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New Radiocarbon Ages from Haleakalā Crater, Island of Maui, Hawai`i

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Introduction

This report describes radiocarbon ages, stratigraphic setting, and geographic location of ten new charcoal samples from East Maui (fig. 1). The results include the first successful dating of young lava flows from Haleakalā Crater, providing us with sufficient information to divide the crater lava flows into broad age groups on the basis of isotopic age, stratigraphic setting, degree of soil development, and vegetative contrasts. An

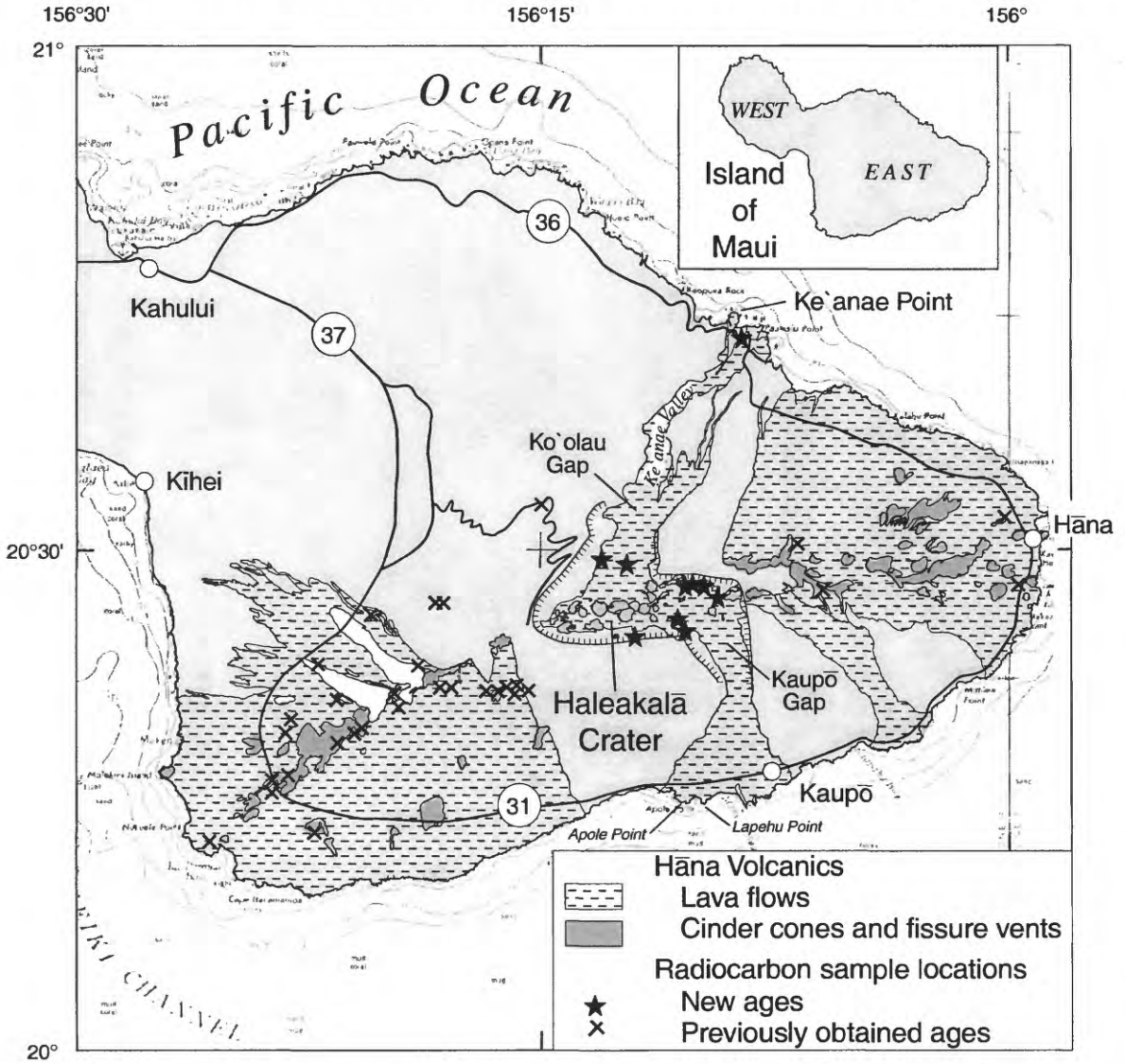


Figure 1. Map showing locations for new carbon-14 ages from East Maui, Hawai`i. Distribution of Hāna Volcanics from Stearns and Macdonald (1942). Previously obtained radiocarbon ages from Crane (1956), Reber (1959), Crandell (1983), and Bergmanis (1998).

Table 1. Radiocarbon age determinations and calibrated ages for charcoal collected at Haleakalā Crater and north coast of East Maui, Hawai`i, in order of increasing age.

Lab No.[1]	Field No.	Age and error[2] ^{14}C yr B.P.	Calibrated age[3] Calibrated yr B.P. Maximum	Intercept(s)	Minimum
WW-1665	S97-HC265	330±50	506	428, 377, 323	291
WW-1663	S97-HC232C	870±40	914	785, 784, 762	689
WW-1659	S97-HC137	940±50	951	910, 850, 834, 809, 799	733
WW-1657	S97-HC63C	970±50	967	921	743
WW-1660	S97-HC152	1,040±40	1,052	950	804
WW-1662	S97-HC209	1,160±50	1,228	1,060	956
WW-1664	S97-HC242	1,870±40	1,917	1,821	1,709
WW-1661	S97-HC129	3,750±50	4,246	4,141; 4,125; 4,091	3,930
WW-1658	S97-HC64C	4,070±50	4,812	4,566; 4,562; 4,529	4,418
WW-1881	S98-HC310	43,800±1,400			

Notes:

[1] Samples processed at ^{14}C Laboratory of the U.S. Geological Survey, Reston, Virginia. Radiocarbon ages determined at the Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, Calif.

[2] Age in radiocarbon years using Libby half-life of 5,568 years. Error is one standard deviation, in radiocarbon years.

[3] Calibrated using CALIB Radiocarbon Calibration Program version 4.0, after Stuiver and Reimer (1993), in conjunction with decadal atmospheric ^{14}C database (Stuiver and others, 1998). Ages reported as two-sigma error. CALIB software is available on the World-wide Web at the homepage for the University of Washington's Quaternary Isotope Laboratory (Universal Resource Locator is http://depts.washington.edu/qil/).

ongoing paleomagnetic study of crater flows will further our understanding of the emplacement history of young lava flows at Haleakalā Crater.

The ten new ^{14}C ages are given in table 1. Nine ages are from Haleakalā Crater. Of these, seven range in age from 870±40 ^{14}C yr B.P. to 4,070±50 yr B.P. and are thought to represent emplacement ages of lava flows. (All ages are in carbon-14 years before present except where noted as calibrated ages.) An eighth sample establishes a maximum age for thick lapilli tephra deposited against the south crater wall; its age is 3,750±50 yr B.P. The ninth sample gives an age of 330±50 yr B.P., which appears to be too young and likely is erroneous in view of similar character, weathering, soil development, and vegetative cover of this flow and nearby flows that are about 1,000 yr B.P.

