



## HAWAIIAN RADIOCARBON DATES

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### ABSTRACT

Radiocarbon dates have been obtained from 306 geologic samples collected from the Island of Hawaii and analyzed by the U.S. Geological Survey laboratory at Reston, Virginia. The dates range from modern (present-day carbon) to greater than 38 ka. For convenience, the tabulated dates are grouped by volcano: 185 from Mauna Loa, 90 from Kilauea, 30 from Hualalai, and 1 from Mauna Kea. Maps show sample locations, and a selected bibliography of articles covers aspects of Hawaiian radiocarbon dates.

### INTRODUCTION

Understanding the history of volcanism in Hawaii requires an understanding of the timing of the volcanic events. This article lists the radiocarbon dates from the Island of Hawaii, giving their sample locations, ages, significance, and stratigraphic relations in tabular form. Dates from each volcano on Hawaii are grouped in a separate table. These tables and the accompanying bibliography provide a comprehensive source of information on Hawaiian radiocarbon dates.

### HISTORY OF $^{14}\text{C}$ DATING IN THE HAWAIIAN ISLANDS

Although radiocarbon dating methods have been available since the late 1940's, only a handful of dates were determined on material from Hawaiian lava flows before 1976. This was not because of lack of interest but because samples of datable organic material were not available. With improved understanding of the conditions of charcoal formation and preservation beneath basaltic lavas, opportunities for discovery increased. Lockwood and Lipman (1979) pioneered the recovery of such material, allowing the dating of many new samples. Dates from Hawaii before 1979 are listed in Kelley (1979) and Kelley and others (1979). In the present paper, we list all dates from Hawaii analyzed for volcano-stratigraphic purposes at the U.S. Geological Survey radiocarbon laboratory at Reston, Va. Many dates obtained for other purposes, such as archaeological dates, geochemical dates related to volcanic gases and volcanic emanations affecting the biosphere, and dates on ground water are not listed here, as they are beyond the scope of this article.

A curve depicting the number of radiocarbon dates by year since 1950 would be a steeply rising one. The development of the new technique of tandem-accelerator mass spectrometry, with its attendant thousandfold decrease in the required sample size, will undoubtedly cause this curve to rise even more steeply. Many sites yield charcoal in insufficient quantity for a conventional radiocarbon

age without large-scale quarrying operations, but the new method can provide a reliable date from a few milligrams of carbon. The experience of volcanologists indicates that many additional flows can be dated, now that the sample requirements have been reduced significantly.

Radiocarbon dates from Hawaii have revolutionized our understanding of the island's volcanic history. Previous workers had to be satisfied with relative ages, rather than numerical dates. In addition to directly dating the geologic deposit,  $^{14}\text{C}$  dating has helped to calibrate other forms of dating, which then could be used as a substitute dating technique where carbon is not available. These alternate methods include paleomagnetic-age curves of various types and individual weathering indices developed by several workers. All of these are calibrated on  $^{14}\text{C}$ -dated flows.

### CARBON SOURCES

The ideal sample for radiocarbon dating of a flow would be a sample from a short-lived plant converted to vitreous charcoal by the heat of the advancing lava (Lockwood and Lipman, 1979). The plant should have been growing away from the influence of volcanic-source  $\text{CO}_2$ , which lacks the  $^{14}\text{C}$  present in atmospheric  $\text{CO}_2$ , should be buried too deeply for surface rootlet penetration, and should not be soaked in ground water rich in organic components. Poor samples would be those from buried soils, poor in organic matter, having modern rootlets, or lying under the water table. Various enrichment and purification techniques for removing contaminants have been developed to analyze such poor-quality samples, but the results are not always reliable. Charcoal from post-flow fires commonly trickles down through the flow (most easily with aa) and can give the appearance of having been formed during the flow's advance, but such material will not date the actual flow.

### VALIDITY OF THE DATES

The uncertainty given for the dates in the tables (the figure after the  $\pm$ ) is the standard deviation (one sigma) based only on the counting statistics and not on analysis of replicate samples from the field. This counting error does not include variable factors, such as contamination, isotopic fractionation, and other laboratory uncertainties. Experience has shown that these factors raise the uncertainty to more than twice the quoted error.

Another type of error encountered in some samples taken from volcanic areas is that caused by dilution of the normal  $^{14}\text{C}$  content in atmospheric  $\text{CO}_2$  by volcanic emanations that contain no  $^{14}\text{C}$ .

Plants take up this  $^{14}\text{C}$ -poor  $\text{CO}_2$  in their metabolism and therefore have an initial apparent age because of such deficient initial activity. This error in extreme cases can produce an apparent age of 3 ka in living plants (Rubin and others, chapter 9). However, common practice suggests that unless a plant is known to be growing immediately adjacent to a vent, it can be assumed to give a reasonably correct age.

### HOW $^{14}\text{C}$ DATING HAS AFFECTED THE THINKING OF HAWAIIAN GEOLOGISTS

What surprises have been produced by the numerous  $^{14}\text{C}$  dates obtained in recent years? In general, geologists did not have to revise greatly their age estimates for flows younger than 1 ka. By extrapolation of historical weathering rates, they had been able to estimate fairly accurately the ages of the younger flows. Flows having a very weathered appearance, however, had been estimated to be much older than the dates ultimately derived by  $^{14}\text{C}$  measurements.

### SUMMARY OF HAWAIIAN RADIOCARBON DATES AND THEIR SIGNIFICANCE

Sample locations, laboratory numbers, and ages of Hawaiian radiocarbon dates have been plotted (figs. 10.2–10.5; see also fig. 10.1) and are also listed by volcano (tables 10.1–10.4). The tables list samples in order of increasing age and also give additional information on location, geologic section, altitude and flow name. Only those samples that were processed at the U.S. Geological Survey radiocarbon laboratory at Reston, Va., and that have geologic significance are included in this compilation.

Much further information for each sample, including the complete geologic section and significance, the date of collection, and the collector's judgment as to whether the sample age appears to be a valid age for the overlying flow or ash is available from the U.S. Geological Survey laboratory at Reston or from the collector. All collectors are or were members of the U.S. Geological Survey. Other chapters in the present work make use of the dates collected here in their studies of separate volcanic areas, and they constitute prime sources of information on Hawaiian chronology.

#### MAUNA LOA

The numerous samples dating the flows of Mauna Loa (table 10.1; figs. 10.2–10.4) serve only to establish a foundation for further work. Of the hundreds of individual flows that have been mapped, many have been dated, but there are still many more flows to be dated. Where carbon is not available, or the age is beyond the range of  $^{14}\text{C}$  dating, observational methods of relative dating will be used, with the radiocarbon dates as a calibration where possible.

Some tentative statements as to the activities of the various volcanoes can be made. Mauna Loa appears to have been more active during the brief period of its recorded history than during the several centuries immediately preceding 1840. Activity was also higher around 0.8–1.0 ka (800–1,000 years before present).

Surface flows on Mauna Loa appear to be older than those of Kilauea. Areal percentages covered by various ages of flows are discussed by Lockwood and Lipman (chapter 18). Flows several thousand years old are common on Mauna Loa, but flows more than a few hundred years old are rare on Kilauea. About 30 percent of the surface of the southwest side of Mauna Loa has been covered by lava in the past 1,000 years, but about 90 percent of Kilauea's surface is younger than 1 ka.

Ages of Mauna Loa flows range from very recent to greater than 38 ka, the very oldest flows being exposed along deeply incised river channels and fault scarps.

#### KILAUEA

As is evident from the dates (table 10.2; fig. 10.5), Kilauea is a young, active volcano. Kilauea's surface is only about one-tenth as old as was thought previously. The northeast rift zone appears to be the same age as the southwest rift zone but has more bulk, erupting more often and with greater volume. The older rocks are, in general, found farther away from the rift zone. About 90 percent of the surface flows are younger than 1.1 ka (Holcomb, chapter 12). Kilauea is the youngest volcano on the Island of Hawaii, with dated eruptions from the present time back to about 23 ka.

#### HUALALAI

Although the flows of Hualalai (table 10.3; fig. 10.2) have not been as frequent as Kilauea in historical time, the flows in the past 1,500 years have been very large and cover 10–20 percent of the area. All of the approximately 200 cones on Hualalai are of Holocene age (less than 10 ka) and 95 percent of the surface flows are also Holocene in age. As much as 50 percent of the area is covered by flows younger than 5 ka. Hualalai is still an active volcano, with an average of one eruption every 50 years during Holocene time, and the last known eruption occurred in 1801. Ages range from less than 200 years to 13 ka.

#### MAUNA KEA

Mauna Kea is, next to Kohala Volcano, the oldest and least active of the Hawaiian volcanoes. The date from Mauna Kea (table 10.4; fig. 10.3) is Holocene in age, but this does not reflect the age of the majority of deposits (see Porter, chapter 21).

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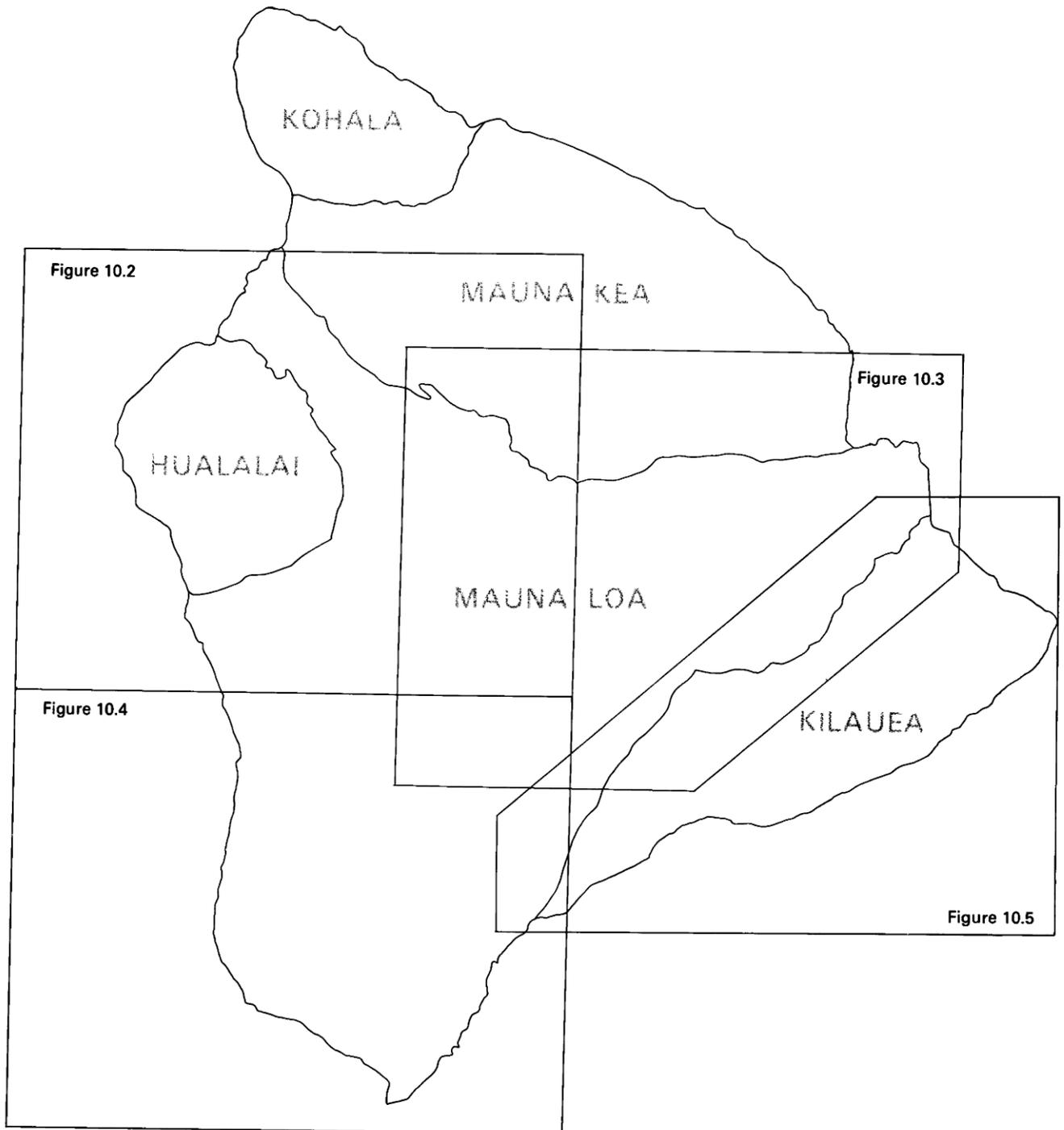


FIGURE 10.1.—Index map of Island of Hawaii showing areas covered by locality maps, figures 10.2.–10.5.



