

PRELIMINARY GEOLOGIC MAP OF THE KAILUA QUADRANGLE, HAWAII

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88-650

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

GEOLOGIC SUMMARY

Vent deposits and lava flows from the summit area and northwest rift zone of Hualalai Volcano cover the Kailua 7 1/2-minute quadrangle. Steep-sided spatter and cinder cones, spatter ramparts, and a few satellitic shields mark the rift zone and summit vent complex. Open cracks and normal faults, prominent on Mauna Loa and Kilauea Volcanoes, are virtually absent. Tropical rain forest covers most of the quadrangle; annual rainfall locally exceeds 100 inches.

Basaltic lavas of Hualalai in this quadrangle range in age from latest Pleistocene to A.D. 1800. Pleistocene lavas cover an estimated 18 percent of the area, appreciably more than the 5 percent covered by Pleistocene lava on the volcano as a whole (Moore and others, 1987). Lavas of this age are recognized chiefly by stratigraphic relations, the virtual absence of original surficial glass, and the presence of relatively thick (>0.3 m) soils. Pleistocene lavas on the modern surface came from the summit area and generally are confined to the southern half of the quadrangle. Some of these lavas could be earliest Holocene in age, but a ¹⁴C age of $12,950 \pm 150$ years (all radiocarbon ages from Moore and others, 1987, unless otherwise noted) on the stratigraphically third highest Pleistocene flow (Q90S90) suggests that most are Pleistocene.

Lavas 5,000-10,000 years old cover about 10 percent of the quadrangle. Their assignment to this age classification is based on stratigraphic relations, absence of delicate flow structures, extensive weathering, development of soil 0.1-0.3 m thick, and rare preservation of surficial glass.

Lavas 3,000-5,000 years old cover an estimated 20 percent of the quadrangle. Seven radiocarbon ages of deposits in the Kailua quadrangle fall in this range. Vent deposits and flows generally are weathered brown, with little or no soil cover, except in the rain forest. Delicate spatter and flow structures generally are present, as is local surficial glass. Stratigraphic relations are a further aid in

assignment of volcanic units to this age classification.

Lavas 1,500-3,000 years old cover about 30 percent of the quadrangle. Ten volcanic units, five of which have been dated, occur in this age range. Most of the flows are relatively extensive, as is typical of the most recent eruptions of Hualalai (Moore and others, 1987). Lavas of this age generally are dark gray, lack soil, and commonly have surficial glass and delicate flow and spatter structures.

Two volcanic units occur in the age range 750-1500 years and cover an estimated 10 percent of the quadrangle. Flows occur largely within the rain forest and are medium to dark gray, with thin or no soil and well-preserved surficial glass and delicate structures.

Two volcanic units are 200-750 years old and cover an estimated 4 percent of the quadrangle. The flows are similar in appearance to other relatively young units and only radiocarbon ages and stratigraphic relations permit age distinctions.

Vent deposits and lava flows of the historic A.D. 1800 eruption cover about 8 percent of the quadrangle. Three right-stepping, en echelon vent concentrations occur along a 3.4-km-long segment of the northwest rift zone. The northwesternmost of the A.D. 1800 vents and its associated flows were discovered in 1982. A radiocarbon date confirmed its historic age. All A.D. 1800 vents are located near the topographic axis of the rift, so that lava flowed both west or southwest and north from them. The deposits are black to dark gray, lack soil, and contain surficial glass and delicate structures.

Deposits of black to brown basaltic cinders, mapped only where underlying units cannot be recognized, are shown over a much smaller area of the Kailua quadrangle compared to the drier Hualalai quadrangle (Moore and others, 1986). The thick vegetation of the rain forest probably masks these thin airfall deposits. In addition, thin alluvial and colluvial deposits are present but have not been mapped.

Alkali olivine basalts of the Kailua quadrangle contain variable amounts

(estimated in the field) of olivine, plagioclase, and pyroxene phenocrysts; a few basaltic rocks are aphyric. MgO contents range from about 4-16 percent; the lowest values occur in basalts that are transitional to hawaiiite, and the highest values occur in ankaramitic lavas that contain abundant olivine and pyroxene phenocrysts. The latter rocks commonly have xenoliths of dunite, pyroxenite, and gabbro, although similar xenoliths also occur in less porphyritic lavas, especially those of A.D. 1800. Xenoliths of microsyenite (Moore and others, 1987) occur in one deposit.

