Soil Survey Investigations Report No. 29

Soil Survey Laboratory Data and Descriptions for Some Soils of...

...HAWAII

Soil survey investigations reports already published:

SSIR No. 1 Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples

SSIR No. 21 A Toposequence of Soils in Tonalite Grus in the Southern California Peninsular Range

Soil Survey Laboratory Data and Descriptions for Some Soils of:

SSIR No. 2 North Dakota
SSIR No. 3 Iowa
SSIR No. 4 Kansas
SSIR No. 5 Nebraska
SSIR No. 6 Arkansas, Louisiana, and Missouri
SSIR No. 7 Montana
SSIR No. 8 Wyoming
SSIR No. 9 Minnesota
SSIR No. 10 Colorado
SSIR No. 11 Oklahoma
SSIR No. 12 Puerto Rico and the Virgin Islands
SSIR No. 13 Mississippi
SSIR No. 14 Kentucky
SSIR No. 15 Tennessee
SSIR No. 16 North Carolina, South Carolina, and Georgia
SSIR No. 17 Wisconsin
SSIR No. 18 Indiana
SSIR No. 19 Illinois
SSIR No. 20 New England States

SSIR No. 23 Nevada
SSIR No. 24 California
SSIR No. 25 New York
SSIR No. 26 New Jersey

SSIR No. 28 Arizona

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January 1976

SOIL CONSERVATION SERVICE • U.S. DEPARTMENT OF AGRICULTURE
In cooperation with
HAWAII AGRICULTURAL EXPERIMENT STATION · HAWAIIAN SUGAR PLANTERS' ASSOCIATION

PREFACE

The Soil Survey Investigations Report (SSIR) series was established to preserve and make available technical information resulting from soil survey investigations of the Soil Conservation Service, U.S. Department of Agriculture. SSIR No. 1, "Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples," revised April 1972, describes in detail the methods used in the soil survey laboratories. Most of the remaining reports are a collection of pedon descriptions and laboratory data for pedons from individual states and groups of states. The reports already published are listed on the inside front cover of this report.

This report covers the results of a joint effort of the Department of Agronomy and Soil Science of the University of Hawaii, the Hawaiian Sugar Planters' Association, the SCS soil survey laboratories, the SCS soil mechanics laboratories, and SCS field soil scientists to characterize in detail the important soils of Hawaii. It supplements "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii" (1972) and "Soil Survey of Island of Hawaii, State of Hawaii" (1973). The soils contained in this report represent the central concept of important soil series that had been recognized in these surveys. The reader should consult these soil surveys for information on the extent, use, and interpretation of the soils for farm and nonfarm purposes. These published soil surveys also contain information on soil-forming factors. The reader should consult "Soil Taxonomy--A Basic System of Soil Classification for Making and Interpreting Soil Surveys," AH-436 (in press) for criteria used in the classification of these soils.

The pedons contained in this report were classified in soil series and taxa at higher categories. Taxonomic standards were applied rigorously. If a pedon was outside the limits of a recognized soil series, it was designated a taxadjunct to the series it resembled most closely. All these pedons were similar enough to a recognized series to allow use of the taxadjunct concept.

Soil scientists of the Soil Conservation Service selected typical sample sites for individual series and prepared pedon descriptions. The soils were sampled cooperatively by soil scientists of the three organizations that participated in this project. The Hawaiian Sugar Planters' Association made particle density, bulk density, and water retention determinations on all samples collected in 1962, 1963, and 1965. The University of Hawaii made the total analyses and the mineralogical analyses for soils sampled after 1961. The SCS soil survey laboratories made the remaining analyses with the exception of those for Atterberg limits, which were made by the SCS soil mechanics laboratory at Portland, Oregon.

Since some soils in Hawaii never dry in the field, samples from these soils may change drastically when dried in the laboratory. Special precautions were therefore taken to measure the following moisture-influenced properties as near the field moisture content as possible. These are cation exchange capacity, exchangeable cations, extractable sulfate, extractable acidity (when measured), pH, water retention properties, and Atterberg limits. Other properties were determined on samples that were allowed to become air dry. In a few instances the values for the field moist and the air dry soil are given. All results, however, are reported on an oven dry basis.