The tenth age reported here is from the north coast of East Maui, at the mouth of the Ke`anae Valley (fig. 1; tables 1, 2). Lava from Haleakalā Crater periodically reaches the ocean via Ke`anae. The Ke`anae charcoal dated for this report was beneath a bench-forming intracanyon lava flow, an early part of the sequence of young volcanic rocks on East Maui. Its age is 43,800±1,400 yr B.P. The youngest flow in that area, which forms Ke`anae Point, remains undated.

Stratigraphic setting

The eastern part of the Island of Maui was built by Haleakalā, one of several volcanoes in the Hawaiian Islands. Haleakalā ("house of the sun") is the name used by ancient Hawaiians for a site near the volcano's summit and now commonly applied to the entire volcano. Haleakalā completed its shield-building volcanic stage about 1 million years ago (mega-annums ago, or Ma) (Chen and others, 1991). Lava of its alkalic-stage volcanism, the Kula Volcanics, have K-Ar and ^{40}Ar/^{39}Ar ages ranging from about 0.9 to 0.36 Ma (McDougall, 1964; Naughton and others, 1980; Chen and others, 1991; Baksi and others, 1992). Kula volcanism was characterized by eruptions along a rift zone that traverses the island from southwest to east. This rift zone goes by different names depending on the geographic segment discussed: southwest rift, a central segment (in Haleakalā Crater), Hāna or east rift zone where it traverses the east slope of the volcano, and Haleakalā Ridge where the rift forms a prominent

bathymetric ridge on the eastern submarine flank of the island.

Distinctly younger volcanic rocks, the Hāna Volcanics, lie disconformably above the Kula Volcanics and are the strata of interest in this report. The Hāna Volcanics comprise all the youthful flows on East Maui, including lava emplaced as recently as about 200 years ago. Thus an accurate volcano-hazard assessment for East Maui depends on understanding the age and distribution of Hāna Volcanics.

Radiocarbon ages from the Hāna Volcanics are as old as 45,000±1,800 yr B.P. (F.A. Trusdell and J.P. McGeehin, in Bergmanis, 1998). Preliminary $^{40}Ar/^{39}Ar$ ages from three of the oldest Hāna flows on the southwest rift zone are 43,000±12,000 yr, 58,000±1,000 yr, and 60,000±8,000 yr ago (one-sigma analytical error) (Bergmanis, 1998). Whether the 300,000-yr gap between published ages from the Kula and Hāna Volcanics represents a true hiatus or only a period of greatly diminished volcanic flux awaits systematic sampling and dating. During the time from 0.36 to 0.06 Ma, however, erosional downcutting and broadening of large valleys modified the slopes of Haleakalā. Two of these valleys breached the summit area and coalesced to form an elliptical topographic depression, Haleakalā Crater (Stearns, 1942). Hāna Volcanics coat the crater floor with an unknown thickness of cinder deposits and lava flows (Macdonald, 1978). Many of these flows are younger than 5,000 year in age (fig. 2).

Sample processing

The charcoal samples, which ranged in weight from 0.05 to 3.7 g, were treated physically and chemically to remove as many contaminants as possible. A contaminant is defined here as any carbonaceous compound with ^{14}C activity that does not reflect the true ^{14}C activity of the sample. Generally this added carbon is the result of postdepositional effects, such as prolonged contact of the sample with percolating water or infiltration by modern rootlets. A standard acid-alkali-acid pretreatment was used for all the charcoal samples, as described next.

The samples were first picked clean of obvious surface contamination, including rootlets and sediment encrustation. Each sample was then soaked in a warm 1N hydrochloric acid (HCl) solution for one hour. The HCl removes inorganic carbon contaminants such as caliche, limestone, or shells. After neutralizing with distilled water rinses, each sample was soaked in a warm solution of 2 percent sodium hydroxide (NaOH) for two hours. The NaOH extracts humic acid contaminants, which are the degraded and transported byproducts of humus produced in active surface soils. Care was taken when performing the NaOH pretreatment, since carbon-bearing materials will exchange modern CO_2 from the atmosphere if left in an alkaline solution for an extended period. Therefore, a second HCl wash of equal strength and duration as the first was performed on each sample to assure that the final pH of the sample

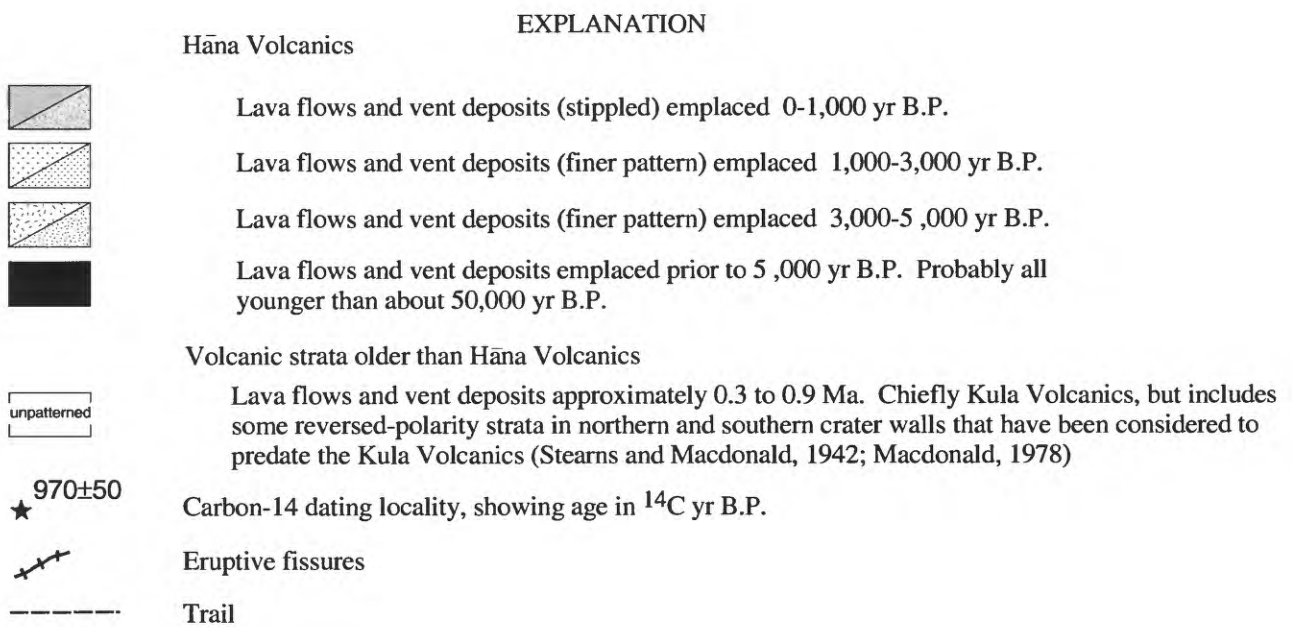


Figure 2. Explanation; see next page for map.