DESCRIPTION OF MAP UNITS

UNITS LESS THAN 200 YEARS OLD

R19T10

v	f	c
7	7	7

Vent deposits, consisting of spatter and cinders that form ramparts and cones, and pahoehoe and aa flows, erupted in A.D. 1800. Vents occur discontinuously along 3.4 km of the northwest rift zone. At the highest (southeasternmost) vent, Kaupulehu Crater, little pyroclastic material is present; lava welled up inside a preexisting cone and spilled down its flanks. The middle vents produced the most cinders and the most voluminous flow, which reached the ocean in the Kiholo quadrangle (Clague and Bohrson, 1986). Unit consists of alkali olivine basalt with 1-3 percent olivine, 0-1 percent plagioclase, and 0-1 percent pyroxene phenocrysts. Xenoliths of mafic and ultramafic plutonic rocks are abundant. Radiocarbon ages of <200 years on flows (W-4634, W-5124) from the upper and lower vents confirm their temporal association with the large Kaupulehu flow in the Kiholo quadrangle.

UNITS 200-750 YEARS OLD

R00S75

v	f
6	6

Spatter deposits of Luamakami (Hualalai quadrangle; Moore and others, 1986)

and pahoehoe and aa flows. Unit consists of alkali olivine basalt with 2-5 percent olivine phenocrysts. ¹⁴C age is 300 ± 60 years (W-4394), but paleomagnetic studies (D.E. Champion, written commun., 1987) and degree of weathering suggest that the age of this unit is 600-700 years.

R14S84

v	f
6	6

 Spatter deposits and an aa and pahoehoe flow. Vent cuts an older spatter rampart (v R15S83) at a 90° angle. Unit consists of alkali olivine basalt with 1-3 percent olivine and 1-2 percent plagioclase phenocrysts.

UNITS 750-1,500 YEARS OLD

R05S81

v	f
5	5

 Spatter deposits and pahoehoe and aa flows. Unit consists of compositionally-variable alkali olivine basalt with 2-5 percent olivine, 1-6 percent plagioclase, and less than 1 percent pyroxene phenocrysts. ¹⁴C age is $1,030 \pm 60$ years (W-5130).

R15T08

v	f
5	5

 Spatter deposits and aa and pahoehoe flows. Vent deposits include the older part of Kaupulehu Crater. Composition is variable: early lava is differentiated alkali olivine basalt with about 1 percent olivine phenocrysts; lava intermediate in age and volumetrically greatest is alkali olivine basalt with 4-6 percent olivine, less than 1 percent plagioclase, and less than 1 percent pyroxene phenocrysts; late lava, extruded from the east side of the southeastern vent, is alkali olivine basalt with 5 percent olivine, 2 percent plagioclase, and 2 percent pyroxene phenocrysts and common xenoliths of mafic and ultramafic plutonic rocks.

UNITS 1,500-3,000 YEARS OLD

R13S97

f
4

 Pahoehoe and aa flows from a small satellitic shield. Pahoehoe buries the vent area; no pyroclastic materials are exposed. Unit consists of alkali olivine basalt with 1-3 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts. ¹⁴C age is 1,590 ± 100 years (W-5788).

R35T41

v	f
4	4

 Spatter deposits and extensive aa and pahoehoe flows. Four vent systems occur on the south side of the northwest rift zone; the middle two ramparts strike N25 W, in contrast to the N55 W trend of the other two vents and the northwest rift zone. Unit consists of alkali olivine basalt with 2-4 percent olivine, 1-2 percent plagioclase, and about 1 percent pyroxene phenocrysts and common xenoliths of gabbro. ¹⁴C age is 2,140 ± 100 years (W-5828).

R12S92

v	f
4	4

 Spatter deposits and extensive aa and pahoehoe flows. Deposits around source vent are dominantly pahoehoe flows, with little spatter, that built a satellitic shield. Unit consists of alkali olivine basalt with 2-3 percent olivine and less than 1 percent plagioclase phenocrysts.

R27T25

v	f
4	4

 Spatter deposits and pahoehoe and aa flows. Unit consists of alkali olivine basalt with 2-3 percent olivine, 0-1 percent plagioclase, and 0-1 percent pyroxene phenocrysts.

