	hono	felt	Central Kona; assume 15 km from Kona; felt-Capt. Cook.	VL 522, p. 3; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
10/27/53	4:30:00	19	22.10	155	12.00	kl kuer sf?		10.0	9.0	9.5	13.8	st	4.37	4.38	4.44	4.65	4.55			4.51	hono	III	East rift near Alae crater; felt-volcano; volcano-slight. Warshauer notes: No mention of earthquake being felt; volcano-slight.	Checked paper records w. bob k 8/96-all four quakes look the same; VL 522, p. 4; HTH, 10/27; 28/1953; HA, 10/28; 29/1953; HVO, unpub.
10/27/53	6:20:00	19	22.10	155	8.80	kl kuer sf?		5.0	13.5	8.0	9.4	st (m?)	4.11	<4.22	<4.22	<4.15	<3.90			4.11	nomo		East rift S of Napau crater. Warshauer notes: No mention of earthquake being felt.	Lack of Honolulu signature suggests shallow uer closer to summit than location given, or moderate; checked paper records w. bob k 8/96-all four quakes look the same; VL 522, p. 4; HTH, 10/27; 28/1953; HA, 10/28; 29/1953.
11/28/53	15:38:00					kl cal 05-10		8.0		5.0	9.4	m	3.83	no trace	no trace	no trace	4.03			4.03	hono	felt	Near Kilauea crater; felt-hnp.	Depth assumed consistent with Honolulu magnitude and felt report; VL 522, p. 4.
11/29/53	20:43:00	19	22.60	155	8.80	kl mer sf?	2.0	10.0		13.5	16.8	st	4.51	<4.52	<4.42	4.30	4.49			4.40	hono	IV	East rift near Napau crater; felt-hnp to Hilo. Warshauer notes: Shook Hilo home sharply, intensity 3; hit Hilo with a joggly sharpness, SE NW; heavy shock, then lighter; sustained motion that rattled windows and doors vigorously; depth, 10 mi (change VL?)	Honolulu amplitude average of two readings; VL 522, p. 4; additional felt reports in HVO, unpub.; HTH, 11/30/1953.
3/30/54	6:40:00	19	21.00	155		kl mer sf	24.0	10.0		29.0	30.6	st	4.93	6.06	6.13	5.91	6.01			6.03	hono	VI	About 15 mi deep between east rift and Kalapana; felt-entire Hawaii Island; Hilo-5, dishes off shelves; Kalahiki (Kona)-4, long and gentle. Warshauer notes: See references for damage report in Hilo.	VL 523, p. 5, 7; HVO, unpub.; HTH, 3/30/1954; HA, 3/31/1954; HSB, 3/31/1954.
3/30/54	6:57:00	19	21.00	155		kl mer sf	24.0	10.0	29.6	29.0	30.6	s	4.16							4.16	nomo		Aftershock; Hilo-light aftershock.	VL 523, p. 7; HVO, unpub.
3/30/54	8:42:00	19	21.00	155		kl mer sf	24.0	10.0		29.0	30.6	st	4.93	6.50	6.51	6.39	6.41	6.5; 6.0	W&K; PAS	6.45	hono	VII; VII (USE); VI (S&C)	Felt-entire Hawaii Island, parts of Maui; shaking most intense in Puna: water tanks thrown down, stone fences damaged; extensive damage in Hilo: broken windows, houses moved or thrown down. Warshauer notes: See reference for complete damage report in Hilo	Isoseismal map in W&K; VL 523, p. 5, 7; additional felt reports in HVO, unpub.; HTH, 3/30/1954; HA, 3/31/1954; HSB, 3/31/1954.
3/31/54	16:00:00					kl mer sf	24.0	10.0	15.0	15.0	18.0	m	4.05	<4.22	<4.30	<4.2	4.03			4.03	hono		Aftershock-magnitude comparison suggests epicenter closer to Kilauea's summit than the main shock.	VL 523, p. 7.
4/1/54	15:56:00					kl ler		2.0	35.0	35.0	35.1	s	4.03	<4.27	<4.27	poor	<3.70			4.03	nomo	felt	East Puna; felt-Puna.	VL 524, p. 10.