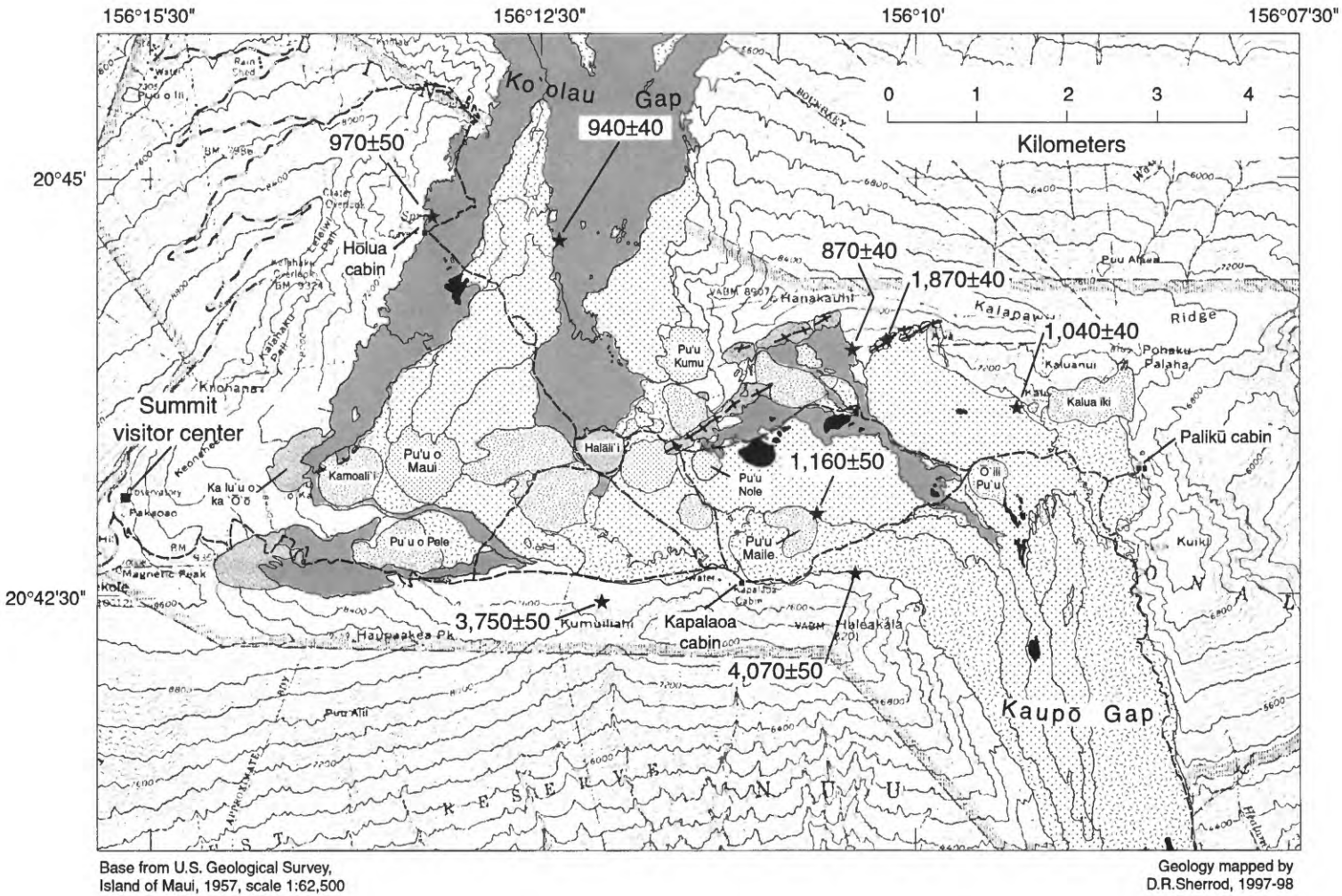


Figure 2. Simplified geologic map of Haleakalā Crater showing lava younger than 5,000 yr B.P. and recently obtained radiocarbon sample locations, by age. Not shown is location of S97-HC265 (330±50 yr B.P.), which is considered too young. See previous page for explanation of shading and symbols.

Table 2. Sample locations for charcoal collected at Haleakalā Crater and north coast of East Maui, Hawai`i. Coordinates referable to Old Hawaiian datum (Old Hawaiian Mean of some GIS software). Vertical datum is mean sea level.

Lab No.	Field No.	Age and error ^{14}C yr B.P.	Latitude (N)	Longitude (W)	Elevation ft	Quadrangle	Description
WW-1665	S97-HC265	330 ±50	20°43.958'	156°09.908'	7300	Nahiku	480 m east-southeast of Kalua Awa, on lower slope of north wall, north-central Haleakalā Crater
WW-1663	S97-HC232C	870 ±40	20°43.979'	156°10.514'	7300	Nahiku	West wall of gully that incises foot of north wall, 920 m southeast of rim point Hanakauhi, north-central Haleakalā Crater
WW-1659	S97-HC137	940 ±50	20°44.632'	156°12.391'	6840	Nahiku	1.5 km east of Hōlua cabin, midway across Ko`olau Gap, northwest Haleakalā Crater
WW-1657	S97-HC63C	970 ±50	20°44.776'	156°13.201'	6820	Kilohana	190 m north-northeast of Holūa cabin, northwest Haleakalā Crater
WW-1660	S97-HC152	1,040 ±40	20°43.632'	156°09.456'	6720	Nahiku	North side of Lā`ie Pu`u cinder cone where banked by younger pahoehoe lava, northeast Haleakalā Crater
WW-1662	S97-HC209	1,160 ±50	20°42.995'	156°10.740'	7120	Nahiku	Northwest side of Pu`u Maile cinder cone where banked by younger spiny pahoehoe, central Haleakalā Crater
WW-1664	S97-HC242	1,870 ±40	20°44.035'	156°10.295'	7400	Nahiku	200 m west of Kalua Awa, on lower slope of north wall, north-central Haleakalā Crater
WW-1661	S97-HC129	3,750 ±50	20°42.465'	156°12.119'	7320	Kaupo	1.6 km west of Kapalaoa cabin, 220 m south of trail, in gully that cuts alluvial fan, south-central Haleakalā Crater
WW-1658	S97-HC64C	4,070 ±50	20°42.636'	156°10.495'	7000	Nahiku	800 m southeast of Pu`u Maile cinder cone, in north wall of shallow canyon adjacent to Haleakalā Crater's south wall
WW-1881	S97-HC310	43,800 ±1400	20°51.315'	156°08.675'	200	Keanae	Roadcut along Hāna Highway, west bank of `Ōhi`a Stream, north coast of East Maui

after pretreatment was safely out of the alkaline range. The final step was overnight drying in a convection oven at 80°C.

Carbon was extracted from the pretreated samples as CO_2 and then reduced to graphite (100 percent carbon). Approximately 4 mg of pretreated charcoal was selected from each sample and combusted in a sealed Vycor glass tube with copper oxide and silver at 900°C for six hours. The tubes were placed on a high-vacuum extraction line and cracked in a break-seal apparatus. The resulting CO_2 was purified of volatile gases and sent through a cold trap to remove water. The purified and dried CO_2 was reduced to graphite by placing a measured volume (equivalent to 1 mg carbon) in a chamber with approximately 4 mg of 63-mesh spherical iron, hydrogen, and zinc as a catalyst at 575°C for ten hours. The sample carbon (precipitated on the iron) was pressed into aluminum targets for accelerator mass spectrometry analysis.

Lawrence Livermore Lab's Center for Accelerator Mass Spectrometry did the actual ^{14}C dating using their FN tandem accelerator. Ages are reported as radiocarbon years before present (B.P.) using the Libby half-life of 5,568 years (table 1). Analytical error is reported as one standard deviation. No measurements were made for $\delta^{13}C$ fractionation effects in these charcoal samples; the assumed value for terrestrial charcoal of –25 per mil was used for purpose of the age calculations.