R23T24

v	f
4	4

 Spatter deposits and extensive aa and pahoehoe flows. Unit consists of alkali olivine basalt with 6-10 percent olivine, less than 1 percent plagioclase, and less than 1 percent pyroxene phenocrysts. Age, based on paleomagnetic studies (D.E. Champion, written commun., 1987), is about 2,200-2,300 years.

R15S83

v f
4 4

Spatter deposits and an aa and pahoehoe flow. Rampart strikes E-W. Unit consists of alkali olivine basalt with 1-2 percent olivine and 1-2 percent plagioclase phenocrysts.

R11S81

v f
4 4

Spatter deposits and a pahoehoe flow. Unit consists of alkali olivine basalt with 2 percent olivine and less than 1 percent pyroxene phenocrysts.

R10T01

v f
4 4

Spatter deposits and an extensive pahoehoe and aa flow. Unit consists of alkali olivine basalt with 1-3 percent olivine and 0-1 percent plagioclase phenocrysts. ¹⁴C age is $2,250 \pm 105$ years (R.I. Dorn, written commun., 1986).

Q98S73

v f
4 4

Spatter deposits and aa and pahoehoe flows. Source is the older part of Luamakami (Hualalai quadrangle). Unit consists of alkali olivine basalt with 1-3 percent olivine phenocrysts. ¹⁴C age is $2,350 \pm 80$ years (W-5068).

R29T31

v f
4 4

Spatter deposits and an aa and pahoehoe flow. Unit consists of alkali olivine basalt with about 6 percent olivine phenocrysts. ¹⁴C age is $2,700 \pm 100$ years (W-5796).

UNITS 3,000-5,000 YEARS OLD

R22T63

f
3

Pahoehoe and aa flow. Unit consists of alkali olivine basalt generally with 1-3 percent olivine and less than 1 percent plagioclase phenocrysts and rare xenoliths of mafic and ultramafic plutonic rocks; locally, olivine ranges up to 5 volume percent in the lower parts of individual pahoehoe flow units. ¹⁴C age is $3,020 \pm 150$ years (W-5801).

Q94S84

v f
3 3

Spatter deposits and an extensive aa and pahoehoe flow. Unit consists of alkali olivine basalt with 6-8 percent olivine, 0-1 percent pyroxene, and 0-1 percent plagioclase phenocrysts.

R01S77

v f
3 3

Spatter deposits and aa and pahoehoe flows. Unit consists of alkali olivine basalt with 4-6 percent plagioclase, 2-3 percent olivine, and 1-2 percent pyroxene phenocrysts. ¹⁴C age is $3,100 \pm 80$ years (W-5127).

R15T09

v f
3 3

Spatter deposits and a pahoehoe and aa flow. Unit consists of alkali olivine basalt with 1-5 percent plagioclase, 1-3 percent olivine, and 0-1 percent pyroxene phenocrysts; plagioclase abundances are variable in cross-sectional exposures. ¹⁴C age is $3,600 \pm 70$ years (W-4376).

Q98S70

v f
3 3

Spatter deposits and pahoehoe and aa flows. Unit consists of alkali olivine basalt with 1-3 percent olivine and 1-2 percent plagioclase phenocrysts. ¹⁴C age is $3,990 \pm 70$ years (W-5132).

Q97S80

v f
3 3

Spatter deposits and an aa and pahoehoe flow. Unit consists of alkali olivine basalt with 4-6 percent olivine phenocrysts. ¹⁴C age is $4,390 \pm 70$ years (W-5070).

R38T40

v f
3 3

Spatter deposits and an aa and pahoehoe flow. Unit consists of alkali olivine basalt with 8-10 percent olivine, less than 1 percent plagioclase, and less than 1 percent pyroxene phenocrysts. ¹⁴C age is $4,700 \pm 350$ years (W-5789).

Q96S77

v f
3 3

Spatter deposits and a pahoehoe and aa flow. Unit consists of alkali olivine basalt with 10-15 percent olivine, 1-3 percent pyroxene, and less than 1 percent plagioclase phenocrysts and abundant xenoliths of mafic and ultramafic plutonic rocks

and microsyenite. C age is $4,720 \pm 80$ years (W-4378).

Q98S79

v	c
3	3

 Spatter deposits and associated airfall cinders. Unit consists of alkali olivine basalt with 6-8 percent olivine, less than 1 percent pyroxene, and less than 1 percent plagioclase phenocrysts.