7/3/54	11:52:35	19	22.10	155	12.00	kl mer sf?	12.0	10.0		9.5	13.8	st	4.37	4.83	5.02	5.21	5.24	5.40	hvo (S&C)	5.24	aver	VI (W&K; S&C)	E rift near Alae crater, felt generally-S half Hawaii Island, accompanied and followed by numerous rockfalls on seaward face of Puu Kapukapu. Warshauer notes: int 4, felt in Hilo, Volcano and Kapapala, items off shelves; detailed felt reports in HVO unpub	Magnitude not given in VL; VL 525, p. 6; HTH, 7/4/1954; HVO, unpub.
8/2/54	13:40:33					kl uer	15.0	2.0	9.0	9.0	9.2	st	4.09	<4.17	<4.17	<3.85	<3.75			4.09	nomo	felt	East rift Alae crater; felt-hnp.	Magnitude agrees if shallow; VL 525, p. 7.
8/7/54	14:26:17					kl cal deep	25.0	25.0	4.0	4.0	25.3	st	4.80	5.16	4.45	4.98	5.42			5.00	hono	V	Kilauea crater; felt generally-central Hawaii Island; Kamuela-5, vigorous shake, rumbling, windows rattle; Capt. Cook-3 to 4, 2 distinct, 2nd stronger, comb dur 1 min, swaying, felt by persons walking outdoors; Honokahau-window rattle.	VL 525, p. 7; additional felt reports in HVO, unpub.
8/30/54	23:17:04	19	22.00	155	10.50	kl mer	20.0	5.0	11.5	11.5	12.6	m	4.03	4.12	<4.22	3.78	4.35			4.08	hono	felt	East rift Makaopuhi crater; felt-hnp.	Honolulu amplitude average of two readings; mag agreement best for shallow depth; VL 525, p. 7.
10/7/54	18:43:22	19	22.50	155	13.70	kl uer	10.0	10.0	7.0	7.1	12.3	m	4.02	no trace	no trace	no trace	no trace			4.02	nomo		East rift near Pauahi. Warshauer notes: Slight shock at 6:43 p.m.; hnp (time 18:58)-set off buzzer.	VL 526, p. 5; HTH, 10/8/1954; HVO, unpub.
10/8/54	11:56:39	19	29.5	155	23.5	kaoiki			15.5	15.3	17.8	vf; f (ml)	2.22							4.28	aver		SE flank Mauna Loa near ml seismometer.	ml mag, 2.2-2.8; VL 526, p. 5.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
2/23/55	13:58:49	19	22.00	155	10.50	kl cal deep?	25.0	30.0	13.5	14.0	33.1	s (uwe, ml, pahoa; vf (hilo, naalehu, kamuela)	4.01	<4.22	<4.37	<4.23	4.08			4.08	hono	V	East rift near Makaopuhi crater; felt-hnp, volcano; volcano-awakened; felt by several hnp/volcano, quite strong acc by a roar; felt; depth as given or deeper gives best fit to Honolulu magnitude and felt report.	Honolulu amplitude average of two readings; ml mag, 3.8-4.3; Pahoa mag, 3.8-4.3; Hilo mag, 2.2-3.4; Naalehu mag, 2.30-3.5; Kamuela mag, 2.6-3.8; mags reconciled if Naalehu, Kamuela, and Hilo were feeble; VL 527, p. 5; HVO, unpub.
3/1/55	14:21:30	19	24.30	155	4.20	kl mer		2.0	13.5	16.4	16.5	st (pahoa)	>4.17	4.35	4.43	4.70	4.55			4.51	hono	V	East rift near Kalalua; felt-volcano; hnp (bird park)-felt like someone shaking car; hnp-rec on experimental instrument, not felt; volcano-felt, water tank splashed; hnp-mirror thrown to floor, felt.	Assume strong at Whitney (VL 527, p. 4, table); *M* (Whitney)>4.65; VL 527, p. 5; HVO, unpub.
3/5/55	12:39:08	19	23.70	155	6.10	kl mer	2.0	10.0	20.5	19.8	22.1	st; m? (pahoa)	4.38	no record	<4.28	<3.9	<3.95			4.38	nomo	III	Records at Whitney and Uwekahuna unreadable during first few hours of swarm; rift 4 km E of Napau crater; felt-Hilo; Hilo-felt by many, slow and weak, dur 3 s, many near quakes these days.	Closer to Pahoa(?); VL 527, p. 5; HVO, unpub.