In table 1, ages are also shown as calibrated years B.P. using the radiocarbon calibration software of Stuiver and Reimer (1993) in conjunction with the decadal atmospheric ^{14}C database (Stuiver and others, 1998).

Sample sites

Sample sites are described on the basis of age from youngest to oldest. Each description includes a sketch showing the strata that bound the charcoal sample and a geologic map with topographic base.

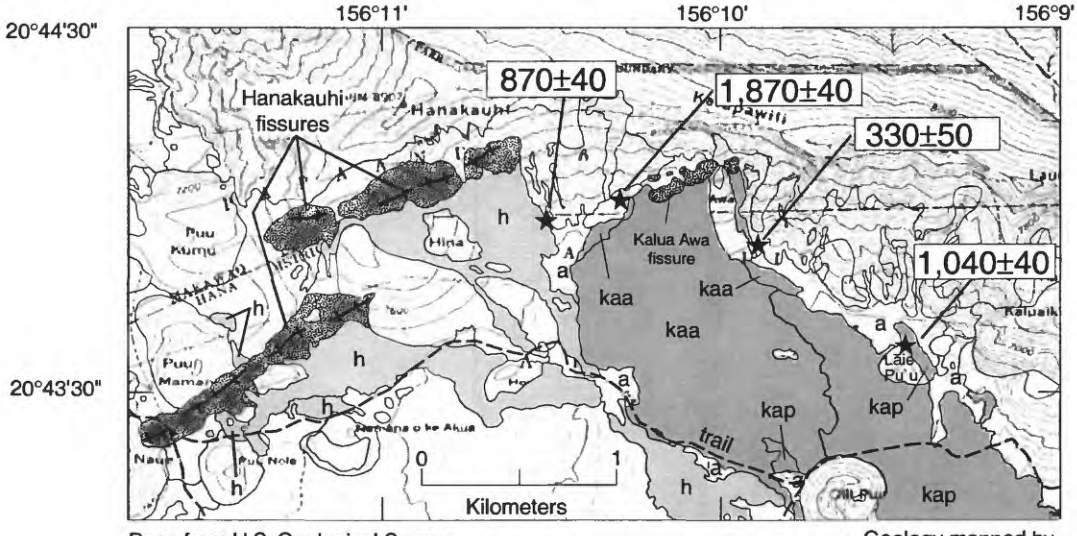
Samples from Haleakalā Crater

S97-HC265: 330±50 yr. B.P. (probably too young for emplacement age)

Kalua Awa fissure, north-central crater wall

Charcoalized stems or twigs (sample weight 0.8 g) were collected from beneath porphyritic pāhoehoe that plastered a gully wall downslope from its vent (figs. 3, 4). Exposure was obtained by peeling away the gully-wall lava (a rind only 10 cm thick) to expose underlying, variably developed soil less than 10 cm thick. The charcoal was in vegetative litter beneath the flow, with largest fragments 4-5 mm in diameter. The zone is heavily rooted by modern plants.

This age is thought too young for the following reasons. The vent that produced the flow is an uprift extension of the Kalua Awa fissure, which produced flows that are petrographically similar to this dated flow, have similar soil cover, and support similarly



Lighter pattern, Hanakauhi flows (labeled "h"). Carbon-14 age 870±40 yr B.P. Vent deposits shown stippled
Approximate fissure alignment shown by hachured lines for closed depressions or gaping cracks
Darker pattern, Kalua Awa flows. Carbon-14 age 1,040±40 yr B.P. Vent deposits shown stippled. Contacts within unit show areas of pāhoehoe (labeled kap) and `a`ā (labeled kaa)
Alluvium labeled "a"; other units unlabeled. Age of 1,870±40 yr B.P. from fissure vent that predates Kalua Awa deposits. See text for discussion of youngest age, 330±50 yr B.P., which is interpreted as too young

Figure 3. Location and geologic setting for samples from north-central part of Haleakalā Crater.

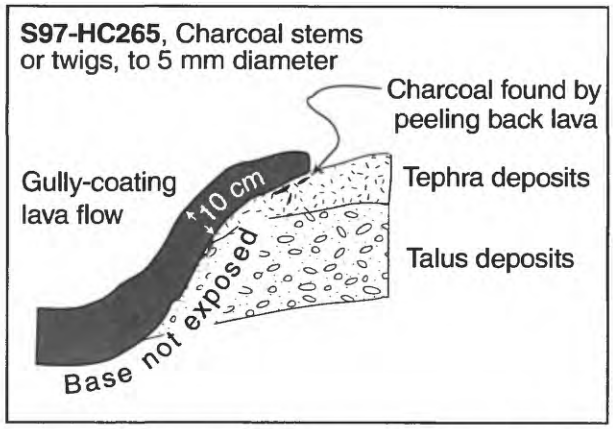


Figure 4. Stratigraphic sketch for sample S97-HC265: 330±50 yr. B.P.

sparse vegetation. Another flow in the sequence yielded an age of 1,040±40 yr B.P. Vegetation on these ~1,000-yr-old flows is denser than on a nearby flow that yielded an age of 870±40 yr B.P. For these reasons, the 330-yr age is considered too young, and the gully-plastering flow is thought to be more closely related to the 1,040-yr-old flow. Preliminary paleomagnetic data place the HC265 lava in a period of steep inclination (~40°) that characterizes much of the paleomagnetic secular variation curve from 1,000 to 300 yr B.P., preventing definitive challenge, on that basis alone, to the seemingly too-young radiocarbon age (D.E. Champion, oral commun., 1998).

S97-HC232c: 870±40 yr B.P.

Hanakauhi fissure, north-central crater wall

A charcoalized root(?) was found beneath aphyric `a`ā erupted from a fissure system that traverses the north crater wall near Hanakauhi, a prominent peak on the north rim (fig. 3). The exposure is in a gully that has eroded the edge of the flow and carved into underlying lapilli tephra deposits (fig. 5). The charcoal, weighing 2.4 g, was 3-4 mm in diameter and at least 2 cm long; it lay near the top of a 50-100-cm-thick soil, and from a depth 10 cm below the base of the overlying lava flow. The bake zone is 8 cm thick, so the charcoal was collected from just beneath the bake zone.

The Hanakauhi fissure system is the youngest volcanic feature in the eastern crater and may be the youngest in all of Haleakalā Crater. Its 870-yr age is the youngest dated lava (discounting the 330-yr age from S97-HC265). No charcoal has been found beneath potentially younger flows in the western crater area (fig. 2 or 6, youngest flows from Ka Lu`u o ka `Ō`ō), and preliminary paleomagnetic results (D.E. Champion, unpub. data, 1998) are ambiguous when comparing the relative ages of the Ka Lu`u flows and Hanakauhi fissure flows. The Hanakauhi flows are essentially unvegetated.