Analyses made by the SCS soil survey laboratories are identified by code. These codes are briefly explained on the following pages. The methods used by the University of Hawaii and the Hawaiian Sugar Planters' Association are described in the appendix.

Soil Survey
Soil Conservation Service
Department of Agronomy and Soil Science
University of Hawaii
Hawaiian Sugar Planters' Association

METHODS CODE SYMBOLS*

1. SAMPLE COLLECTION AND PREPARATION

[redacted]

1. Site selection
2. Soil sampling
   a. Stony soils
   b. Marsh and swamp soils

B. Laboratory preparation
1. Standard (airdry)
   a. Square-hole 2-mm sieve
   b. Round-hole 2-mm sieve
2. Field moist
3. Carbonate-containing material
4. Carbonate-indurated material

2. CONVENTIONS

A. Size-fraction base for reporting
1. <2-mm
2. <size specified

B. Data sheet symbols

tr: trace, not measurable by quantitative procedure used or less than reportable amount

tr(s): trace, detectable only by qualitative procedure more sensitive than quantitative procedure used

- : analysis run but none detected

-(s): none detected by sensitive qualitative test

blank: analysis not run

nd: analysis not run

<: less than reported amount or none present

3. PARTICLE-SIZE ANALYSES

A. Particles < 2-mm (pipet method)
1. Airdry samples
   a. Carbonate and noncarbonate clay
   b. Fine clay
   c. Water-dispersible clay
2. Moist samples
   a. Carbonate and noncarbonate clay
   b. Fine clay
   c. Water-dispersible clay

B. Particles > 2-mm
1. Weight estimates
   a. By field and laboratory weighing
   b. From volume and weight estimates
2. Volume estimates

4. FABRIC-RELATED ANALYSES

A. Bulk density
1. Saran-coated clods
   a. Field state
   b. Airdry
   c. 30-cm absorption
   d. 1/3-bar desorption I
   e. 1/3-bar desorption II
   f. 1/3-bar desorption III
   g. 1/10-bar desorption
   h. Ovendry
2. Paraffin-coated clods
   a. Ovendry
3. Cores
   a. Field moist
4. Nonpolar-liquid-saturated clods

B. Water retention
1. Pressure-plate extraction (1/3 or 1/10 bar)
   a. Sieved samples
   b. Soil pieces
   c. Natural clods
   d. Cores
2. Pressure-membrane extraction (15 bars)
   a. Field-moist samples
3. Sand-table absorption
4. Field state
5. Airdry

C. Water-retention difference
1. 1/3 bar to 15 bars
2. Scanning electron microscopy

F. Plasticity index
1. Liquid limit
2. Upper plastic limit

5. ION-EXCHANGE ANALYSES

A. Cation-exchange capacity
1. NH_4OAc, pH 7.0
   a. Direct distillation
   b. Displacement, distillation
2. NaOAc, pH 8.2
   a. Centrifuge method
3. Sum of cations
   a. Acidity by $BaCl_2$-TEA, pH 8.2; bases by NH_4OAc, pH 7.0
   b. Sum of bases plus Al
4. KOAc, pH 7.0
5. $BaCl_2$, pH 8.2
   a. Barium by flame photometry
6. NH_4OAc, pH 7.0 leaching tube
   a. Direct distillation

B. Extractable bases
1. NH_4OAc extraction
   a. Uncorrected
   b. Corrected (exchangeable)
   c. See 5B4
2. KCl-TEA extraction, pH 8.2
3. KCl-TEA, pH 8.2 (revised)
   a. Uncorrected
   b. Corrected (exchangeable)
4. NH_4OAc, pH 7.0 (modified)
   a. Uncorrected
   b. Corrected (exchangeable)