Q81S53

f
3

 Extensive pahoehoe and aa flow; source is Umiahu (Hualalai quadrangle). Unit consists of alkali olivine basalt with 4-8 percent olivine, 0-1 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

Q68S57

f
3

 Aa flow; source is Puu Hale (Hualalai quadrangle). Unit consists of alkali olivine basalt with 2-5 percent olivine, 1-3 percent plagioclase, and 1-2 percent pyroxene phenocrysts.

Q90T41

f
3

 Aa flow, consisting of alkali olivine basalt with about 4 percent olivine and 0-1 percent pyroxene phenocrysts.

Q89T72

f
3

 Pahoehoe flow, consisting of alkali olivine basalt with 1-2 percent olivine and 0-1 percent plagioclase phenocrysts.

R03S81

v	f
3	3

 Spatter deposits and an aa flow. Unit consists of alkali olivine basalt with 0-1 percent olivine phenocrysts.

R24T51

f
3

 Pahoehoe flow, consisting of alkali olivine basalt with about 1 percent olivine phenocrysts.

R01T69

f
3

 Pahoehoe flow, consisting of alkali olivine basalt with about 3 percent pyroxene, 2 percent plagioclase, and 1-2 percent olivine phenocrysts.

R48T42

f
3

Pahoehoe flow, consisting of alkali olivine basalt with about 2 percent olivine and less than 1 percent plagioclase phenocrysts.

R36T28

v f
3 3

Spatter deposits and an aa and pahoehoe flow. Unit consists of alkali olivine basalt with about 5 percent olivine and 1 percent plagioclase phenocrysts.

R37T12

f
3

Aa flow, consisting of alkali olivine basalt with about 8 percent olivine, 2 percent plagioclase, and 1-2 percent pyroxene phenocrysts.

R40S77

v f
3 3

Spatter deposits and a pahoehoe and aa flow. Unit consists of alkali olivine basalt with 5-8 percent olivine phenocrysts.

R06S82

v f
3 3

Spatter deposits and pahoehoe and aa flows; includes small areas of debris deposited by phreatic explosions that were probably associated with formation of a 200-m-deep pit crater, the deepest on Hualalai. Unit consists of alkali olivine basalt with less than 1 percent plagioclase phenocrysts.

R06S90

v f
3 3

Spatter deposits and a pahoehoe and aa flow. Spatter forms a rampart and also crops out near the bottom of a pit crater formed near the end of eruption of

v R05S81. Flow is thickly mantled by comagmatic cinders. Unit consists of alkali olivine basalt with 8-12 percent olivine phenocrysts.

UNITS 5,000-10,000 YEARS OLD

Q90S82

v f
2 2

Spatter deposits and an extensive aa flow. Unit consists of alkali olivine basalt with 5-8 percent olivine, 1-2 percent pyroxene, and less than 1 percent

plagioclase phenocrysts. C age is $7,520 \pm 200$ years (W-5978).

Q80T00

f
2

Aa and pahoehoe flow, consisting of alkali olivine basalt with 3-5 percent olivine, 1-3 percent plagioclase, and 1 percent pyroxene phenocrysts.

Q40S75

f
2

Aa flow, consisting of alkali olivine basalt with 1-3 percent plagioclase, 1 percent olivine, and 1 percent pyroxene phenocrysts.

Q39S75

f
2

Aa flow, consisting of alkali olivine basalt with about 1 percent olivine phenocrysts.

Q38S75

f
2

Pahoehoe flow, consisting of alkali olivine basalt generally with 6-10 percent olivine phenocrysts; in tumuli, olivine ranges from 1-20 volume percent.

Q30T10

f
2

Aa flow, consisting of alkali olivine basalt with 6-8 percent olivine, 1-2 pyroxene, and less than 1 percent plagioclase phenocrysts and scattered xenoliths of mafic and ultramafic plutonic rocks.

Q84T78

f
2

Aa flow, consisting of alkali olivine basalt with 2 percent olivine, 1 percent plagioclase, and 1 percent pyroxene phenocrysts.

Q88T77

f
2

Aa flow, consisting of alkali olivine basalt with 3 percent olivine phenocrysts.

R11T76

f
2

Aa flow, consisting of alkali olivine basalt with 4 percent olivine, 1 percent plagioclase, and 1 percent pyroxene phenocrysts and common xenoliths of gabbro.