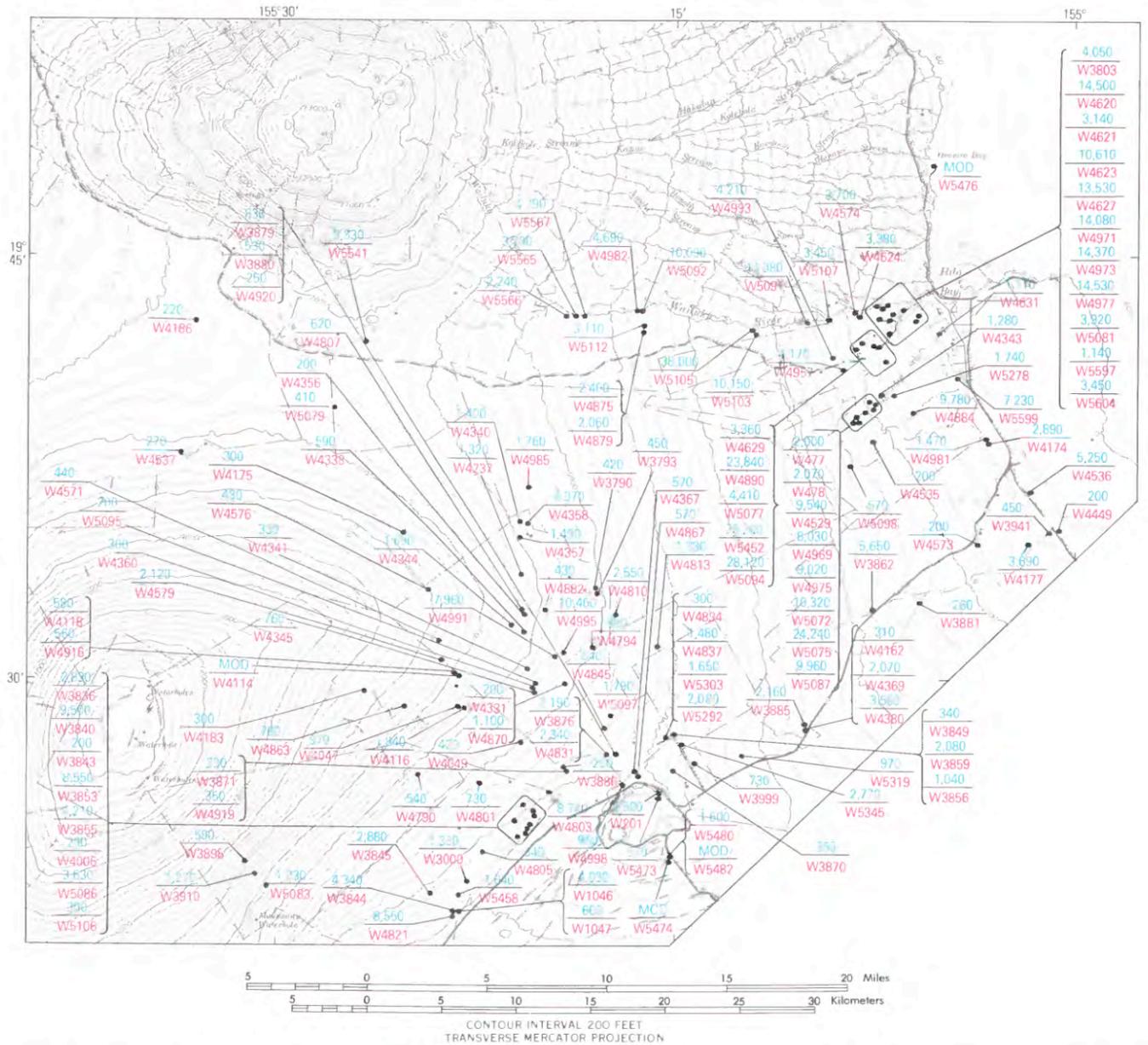


FIGURE 10.3.—Localities and ages of <sup>14</sup>C-dated samples on Mauna Kea Volcano, eastern part of Mauna Loa Volcano, and northwestern part of Kilauea Volcano. Dots, sample localities; for each locality the <sup>14</sup>C age in years B.P. (blue) and the sample number (red) are given. For details of samples, see tables 10.1, 10.2, and 10.4.

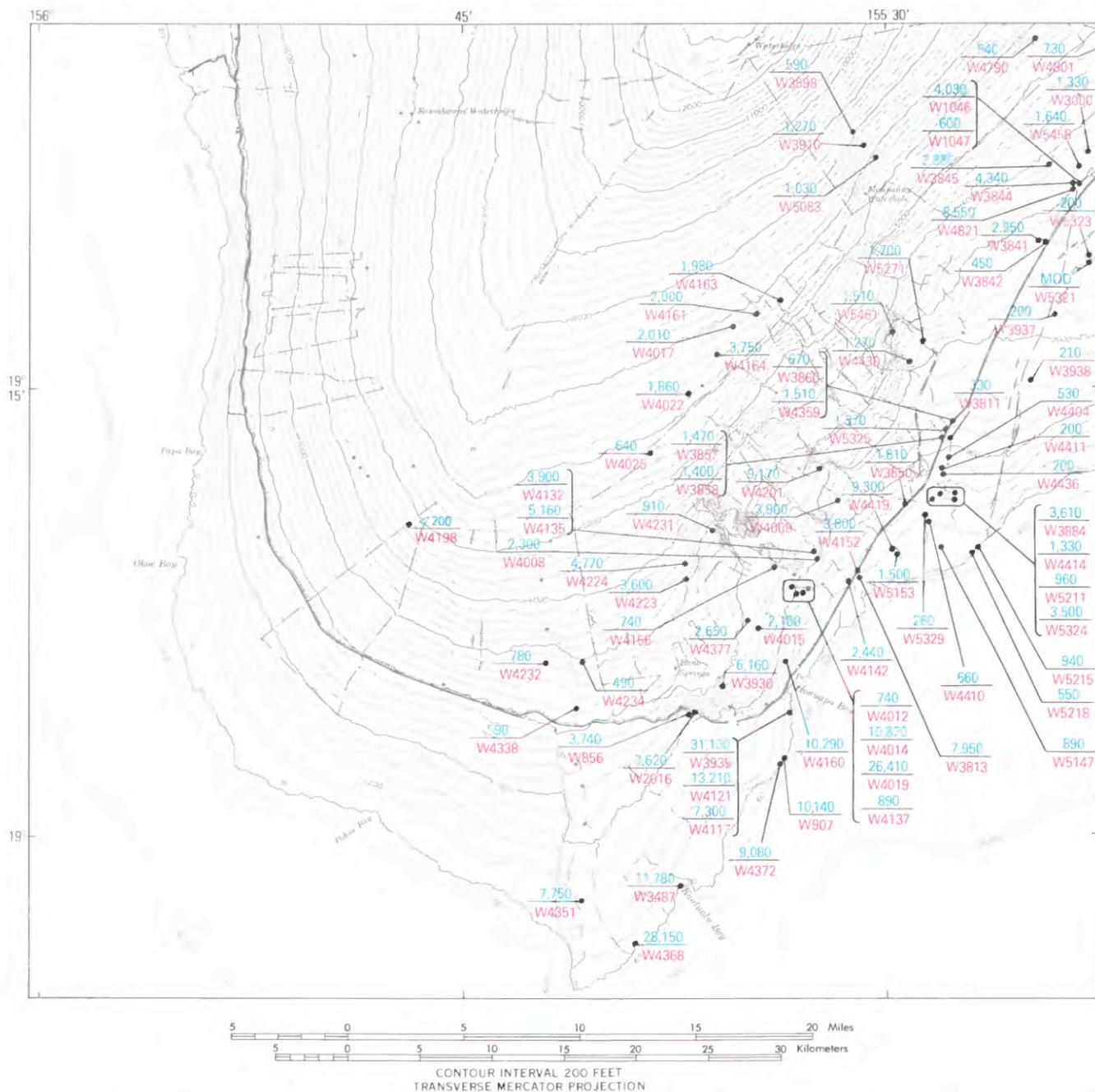


FIGURE 10.4.—Localities and ages of <sup>14</sup>C-dated samples on southwestern part of Mauna Loa Volcano. Dots, sample localities; for each locality the <sup>14</sup>C age in years B.P. (blue) and the sample number (red) are given. For details of samples, see table 10.1.

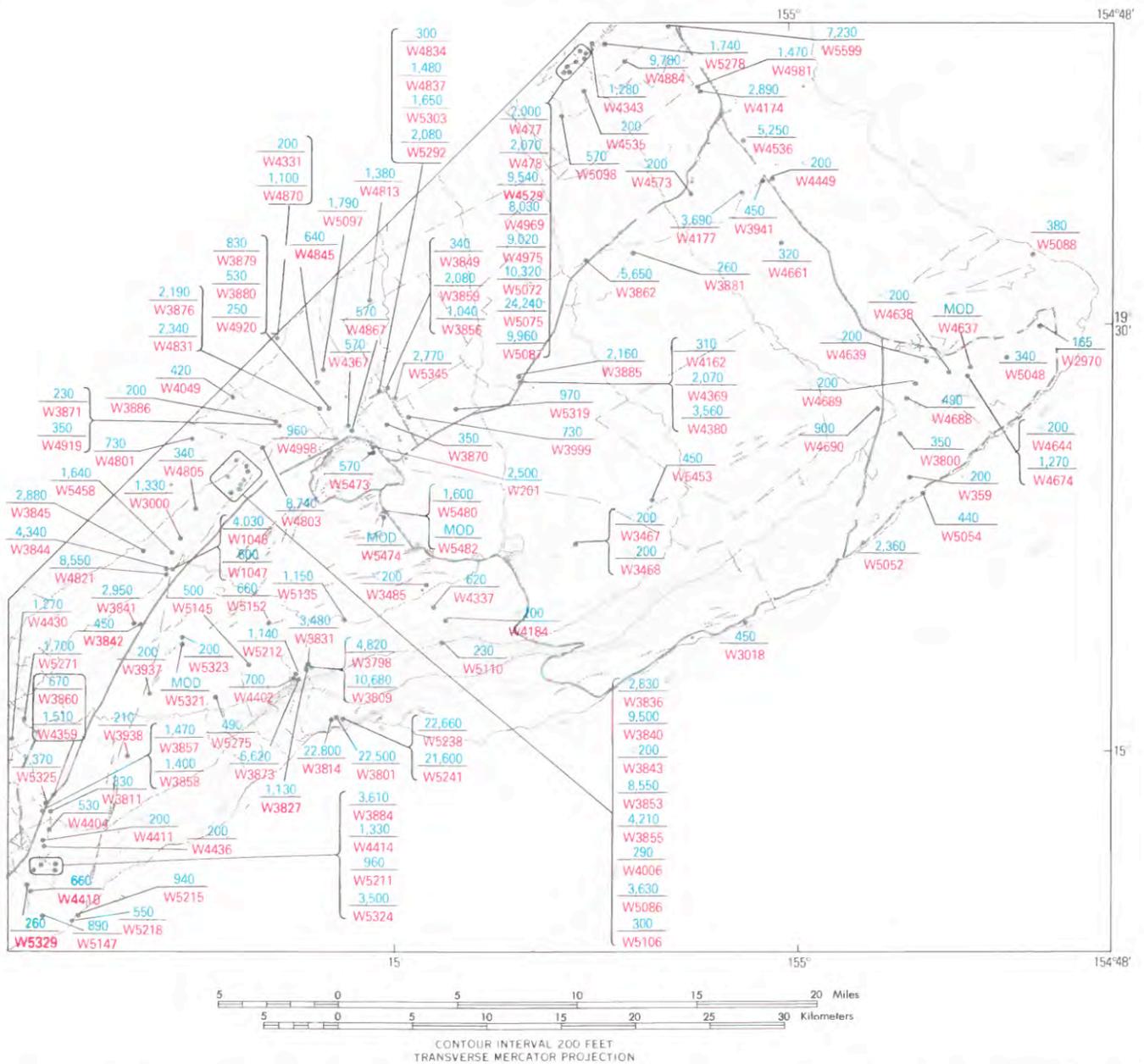


FIGURE 10.5.—Localities and ages of <sup>14</sup>C-dated samples on Kilauea Volcano and southeastern part of Mauna Loa Volcano. Dots, sample localities; for each locality the <sup>14</sup>C age in years B.P. (blue) and the sample number (red) are given. For details of samples, see tables 10.1 and 10.2.