C. Base saturation
1. NH_4OAc, pH 7.0
2. NaOAc, pH 8.2
3. Sum of cations

D. Sodium saturation (exchangeable Na pct.)
1. NaOAc, pH 8.2
2. NH_4OAc, pH 7.0

E. Sodium-adsorption ratio

F. Calcium saturation
1. NH_4OAc, pH 7.0

6. CHEMICAL ANALYSES

A. Organic carbon
1. Acid-dichromate digestion
   a. $FeSO_4$ titration
   b. CO_2 evolution, gravimetric
2. Dry combustion
   a. CO_2 evolution I
   b. CO_2 evolution II
3. Peroxide digestion
   a. Weight loss

B. Nitrogen
1. Kjeldahl digestion
   a. Ammonia distillation
2. Semimicro Kjeldahl
   a. Ammonia distillation

C. Iron
1. Dithionite extraction
   a. Dichromate titration
   b. EDTA titration
2. Dithionite-citrate extraction
   a. Orthophenanthroline colorimetry
   b. Atomic absorption
3. Dithionite-citrate-bicarbonate extraction
   a. Potassium thiocyanate colorimetry
4. Pyrophosphate-dithionite extraction
5. Sodium-pyrophosphate extraction
   a. Atomic absorption
6. Ammonium oxalate extraction
   a. Atomic absorption

D. Manganese

6. CHEMICAL ANALYSES (cont.)
    d. Weight gain
    e. Titrimetric
    f. Warburg method
  2. Sensitive qualitative method
    a. Visual, gas bubbles
  3. H_2SO_4 treatment
    a. Weight gain
F. Gypsum
  1. Water extract
    a. Precipitation in acetone
    b. Indirect estimate
G. Aluminum
  1. KCl extraction I, 30 min.
    a. Aluminon I
    b. Aluminon II
    c. Aluminon III
    d. Fluoride titration
    e. Atomic absorption
  2. KCl extraction II, overnight
    a. Aluminon I
  3. NH_4OAc extraction
    a. Aluminon III
  4. NaOAc extraction
    a. Aluminon III
  5. Sodium pyrophosphate extraction
    a. Atomic absorption
  6. Ammonium oxalate extraction
    a. Atomic absorption
  7. Dithionite-citrate extraction
    a. Atomic absorption
H. Extractable acidity
  1. $BaCl_2$-triethanolamine I
    a. Back-titration with HCl
  2. $BaCl_2$-triethanolamine II
    a. Back-titration with HCl
  3. KCl-triethanolamine
    a. Back-titration with NaOH
I. Carbonate
  1. Saturation extract
    a. Acid titration
J. Bicarbonate
  1. Saturation extract
    a. Acid titration
K. Chloride
  1. Saturation extract
    a. Mohr titration
    b. Potentiometric titration
L. Sulfate
  1. Saturation extract
    a. Gravimetric, $BaSO_4$
    b. EDTA titration
  2. NH_4OAc extraction
    a. Gravimetric, $BaSO_4$
M. Nitrate
  1. Saturation extract
    a. PDS acid colorimetry
    b. Diphenylamine
N. Calcium
  1. Saturation extract
    a. EDTA titration
    b. Atomic absorption
  2. NH_4OAc extraction
    a. EDTA-alcohol separation
    b. Oxalate-permanganate I
    c. Oxalate-permanganate II
      Fe, Al, and Mn removed
    d. Oxalate-cerate
    e. Atomic absorption
  3. NH_4Cl-EtOH extraction
    a. EDTA titration
  4. KCl-TEA extraction
    a. Oxalate-permanganate
    b. EDTA titration
    c. Atomic absorption
O. Magnesium
  1. Saturation extract
    a. EDTA titration
    b. Atomic absorption
  2. NH_2OAc extraction
    a. EDTA-alcohol separation
    b. Phosphate titration