3/5/55	12:53:44	19	24.30	155	4.20	kl mer	2.0	2.0	13.5	16.4	16.5	st (pahoa)	4.17	poor	no trace	no trace	no trace			4.17	nomo		East rift Kalalua.	Closer to Pahoa(?); VL 527, p. 5.
3/5/55	12:58:26	19	23.70	155	6.10	kl mer	2.0	2.0	17.5	19.8	19.9	st (pahoa)	4.30	poor	4.73	4.70	4.95			4.79	hono		4 km w of Kalalua-largest quake of series; assume strong at Whitney (VL 527, p. 4, table); *M* (Whitney)>4.65.	VL 527, p. 5.
3/5/55	14:22:08	19	24.30	155	4.20	kl mer	2.0	2.0	13.5	16.4	16.5	st (pahoa)	4.17	poor	no trace	no trace	no trace			4.17	nomo		East rift Kalalua.	Closer to Pahoa(?); VL 527, p. 5.
3/6/55	11:45:06	19	24.30	155	4.20	kl mer	2.0	2.0	13.5	16.4	16.5	st (pahoa)	>4.17	no trace	no trace	no trace	no trace			4.20	aver		East rift Kalalua; assume moderate at Whitney (VL 527, p. 4, table); *M* (Whitney)=4.13-4.65; preferred mag minimum consistent with Hon, Pahoa, and Whitney.	Closer to Pahoa(?); VL 527, p. 6.
3/7/55	22:21:31	19	21.20	155	0.30	kl mer sf	10.0	10.0	18.0	16.8	19.6	st (pahoa)	>4.29	5.20	5.23	5.23	5.35	5.40	hvo (S&C)	5.32	aver	V (W&K); IV (S&C)	Near Heiheiahulu; felt-s half Hawaii Island; assume strong at Whitney (VL 527, p. 4, table); M (Whitney)>4.92; Note: A second strong quake listed in table on p. 4 inconsistent with Honolulu data; preferred mag average of Honolulu and HVO.	Strong at Whitney (M>4.92); location corrected to south coast of Kilauea 2 mi W of Kalapana (Macdonald and Eaton, 1964, p. 146); VL 527, p. 6; detailed felt reports given in HVO, unpub.; mag not given in VL.
3/7/55	22:57:38	19	21.20	155	0.30	kl mer sf	10.0	10.0	18.0	16.8	19.6	st (pahoa)	>4.29	<4.22	<4.42	3.78	4.27			4.02	hono	IV	Near Heiheiahulu; felt-Pahoa, Hilo, hnp, Capt. Cook; Hilo-3, felt by many, slow and moderate, dur 15 s, windows, doors, dishes rattled; Capt. Cook (23:00)-2, v slight vibration, similar to 22:25 quake but shorter and lighter, no window rattle.	Honolulu amplitude average of two readings; strong at Whitney (VL 527, p. 4, table) yields *M* >4.92, slight(?); location corrected to south coast of Kilauea 2 mi W of Kalapana (Macdonald and Eaton, 1964, p.146); closer to Pahoa(?); VL 527, p. 6; HVO, unpub.
3/7/55	23:32:41	19	21.20	155	0.30	kl mer sf	10.0	10.0	18.0	16.8	19.6	st (pahoa)	>4.29	no trace	no record	det?	no trace			4.00	aver	III	Near Heiheiahulu; felt-Pahoa, Hilo, hnp; Hilo-felt by few, slow and weak, door rattled, felt in bed, slightly, just one jolt; preferred mag average of Pahoa and Whitney.	Close to Pahoa(?); assume feeb 5 at Whitney (VL 527, p. 4, table); *M* (Whitney)=3.33-3.92; location corrected to south coast of Kilauea 2 mi W of Kalapana (Macdonald and Eaton, 1964, p.146); VL 527, p. 6; HVO, unpub.
3/11/55	23:59:00					kl ler		5.0	7.0	7.0	8.6	s (pahoa)	2.95							4.02	calc		Do.	Lower east rift earthquake swarm; 15 events; VL 527, p. 6.
3/28/55	14:31:00					hilea?														4.15	nomo	III	Pahala-5, felt generally, heard as well as felt, movement acc by rumbling.	Not in VL 527-date and time from felt report; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
3/30/55	13:41:31	19	20.3	155	41.0	ml swr				32.3	33.5	m (naalehu)	4.15	no trace	no trace	no trace	no trace			4.13	nomo			Closer to Naalehu(?); VL 527, p. 6.