TABLE 10.1—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii

[Samples listed in order of increasing age; uncertainty is one standard deviation,  $\pm 1\sigma$ ; modern age means sample is younger than AD 1950; ML = Mauna Loa; MK = Mauna Kea; mauka = toward the mountain, makai = toward the sea; see figs. 10.2–10.4 for localities. Stratigraphic nomenclature from Langenheim and Clague (chapter I, part II)]

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4114	Modern	19°30'09" 155°23'10" Puu Ulaula	2,070	Root fragments under margin of aa, Keamoku flow, 800 m N. of end of Strip Rd., 300 m E. of Puu Ulaula Trail.	J. P. Lockwood
W3843	<200	19°24'32" 155°20'37" Kilauea Crater	1,050	Charcoal root fragments from Pahala Ash below flow of Kipuka Maunaiu, at head of gully, along contact with Keamoku flow, Ohaikea Rd.	P. W. Lipman
W4198	<200	19°10'28" 155°46'37" Papa	1,481	Charcoal fragments along basal aa, at edge of Manuka flow, resting on pumice blanket from Hapaimanu, N. end of prominent kipuka, NW. of Pohakuloa.	P. W. Lipman
W4331	<200	19°29'52" 155°19'07" Kilauea Crater	1,542	Charcoal rootlets, in soil at base of pahoehoe, E. Keamoku flow, overlain by grey tube-fed pahoehoe, Puu Oo Trail, Keauhou Ranch Rd. pit, 4 km SE. of Keawewai Camp.	J. P. Lockwood
W4356	<200	19°32'20" 155°20'44" Kulani	1,913	Charcoal, at base of large tree mold, Solomon's Water Hole flow, overlain by aphanitic tube-fed pahoehoe, Powerline Rd., between pole 103 and 104.	J. P. Lockwood
W4411	<200	19°12'22" 155°28'02" Pahala	238	Charcoal roots under aa clinkers at edge of flow, SE. of Highway 11, NE. of Paaauu Gulch.	N. G. Banks
W4535	<200	19°38'31" 155°07'35" Piihonua	337	Charcoal roots, in red-orange sub-laterite soil, young Ainaola pahoehoe flow, overlain by very fine crystalline, near aphanitic dark grey pahoehoe, drainage ditch 10 m S. of Ainaola Dr.	J. P. Lockwood
W5095	<200	19°29'46" 155°20'39" Kilauea Crater	1,684	Charcoal rootlets from edge of Keamoku flow, NW. of Kipuka Kekake, Powerline Rd., pole 140.	J. P. Lockwood
W5108	<200	19°30'42" 155°44'24" Puu O Uo	2,082	Charcoal twigs from Puu O Uo flow, along S. margin of the flow near uppermost ohia forest, 5 km WNW. from summit of Puu O Uo.	J. P. Lockwood
W4186	220±60	19°42'41" 155°33'09" Puu Koli	1,914	Charcoal, beneath thin pahoehoe toes at contact with old MK aa around small kipuka, Red Leg Trail, 5 km SSE. of Pohakuloa cabins.	J. P. Lockwood
W3871	230±60	19°26'44" 155°19'07" Kilauea Crater	1,281	Charcoal roots in ash below Keamoku aa flow, from roadcuts in Kipuka Ki.	J. P. Lockwood
W4920	250±70	19°27'48" 155°17'04" Kilauea Crater	1,250	Charcoal (rerun of W-3879, age 830±60).	J. P. Lockwood
W5329	260±200	19°10'52" 155°28'41" Pahala	85	Charcoal, from soil beneath pahoehoe overlying Pahala Ash, top of Pahala section, at base of cliff below Puu Kalea.	N. G. Banks
W4537	270±60	19°37'49" 155°33'43" Puu Koli	2,243	Charcoal roots beneath aa margin of Keamoku flow, 3 km NNE. of Puu Kokoalau.	J. P. Lockwood

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4006	290±70	19°24'44" 155°20'33" Kilauea Crater	1,095	Charcoal roots in Pahala Ash, underlying Kipuka Maunaiu flow, Ohaieka Rd.	P. W. Lipman
W4183	300±60	19°29'44" 155°26'40" Kipuka Pakekake	2,550	Charcoal, SW. margin of prominent red pahoehoe kipuka on W. margin of Kau 1880 flow.	J. P. Lockwood
W4360	300±60	19°39'37" 155°20'41" Kilauea Crater	1,676	Charcoal underlying marginal blocks of aa, Keamoku flow, Powerline Rd., pole 142.	J. P. Lockwood
W4175	300±50	19°35'12" 155°25'17" Puu Ulaula	2,292	Charcoal underlying dark grey aa, Puu Kupanaha flow, overlain by 1880 lavas, Kulani-Mauna Loa Observatory Rd.	J. P. Lockwood
W5106	300±80	19°24'58" 155°20'59" Kilauea Crater	1,166	Coarse charcoal roots, beneath tree mold in base of flow, Lacey Cesspool picrite-rich flow overlain by basalt of Kipuka Maunaiu, Peter Lee Rd.	J. P. Lockwood
W4238	300±70	19°04'17" 155°40'57" Kahuku Ranch	688	Charcoal root fragments in olivine-rich pahoehoe, Puu Lokuana.	P. W. Lipman
W4341	330±60	19°30'29" 155°20'36" Kulani	1,766	Charcoal rootlets under aa at margin of pahoehoe flow, Puu Kulua flow, lowest unit in Keamoku suite, Powerline Rd., 1.6 km S. of Keawewai Camp.	J. P. Lockwood
W4805	340±60	19°23'50" 155°22'16" Kilauea Crater	1,155	Charcoal rootlets beneath thin edge of fresh pahoehoe flow, Ke A Poomoku Ohaieka, 3 m mauka of Powerline Rd.	J. P. Lockwood
W5535	340±150	19°36'14" 155°40'36" Puu O Uo	2,137	Charcoal roots at margin of loose shelly pahoehoe, under radial vent surrounded by 1859 lava.	J. P. Lockwood
W4919	350±70	19°26'44" 155°19'07" Kilauea Crater	1,281	Charcoal (rerun of W-3871, age 230±60).	P. W. Lipman
W5539	360±150	19°50'23" 155°47'23" Puu Anahulu	710	Bush fragments at basal contact of 1859 aa flow, Mamalahoa Highway, 37 km NE. of Kailua.	J. P. Lockwood
W5079	410±60	19°32'37" 155°27'56" Puu Oo	2,059	Charcoal roots in pocket of ash beneath thin pahoehoe toe above picrite, Humuulu flow, overlain by 1855 flow, 1 km E. of Mauna Loa Observatory Rd.	J. P. Lockwood
W4049	420±70	19°27'47" 155°20'48" Kilauea Crater	1,498	Vitreous charcoal from Keamoku flow, upper unit, underlying thin outlier of aa.	J. P. Lockwood
W3790	420±70	19°33'15" 155°18'04" Kulani	1,574	Charcoal from thin soil, developed on old spatter, underlying Kulani picrite, on high-standing dry hillock.	J. P. Lockwood
W4882	430±70	19°32'28" 155°19'54" Kulani	1,795	Coarse charcoal fragments in a horizontal tree mold at margin of tube-fed pahoehoe Kulaloa flow, Kilauea Forest Reserve lobe, overlain by Kulani picrite, 200 m SW. of Kilauea Forest Reserve Boundary Rd.	J. P. Lockwood

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4571	440±70	19°31'08" 155°23'42" Puu Ulaula	2,268	Charcoal rootlets beneath margin of aa breccia, W. Keamoku flow, 1.3 km NE. of Puu Ulaula Trail.	J. P. Lockwood
W3793	450±60	19°33'15" 155°18'07" Kulani	1,574	Charcoal from water-saturated spatter underlying 2 m of Kulani picrite.	J. P. Lockwood
W4576	480±60	19°33'19" 155°24'15" Puu Ulaula	2,414	Charcoal roots beneath Mauna Loa Boys' School flow, at crescent-shaped spatter cone, 1 km ENE. of Puu Kulua.	J. P. Lockwood
W4243	490±80	19°05'49" 155°40'43" Kahuku Ranch	829	Charcoal fragments in dirt and ash adjacent to flow margin, underlying aa containing small phenocrysts of plagioclase and olivine, Akihi.	J. P. Lockwood
W5568	510±150	19°31'52" 155°46'08" Puu Lehua	1,762	Vitreous twigs and fine rootlets, under slabby pahoehoe fragments at outer margin of thin pahoehoe squeeze-out, N. margin of Puu O Uo flow, 250 m NW. of prominent kipuka.	J. P. Lockwood
W3880	530±60	19°27'48" 155°17'04" Kilauea Crater	1,250	Organic debris and sooty soil directly underlying ropy pahoehoe.	J. P. Lockwood
W4790	540±70	19°26'25" 155°24'07" Kipuka Pakekake	1,609	Charcoal rootlets, Ke A Poomoku pahoehoe flow, W. edge of fresh flow, 1.3 km S. of National Park boundary, 700 m SE. of prominent rockwall.	J. P. Lockwood
W4916	560±70	19°30'11" 155°23'10" Puu Ulaula	2,079	Charcoal (rerun of W-4118, age 580±80).	J. P. Lockwood
W5098	570±60	19°37'37" 155°08'28" Piihonua	463	Charcoal twigs and roots, in muddy ash layer between Kulaloo and Panaewa pahoehoe flows, off Kulaloo Rd., Waiakea Homesteads.	J. P. Lockwood
W4367	570±70	19°26'33" 155°16'29" Kilauea Crater	1,238	Charcoal under basalt flow on Volcano Golf Course, Keamoku flow, 50 m W. of third green on golf course.	R. B. Moore
W4118	580±80	19°30'11" 155°23'10" Puu Ulaula	2,079	Charcoal from younger phase of Keamoku flow.	J. P. Lockwood
W4338	590±50	19°31'43" 155°20'48" Kulani	1,887	Coarse charcoal fragments from tree mold at margin of aa flow, Keawewai Camp flow, Powerline Rd., pole 112.	J. P. Lockwood
W3898	590±70	19°23'25" 155°30'53" Mauna Loa	2,428	Charcoal from pocket of baked ash, very young precaldera aa flow, Ainapo Trail.	J. P. Lockwood
W1047	600±250	19°21'54" 155°23'06" Wood Valley	910	Charcoal fragments in sandy ash, top of Pahala Ash, just below black sandy ash, Kaoiki Pali.	G. A. Macdonald
W4807	620±70	19°32'22" 155°20'44" Kulani	1,917	Charcoal roots in ash pockets of picrite-rich aa, at contact with aphanitic pahoehoe, Solomon's Water-hole flow, Powerline Rd., between pole 103 and 104, Puu Oo Trail.	J. P. Lockwood
W4025	640±45	19°13'09" 155°37'54" Puu Keokeo	1,774	Charcoal fragments at base of Pohina flow, where it rests on Pahala Ash at edge of Na Manua Haalou Swamp.	J. P. Lockwood