6. CHEMICAL ANALYSES (cont.)
    c. Gravimetric, $Mg_2P_2O_7$
    d. Atomic absorption
  3. NH_4Cl-EtOH extraction
    a. EDTA titration
  4. KCl-TEA extraction
    a. Phosphate titration
    b. EDTA titration
    c. Atomic absorption
P. Sodium
  1. Saturation extract
    a. Flame photometry
    b. Atomic absorption
  2. NH_4OAc extraction
    a. Flame photometry
    b. Atomic absorption
Q. Potassium
  1. Saturation extract
    a. Flame photometry
    b. Atomic absorption
  2. NH_4OAc extraction
    a. Flame photometry
    b. Atomic absorption
R. Sulfur
  1. $NaHCO_3$ extract, pH 8.5
    a. Methylene blue
  2. HCl release (sulfide)
    a. Iodine titration
S. Total phosphorus
  1. Perchloric acid digestion
    a. Molybdovanadophosphoric acid colorimetry
7. MINERALOGY
A. Instrumental analysis
  1. Preparation
    a. Carbonate removal
    b. Organic-matter removal
    c. Iron removal
    d. Particle-size fractionation
    e. PSDA pretreatment
  2. X-ray diffraction
    a. Thin film on glass, solution pretreatment
    b. Thin film on glass, resin pretreatment
    c. Thin film on glass, $NaPO_3$ pretreatment
    d. Thin film on tile, solution pretreatment
    e. Thin film on tile, resin pretreatment
    f. Thin film on tile, $NaPO_3$ pretreatment
    g. Powder mount, diffractometer recording
    h. Powder mount, camera recording
  3. Differential thermal analysis
B. Optical analysis
  1. Grain studies
  2. Electron microscopy
C. Total analysis
  1. Chemical
  2. X-ray emission spectrography
D. Surface area
  1. Gylcerol retention
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A. Saturated paste, mixed
  1. Saturation extract
    a. Conductivity
    b. Conductivity, quick test
  2. Conductivity, saturated paste
B. Saturated paste, capillary rise
  1. Saturation extract
    a. Conductivity
C. pH
  1. Soil suspensions
    a. Water dilution
    b. Saturated paste
    c. KCl
    d. NaF
    e. $CaCl_2$
D. Ratios and estimates
  1. To total clay
  2. To noncarbonate clay
  3. Ca to Mg (extractable)
  4. Estimated clay percentage
  5. Estimated total salt
E. Soil resistivity
  1. Saturated paste

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ARIDISOLS

ORTHIDS

CAMBORTHIDS

Ustollic Camborthids
Medial, isohyperthermic
Kawaihae 3
Kawaihae 5

Fine-loamy, kaolinitic, isohyperthermic
Holomua 7
Holomua 9

Fine, kaolinitic, isohyperthermic
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Ewa, taxadjunct 13