R19T98

f
2

Pahoehoe flow, consisting of alkali olivine basalt with 8 percent olivine

phenocrysts.

R27T86

f
2

 Pahoehoe flow, consisting of alkali olivine basalt with 7 percent olivine phenocrysts.

R34T68

v	f
2	2

 Spatter deposits and pahoehoe and aa flows. Unit consists of alkali olivine basalt with 6-8 percent olivine phenocrysts.

R39T76

v	f
2	2

 Spatter deposits and an aa flow. Unit consists of alkali olivine basalt with 4-6 percent olivine phenocrysts.

R40T51

v	f
2	2

 Spatter deposits of Moanuaiea, and pahoehoe flows. Unit consists of alkali olivine basalt with 1-6 percent olivine and less than 1 percent plagioclase phenocrysts.

R40T41

f
2

 Aa and pahoehoe flow, consisting of alkali olivine basalt with 2-4 percent plagioclase, 2-4 percent olivine, and 1 percent pyroxene phenocrysts and common xenoliths of gabbro.

R49T55

f
2

 Aa flow, consisting of alkali olivine basalt with 1-3 percent olivine and less than 1 percent plagioclase phenocrysts. Flow appears only slightly weathered and young, but it clearly underlies f R40T41.

2

R48T50

f
2

 Aa flow, consisting of alkali olivine basalt with 6 percent olivine phenocrysts.

R39T46

v	f
2	2

 Spatter deposits and a pahoehoe and aa flow. Unit consists of alkali olivine

basalt with 4 percent olivine phenocrysts.

R49T53

f
2

 Pahoehoe flow, consisting of alkali olivine basalt with 5 percent olivine phenocrysts.

R42T37

v	f
2	2

 Spatter deposits and an aa flow. Unit consists of alkali olivine basalt with 6 percent olivine, less than 1 percent pyroxene, and less than 1 percent plagioclase phenocrysts.

R41T35

f
2

 Pahoehoe flow, consisting of alkali olivine basalt with 1 percent olivine phenocrysts.

R43T39

f
2

 Aa flow, consisting of alkali olivine basalt with 5 percent olivine, 1 percent pyroxene, and 1 percent plagioclase phenocrysts.

R40T38

v
2

 Spatter deposits, consisting of alkali olivine basalt with 10-15 percent olivine phenocrysts and scattered xenoliths of dunite.

R31T33

v	f
2	2

 Spatter deposits and an aa and pahoehoe flow. Unit consists of alkali olivine basalt with 5 percent olivine phenocrysts.

R32T31

v
2

 Spatter deposits, consisting of alkali olivine basalt with 6 percent olivine phenocrysts.

R49T27

v	f
2	2

 Spatter deposits and an aa flow. Unit consists of alkali olivine basalt with 2-4 percent plagioclase and 1-2 percent olivine phenocrysts.

R29T16

v	f
2	2

 Spatter deposits and an aa flow. Unit consists of alkali olivine basalt with

5 percent olivine, 3 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

R22T21

v
2

 Spatter deposits, consisting of alkali olivine basalt with less than 1 percent plagioclase phenocrysts.

R20T16

v
2

 Spatter deposits of Hinakapoula, consisting of alkali olivine basalt with 2-4 percent olivine and 1-3 percent plagioclase phenocrysts.

R49T09

f
2

 Aa flow, consisting of alkali olivine basalt with 1 percent olivine phenocrysts.

R47T01

f
2

 Aa flow, consisting of alkali olivine basalt with 3 percent plagioclase and 1 percent olivine phenocrysts.

R44S87

v
2

 Spatter deposits, consisting of alkali olivine basalt with 8-10 percent olivine phenocrysts.

R39S85

v
2

 Spatter deposits, consisting of alkali olivine basalt with 4-7 percent olivine and 1 percent pyroxene phenocrysts.

R49S79

v
2

 Spatter deposits, consisting of alkali olivine basalt with 8-12 percent olivine phenocrysts.

R25S67

f
2

 Aa flow, consisting of alkali olivine basalt with 3-6 percent plagioclase and 1-2 percent olivine phenocrysts.

R10S89

v	f
2	2

 Spatter deposits and aa flows. Unit consists of alkali olivine basalt with 4-8 percent olivine phenocrysts and abundant xenoliths of gabbro and anorthosite.