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4845	640±70	19°28'17" 155°17'44" Kilauea Crater	1,349	Charcoal rootlets in soot, beneath thick pahoehoe toe, Keamoku flow, Keauhou Ranch, Golf Course lobe.	J. P. Lockwood
W4410	660±70	19°10'37" 155°28'37" Pahala	53	Charcoal roots in Pahala Ash just below lava basalt flow, stream bed, Kananelu flat, Hionamoa Gulch.	N. G. Banks
W4801	730±70	19°26'20" 155°22'21" Kilauea Crater	1,442	Charcoal fragments and soot, from small bush molds, upper part of deep ash below pahoehoe toe, picrite-rich Kipuka Maunaiu pahoehoe, overlying Ke A Poomoku flow, 1.5 km mauka of Powerline Rd.	J. P. Lockwood
W4156	740±60	19°09'02" 155°33'56" Punaluu	473	Charcoal roots from ash at base of Kipuka Nene flow, exposed in pothole along Hilea Gulch.	P. W. Lipman
W4012	740±60	19°08'17" 155°33'08" Punaluu	305	Charcoal roots from ash underlying thin variable-olivine pahoehoe flow at Kipuka Nene, Hilea Gulch.	P. W. Lipman
W5301	760±100	19°35'46" 155°47'11" Puu Lehua	1,561	Charcoal in soil on Hualalai cinder cone, overrun by picritic ML flow, 1 km NE. of Kanahaha.	R. B. Moore
W4345	760±70	19°29'34" 155°20'37" Kilauea Crater	1,661	Charcoal rootlets beneath thin pahoehoe lobe, Powerline Rd., pole 142.	J. P. Lockwood
W4232	780±70	19°05'41" 155°42'09" Kahuku Ranch	780	Small sparse hard charcoal, in thin marginal aa near its base, where lapping onto pumice from Kahuku picrite cone.	P. W. Lipman
W4863	780±70	19°29'12" 155°25'08" Kipuka Pakekake	2,254	Charcoal roots in discontinuous soil above picrite-rich aa where overlain by thin aphanitic tube-fed pahoehoe and vesicular aa, overlain by 1880 and Ke A Poomoku flows, E. margin of small kipuka 400 m ESE. of 1880 lobe distal end.	J. P. Lockwood
W3879	830±60	19°27'48" 155°17'04" Kilauea Crater	1,250	Charcoal from flaky roots in Pahala Ash, 15 cm beneath ropy pahoehoe.	J. P. Lockwood
W4794	880±60	19°31'11" 155°18'06" Kulani	1,533	Tiny vitreous fragments of ohia leaves and twigs in soot, from overlying tree canopy knocked off by falling spatter, Olaa Uka flow, dense rain forest in gully on S. edge of Kulani Cone.	J. P. Lockwood
W4137	890±60	19°08'30" 155°33'17" Punaluu	381	Charcoal roots from lens of Pahala-like ash, below thin olivine-rich pahoehoe, Kipuka Nene flow, Hilea Gulch.	P. W. Lipman
W4047	910±70	19°29'15" 155°23'11" Kipuka Pakekake	1,934	Charcoal under olivine-rich aa flow.	J. P. Lockwood
W4231	910±60	19°10'17" 155°36'05" Punaluu	878	Charcoal roots in Pahala Ash, underlying olivine-rich pahoehoe, and overlying phenocryst-poor aa, stream bed, Hilea Gulch gauging station.	P. W. Lipman

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W5083	1,030±60	19°22'50" 155°30'17" Mauna Loa	2,091	Elongate charcoal fragments, beneath thin Keamoku pahoehoe toes, overlying discontinuous ash, Lower Ainapo Trail.	J. P. Lockwood
W4870	1,100±70	19°29'52" 155°19'07" Kilauea Crater	1,542	Coarse charcoal root fragments underlying thick pahoehoe, overlain by Keamoku flow, Puu Oo Trail, Keauhou Ranch Rd.	J. P. Lockwood
W4631	1,110±60	19°42'23" 155°05'10" Hilo	41	Charcoal roots underlying pahoehoe with round vesicles, at top of stream deposit, overlying thin Kulaloe pahoehoe flow, Waiakea Stream, S. of Kumakoa St. bridge.	J. M. Buchanan-Banks
W5537	1,120±200	19°28'44" 155°42'38" Sulphur Cone	2,499	Charcoal rootlets in small ash pocket below narrow young aphanitic pahoehoe toes, 2.8 km SW. of Puu O Uo.	J. P. Lockwood
W5597	1,140±300	19°42'50" 155°05'56" Hilo	67	Scattered charcoal fragments in ash deposit, overlain by Kinooles aa, Alenaio Stream at tributary E. of Komohana Street.	J. M. Buchanan-Banks
W5519	1,150±200	19°37'28" 155°45'22" Puu Lehua	1,649	Charcoal in soil on picritic pahoehoe, under young pahoehoe, SE. of Ahu a Umi Heiau.	R. B. Moore
W3910	1,270±60	19°23'22" 155°33'45" Mauna Loa	2,318	Charcoal in ash pocket underlying tree mold in tube-fed late prehistoric pahoehoe flow, Ainapo Trail, ML S. flank.	J. P. Lockwood
W4430	1,270±70	19°16'03" 155°29'06" Wood Valley	689	Charcoal roots in soil and ash below lava flow, overlain by crystal-poor pahoehoe, Pelelilii Gulch.	N. G. Banks
W4343	1,280±70	19°40'11" 155°07'20" Hilo	232	Charcoal roots beneath thin pahoehoe flow, young Waiakea-Uka pahoehoe, Waiakea-Uka School.	J. P. Lockwood
W4237	1,320±50	19°33'47" 155°20'42" Kulani	1,884	Vitreous narrow rootlets under pahoehoe toes, overlying weathered phenocryst-rich aa kipuka, and overlain by Kulani picrite.	J. P. Lockwood
W3000	1,330±70	19°22'29" 155°22'33" Wood Valley	915	Organic debris and charcoal, at uppermost part of yellow ash section, overridden by ML pahoehoe, Kaoiki Pali.	R. I. Tilling
W5325	1,370±200	19°13'55" 155°27'59" Pahala	389	Charcoal roots in soil and in ash and pahoehoe, Highway 11, Piukea Gulch.	N. G. Banks
W4813	1,380±60	19°31'08" 155°15'53" Kulani	1,297	Soot with scattered fragments of fern leaves, in deep ash above old spatter, under fresh spatter covered by fountain-fed pahoehoe, Olaa Uka flow, one day's hike S. of Stainback Highway.	J. P. Lockwood
W3858	1,400±60	19°13'26" 155°27'56" Pahala	457	Carbonized wood fragments (ohia lehu) in Pahala Ash, beneath young prehistoric ML pahoehoe flow, Kaalaala Gulch.	P. W. Lipman

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4340	1,400±70	19°35'43" 155°20'52" Kulani	1,779	Charcoal rootlets imbedded in soot at base of pahoehoe, overlain by nearly aphanitic tube-fed pahoehoe, overlain by 1942 aa, 1 km NW. of Mauna Loa Boys' School.	J. P. Lockwood
W4981	1,470±50	19°38'34" 155°03'23" Hilo	110	Charcoal rootlets in unoxidized pocket of older, coarse grey-black aa at base of Panaewa picrite flow, Allied Aggregates Quarry.	J. P. Lockwood
W3857	1,470±60	19°13'26" 155°27'56" Pahala	457	Charcoal fragments beneath young prehistoric ML pahoehoe flow, Kaalaala Gulch.	P. W. Lipman
W4357	1,490±50	19°35'03" 155°20'52" Kulani	1,812	Charcoal roots in soil beneath aphanitic pahoehoe, with uniform-size, spherical vesicles, 1 km E. of Mauna Loa Boys' School.	J. P. Lockwood
W5153	1,500±70	19°09'48" 155°27'46" Pahala	53	Charcoal roots in soil and ash under pahoehoe, Punaluu Gulch.	N. G. Banks
W5461	1,510±110	19°17'02" 155°29'50" Wood Valley	963	Charcoal roots in sooty zone at top of Pahala Ash, young Upper Wood Valley pahoehoe, overlies section exposed on Wood Valley headwall, Kapapala Ranch Water Tunnel Trail.	J. P. Lockwood
W5458	1,640±150	19°22'16" 155°22'49" Wood Valley	920	Charcoal roots in black sooty ash at top of Pahala Ash, Halfway House olivine-rich pahoehoe, Peter Lee Rd. and Highway 11 junction, 2 m above base of Kaoiki Pali, in fresh slump.	J. P. Lockwood
W4344	1,690±70	19°31'57" 155°21'13" Kulani	1,963	Large charcoal roots underlying marginal blocks of aa above old spatter on this mostly buried spatter cone, Powerline Rd., 5.5 km SW. of Kulani Prison Headquarters.	J. P. Lockwood
W5271	1,700±80	19°27'58" 155°48'14" Wood Valley	?	Charcoal rootlets in ash under pahoehoe, upper crossover of water-course along E. edge of Wood Valley.	N. G. Banks
W5278	1,740±100	19°40'12" 155°36'52" Hilo	201	Charcoal twigs and roots in pockets at top of ash deposit overlying aa, overlain by young pahoehoe flow, Kukuau flow, Waiakea Stream, N. of Hoaka Rd.	J. M. Buchanan-Banks
W5564	1,740±250	19°36'36" 155°40'17" Puu O Uo	2,140	Charcoal roots beneath thin pahoehoe sheets, W. of eastern 1859 lobe, 500 m SE. of P.T.A. Bobcat Trail.	J. P. Lockwood
W4985	1,760±60	19°36'49" 155°20'26" Kulani	1,666	Charcoal fragments beneath pahoehoe toes in ash pockets of aa, overlain by Punahoa flow, N. of 1942 flow, Powerline Rd.	J. P. Lockwood
W3850	1,810±80	19°11'14" 155°29'09" Pahala	137	Charcoal in Pahala Ash, overlain by phenocryst-poor ML pahoehoe from SW. rift zone, Moaula Gulch.	P. W. Lipman
W4116	1,840±60	19°29'10" 155°23'08" Kipuka Pakekake	1,940	Charcoal from thin soil at contact of pahoehoe and aa.	J. P. Lockwood

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4022	1,860±70	19°14'56" 155°36'50" Punaluu	1,891	Charcoal fragments at base of plagioclase porphyritic aa flow, Punaluu Kahawai.	P. W. Lipman
W4163	1,980±80	19°18'01" 155°33'43" Keiwa Reservoir	2,036	Charcoal roots in Pahala Ash, at base of flow, underlying phenocryst-poor aa flow, collected where aa cascaded through small lava tube, Kauhuhuula Gulch.	P. W. Lipman
W4161	2,000±70	19°17'47" 155°34'12" Keiwa Reservoir	2,060	Charcoal fragments from basal Hionamoa flow, a large phenocryst-poor unit, head of Makaka Ravine.	P. W. Lipman
W477	2,000±250	19°39'45" 155°08'06" Hilo	244	Charcoal of ohia buried in cinders of prehistoric vent of the last group of lavas of ML, Kau volcanic series, Waiakea Homesteads.	G. A. Macdonald
W4017	2,010±70	19°17'10" 155°35'24" Keiwa Reservoir	2,074	Charcoal fragments from Pahala-like ash, underlying weathered phenocryst-poor pahoehoe, Hionamoa Gulch.	P. W. Lipman
W4550	2,030±60	19°29'13" 155°56'17" Honaunau	61	Carbonaceous soil underlying glassy pahoehoe flow and overlying the entire Kealakekua Pali sequence, Captain Cook Monument, Kaawaloa, Kealakekua Bay.	J. P. Lockwood
W478	2,070±250	19°39'45" 155°08'06" Hilo	244	Charcoal of tree fern, Kau Basalt, Waiakea Homesteads.	G. A. Macdonald
W4579	2,120±70	19°30'32" 155°23'45" Puu Ulaula	2,213	Charcoal roots beneath pahoehoe toes, overlain by all Keamoku flow units, Upper Strip Rd. pahoehoe, 250 m NE. of Puu Ulaula.	J. P. Lockwood
W4015	2,180±60	19°07'04" 155°34'28" Naalehu	534	Charred log, base of young aa flow containing large olivine phenocrysts.	P. W. Lipman
W3876	2,190±70	19°27'50" 155°17'36" Kilauea Crater	1,256	Charcoal from root underlying ML NE. rift aa flow, covering Pahala Ash on E. extension of Kaoiki fault, Puu Oo Trail.	J. P. Lockwood
W5566	2,240±150	19°42'07" 155°23'25" Puu Oo	1,742	Charcoal root fragments overlain by Puu Kahiliku picrite-rich flow, deep gully in ash along cow path, 50 m E. of Puu Oo Ranch access road.	J. P. Lockwood
W4008	2,300±60	19°09'23" 155°32'26" Punaluu	316	Carbonized wood fragments in ash at base of the plagioclase-porphyritic aa flow in the Ninole Gulch area, one of the last flows from this sector of ML to flow into ocean.	P. W. Lipman
W4831	2,340±70	19°27'50" 155°17'36" Kilauea Crater	1,256	Charcoal root in sooty ash, under Keauhou Ranch aa flow, overlain by all Keamoku flows, junction of Puu Oo Rd. and Kaoiki Pali.	J. P. Lockwood
W4142	2,440±60	19°08'36" 155°31'19" Punaluu	53	Charcoal fragments in Pahala-like ash, base of Ninole aa flow, Ninole Gulch.	P. W. Lipman