4/1/55	4:24:28	19	24.30	155	17.70	kl cal deep	10.0	30.0	4.5	2.1	30.1	st (uwe)	4.46	4.75	4.78	5.13	5.33	5.20	hvo	5.10	aver	V; V (W&K; S&C)	South rim of Kilauea crater; felt generally-Hawaii Island; few on Maui, Oahu; detailed felt reports in HVO unpub. Warshauer notes: Hilo, Kona seismometers dismantled; felt-Kona, Kau, Hilo. Pahoa, volcano, Glenwood-Mt. view; objects off shelves at Kapapala	Depth changed to 30 km in accordance with similar felt reports over a broad area of Hawaii Island; VL 528, p. 5; HVO unpub.; HTH, 4/1/1955; mag not published in VL; preferred mag average of Honolulu and HVO.
4/7/55	1:27:22					kl cal deep	25.0	25.0	15.0	15.0	29.2	s (uwe)	3.93	<3.90	<4.12	<3.75	4.25			4.25	hono		Hilina pali.	Honolulu amplitude average of two readings; VL 528, p. 5.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
8/5/55	2:33:00					kona?														5.21	hono	II	Kalahiki-2	Not in VL 529-530-date and time from felt report; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
8/14/55	2:28:05	19	18.60	155	17.40	kl cal deep	25.0	25.0	15.0	12.7	28.0	st (uwe)	4.41	6.11	5.97	5.73	5.50	6, 5.7	W&K; hvo	5.84	aver	VI; VI (S&C)	Hilina fault s of HVO; felt over entire island of Hawaii, on Maui, Oahu and by a few persons on Kauai; detailed felt report in HVO unpub. Warshauer notes: dur 5 min, felt only few sec; cracked paint, plaster fall, articles from shelves at Kapapala	Isoseismal map in W&K; VL 529-530, p. 12; HVO, unpub.; HTH, 8/14/1955; HVO mag not published; preferred mag calculated as average of Hon, HVO, and W&K.
9/20/55	23:50:00					kona?														4.13	hono	III	Kalahiki-3, pictures creaked.	Not in VL 529-530-date and time from felt report; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
10/24/55	17:16:53					kohala	25	25	2	2.0	25.1	s (kamuela)	3.47	no trace	no trace	no trace	no trace			4.55	hono	IV	Near Kamuela; Kamuela-4, slight rumble, very moderate, duration 3-5 s, buildings shook, rattled windows; Umikoa-felt.	VL 529-530, p. 13; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
2/18/56	17:02:50	19	25.0	155	21.0	kaoiki				6.1	10.9	m (uwe)	3.48							4.27	hono	felt	Kaoiki Fault W of Kilauea crater; felt-hnp.	Macdonald and Eaton, 1956a.
4/15/56	19:09:20	19	54.0	156	7.0	kohala os	15	15		48.8	51.1	m (kamuela)	4.45	no trace	no trace	no trace	3.97			4.62	aver	IV	20 km NNW of Keahole pt; felt-; Kealakekua-5, very fast and quite strong; Kukuihaele-4, shook buildings, also felt in; Hakalau-not strong, house shook; preferred magnitude calculated as average of nomogram and Honolulu.	Macdonald and Eaton, 1956b; additional felt reports in HVO, unpub.
5/21/56	1:06:30	20	6.7	155	46.7	kohala	30	30	15	15.0	33.5	s (kamuela)	3.67							4.24	hono		15 km NW of Kamuela.	Macdonald and Eaton, 1956b.