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AQUENTS

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Tropic Fluvaquents
Very fine, oxidic, nonacid, isohyperthermic
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Kekaha	S65Ha-2-1	Haplustoll	103
Kohala	S65Ha-1-3	Humitropept	83
Kohala	S65Ha-1-4	Humitropept	85
Koolau	S58Ha-2-105	Tropaquept	75
Lahaina, taxadjunct	S61Ha-7-6	Ustropept	89
Lawai	S63Ha-2-5	Umbriorthox	171
Lawai	S63Ha-2-6	Umbriorthox	173
Leilehua	S61Ha-7-9	Tropohumult	137
Lihue	S62Ha-2-7	Eutrustox	185
Lihue	S62Ha-2-8	Eutrustox	187
Lolekaa	S63Ha-7-3	Tropohumult	129
Lualualei	S62Ha-7-1	Chromustert	203
Lualualei	S62Ha-7-2	Chromustert	205
Mahana	S65Ha-2-2	Acrohumox	157
Mahana	S65Ha-2-3	Acrohumox	159
Maile	S65Ha-1-7	Dystrandept	31
Maile	S65Ha-1-8	Dystrandept	33
Makapili	S63Ha-2-3	Umbriorthox	175
Makapili	S63Ha-2-4	Umbriorthox	177
Makaweli	S62Ha-2-2	Haplustoll	105
Makaweli	S62Ha-2-3	Haplustoll	107
Manana	S61Ha-7-2	Tropohumult	149
Manana	S61Ha-7-11	Tropohumult	151
Molokai	S61Ha-7-5	Torrox	181
Molokai	S61Ha-7-10	Torrox	183
Naalehu	S65Ha-1-11	Eutrandept	39
Naalehu	S65Ha-1-12	Eutrandept	41
Naiwa	S58Ha-4-18	Humitropept	79
Naiwa	S58Ha-4-19	Humitropept	81
Nohili	S63Ha-2-7	Haplaquoll	95
Nohili	S63Ha-2-8	Haplaquoll	97
Paaloa	S58Ha-7-1	Tropohumult	139
Paaloa	S58Ha-7-2	Tropohumult	141
Paaloa	S61Ha-7-1	Tropohumult	143
Paaloa	S65Ha-7-1	Tropohumult	145
Paaloa	S65Ha-7-2	Tropohumult	147
Paauhau	S61Ha-1-3	Dystrandept	29
Paia	S65Ha-4-17	Haplustoll	109
Paia	S65Ha-4-18	Haplustoll	111
Pakini	S65Ha-1-9	Eutrandept	53
Pakini, taxadjunct	S65Ha-1-10	Eutrandept	43
Pamoa	S63Ha-5-5	Haplustoll	113
Pamoa	S63Ha-5-6	Haplustoll	115
Pane	S65Ha-4-23	Dystrandept	25
Pane	S65Ha-4-24	Dystrandept	27
Pauwela	S62Ha-4-3	Tropohumult	131
Pauwela	S62Ha-4-4	Tropohumult	133
Pooku	S62Ha-2-4	Gibbsiorthox	167
Pooku	S62Ha-2-5	Gibbsiorthox	169
Puhi	S63Ha-2-1	Eutrorthox	161
Puhi, taxadjunct	S63Ha-2-2	Umbriorthox	179
Uwala	S62Ha-3-3	Ustropept	91
Uwala	S62Ha-3-4	Ustropept	93
Wahiawa	S61Ha-7-7	Eutrustox	189
Wahiawa	S61Ha-7-8	Eutrustox	191
Waiakoa	S65Ha-4-19	Haplustoll	125
Waiakoa, taxadjunct	S65Ha-4-20	Haplustoll	101
Waihuna	S62Ha-3-1	Chromustert	199
Waihuna	S62Ha-3-2	Chromustert	201
Waikaloa	S65Ha-1-1	Eutrandept	55
Waikaloa	S65Ha-1-2	Eutrandept	57
Waimea	S58Ha-1-3	Eutrandept	45
Waimea	S58Ha-1-4	Eutrandept	47

1/ In Hawaii the alphabetical numbers of the inhabited islands instead of those of the counties are used in the Soil Survey Number. Island numbers (the number following "Ha" in the Soil Survey Number) are as follows:

1. Hawaii
2. Kauai
3. Lanai
4. Maui
5. Molokai
7. Oahu

SOIL FAMILY Ustollic Camborthid, medial, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kawaihae very stony very fine sandy loam SOIL Nos. S65Ha-1-5 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 6542 - 6545

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-7	A1			5	40	3		20			10	5						
7-33	B2			5	40	3		20			10	5						
33-60	C1			5	10	15		20			20	10						
60-90	Cca			3	10	15		20			25	10						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-7	A1	28.0	4.8	27.1	24.8	0.40	1.37	0.80	0.36	0.51	0.48	11.8	100.4	11.6	16.6	-	10.93	6.94
7-33	B2	26.6	5.1	30.7	23.4	0.36	0.94	0.19	0.20	0.53	0.34	12.8	101.2	11.7	16.7	-	12.03	9.44
33-60	C1	13.1	10.0	25.2	34.9	0.30	0.92	0.81	0.18	0.33	0.46	14.4	100.6	13.6	19.4	2	5.97	5.78
60-90	Cca	10.1	11.8	23.9	36.2	0.12	1.13	2.29	0.20	0.23	0.42	14.1	100.5	12.8	18.3	9	4.87	8.60