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4810	2,550±80	19°32'06" 155°17'20" Kulani	1,448	Charcoal and rootlets in organic mat at base of pahoehoe toes, overlain by dense tube-fed pahoehoe, N. of Kulani Cone, 2.5 km S. of Stainback Highway, Kulani Prison boundary road, S. of prominent picrite exposures.	J. P. Lockwood
W4377	2,650±50	19°07'04" 155°34'28" Naalehu	533	Carbonized wood fragment at base of olivine-rich aa flow, Kaalaiki quarry.	P. W. Lipman
W3836	2,830±60	19°26'28" 155°20'38" Kilauea Crater	1,064	Carbonaceous soil below aa of the Keamoku flow.	P. W. Lipman
W3845	2,880±70	19°22'20" 155°23'56" Wood Valley	1,083	Charcoal root fragments, top of Pahala Ash below olivine-rich ML pahoehoe flow, where draped over Kaoiki fault scarp, Kaoiki Pali.	P. W. Lipman
W4174	2,890±70	19°38'34" 155°02'53" Hilo	111	Amorphous sooty material underlying Panaewa flow, Hilo side of Allied Aggregates quarry.	J. P. Lockwood
W3841	2,950±80	19°20'02" 155°24'29" Wood Valley	793	Charcoal root fragments from Pahala Ash, overlain by olivine-rich pahoehoe, Puu Kuanene area.	P. W. Lipman
W5112	3,110±60	19°42'34" 155°16'22" Upper Piihonua	1,105	Charcoal rootlets in ash mixed with aa clasts at base of pahoehoe, overlain by upper Piihonua Punahoa flow, Wailuku River.	J. P. Lockwood
W4621	3,140±70	19°42'17" 155°07'01" Hilo	169	Charcoal root at contact between lava flow and ash deposit, overlain by pahoehoe with spherical vesicles, 698 Kaumana Dr.	J. M. Buchanan-Banks
W5542	3,200±200	19°36'25" 155°40'21" Puu O Uo	2,131	Charcoal roots beneath thick pahoehoe toes, overlain by Kaniku flow, Naio-mamani Kipuka.	J. P. Lockwood
W4629	3,360±80	19°41'52" 155°07'29" Hilo	216	Charcoal roots beneath thin pahoehoe flow at contact with thick ash deposit, underlies 1880 flow and overlies ash, Waipahoehoe Stream, Ponahawai Homesteads, N. of Kaumana Dr.	J. M. Buchanan-Banks
W5536	3,360±200	19°50'47" 155°47'12" Puu Anahulu	756	Charcoal roots in basal aa breccia, under Mamalahoa Highway, Kaniku euhedral olivine laths with aa, Highway 190, E. of 1859 contact.	J. P. Lockwood
W4624	3,380±80	19°43'00" 155°08'08" Piihonua	256	Charcoal tree trunk in sealed tree mold, overlain by KPUA pahoehoe, Wailuku-Alenaio diversion canal, N. of Waianuenue Ave.	J. M. Buchanan-Banks
W5107	3,450±60	19°42'56" 155°09'11" Piihonua	299	Charcoal root at base of tree mold, Lauiole Falls pahoehoe, overlain by Waianuenue pahoehoe, Wailuku River, 20 m E. of Hilo County Water Department gauging ladder.	J. P. Lockwood
W5604	3,450±200	19°42'50" 155°05'56" Hilo	67	Charcoal (rerun of W-5081, age 3920±80).	J. M. Buchanan-Banks

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4223	3,600±70	19°08'41" 155°36'58" Punaluu	983	Charcoal roots in Pahala Ash, overlain by transitional aa-pahoehoe containing sparse large olivine and plagioclase phenocrysts, roadcut, Mountain House tunnel road.	P. W. Lipman
W2016	3,620±250	19°04'15" 155°36'52" Naalehu	326	Charcoal, depth 417 cm, underlying surface pahoehoe lava flow, Bishop Museum cesspool excavation, Waiohinu.	R. R. Doell
W5086	3,630±80	19°25'25" 155°20'50" Kilauea Crater	1,244	Charcoal roots in patches in unconsolidated oxidized ash, overlain by Upper Strip Rd. phenocryst-picrite pahoehoe, 1.9 km N. of Kapapala Ranch corral.	J. P. Lockwood
W4574	3,700±70	19°43'05" 155°08'18" Piihonua	263	Charcoal roots beneath young tube-fed pahoehoe, overlying massive olivine-rich aa, KPUA flow, Wailuku River, across from KPUA.	J. P. Lockwood
W856	3,740±250	19°04'00" 155°37'00" Naalehu	326	Charcoal, under pahoehoe flow in churchyard, Waiohinu.	K. J. Murata
W4164	3,750±70	19°16'02" 155°36'38" Keaiwa Reservoir	1,996	Charcoal fragments, base of aa flow which contains abundant small plagioclase phenocrysts, Puu Kinikini.	P. W. Lipman
W5565	3,790±200	19°42'56" 155°18'53" Upper Piihonua	1,314	Charcoal root fragments, at base of Wailuku River olivine-pahoehoe flow, S. bank of river, 500 m upstream from Water Gauging Station Trail.	J. P. Lockwood
W4152	3,800±90	19°08'53" 155°30'58" Punaluu	84	Charcoal fragments from thin lens of Pahala-like ash below transitional hummocky pahoehoe-aa flow, Highway 11 roadcut.	P. W. Lipman
W4009	3,900±80	19°11'22" 155°31'42" Punaluu	488	Carbonized wood, base of Punaluu aa flow, Punaluu Gulch.	P. W. Lipman
W4132	3,900±90	19°09'39" 155°32'33" Punaluu	372	Charcoal roots from thin lens of Pahala-like ash, below pahoehoe flow, Ninole Gulch.	P. W. Lipman
W5081	3,920±80	19°42'50" 155°05'56" Hilo	67	Charcoal from stream deposit between two pahoehoe flows, overlain by Kulaloe flow, Alenaio Stream at Komohana St.	J. M. Buchanan-Banks
W1046	4,030±350	19°21'54" 155°23'06" Wood Valley	911	Charcoal in sandy silty ash, top of Pahala Ash, Mamalahoa Highway, Kaoiki Pali.	G. A. Macdonald
W3803	4,050±50	19°42'48" 155°07'05" Hilo	152	Soil, rich in organic matter and containing bits of charcoal, from cesspool excavation, Kaumana area of Hilo.	J. P. Lockwood
W4358	4,070±70	19°35'41" 155°20'41" Kulani	1,762	Fine charcoal rootlets in sooty organic layer at base of Kulani pahoehoe, underlying thick lobe of pahoehoe, 1.2 km NW. of Mauna Loa Boys' School.	J. P. Lockwood
W4957	4,170±90	19°41'06" 155°08'46" Piihonua	354	Charcoal atop orange ash, Wilder Rd. pahoehoe, under Kulaloe flow, 400 m S. of Humuulu Saddle Rd.	J. P. Lockwood

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4993	4,210±80	19°41'29" 155°09'08" Piihonua	372	Charcoal exposed at base of pahoehoe by slumping of underlying ash along streambed, under Piihonua pahoehoe, W. of Akolea Rd., Kaliuiki Stream.	J. P. Lockwood
W3855	4,210±90	19°25'25" 155°20'22" Kilauea Crater	?	Charcoal from Pahala Ash, below phenocryst-poor aa flow draped on Kaoiki fault scarp.	P. W. Lipman
W3844	4,340±80	19°21'52" 155°23'16" Wood Valley	920	Charcoal fragments from soil zone below aa flow, draped over Kaoiki fault scarp.	P. W. Lipman
W5077	4,410±120	19°41'24" 155°07'12" Hilo	183	Vegetative mat beneath surficial pahoehoe at contact with underlying ash, overlain by Wilder Rd. pahoehoe, Brilhante property, Edita Rd.	J. M. Buchanan-Banks
W4982	4,690±60	19°43'07" 155°16'30" Piihonua	1,160	Charcoal from yellow-brown ash overlain by aa of MK hawaiiite, N. bank of Wailuku River.	J. P. Lockwood
W4224	4,770±90	19°09'14" 155°36'59" Punaluu	1,044	Charcoal roots in Pahala Ash, overlain by phenocryst-poor pahoehoe flow, roadcut on Mountain House tunnel road.	P. W. Lipman
W5567	4,790±250	19°42'56" 155°18'30" Upper Piihonua	1,292	Charcoal root fragments in scattered pockets of soft MK ash at base of dense aphanitic aa of Upper Wailuku River, S. bank of river.	J. P. Lockwood
W4135	5,160±100	19°09'38" 155°32'33" Punaluu	369	Charcoal roots from thin layer of Pahala-like ash, overlain by phenocryst-poor pahoehoe flow, Ninole Gulch.	P. W. Lipman
W4536	5,250±100	19°36'40" 155°01'55" Mountain View	98	Large charcoal root, Puna Sugar Picrite aa, overlying yellow-red ash, 700 m SW. of plantation house, Keaau-Pahoia Rd.	J. P. Lockwood
W3862	5,650±90	19°32'34" 155°07'28" Mountain View	528	Charcoal fragments, top of Pahala-type ash overlain by young ML aa flow, SW. of Mountain View.	P. W. Lipman
W3930	6,160±110	19°25'05" 155°35'42" Naalehu	567	Charcoal root fragments in ash, overlain by transitional pahoehoe-aa ML flow, Alapai Gulch.	P. W. Lipman
W5599	7,230±230	19°40'48" 155°04'31" Hilo	76	Carbonaceous roots at top of ash layer, overlain by Malaai aa, Hilo Golf Course, drainage ditch N. of Haihai St.	J. M. Buchanan-Banks
W4117	7,300±100	19°04'19" 155°33'26" Naalehu	21	Carbonaceous soil from ash at base of top ML flow, bay S. of Kahukupoko Point.	P. W. Lipman
W4351	7,750±70	18°56'37" 155°40'48" Ka Lae	98	Charcoal and soil from top of Pahala Ash, along contact with flow in Kahawai Kolano gully, 0.6 km ENE. of Pacific Missile Range Facility.	J. P. Lockwood

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W3813	7,950±110	19°08'45" 155°30'58" Punaluu	76	Black carbonaceous soil at top of Pahala Ash, Puehu quarry.	J. P. Lockwood
W4991	7,960±110	19°30'44" 155°19'36" Kulani	1,658	Charcoal rootlets at contact between Keauhou Ranch picrite and nearly buried spatter cone, middle of logging road, 900 m W. of Puu Lalaau.	J. P. Lockwood
W4969	8,030±70	19°39'16" 155°08'21" Piihonua	372	Organic matter in zones around aa clasts at base of D. Smith flow, Waiakea Stream, 1.9 km above Hoaka Rd. Bridge.	J. P. Lockwood
W4821	8,550±90	19°21'49" 155°23'18" Wood Valley	930	Rootlets and carbonaceous sooty ash, top of Pahala Ash, Halfway House picrite-rich pahoehoe that mantles Kaoiki Pali here, halfway up prominent gully at Old Halfway House.	J. P. Lockwood
W3853	8,550±100	19°25'11" 155°20'20" Kilauea Crater	1,122	Charcoal root fragments from soil zone, overlain by ML pahoehoe flow, interbedded with Pahala Ash, or reworked ash, Kaoiki Pali.	P. W. Lipman
W4803	8,740±100	19°26'08" 155°19'45" Kilauea Crater	1,219	Soft charcoal rootlets in soot below thick Strip Rd. pahoehoe, in prominent deep gully near National Park SW. boundary fence, 1.5 km SW. of Strip Rd. in Kipuku Ki.	J. P. Lockwood
W4975	9,020±130	19°39'38" 155°07'40" Piihonua	274	Charcoal rootlets in thin ash at base of flow, overlain by Puu Hoakalei picrite flow, Waiakea Stream, 500 m upstream from Hoaka Rd. bridge.	J. P. Lockwood
W4372	9,080±80	19°02'45" 155°33'32" Naalehu	37	Sooty soil at top of ash zone, Maniania Pali, overlain by olivine-rich pahoehoe, top of seacliff, 100 m NE. of contact with plagioclase-phyric flow.	P. W. Lipman
W4201	9,170±100	19°12'26" 155°32'17" Punaluu	652	Charcoal roots in Pahala Ash, overlain by phenocryst-poor pahoehoe flow, part of flow sequence from ML that laps out against eroded Ninole Hills, Upper Moaula Gulch.	P. W. Lipman
W4419	9,300±130	19°09'46" 155°29'51" Pahala	64	Charcoal roots in soil and ash below lava flow, under crystal-poor ML flow, in kipuka, Punaluu Gulch.	N. G. Banks
W3840	9,500±140	19°25'05" 155°24'29" Kilauea Crater	1,144	Charcoal rootlets and carbonaceous soil from Pahala Ash between two ML aa flows, draped over Kaoiki fault scarp, Kaoiki Pali.	P. W. Lipman
W4529	9,540±110	19°39'14" 155°08'22" Piihonua	379	Charcoal roots and wood fragments beneath capped tree mold, Old Waiakea Uka aphanitic pahoehoe, Waiakea Stream, between Hoaka and Ainaole Rds.	J. P. Lockwood
W4884	9,780±140	19°39'32" 155°06'03" Hilo	201	Charcoal tree root in thin ash deposit under plagioclase phyric pahoehoe, Waiakea Homesteads, streambed, Alaloa Rd.	J. M. Buchanan-Banks