R19T01

v	f
2	2

 Spatter deposits of Kalulu and an adjacent cone, and a pahoehoe and aa flow. Unit consists of alkali olivine basalt with 6-8 percent olivine phenocrysts.

R22T02

v	f
2	2

 Spatter deposits and an aa flow. Unit consists of alkali olivine basalt with 3 percent plagioclase and 1 percent olivine phenocrysts.

R40T49

v	
2	

 Spatter deposits that form two small cones. Unit consists of alkali olivine basalt with about 1 percent olivine phenocrysts.

R05S79

v	f
2	2

 Spatter deposits and a pahoehoe and aa flow. Unit consists of alkali olivine basalt with 6-8 percent olivine, 1 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

R06S81

v	f
2	2

 Spatter deposits and a pahoehoe and aa flow. Unit consists of alkali olivine basalt with 6-8 percent olivine, 1 percent pyroxene, and 1 percent plagioclase phenocrysts and abundant xenoliths of gabbro.

R08S78

v	
2	

 Spatter deposits, consisting of alkali olivine basalt with 6-10 percent olivine phenocrysts and abundant xenoliths of gabbro.

R13S84

v	f
2	2

 Spatter deposits and an aa and pahoehoe flow. Unit consists of alkali olivine basalt with about 6 percent olivine phenocrysts and scattered xenoliths of gabbro.

R12S86

f	
2	

 Aa flow, consisting of alkali olivine basalt with 5 percent plagioclase and 2

percent olivine phenocrysts.

R18S86

v	f
2	2

 Spatter deposits and an aa and pahoehoe flow. Unit consists of alkali olivine basalt with 7-10 percent olivine phenocrysts.

R12S88

v
2

 Spatter deposits, consisting of alkali olivine basalt with about 2 percent olivine phenocrysts.

R04S76

v
2

 Spatter deposits that form three small cones. Unit consists of alkali olivine basalt with 3-5 percent olivine phenocrysts and abundant xenoliths of gabbro.

Q50S80

f
2

 Pahoehoe flow, consisting of alkali olivine basalt with about 5 percent olivine and 1 percent pyroxene phenocrysts and scattered xenoliths of mafic and ultramafic plutonic rocks.

R04S87

v
2

 Spatter deposits, consisting of alkali olivine basalt with 1-3 percent olivine and 1-2 percent plagioclase phenocrysts.

R08S91

v
2

 Spatter deposits exposed in a small pit crater that probably formed near the end of eruption of R05S81. Unit consists of alkali olivine basalt with 4-8 percent plagioclase and less than 1 percent olivine phenocrysts.

UNITS MORE THAN 10,000 YEARS OLD

Q92S73

v	f
1	1

 Spatter deposits of Puu Honuaula (Hualalai quadrangle), and a large aa and pahoehoe flow. Unit consists of alkali olivine basalt with 5-10 percent olivine, 1 percent pyroxene, and less than 1 percent plagioclase phenocrysts.

oc Widespread airfall cinders of alkali olivine basalt, representing the products of vigorous Strombolian or sub-Plinian eruptions. Cinder deposits are up to several meters thick and are yellow-brown. Sources include Hainoa Crater (Hualalai quadrangle) and possibly other nearby vents. Not mapped where underlying units can be recognized.

Q94S70

f
1 Extensive pahoehoe and aa flow; source is former lava lake at Hainoa Crater (Hualalai quadrangle). Unit consists of alkali olivine basalt, transitional to hawaiite, generally with 4-12 percent plagioclase, 1-4 percent olivine, and 1-2 percent pyroxene phenocrysts; locally, settling of olivine and pyroxene has resulted in development of ankaramite near the bases and plagioclase-rich lava near the tops of individual pahoehoe flow units.

Q90S90

v f
1 1 Spatter deposits and a extensive pahoehoe and aa flow. Unit consists of alkali olivine basalt generally with 5 percent plagioclase, 3 percent olivine, and 1-2 percent pyroxene phenocrysts; settling of phenocrysts has resulted in petrographic variability that is visible in cross-sectional exposures. ¹⁴ C age is 12,950 ± 150 years (W-5056).

Q72T10

f
1 Pahoehoe flow, consisting of alkali olivine basalt, transitional to ankaramite, generally with 15-30 percent olivine, 5-10 percent pyroxene, and 0-1 percent plagioclase phenocrysts; settling of phenocrysts has resulted in petrographic variability that is visible in cross-sectional exposures.