10/11/56	12:53:34	20	8.9	155	48.4	kohala	15	15	20	20.0	25.0	s (kamuela)	3.69							5.26	aver	felt	20 km NNW of Kamuela; felt-Kamuela; Kamuela-felt by several.	Eaton and Fraser, 1956b; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
10/16/56	0:44:55	19	38.9	156	25.5	kona os	5	5	54	55.4	55.7	st (kona)	5.34	5.03	5.25	5.14	light trace	5.5	HVO	4.50	hono	V (S&C); IV (hilo, kona)	45 km w of Kailua, Kona; felt-all Hawaii Island, Oahu; extensive felt reports in HVO, unpub.; preferred magnitude calculated as average of Honolulu (wt 2) and HVO.	Assume 5-km depth (too shallow to fit felt reports?); Eaton and Fraser, 1956b [magnitude given to S&C not published]; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
1/6/57	8:45:00					kona			5	5.0	10.3	f (kona)	3.18							4.00	aver	felt	Felt-central Kona.	Central Kona; Eaton and Fraser, 1957a; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
1/14/57	16:15:00					kona?														4.04	aver	IV	Capt. Cook-3, like explosion, strong jolt, mauka heard rumble from Kau and strong shake; Konawaena-boom followed by jolt, also felt in Kona theater area.	Not in Eaton and Fraser, 1957a; date and time from felt report; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
2/11/57	14:03:24	19	15.7	155	16.00	kl kuer sf	15.0	10.0	16.5	19.1	21.5	m (uwe)	4.23	<4.07	<4.07	<4.76		4.00	hvo	4.00	hvo	IV	7 km w of Apua pt, felt-hnp, Kona; hnp-sharp jolt like car striking house, also felt at volcano; Capt. Cook-2, gentle, quick jiggle, dur >7 s, prob 12-15 s, pheasants cackling, felt lightly by few.	HTL high; Eaton and Fraser, 1957a; HVO, unpub.
3/17/57	10:51:11	19	25.8	155	23.4	kaoiki	5	5	7	6.9	8.5	s (ml)	2.94							4.08	nomo		7 km S. of ml seismometer.	Eaton and Fraser, 1957a.
6/23/57	23:00:25	19	10.8	155	35.0	hilea	5	5	13	13.0	13.9	m (naalehu)	3.78					3.3	hvo	4.47	aver		13 km N of (?).	Eaton and Fraser, 1957b.
7/22/57	10:17:22	21	5.0	156	14.0	maui	35	35		35.3	49.7							3.2	hvo	4.52	aver		35 km N of Haleakala seismometer.	Eaton and Fraser, 1957c.
7/27/57	2:16:57					kona			10	10.0	13.5	f (kona)	3.04							4.16	aver	felt	Near Kealakekua; felt-Kealakekua; sharp at Kealakekua, awakened people; felt by a few people in Capt. Cook.	Eaton and Fraser, 1957c; HVO, unpub. [intensities-arabic numerals-in remarks column refer to HVO postcards].
8/10/57	14:43:43	20	48.0	155	28.0	maui	10	10		153.5	153.8			4.25	4.05	4.06		4.2	hvo	4.21	aver	III	Preferred magnitude calculated as average of Honolulu and HVO.	Latitude given in error as 23°48′; Eaton and Fraser, 1957c.
8/16/57	13:30:00					maui?								no trace	no trace	3.53				5.41	aver			Not in Eaton and Fraser, 1957c.
9/4/57	6:28:18	20	3.5	155	42.4	kohala	30	30		83.6	88.8							3.3	hvo	4.03	aver		5 km NW of Kamuela.	Eaton and Fraser, 1957c.
2/15/58	16:48:38	18	58.0	155	29.0	kl swr sf os deep	35.0	35.0	56.0	56.7	66.6			<4.04	no trace	4.54		3.90	hvo	4.10	aver	felt	17 km se of Naalehu, felt-Naalehu, Pahoa; felt at Pahoa and Naalehu; preferred magnitude calculated as average of Honolulu and HVO.	HTL high; Eaton and Fraser, 1958a; HVO, unpub.
4/18/58	7:57:41	19	28.1	155	55.1	kona	5	5		68.8	69.0							2.5	hvo	4.49	aver		5 km s of Kealakekua on Kealakekua fault	Eaton and Fraser, 1958b.

Table 13. All earthquakes of $M \geq 4.0$ during the period 1903–59—Continued

Date	Time (HST)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	Region	Publ. Depth	Pref. Depth	Publ. Dist.	Calc. Dist	Slant dist	Mag class	M nomo	M M-S E-W	M M-S N-S	M vert	M hor N-L	M other	M (other) source	M pref	M (pref) source	I (max)	Location/felt report	Comment
7/6/58	23:59:00	19	28.5	155	12.80	kl gln deep	55.0	55.0	10.0	7.3	55.5									4.82	calc		Preferred magnitude calculated as Richter distribution.	Deep earthquake swarm north of Kilauea caldera; 2,052 events of M <2.5 with b =1.5 whose magnitudes are not tabulated separately (Eaton and Krivoy, 1958, p. 4).