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W5087	9,960±70	19°39'19" 155°08'17" Piihonua	360	Charcoal in brown layer of thick yellow ash at base of pahoehoe, under very old pahoehoe of Waiakea Stream, 1.7 km upstream from Hoaka Rd. bridge.	J. P. Lockwood
W5092	10,090±120	19°43'06" 155°16'23" Upper Piihonua	1,097	Charcoal roots at base of Wailuku River pahoehoe, in ash deposit which overlies MK rocks, S. bank of Wailuku River.	J. P. Lockwood
W907	10,140±300	19°03'00" 155°35'00" Naalehu	61	Carbonaceous ash exposed in sea cliff, S. of Honuapu, top of Pahala Ash, which is underlain and overlain by basalt, Maniani Pali.	G. D. Fraser
W5103	10,150±80	19°42'23" 155°12'02" Piihonua	663	Coarse charcoal at base of tree mold, Upper Wailuku River young pahoehoe, under Punahoa flow, Wailuku River, 70 m above waterfall.	J. P. Lockwood
W4160	10,290±150	19°06'01" 155°33'34" Naalehu	186	Charcoal roots in Pahala Ash, overlain by phenocryst-poor pahoehoe flow, Honuapu.	P. W. Lipman
W5072	10,320±70	19°39'32" 155°07'51" Piihonua	305	Charcoal root beneath pahoehoe at contact with underlying ash deposit, overlain by D. Smith and University of Hawaii flows, Waiakea Stream in Waiakea-Uka, Kalana Place.	J. M. Buchanan-Banks
W4995	10,400±150	19°30'53" 155°19'11" Kulani	1,635	Root fragments under pahoehoe flow that overlies Puu Lalaau olivine-rich spatter, N. bank of water hole, 50 m NW. of Puu Lalaau.	J. P. Lockwood
W4623	10,610±150	19°43'24" 155°06'59" Hilo	140	Charcoal root at contact between lava rubble and ash, under Wailuku River channel aa, W. of Rainbow Falls.	J. M. Buchanan-Banks
W4014	10,820±90	19°08'18" 155°32'56" Punaluu	229	Charcoal roots in uppermost main Pahala Ash, near tree molds in overlying pahoehoe flow sequence, Hilea Gulch.	P. W. Lipman
W3487	11,780±100	18°58'18" 155°37'18" Ka Lae	5	Charcoal fragments in Pahala Ash overlain by an intercalated basalt flow, W. side of Kaalualua Bay, 9.2 km NE. of South Point.	J. P. Lockwood
W4121	13,210±190	19°04'20" 155°33'25" Naalehu	15	Carbonaceous soil from ash at base of middle flow sequence, bay S. of Kahukupoko Point.	P. W. Lipman
W4627	13,530±180	19°43'12" 155°06'32" Hilo	99	Crumbly rootlets at top of ash deposit at contact with overlying pahoehoe, Rainbow Falls intersection, Waianuenu Ave. and Kaumana Dr.	J. M. Buchanan-Banks
W4392	13,800±300	19°32'51" 155°55'57" Kealakekua	439	Charcoal from shrub in soil, on picritic basalt flow, under basalt flow from Hualalai in Honalo, E. side of Mamalahoa Highway.	R. B. Moore
W4971	14,080±150	19°43'14" 155°07'13" Hilo	162	Tree charcoal at contact between pahoehoe flow and basal ash, underlying picrite-porphyrific pahoehoe, parking lot of First Protestant Church, Waianuenu Ave.	J. M. Buchanan-Banks

TABLE 10.1.—Radiocarbon dates from Mauna Loa Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W5091	14,080±160	19°42'41" 155°10'05" Pihihouna	451	Charcoal roots at base of pahoehoe in kipuka of yellow ash, underlying Punahoa flow, Kahoama Stream, upstream from Wailuku River.	J. P. Lockwood
W4973	14,370±190	19°42'58" 155°07'25" Hilo	186	Charcoal tree root beneath pahoehoe flow at contact with underlying ash, overlain by porphyritic pahoehoe, Ainaloa Subdivision, Kaeokulani St.	J. M. Buchanan-Banks
W4620	14,500±200	19°45'20" 155°07'27" Hilo	163	Charcoal root at contact between ash unit and pahoehoe flows sequence, which underlies thick ash, saprolite, and lava from MK, Wailuku River.	J. M. Buchanan-Banks
W4977	14,530±120	19°43'05" 155°07'01" Hilo	146	Charcoal roots at contact between pahoehoe flow and underlying ash, overlain by picrite-porphyritic pahoehoe, Kaumana Springs, Waianuenue Ave.	J. M. Buchanan-Banks
W4894	21,900±270	19°39'32" 155°07'51" Pihihouna	305	Charcoal root beneath pahoehoe in ash deposit, underlying picrite-rich and olivine-poor pahoehoe, Waiakea Stream in Waiakea-Uka, Kalana Place.	J. M. Buchanan-Banks
W4890	23,840±600	19°41'50" 155°07'25" Hilo	207	Charcoal root in ash deposit, between pahoehoe flows, Waipahoehoe Stream, Chong's Bridge.	J. M. Buchanan-Banks
W5075	24,240±500	19°39'40" 155°07'38" Pihihouna	268	Charcoal roots beneath pahoehoe at contact with underlying ash deposit, underlies University of Hawaii and D. Smith aa flows, Waiakea Stream in Waiakea-Uka, Hoaka Rd.	J. M. Buchanan-Banks
W4019	26,410±390	19°08'19" 155°32'53" Punaluu	183	Thin carbonaceous mat, scraped from base of pahoehoe flow of the Ninole volcanic rocks, Hilea Gulch.	P. W. Lipman
W5094	28,120±400	19°41'53" 155°08'06" Pihihouna	256	Charcoal rootlets at top of yellow ash, overlain by Punahoa flow, overlies old picrite-rich flow, Lower Kaluiki Stream, 600 m W. of Chong's Bridge.	J. P. Lockwood
W4368	28,150±800	18°56'20" 155°38'50" Ka Lae	9	Carbonaceous soil under pahoehoe flow interlayered with main unit of Pahala Ash, sea cliff exposure, 75 m SW. of margin of Puu O Mahaua Cone.	P. W. Lipman
W5452	28,200±600	19°41'50" 155°08'14" Pihihouna	287	Charcoal roots under aphanitic pahoehoe flow, Kaluiki Stream.	J. P. Lockwood
W3935	31,100±900	19°04'16" 155°33'24" Naalehu	1.5	Charcoal roots in Pahala-like ash, at base of tree mold in overlying ML aa flow, base of sea cliff in bay S. of Kahukupoko Point.	P. W. Lipman
W4128	31,400±1,600	19°29'07" 155°55'53" Honaunau	5	Charcoal fragments in ash, overlain by small pahoehoe lobe of mainly aa flow, along prominent main ash bed exposed along Pali Kapu Keoua, Kealakekua scarp.	P. W. Lipman
W5105	>38,000	19°42'25" 155°12'06" Pihihouna	664	Charcoal fragments at top of thick ash, overlain by Homelani ash, in turn overlain by Punahoa aphanitic pahoehoe, Upper Wailuku River.	J. P. Lockwood

TABLE 10.2—Radiocarbon dates from Kilauea Volcano, Island of Hawaii

[Samples listed in order of increasing age; uncertainty is one standard deviation,  $\pm 1\sigma$ ; modern age means sample is younger than AD 1950; ML = Mauna Loa; MK = Mauna Kea; mauka = toward the mountain, makai = toward the sea; see figs. 10.2-10.4 for localities. Stratigraphic nomenclature from Langenheim and Clague (chapter 1, part II)]

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W2999	Modern	19°24'18" 155°14'53" Volcano	1,166	Humus layer in yellow ash, overlying pahoehoe flow of prehistoric age, Thurston Lava Tube.	R. I. Tilling
W3481	Modern	19°24'00" 155°20'00" Kilauea Crater	1,076	Wood (ohia) from fallen tree in ohia-koa forest, in aa and ash.	J. P. Lockwood
W3486	Modern	19°22'00" 155°18'00" Kilauea Crater	1,257	Wood (ohia) from fallen tree in kipuka, overlying pahoehoe.	J. P. Lockwood
W4122	Modern	19°26'37" 155°15'05" Kilauea Crater	1,196	Charcoal, 60-80 cm above base in lithic ash of upper Keanakoi, makai side of Iiwi Road across from Lockwood house.	J. P. Lockwood
W4637	Modern	19°28'36" 154°53'25" Pahoa South	177	Charcoal rootlets, underlying thin Puu Pilau flow, W. side of quarry.	R. B. Moore
W5321	Modern	19°19'21" 155°22'46" Wood Valley	786	Wood and charcoal roots below tree mold underlying historical but undescribed shield, N. of 1920 lava flow.	N. G. Banks
W2970	<200	19°30'06" 154°51'48" Kapoho	61	Wood from Kapoho Cone, E. rift zone.	R. I. Tilling
W3467	<200	19°22'27" 155°08'10" Makaopuhi Crater	765	Charcoal underlying fountain-fed pahoehoe flow, SE. side of small crater SE. of Napau, E. rift zone.	R. T. Holcomb
W3468	<200	19°22'27" 155°08'10" Makaopuhi Crater	765	Charcoal in root mold where lava flowed into crack, underlying fountain-fed pahoehoe, E. rift zone.	R. T. Holcomb
W3480	<200	19°24'00" 155°20'00" Kilauea Crater	1,079	Wood (ohia) from kipuka of older aa lava surrounded by finer, fresher aa of the Keamoku flow.	J. P. Lockwood
W3483	<200	19°24'00" 155°20'00" Kilauea Crater	1,076	Wood (ohia) from standing tree in ohia-koa forest.	J. P. Lockwood
W3485	<200	19°21'00" 155°14'00" Makaopuhi Crater	920	Wood (ohia) from standing tall tree, in Ainahou Ranch pahoehoe.	J. P. Lockwood
W3886	<200	19°26'48" 155°19'09" Kilauea Crater	1,283	Charcoal fragments in Keanakakoi ash, from pit, Kipuka Ki.	P. W. Lipman
W359	<200	19°24'55" 154°55'50" Pahoa South	69	Charcoal in tree mold in prehistoric pahoehoe, E. rift zone, Puna.	G. A. Macdonald
W3937	<200	19°17'37" 155°24'24" Wood Valley	?	Charcoal from tree mold where lava ponded rapidly against the base of a fault scarp.	R. T. Holcomb
W4184	<200	19°19'48" 155°12'59" Makaopuhi Crater	765	Charcoal underlying tube-fed pahoehoe in large kipuka, E. rift zone, Ainahou Range.	J. P. Lockwood
W4436	<200	19°12'13" 155°27'58" Pahala	218	Charcoal roots in soil layer underlying young pahoehoe, 671 m E. of benchmark 803 on Highway 11 just N. of Pahala turnoff.	N. G. Banks