Q76S77

v f
1 1 Spatter deposits that form Puu Laalaa and another cone 1.5 km to the southwest, and aa and pahoehoe flows. Unit consists of alkali olivine basalt, transitional to hawaiite, with 8-12 percent plagioclase, 2-5 percent olivine, and 1-2 percent pyroxene phenocrysts.

Q30T64

F
1 Pahoehoe flow, consisting of alkali olivine basalt with 2 percent olivine phenocrysts.

Q42T20

F
1 Aa flow, consisting of alkali olivine basalt, transitional to hawaiite, that is either aphyric or contains less than 1 percent plagioclase phenocrysts.

Q65T48

F
1 Pahoehoe and aa flows, consisting of alkali olivine basalt with about 1 percent olivine and less than 1 percent plagioclase phenocrysts.

Q52T51

F
1 Aa flow, consisting of alkali olivine basalt with 8 percent plagioclase, 1 percent olivine, and 1 percent pyroxene phenocrysts.

Q96S90

v
1 Spatter deposits, consisting of alkali olivine basalt, transitional to hawaiite, with about 1 percent plagioclase phenocrysts.

Q29T32

F
1 Pahoehoe flow, consisting of alkali olivine basalt with 6 percent olivine phenocrysts.

Q88S85

F
1 Aa flow, consisting of alkali olivine basalt with about 1 percent each of plagioclase, pyroxene, and olivine phenocrysts.

REFERENCES

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Moore, R.B., Trusdell, F.A., Clague, D.A., and Bohrson, W.A., 1986, Preliminary geologic map of the Hualalai quadrangle, Hawaii: U.S. Geol. Survey open-file report

86-270, scale 1:24,000.

Moore, R.B., Clague, D.A., Rubin, M., and Bohrson, W.A., 1987, Hualalai Volcano, Hawaii: a preliminary summary of geologic, petrologic, and geophysical data: U.S. Geol. Survey Prof. Paper 1350, chap. 20, p. 571-585.

GEOLOGIC MAP SYMBOLS

v=vent deposit, f=lava flow, c=cinders

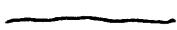
Subscripts (1-7) indicate relative age classification: 7=<200 years old; 6=200-750 years old; 5=750-1,500 years old; 4=1,500-3,000 years old; 3=3,000-5,000 years old; 2=5,000-10,000 years old; 1=>10,000 years old.

A six-character symbol consisting of a letter plus two digits followed by a second letter and two more digits is a unique geographic identifier for each vent deposit and its related flows. The pair of letter-digit-digit combinations represents a pair of coordinates on an island-wide grid based on latitude and longitude (E.W. Wolfe and C.A. Neal, written commun., 1985). The letters represent 6-minute intervals in the grid. In the Kailua quadrangle, Q or R in the first position correspond, respectively, to latitude $19^{\circ} 36'$ and $19^{\circ} 42'$ or 19.6° and 19.7° . Similarly, S or T in the fourth position correspond, respectively, to longitude $155^{\circ} 48'$ and $155^{\circ} 54'$ or 155.8° and 155.9° . The two numbers that follow each letter correspond to hundredths and thousandths of degrees. Thus, the identifier R10T01 refers to a grid position at latitude 19.710° and longitude 155.901° . The identifier for flows that cannot be traced to vents within the Kailua or Hualalai quadrangles is chosen arbitrarily to represent the grid position of the part of the flow closest to the axis of Hualalai's major northwest-trending rift zone.

Each volcanic map unit is the product of a brief geologic event. In the absence of

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¹⁴C ages (there are 18 for the Kailua quadrangle), there is no certainty about the absolute age of a map unit. The units are included in chronostratigraphic groups on the bases of field stratigraphic relationships, the few ¹⁴C ages, amount of soil development, paleomagnetic studies (D.E. Champion, written commun., 1987), and degree of degradation of surface glass and primary flow features. A bracket on the correlation chart indicates the possible age range of any unit or sequence of units. Stratigraphic relationships are indicated by the vertical placement on the correlation chart.



Contact, approximately located

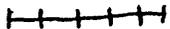
X
1,030 ± 60
years

Location and age of ¹⁴C-dated charcoal sample

Geology mapped in 1987

O/Y

Relatively older and younger units, at location where relationship is demonstrable



Buried vent for f R13S97
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