9/20/58	20:09:18	20	4.0	155	36.4	mauna kea deep	40	40		79.0	88.6							2.7	hvo	4.04	aver		10 km E of Kamuela.	Eaton and Krivoy, 1958a.
10/22/58	23:43:28	19	12.5	155	19.00	kl kuer sf os	5.0	5.0		25.5	26.0			<4.57	<4.57	4.53		4.30	hvo	4.41	aver	V	Felt-hnp to Kealakekua; hnp-felt; Pahala-felt by many in Kau, very strong; Capt. Cook-felt [postcard time 23:50-24:00—should be earlier to agree with seismic summary felt info]; preferred magnitude calculated as average of HVO and Honolulu.	Honolulu amplitude average of two readings; HTL high; Eaton and Krivoy, 1958b; HVO, unpub.
10/23/58	12:23:23	19	12.5	155	19.00	kl kuer sf os	5.0	5.0		25.5	26.0			4.62	4.74	4.60		4.30	hvo	4.47	aver	IV	Felt-Pahala; hnp-felt; Pahala-felt by many in Kau, very strong; Capt. Cook-felt; preferred magnitude calculated as average of HVO and Honolulu.	Honolulu amplitude average of two readings; Eaton and Krivoy, 1958b; HVO, unpub.
11/2/58	5:55:44	19	24.4	155	18.40	kl cal deep	30.0	30.0	4.5	5.1	30.4			<4.50	4.60	4.70		4.40	hvo	4.40	hvo	IV	4 km SE of Uwekahuna, felt-hnp to Hilo; hnp/volcano-felt generally; Hilo-felt; Kapoho-felt (ranch), wakened by gentle motion, E-W, 2 distinct waves, dur 15 s; Hilo-moderate, began gradually, dur 10 s, pulsating rocking motion, felt generally.	Honolulu amplitude average of two readings; Eaton and Krivoy, 1958b; HVO, unpub.
12/24/58	17:05:21	19	24.5	155	25.5	kaoiki	10	10		16.9	19.6							3.5	hvo	4.50	hvo		5 km w of Ohaikea.	Eaton and Krivoy, 1958b.
1/7/59	23:59:00					kl gln deep														4.47	calc		Preferred magnitude calculated as a Richter swarm	Deep earthquake swarm north of Kilauea caldera; 571 events of M <2.5 with b =1.5 whose magnitudes are not tabulated separately (Eaton and Krivoy, 1963a, p. 2).
2/19/59	20:00:28	19	21.0	155	9.00	kl mer sf	5.0	5.0		15.4	16.2			4.62	4.90	5.11		4.50	hvo	4.69	aver	III (S&C)	Felt-Capt. Cook, Honokaa, Hilo, hnp; preferred magnitude calculated as average of HVO and Honolulu.	Honolulu data is average of two readings; Eaton and Krivoy, 1963a.
2/28/59	6:54:54	19	26.0	155	29.0	kaoiki	5	5		22.8	23.4							3.2	hvo	4.10	aver			Eaton and Krivoy, 1963a.
6/25/59	16:11:30	19	15.0	155	31.0	hilea	5	5		33.3	33.6							2.6	hvo	4.18	aver			Eaton and Krivoy, 1963b.
8/18/59	13:54:50	19	17.0	154	57	deep?	45.0	45.0		37.3	58.5			no trace	no trace	det?		4.00	hvo	4.00	hvo	felt	Felt-hnp, Hilo.	Eaton and Krivoy, 1963c.
8/20/59	23:59:00					kl gln deep	51.5	51.5		6.5	51.9									4.75	calc		Preferred magnitude calculated as a Richter swarm.	Deep Glenwood earthquake swarm; 2,358 events of M<2.5 with b=1.5 whose magnitudes are not tabulated separately (Eaton and Krivoy, 1963c, p. 2, 10–13).
9/18/59	14:50:04	19	24.0	155	6	kl mer	5.0	5.0		18.0	18.7			no record	no record	no record		4.00	hvo	4.00	hvo	felt	Felt-hnp, Hilo.	Eaton and Krivoy, 1963c.

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