TABLE 10.2.—Radiocarbon dates from Kilauea Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4449	<200	19°35'16" 155°01'01" Mountain View	96	Charcoal roots in baked ash beneath surficial lava flow at Waipahoehoe Gulch, E. rift zone, S. bank of gulch along S. margin of Puna Sugar Co. field 20.	R. T. Holcomb
W4452	<200	19°15'35" 155°24'37" Wood Valley	530	Charred wood from within the hollow interior of sealed lava tree protruding from surface of Red Cone flow, along gaping eruptive fissures about 1 km uplift from Red Cones, along the SW. rift zone.	R. T. Holcomb
W4573	<200	19°34'53" 155°03'43" Mountain View	244	Charcoal roots in ash beneath thin tube-fed pahoehoe of the Kurtistown Kilauea flow, 400 m SW. of Kurtistown Assembly of God Church.	J. P. Lockwood
W4638	<200	19°28'28" 154°54'01" Pahoa South	204	Charcoal rootlets in young flow overlying Kiapu Cone in Leilani Estates.	R. B. Moore
W4639	<200	19°28'55" 154°55'00" Pahoa South	229	Charcoal under tree mold beneath pre-1790 flow in Leilani Estates, roadcut on Kahukai St., N. side of intersection with Kupono St.	R. B. Moore
W4644	<200	19°28'19" 154°53'31" Pahoa South	171	Charcoal roots in soil under surface lava flow, in roadcut W. side of Malama Homesteads road, 80 m S. of old Pohoiki Rd.	R. B. Moore
W4689	<200	19°28'03" 154°55'24" Pahoa South	242	Charcoal roots in thin soil underlying pre-1790 flow, roadcut, S. Pomaikai St., Leilani Estates.	R. B. Moore
W5323	<200	19°19'43" 155°22'49" Wood Valley	792	Wood and charcoal at edge of tree mold and in underlying roots, beneath 1920 lava flow, 700 m N. of 81-6 geodimeter station.	N. G. Banks
W3938	210±60	19°15'35" 155°24'37" Wood Valley	?	Charcoal in tree mold, 3 m from eruptive fissure.	R. T. Holcomb
W5110	230±60	19°19'01" 155°13'07" Makaopuhi Crater	512	Charcoal roots along vertical contact between Kamapuaa flow and pahoehoe at W. flow contact, at base of Poliokeawe Pali, below cascade drapery 125 m NE. of easternmost switchback in Ainahou Ranch.	J. P. Lockwood
W3881	260±70	19°32'47" 155°05'53" Mountain View	415	Charcoal root fragments in ash below phenocryst-poor Kilauea pahoehoe, in Fern Acres.	P. W. Lipman
W4834	300±70	19°27'55" 155°15'25" Kilauea Crater	1,187	Charcoal in thick organic mat underlying Keanakakoi Ash Member of Puna Basalt on east-west section of Wright Road.	J. P. Lockwood
W4162	310±70	19°28'17" 155°10'10" Volcano	784	Charcoal roots from ash at base of Kilauea pahoehoe flow, SE. side of Wung Ranch quarry.	P. W. Lipman
W4470	310±70	19°13'02" 155°27'42" Pahala	341	Charcoal root in ash underlying young pahoehoe lava flow exposed in gully, NE. edge of macadamia orchard.	R. T. Holcomb

TABLE 10.2.—Radiocarbon dates from Kilauea Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4661	320±70	19°33'09" 155°01'23" Mountain View	151	Charcoal in tree mold, enclosed in pahoehoe flow in Iki-Thurston lava tube area, located near private home 100 m W. of Melia St. in Orchid Land Estates.	R. B. Moore
W3811	330±60	19°13'02" 155°27'42" Pahala	341	Charcoal fragments from Kilauea pahoehoe flow, beneath young prehistoric ML pahoehoe flow exposed in gully.	J. P. Lockwood
W3849	340±60	19°28'02" 155°15'05" Kilauea Crater	1,177	Carbonaceous soil and charcoal, base of pyroclastic sequence, underlying basal reticulite of Keanakakoi Ash, Member of Puna Basalt in pit in Olaa Forest Reserve, depth 50 cm, Wright Rd.	P. W. Lipman
W5048	340±60	19°29'00" 154°52'05" Kapoho	110	Charcoal in tree mold underlying Honuaula flow, in new papaya field 100 m mauka of road connecting Pohoiki and Kapoho Rds.	R. B. Moore
W3800	350±150	19°26'14" 154°56'07" Pahoa South	174	Carbonaceous debris under prehistoric aa flow, depth 2 m, in cesspool excavation, Puna.	J. P. Lockwood
W3870	350±60	19°26'38" 155°15'07" Kilauea Crater	?	Clay, rich in organic matter and containing charcoal fragments near base of Keanakakoi Ash.	J. P. Lockwood
W5054	440±60	19°24'05" 154°55'15" Pahoa South	15	Charcoal fragments in soil underlying Kehena Beach Section, 50 m N. of small old quarry on makai side of Highway 137.	R. B. Moore
W3842	450±60	19°19'59" 155°24'20" Wood Valley	792	Charcoal fragments from soil below phenocryst-poor pahoehoe flow from Kilauea along base of Kaoiki Pali, old quarry, SW. rift zone.	P. W. Lipman
W3941	450±60	19°35'16" 155°01'06" Mountain View	518	Charcoal from top of ash layer beneath tube-fed pahoehoe flow partly filling old stream channel between two kipukas of ash-covered aa apparently derived from Mauna Loa.	R. T. Holcomb
W5453	450±110	19°24'00" 155°05'23" Kalalua	677	Charcoal roots overlain by prehistoric flow SE. of Puu Kahaualea, 250 m E. of crack that consumed January 1983 eruption.	J. P. Lockwood
W4688	490±60	19°27'26" 154°55'43" Pahoa South	274	Charcoal underlying young flow W. of Kaliu, Leilani Estates, South Kumakahi St., 40 m S. of intersection with Malama St.	R. B. Moore
W5275	490±150	19°17'17" 155°21'11" Kau Desert	640	Charcoal in soil layer recording old fire, buried by Keanakakoi Ash, Member of Puna Basalt, 15 km SW. of crater.	N. G. Banks
W5145	500±100	19°18'09" 155°20'29" Kau Desert	724	Charcoal roots in soil-ash pockets underlying Puu Koae aa.	N. G. Banks
W4404	530±70	19°12'48" 155°27'44" Pahala	271	Charcoal roots in soil beneath pahoehoe flow, 0.7 km SE. of Highway 11 in gulch that parallels the highway.	N. G. Banks

TABLE 10.2.—Radiocarbon dates from Kilauea Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W5218	550±70	19°09'36" 155°26'50" Pahala	15	Charcoal in soil pockets underlying Ulekuwale Pueo.	N. G. Banks
W4867	570±70	19°26'35" 155°16'24" Kilauea Crater	1,238	Vitreous fern and ohia leaves in organic black soot lens, underlying Keanakakoi Ash, Member of Puna Basalt near cesspool excavation at SE. end of Dahlberg residence, 150 m NW. of golf course number 3 green.	J. P. Lockwood
W5423	570±100	19°25'58" 155°15'52" Kilauea Crater	1,201	Charcoal rootlets in soil developed within Keanakakoi surge deposit, on Sandalwood Trail between steaming bluff and Volcano House.	J. M. Buchanan-Banks
W4337	620±70	19°20'11" 155°13'25" Makaopuhi Crater	815	Charcoal rootlets at base of tube-fed Ainahou flow located 1.5 km SSE. of Ainahou Ranch House, Kamapuaa flow, 20 m E. of Poliokuwe Pali Rd.	J. P. Lockwood
W5152	660±70	19°19'41" 155°19'47" Kau Desert	853	Charcoal roots in mixed ash and eolian sand under pahoehoe.	N. G. Banks
W3860	670±60	19°13'02" 155°27'35" Pahala	399	Charcoal in Pahala Ash, below thin pahoehoe (one of the last major prehistoric flows on Kilauea SW. rift zone), along small gully, tributary to Kaalaala Gulch.	P. W. Lipman
W4402	700±70	19°17'44" 155°08'41" Kau Desert	658	Charcoal roots in soil and ash underlying pahoehoe flow, 325 m SW. of Hilina Pali Rd. end.	N. G. Banks
W3999	730±80	19°27'04" 155°14'19" Volcano	1,134	Carbonaceous soil containing small charcoal fragments from beneath toe of pahoehoe flow.	P. W. Lipman
W5147	890±70	19°09'52" 155°28'04" Pahala	45	Charcoal roots in ash pockets underlying pahoehoe, E. side of Puu Pili Rd., NW. of Puu Pili.	N. G. Banks
W4690	900±70	19°27'07" 154°56'55" Pahoa South	348	Charcoal underlying rootless lava flow located in cinder pit 500 m W. of Highway 13 in Kamaili Homesteads, SE. part of Norona Quarry.	R. B. Moore
W5215	940±70	19°09'79" 155°26'44" Pahala	46	Charcoal roots in discontinuous soil-ash layer under pahoehoe, E. of Ulekuwale Pueo.	N. G. Banks
W4998	960±60	19°26'11" 155°16'59" Kilauea Crater	1,225	Carbonized leaves in vitric ash rich in organic material, within Uwekahuna Ash Member of Puna Basalt 50 m E. of easternmost point of Tree Molds visitor area road.	J. P. Lockwood
W5211	960±70	19°11'34" 155°27'26" Pahala	145	Charcoal roots in soil and ash under pahoehoe, E. side of flood control ditch makai of aa gravel borrow pits.	N. G. Banks
W5319	970±120	19°27'20" 155°12'25" Volcano	968	Charcoal twigs and rootlets in black sooty soil at base of pahoehoe flow underlying Keanakakoi Ash Member of Puna Basalt located at Volcano Dump off Highway 11.	J. P. Lockwood
W3856	1,040±70	19°28'02" 155°15'05" Kilauea Crater	1,177	Carbonaceous clay and ash at base of pyroclastic base-surge sequence, Uwekahuna Ash Member of Puna Basalt just N. of Kilauea summit, in pit of Olaa Forest Reserve, depth 80 cm, Wright Rd.	P. W. Lipman

TABLE 10.2.—Radiocarbon dates from Kilauea Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W3827	1,130±60	19°18'06" 155°18'23" Kau Desert	704	Charcoal beneath Kilauea basalt flow, overlying Hilina Series rocks exposed in Poliokeawe Pali.	J. P. Lockwood
W5212	1,140±70	19°17'53" 155°18'38" Kau Desert	693	Charcoal roots in soil, makai edge of trail W. of Hilina Pali parking lot in the first gully.	N. G. Banks
W5135	1,150±70	19°19'46" 155°16'51" Kau Desert	892	Charcoal roots in soil under pahoehoe, Kipuka Nene flow, surface flow in parking lot.	N. G. Banks
W4674	1,270±70	19°28'19" 154°53'31" Pahoa South	169	Charcoal rootlets in soil underlying lava flow in roadcut, W. side of Malama Homesteads Rd., 80 m S. of old Pohoiki Rd.	R. B. Moore
W4414	1,330±60	19°11'27" 155°27'29" Pahala	146	Charcoal of one tap root below a tree mold, Cinder Hills.	N. G. Banks
W4837	1,480±60	19°27'55" 155°15'25" Kilauea Crater	1,187	Organic soot within the Uwekahuna Ash Member of Puna Basalt on the east-west section of Wright Rd.	J. P. Lockwood
W4359	1,510±60	19°13'56" 155°27'35" Pahala	399	Carbonaceous soil under thin pahoehoe of Kilauea SE. rift zone, small gully, tributary to Kaalaala Gulch, 25 km mauka of Highway 11.	P. W. Lipman
W5303	1,650±150	19°27'55" 155°15'25" Kilauea Crater	1,187	Dark sooty ash with charcoal flakes (with small modern rootlets present) underlying the Wright Road Uwekahuna Ash Member of Puna Basalt on the east-west section of Wright Rd.	J. P. Lockwood
W5097	1,790±70	19°28'40" 155°17'23" Kilauea Crater	1,347	Black sooty soil from organic layer at base of weathered ash unit, overlain by Uwekahuna Ash, Member of Puna Basalt, Keauhou Ranch, 1.4 km E. of Puu Oo Trail, 2.2 km WSW. of end of Wright Rd.	J. P. Lockwood
W4119	1,800±80	19°14'48" 155°21'09" Maliikakani Point	50	Carbonaceous baked ash containing charred root fragments beneath aa flow mantling Pahala Ash on rim of Kukalauula Pali.	R. T. Holcomb
W4369	2,070±80	19°28'17" 155°10'10" Volcano	786	Charcoal near base of tree mold under pahoehoe flow exposed in quarry on Wung Rd., NW. of Highway 11.	P. W. Lipman
W3859	2,080±70	19°28'02" 155°15'05" Kilauea Crater	1,177	Carbonaceous clay and ash, underlying base-surge sequence, Uwekahuna Ash, Member of Puna Basalt just N. of Kilauea summit, from pit in Olaa Forest Reserve, depth 130 cm.	P. W. Lipman
W5292	2,080±150	19°27'55" 155°15'25" Kilauea Crater	1,187	Dark sooty ash with charcoal flakes (cleaned of modern rootlets) underlying the Uwekahuna Ash Member of Puna Basalt on Wright Road at the same location as W-5303 (age 1,650 ± 150).	J. P. Lockwood
W3885	2,160±70	19°28'17" 155°10'10" Volcano	786	Charcoal around base of tree mold in crystal-poor Kilauea pahoehoe, Wung Ranch quarry.	P. W. Lipman
W5052	2,360±90	19°22'55" 154°57'29" Kalapana	9	Charcoal in soil underlying early Heiheiuhulu pahoehoe flow with tree molds exposed at Kalapana dump on mauka side of road.	R. B. Moore