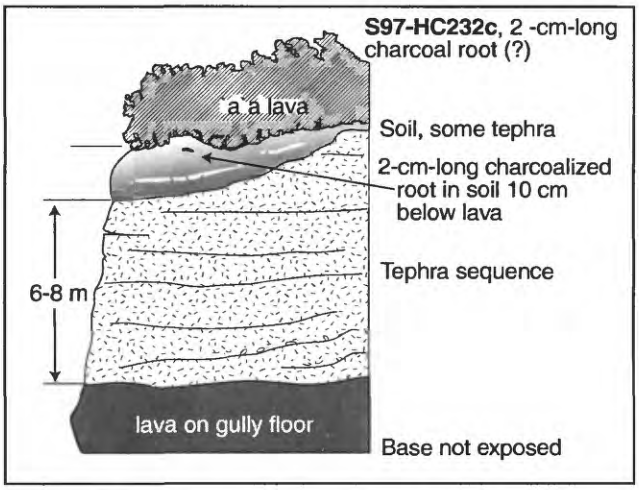


Figure 5. Stratigraphic sketch, sample S97-HC232c: 870±40 yr B.P.

S97-HC137: 940±50 yr B.P.

Likely erupted from Halāli`i vent, central crater floor

This charcoal sample (3.7 g) was a lengthy root as much as 7 mm in diameter, one of several that lie at a soil-ash interface buried beneath a pāhoehoe toe of slightly porphyritic lava (fig. 7). The thin reddish-brown soil is overlain by coarse black ash 8-10 cm thick; some roots in the soil project up into the ash. Exposure was created by pick and shovel. The charcoal age likely is the emplacement age of lava, but no chill features are found in the lava to indicate a connection between the roots and the once-subaerial part of the plant beneath the flow.

The dated lava, in the central part of Ko`olau Gap (fig. 6), is underlain by ankaramite from Pu`u o Maui. Thus Pu`u o Maui is older than 940 yr B.P. The dated lava is overlain upslope by lava that issued from a vent

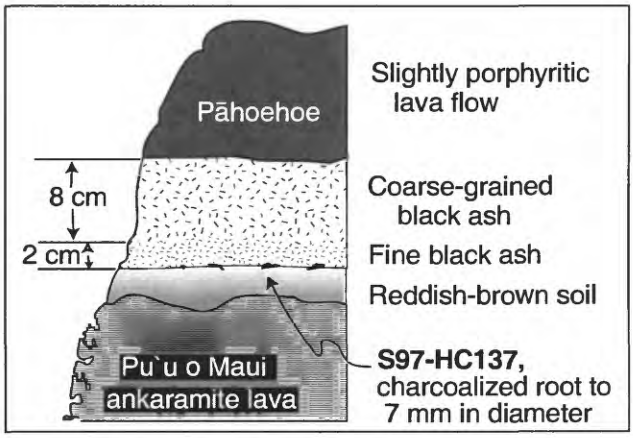


Figure 7. Stratigraphic sketch for sample S97-HC137: 940±50 yr B.P.

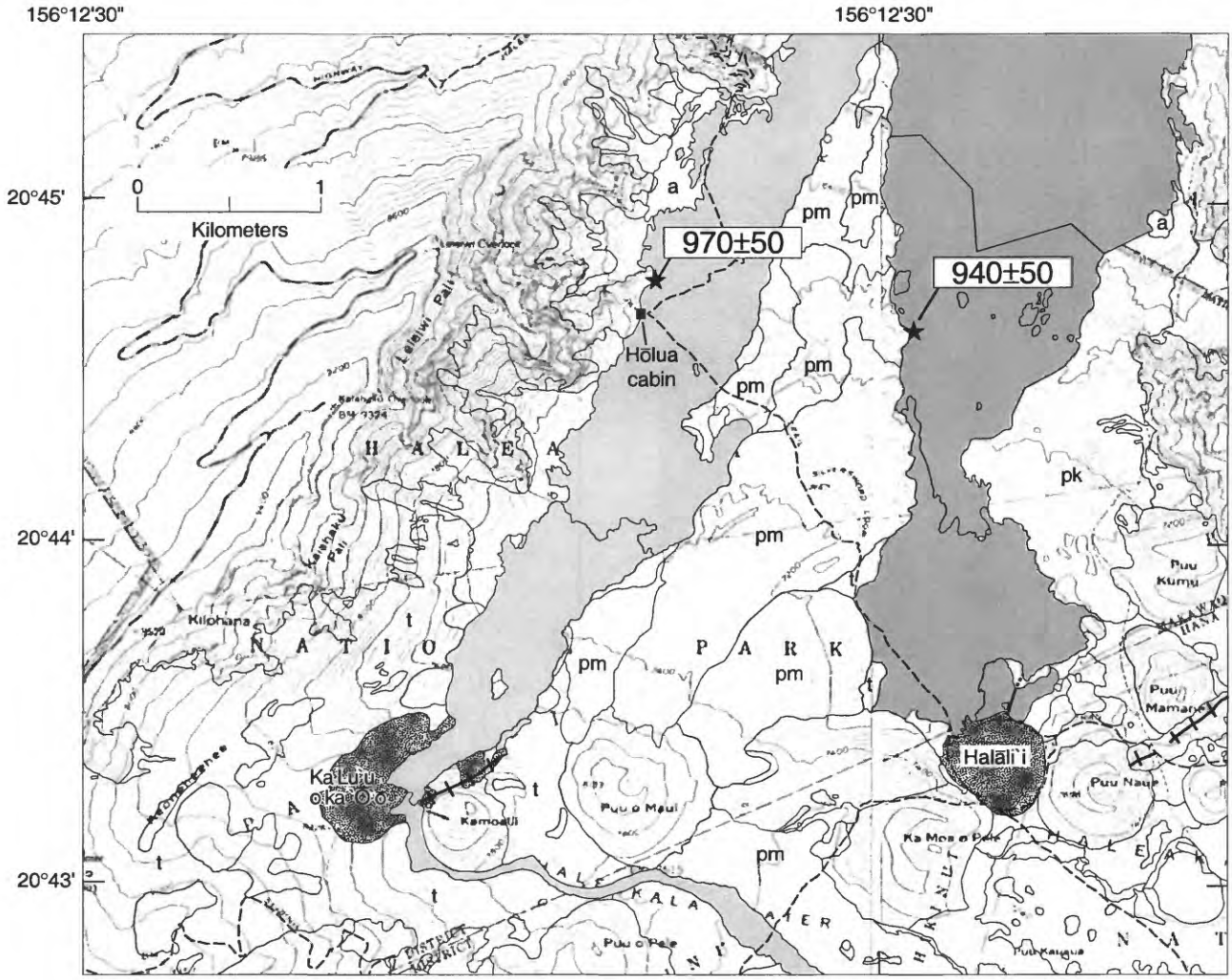
on the northwest flank of Hālali`i cinder cone, so some eruptions from Halāli`i are younger than 940 yr B.P. Given the configuration of older flows and possible vents, it seems likely that the dated flow also issued from Halāli`i, possibly all part of eruptions about 900-1,000 yr B.P.

S97-HC63c: 970±50 yr B.P.

Hōlua flows, likely erupted from vent near or at Ka Lu`u o ka `Ō`ō

Charcoalized twigs (0.3 g) 3-8 mm across were recovered from a thin black ash that underlies the edge of `a`ā where it ramps down a steep slope a few hundred meters north (downslope) from Hōlua Cabin (figs. 6, 8). Exposure was created by pick and shovel. Three discrete samples were collected at increasing distance from the flow front as lava was pried away (a, b, c on fig. 8); dated sample c was 58 cm from the front.

The dated `a`ā lava is from a sequence of flows that mantle the west crater floor. The map pattern of its extent suggests that the Hōlua lava came from Ka Lu`u o ka `Ō`ō, a youthful cinder cone, although the direct connection of lava and vent is obscured by younger, petrographically similar lava from the same vent (fig.