TABLE 10.2.—Radiocarbon dates from Kilauea Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W201	2,500±250	19°25'00" 155°20'00" Kilauea Crater	1,209	Fern mold underlying basaltic pumice, excavation for N. wing of Volcano House, Keanakakoi Ash Members of Puna Basalt.	H. A. Powers
W5345	2,770±150	19°27'37" 155°14'52" Volcano	1,160	Charcoal rootlets at base of pahoehoe flow buried by Uwekahuna Ash and Keanakakoi Ash Members of Puna Basalt, located 15 m E. of Wright Rd. and 3.5 km N. of Old Volcano Highway.	J. P. Lockwood
W3831	3,480±80	19°18'06" 155°18'22" Kau Desert	703	Charcoal beneath Kilauea basalt flow overlying rocks of the Hilina Basalt, exposed in Poliokeawe Pali.	J. P. Lockwood
W5324	3,500±200	19°11'23" 155°28'20" Pahala	137	Charcoal roots in soil under pahoehoe flow at right angle bend of Old Pahala Dump Rd., W. side of road, makai of bagasse flume.	N. G. Banks
W4380	3,560±60	19°28'17" 155°10'10" Volcano	782	Carbonaceous soil and charcoal fragments within Wung Quarry ash sequence on Wung Ranch, Uwekahuna Ash, Member of Puna Basalt, of Highway 11.	P. W. Lipman
W3884	3,610±60	19°12'44" 155°28'10" Pahala	177	Charcoal in ash below olivine-rich pahoehoe flow, Pahala vent.	P. W. Lipman
W4177	3,690±70	19°34'56" 155°01'49" Mountain View	142	Charcoal beneath pahoehoe exposed in trench, Puna Sugar Field 20, SE. from Keauu.	J. P. Lockwood
W3798	4,820±90	19°28'10" 155°18'20" Kau Desert	698	Carbonized charcoal tree fern (hapuu) from ash directly above lava dated by W-3809 (age 10,680 ± 130), from new scar formed during 1975 earthquake Hilina Pali.	J. P. Lockwood
W3873	6,620±150	19°17'11" 155°18'15" Kau Desert	?	Ash rich in organic material and containing charcoal fragments from uppermost level of thick Pahala Ash sequence, W. side Keana Bihopa Arroyo, Hilina Pali.	J. P. Lockwood
W3809	10,680±130	19°18'10" 155°18'20" Kau Desert	696	Charcoal beneath basalt and ash in upper Hilina Pali section, from new scar formed during 1975 earthquake.	J. P. Lockwood
W905	17,360±650	19°20'00" 155°20'00" Kau Desert	189	Carbonaceous ash from contact of lower Pahala Ash with overlying basalt, SE. end of seaward-facing Keone fault scarp, Keone Pali.	G. D. Fraser
W5241	21,600±600	19°16'39" 155°15'30" Kau Desert	107	Charcoal roots in black ash located at the top of the second ash layer above the base of Kapukapu cliff.	N. G. Banks
W3801	22,500±300	19°16'16" 155°17'10" Kau Desert	171	Charcoal from top of Pahala Ash section on Puu Keone.	J. P. Lockwood
W5238	22,660±600	19°16'38" 155°15'30" Kau Desert	91	Charcoal roots in black soil located above lowest ash layer in Kapukapu cliff.	N. G. Banks
W3814	22,800±340	19°16'14" 155°17'20" Kau Desert	183	Charcoal exposed in fresh outcrop created by massive slumping during 1975 earthquake, Puu Keone.	J. P. Lockwood

TABLE 10.3.—Radiocarbon dates from Hualalai Volcano, Island of Hawaii

[Samples listed in order of increasing age; uncertainty is one standard deviation,  $\pm 1\sigma$ ; modern age means sample is younger than AD 1950; ML = Mauna Loa; MK = Mauna Kea; mauka = toward the mountain, makai = toward the sea; see figs. 10.2–10.4 for localities. Stratigraphic nomenclature from Langenheim and Clague (chapter 1, part II)]

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W4634	<200	19°42'55" 155°54'35" Kailua	1,841	Charcoal rootlets from high-water mark of olivine basalt flow from Kaupulahu Crater along main road up NW. flank and rift zone of Hualalai.	R. B. Moore
W4381	<200	19°37'55" 155°48'50" Hualalai	1,667	Charcoal rootlets in soil developed on Puu Ikaaka cinders, overlain by pahoehoe flow, 700 m E. of Hualalai summit road along Judd Trail, 200 m S. of trail at N. base of Puu Ikaaka.	R. B. Moore
W4389	<200	19°35'00" 155°58'33" Kealakekua	3	Charcoal in soil separating two flows at Kahaluu Beach Park, on E. side of Alii Drive, below T.K. Cook's house.	R. B. Moore
W5124	<200	19°44'08" 155°56'25" Kailua	1,250	Charcoal in soil developed on old cone, overlain by young flow on Hualalai Ranch, N. of Moanuahea near flower nursery.	R. B. Moore
W5381	110±60	19°38'46" 155°49'00" Hualalai	1,768	Charcoal in soil under Moore Crater flow, SE. side of airstrip.	R. B. Moore
W4394	300±60	19°41'50" 155°52'44" Kailua	2,316	Charcoal from under edge of Malekule flow at end of road on N. side of cinder cones, edge of flow against cinder cone.	R. B. Moore
W5531	710±150	19°37'00" 155°49'26" Puu Lehua	1,509	Charcoal in soil under toe of Waha Pale flow at E. edge of flow, 800 m S. of Bishop experimental plot.	R. B. Moore
W5491	900±110	19°40'27" 155°45'53" Hualalai	1,545	Charcoal in cinders under toe of Moore Crater flow, one of the largest on the Big Island.	R. B. Moore
W5130	1,030±60	19°43'03" 155°52'48" Kailua	1,987	Charcoal under North Jackson Crater flow between two old cones.	R. B. Moore
W5522	1,180±200	19°43'09" 155°46'11" Hualalai	1,378	Charcoal in soil on ML flow under pahoehoe overflow from channel of Trusdell Crater flow.	R. B. Moore
W4383	1,330±50	19°34'23" 155°55'00" Kealakekua	366	Charcoal from under highest basalt flow in Tanaka's quarry, E. side of quarry.	R. B. Moore
W4171	2,030±80	19°46'52" 155°50'00" Puu Anahulu	866	Charcoal in soil zone on top of trachyte cinders under olivine-bearing basalt flow, N. flank of Puu Waawaa.	R. B. Moore
W4388	2,290±70	19°34'58" 155°56'46" Kealakekua	354	Charcoal in soil on top of aa flow under basalt flow on E. side of Mamalahoa Highway, N. of Tanaka quarry.	R. B. Moore
W5068	2,350±80	19°41'47" 155°52'31" Hualalai	2,353	Charcoal under edge of older Luamakami pahoehoe flow overlying cinders in ditch in road 300 m W. of highest saddle N. of Hualalai summit.	R. B. Moore

TABLE 10.3.—Radiocarbon dates from Hualalai Volcano, Island of Hawaii—Continued

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W5073	2,390±60	19°42'18" 155°50'44" Hualalai	2,000	Charcoal under spatter bombs at edge of deposit from NE. Mawahine Cone along road between Bishop Estate and Puu Waawaa Ranch.	R. B. Moore
W5076	2,670±80	19°41'14" 155°51'55" Hualalai	2,377	Charcoal under 0.5 m bombs from the 8001-ft. cone on S. side of lower saddle on N. side of Hualalai summit.	R. B. Moore
W5559	3,030±200	19°45'07" 155°54'47" Kiholo	1,030	Charcoal in soil under Puu Waawaa Ranch flow at ranch road.	R. B. Moore
W5127	3,100±80	19°44'15" 155°52'40" Hualalai	2,292	Charcoal in soil developed on old cone, covered by flow, transected by pit crater, on E. side of pit crater 700 m NE. of Malekule.	R. B. Moore
W4376	3,600±70	19°40'55" 155°58'44" Kailua	341	Charcoal in soil on aa flow under basalt flow near Palani Junction, in roadcut on side of Highway 19, 0.8 km S. of Palani Junction.	R. B. Moore
W5562	3,610±200	19°45'05" 155°57'29" Kiholo	817	Charcoal in soil beneath old Hualalai Ranch flow along road W. of ranch office.	R. B. Moore
W5132	3,990±70	19°41'50" 155°52'17" Hualalai	2,390	Charcoal in soil developed on older spatter, covered by younger spatter on S. side of main Hualalai summit road, 100 m W. of highest saddle.	R. B. Moore
W5070	4,390±70	19°41'44" 155°52'59" Hualalai	2,256	Charcoal in cinders under edge of slabby pahoehoe flow SW. of Malekule in gully 200 m above main road down Kaupuleku side of Hualalai.	R. B. Moore
W4378	4,720±80	19°41'50" 155°52'47" Kailua	2,292	Charcoal in soil developed on cinders underlying edge of second flow down from West Malekule on E. wall of West Malekule pit crater.	R. B. Moore
W5496	5,350±180	19°40'16" 155°51'55" Hualalai	1,905	Charcoal in cinders from extensive cinder unit S. of Hualalai summit along road near W. boundary of quad.	R. B. Moore
W5297	6,360±100	19°40'13" 155°51'41" Hualalai	1,902	Charcoal under Puu Neneakolu flow along Waiaha Stream between road and Puu Hale.	R. B. Moore
W5299	8,770±200	19°41'45" 155°52'01" Hualalai	2,390	Charcoal in red soil under cinders in canyon above recent alluvial fan at Hualalai summit.	R. B. Moore
W4371	9,490±100	19°51'21" 155°52'15" Puu Anahulu	195	Charcoal under olivine-rich basalt 4 m thick at NW. end of Puu Anahulu Cone, 200 m W. of end of trail leading N. from Mamalahoa Highway.	R. B. Moore
W4391	10,370±150	19°35'25" 155°57'26" Kealakekua	199	Carbonaceous material in yellow to red cinders overlain by basalt flow at intersection of Kuakini Highway and Kam III Rd.	R. B. Moore
W4365	12,230±150	19°48'39" 155°50'30" Puu Anahulu	677	Charcoal roots in soil zone on top of trachyte lava flow, under olivine-rich basalt flow on W. side of Puu Anahulu, roadcut, 200 m E. of Mamalahoa Highway.	R. B. Moore
W5056	12,950±150	19°39'28" 155°57'37" Kailua	439	Charcoal in soil under Keopu flow 100 m W. of Mamalahoa Highway next to Keopu subdivision road.	R. B. Moore

TABLE 10.4—Radiocarbon date from Mauna Kea Volcano, Island of Hawaii

[Samples listed in order of increasing age; uncertainty is one standard deviation,  $\pm 1\sigma$ ; modern age means sample is younger than AD 1950; ML = Mauna Loa; MK = Mauna Kea; mauka = toward the mountain, makai = toward the sea; see figs. 10.2-10.4 for localities. Stratigraphic nomenclature from Langenheim and Clague (chapter 1, part II)]

Sample	Radiocarbon age (years before present)	Location (latitude, longitude, quadrangle)	Elevation (m)	Sample and site description	Collector
W5541	5,630 $\pm$ 200	19°41'53" 155°26'41" Puu Oo	1,986	Charcoal root fragments at top of deep ash overlain by Puu Kalaieha flow on Parker Ranch land off Saddle Rd.	J. P. Lockwood