Lighter pattern, Hōlua flows. Carbon-14 age 970±50 yr B.P. from beneath lava near Holua Cabin. Vent deposits shown stippled at Ka Lu`u o ka `Ō`ō and from fissure (hachured line) that traverses north flank of Kamoali`i cone

Darker pattern, Halāli`i flows. Carbon-14 age 940±50 yr B.P. from flow at ~6800-ft elevation. Vent deposits shown stippled.

Blanket of thick tephra deposits labeled "t". Alluvium labeled "a". Pu`u o Maui lava labeled "pm". Other units unlabeled.

Figure 6. Location and geologic setting for samples from western part of Haleakalā Crater.

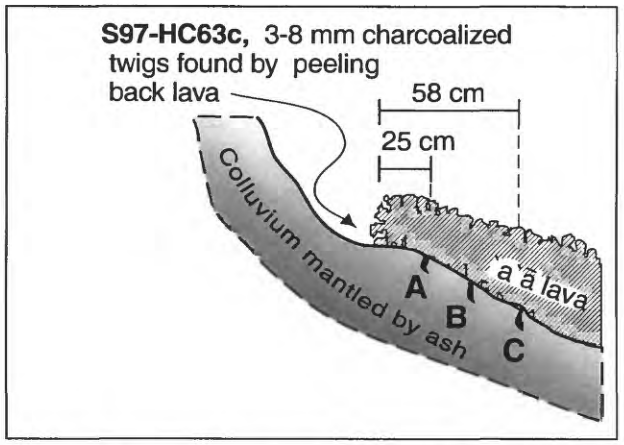


Figure 8. Stratigraphic sketch for sample S97-HC63c: 970±50 yr B.P.

6). The younger lava is the youngest lava flow in the west crater area and must be younger than the dated Hōlua flow on the basis of superposition.

S97-HC152: 1,040±40 yr B.P.

Kalua Awa fissure, north-central crater wall

Sample is from a thin soil that underlies ankaramite pāhoehoe on the east side of Lā`ie Pu`u, a substantially older cinder cone in the east crater area (fig. 3). Charcoalized stems and twigs (0.2 g) were found after digging back 30 cm from the face of a low, natural exposure (fig. 9). The overlying lava flow was 5-10 cm thick at initial edge and 30 cm thick where excavation ceased.

The dated pāhoehoe was an early-erupted lava from the Kalua Awa fissure system. Younger products of the fissure are `a`ā. Expansive pāhoehoe flows are an uncommon eruptive product in Haleakalā Crater; the Kalua Awa pāhoehoe is perhaps the best known, owing to a trail crossing eastward from `Ō`ili Pu`u in the eastern crater area (fig. 3).

Alluvium masks the connection between pāhoehoe near Lā`ie Pu`u and the adjacent broad field of pāhoehoe near `Ō`ili Pu`u, so the dated lava is correlated on the basis of petrographic similarity. Additional correlation is provided by paleomagnetic studies, which indicate nearly coincident inclination and declination of magnetic pole for samples from the disparate areas of pāhoehoe (D.E. Champion, unpub. data, 1998).

The Kalua Awa flows are older than the 870-yr-old lava from Hanakauhi fissure (S97-HC232c). For this reason the 330-yr age (S97-HC265) from an aforementioned flow that issued from the northeastern vent in the Kalua Awa fissure is discounted as erroneously young.

S97-HC209: 1,160±50 yr B.P.

Erupted from Pu`u Nole, central crater floor.

Charcoalized stems and twigs (0.1 g) were collected from a thin sandy soil underlying a short pāhoehoe lobe that oozed from `a`ā or spiny pāhoehoe (fig. 10). Exposure is in a gully floor at the edge of Pu`u Maile cinder cone (fig. 11), but the sample was obtained by peeling lava back 30 cm from the natural cut.

The Pu`u Nole ankaramite flows are the youngest crater lava to reach the ocean southward through Kaupō Gap, building Lapehu and Apole Points (fig. 1). The dated flow is youngest of the sequence. Slightly older flows in the sequence, probably similar in age, are exposed successively down the Kaupō lava fan; phenocryst abundance diminishes as relative stratigraphic age increases.

S97-HC242: 1,870±40 yr B.P.

Spatter rampart along fissure parallel to but slightly north of Kalua Awa fissure.

This sample consists of 0.6 g of charcoalized stems or twigs 2-4 mm in diameter collected from the upper 10

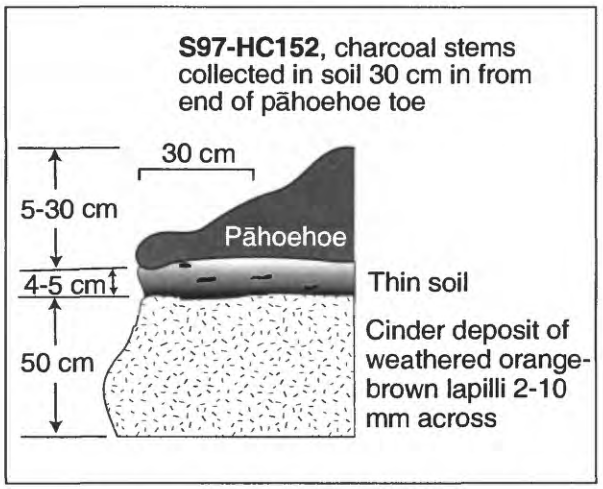


Figure 9. Stratigraphic sketch for sample S97-HC152: 1,040±40 yr B.P.

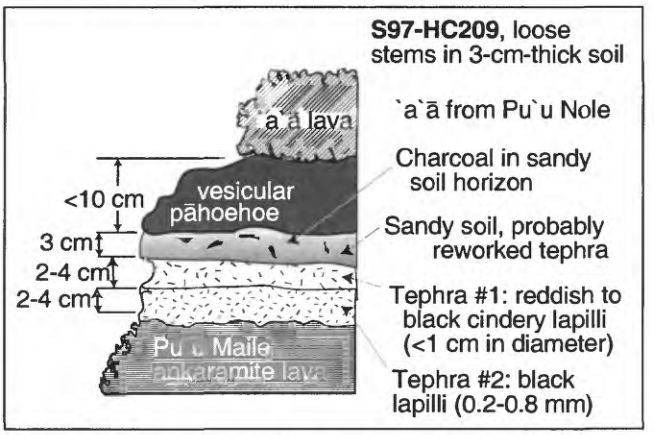


Figure 10. Stratigraphic sketch for sample S97-HC209: 1,160±50 yr B.P.

cm of peaty baked soil on buried talus beneath spatter (fig. 12). Overlying aphyric spatter deposits are less than 2 m thick and surround a pit that formed during eruption. Sloughing of the pit walls has exposed the spatter-soil contact.

The spatter deposit lacks phenocrysts, in contrast to the adjacent, younger Kalua Awa fissure (age 1,040 yr B.P.; S97-HC152). It is uncertain whether the 1,870-yr-old vent erupted lava flows. None is found near the vent, but some aphyric lava flows that may correlate are found downslope in the upper part of Kaupō Gap, where they project from beneath the Kalua Awa lava.

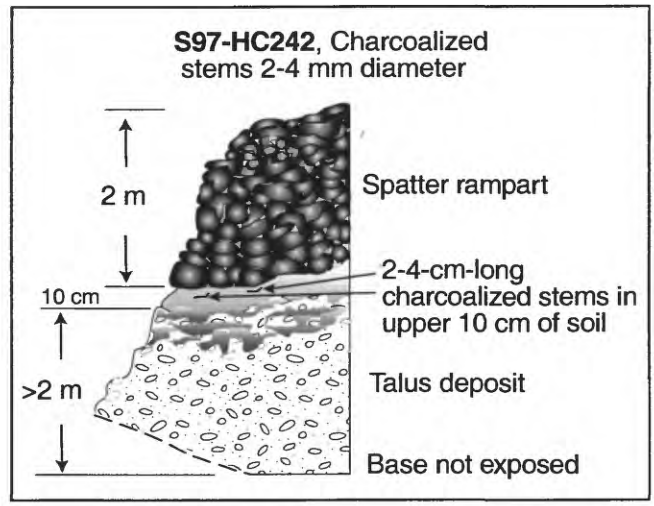


Figure 12. Stratigraphic sketch for sample S97-HC242: 1,870±40 yr B.P.

S97-HC129: 3,750±50 yr. B.P.

Beneath tephra deposits of south crater wall

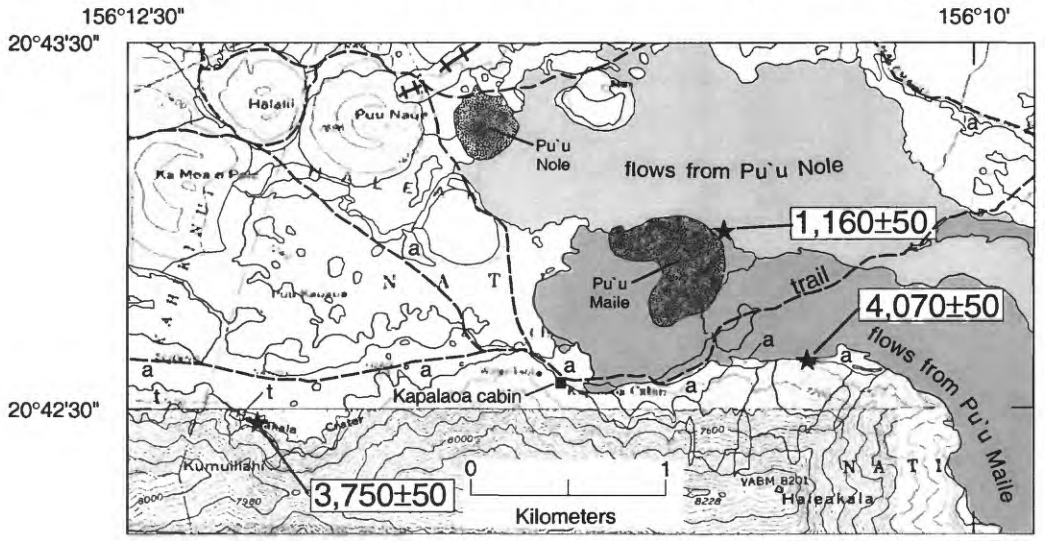
Charcoal flecks (0.06 g total) originating as twigs or other wood were recovered from the upper part of a paleosol formed in windblown ash and silt that underlies thick fallout deposits of black glassy lapilli (less than 2 cm in diameter) (fig. 13). Presumably the charcoal was created by the heat from the lowest tephra deposit. The natural exposure was found in a narrow gully cut into the tephra and talus adjacent to the south wall of Haleakalā Crater (fig. 11).

The tephra is fallout accumulated from numerous cinder-vent eruptions on the crater floor. Prevailing winds disperse most fallout southwestward, where it lands on the south and west crater walls and upper southwestern flanks of Haleakalā. Between eruptive episodes, colluvium is deposited downslope across the tephra. Likely other tephra sequences are present at depth, but this exposure was too shallow to reveal them (base not exposed). Elsewhere in the crater walls, tephra and colluvial wedges are interbedded.

S97-HC64c: 4,070±50 yr B.P.

Lava from Pu`u Maile cinder cone, south-central crater area

The Pu`u Maile charcoal sample is from black, ash-rich soil beneath `a`ā (fig. 14). The site is a natural exposure created by a prominent gully along the contact



Lighter pattern, Pu`u Nole flows. Carbon-14 age 1,160±50 yr B.P. Vent deposits shown stippled

Darker pattern, Pu`u Maile flows. Carbon-14 age 4,070±50 yr B.P. Vent deposits shown stippled.

Blanket of thick tephra deposits labeled "t"; carbon-14 age 3,750±50 yr B.P. from base of 6-m-thick sequence of tephra near south crater wall. Alluvium labeled "a"; other units unlabeled.

Figure 11. Location and geologic setting for samples from south-central part of Haleakalā Crater.

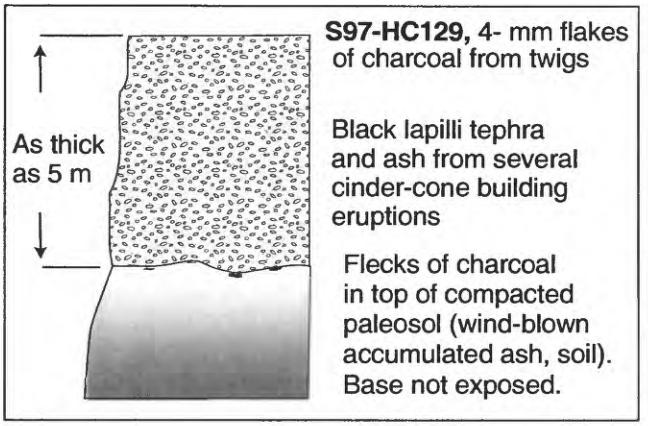


Figure 13. Stratigraphic sketch for sample S97-HC129: 3,750±50 yr. B.P.

between Pu`u Maile lava and an older cinder vent that plastered the south crater wall (fig. 11). Sample "c," which consists of charcoalized twigs or roots (1.1 g), was collected by digging 35 cm back from the gully face.

Aphyric lava from Pu`u Maile poured through Kaupō Gap and reached the ocean. Petrographically similar lava from `Ō`ili Pu`u also flowed southward. These two lava sequences have similar vegetative cover and are thought to be similar in age. More precise correlation may result from additional paleomagnetic studies.

The 4,070-yr-old lava from Pu`u Maile is the oldest of the conspicuous lava sequences exposed on the floor of Haleakalā Crater. Scattered older vents drape the crater walls and form hills poking through the younger lava of the crater floor. As seen in figure 2, most of the crater floor has been covered at least once in the past 5,000 years.

Sample from north coast of East Maui, neaKe`anae Point

S98-HC310: 43,800±1,400 yr B.P.
An early Haleakalā Crater flow that reached coast via Ke`anae Valley

The sample that produced this unexpectedly old age was a charcoalized stick or twig (0.5 g) from a roadcut along the Hāna Highway. It lay about 2 cm below the base of `a`a and near the top of an 8-10-cm-thick bake zone in fine-grained sedimentary strata that cap conglomerate (fig. 15). The stick, nearly 1 cm in diameter and 3 cm long, may have been as long as 6 cm judging from the path of white discoloration in adjacent bake zone.

Several lava flows from Haleakalā Crater have reached the coast via Ke`anae Valley. The dated flow, part of the Pi`ina`au Basalt of Stearns and Macdonald (1942) (fig. 16), lies at an elevation of about 200 ft, where it forms one of several exposures along a prominent topographic bench. Nearby Ke`anae Point, which is only a few feet above sea level, likely formed about 1,000 yr B.P. by the emplacement of the Ke`anae Basalt (fig. 16). (Older flows elsewhere around East Maui commonly develop prominent cliffs as the ocean erodes landward.) Previously published mapping (Stearns and Macdonald, 1942) shows the Ke`anae Basalt filling the middle valley floor, and our mapping from Haleakalā Crater shows that much of the upland valley floor is

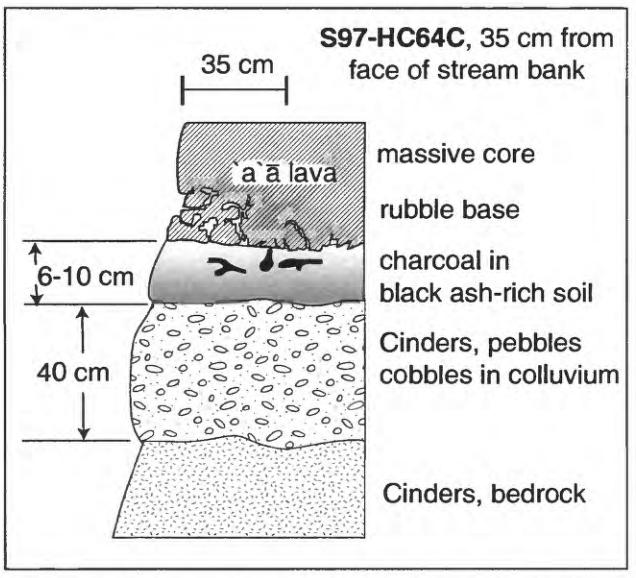


Figure 14. Stratigraphic sketch for sample S97-HC64c: 4,070±50 yr B.P.

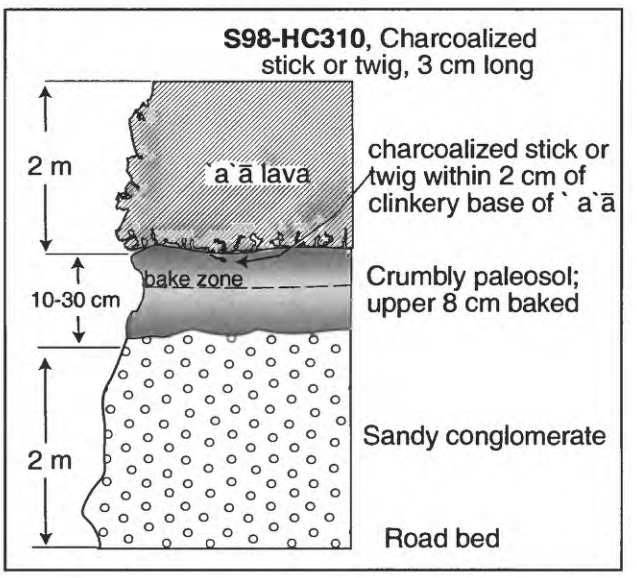


Figure 15. Stratigraphic sketch for sample S98-HC310: 43,800±1,400 yr B.P.

mantled by petrographically similar lava (for example, S97-HC137, 940±50 yr B.P.). Our work in the lower Ke`anae Valley is ongoing.

Acknowledgments

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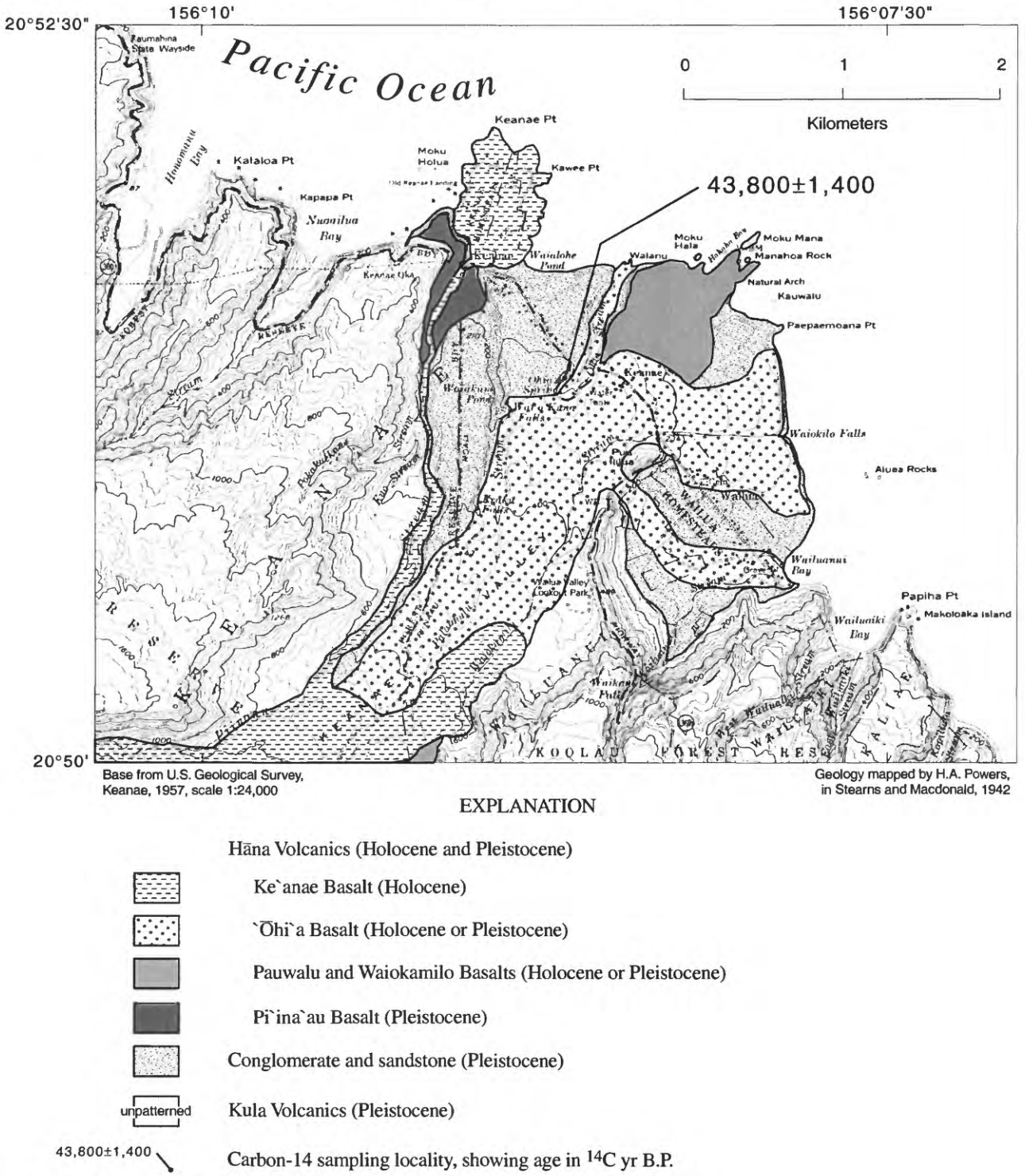

Figure 16. Location and geologic setting for sample from north coast of East Maui.

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