Depth (cm)	8A Water at Saturation Pct.	Water extract from saturated paste 8A1: 6N1b Ca	6O1b Mg	6P1a Na	6Q1a K		6I1a CO_3	6J1a HCO_3	6K1a Cl	6L1b SO_4	8A1a Electrical conductivity mmho/cm
		meq/liter									
0-7											
7-33											
33-60	55.4	1.7	1.3	4.6	0.3		-	2.8	3.0	1.2	0.8
60-90	63.5	2.3	2.6	11.9	0.5		-	1.7	12.0	2.4	1.8

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-7	0.80	0.09	9	10.6	6.7	0.40	2.40	20.1		18.5		-		100+		6.9	6.1
7-33	0.60	0.07	9	6.3	5.4	0.50	1.90	14.1		15.3		-		92		6.9	6.2
33-60	0.80	0.06	13	11.1	5.1	1.30	0.90	18.4		10.0		0.7		100+		7.7	7.4
60-90	0.78	0.07	11	15.3	6.5	2.30	1.00	25.1		6.3		0.7		100+		8.1	7.8

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.				Pct.	Pct.	Pct.	g/cc				Pct. of whole soil			cm/cm	
0-7	47.8	38.9	13.3		31	43	12				2.10		28.2	17.4		
7-33	43.5	46.0	10.5		32	41	9			1.09	2.74		31.3	18.8		
33-60	28.1	48.9	23.0								2.21		40.4	21.5		
60-90	28.6	51.3	20.1		N. P.	N.P.	N.P.				3.27		48.4	20.6		

a/ 7.2 kg of organic carbon per square meter to a depth of 1 meter.

KAWAIHAE VERY STONY VERY FINE SANDY LOAM
S65Ha-1-5

Location: Island of Hawaii, Hawaii County, Hawaii. Kawaihae Quadrangle -- 20°04'10" north latitude and 155°50'10" east longitude. A pit located about 1.61 km (1 mile) N. of Honokaa Gulch and 20 m (200 yards) E. of new Kawaihae Road. Date of sampling: April 6, 1965.

Description by: H. Sato and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, H. Sato, R. Smythe, G. Yamamoto, and W. Subica.

Classification: **Ustollic Camborthid, medial, isohyperthermic.**

Vegetation: Kiawe-grass cover. Vegetation consists of kiawe (Prosopis chilensis), ilima (Sida fallax), piligrass (Heteropogon contortus), uhaloa (Waltheria indica). Climate: Average annual precipitation is 25 to 50 cm (10-20 inches). The mean annual temperature is 24° C (75° F). Parent material: Volcanic ash. Topography: Leeward mountain foot slopes of Kohala Mountain. Slope gradient 6 percent; convex slope; west aspect. Elevation: 120 m (400 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Stones cover 50 percent of surface. Some stones coated with calcium carbonate. Paired sample number S65Ha-1-6.

HORIZON	DESCRIPTION
A1 RSL No. 6542	0 to 7 cm (0-3 inches), dark reddish brown (2.5YR 2/4) very fine sandy loam, dark reddish brown (2.5YR 3/4) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many roots; many very fine pores; less than 10 percent stones over 20 mm (3/4 inch) diameter; neutral (pH 7.0); abrupt smooth boundary.
B2 RSL No. 6543	7 to 33 cm (3-13 inches), dark reddish brown (2.5YR 3/4) silt loam, dark reddish brown (2.5YR 3/4) dry; weak coarse prismatic structure; soft, friable, nonsticky and slightly plastic; common roots; many very fine pores; less than 10 percent highly weathered stones over 20 mm (3/4 inch) diameter; neutral (pH 7.2); clear smooth boundary.
C1 RSL No. 6544	33 to 60 cm (13-24 inches), dark reddish brown (2.5YR 3/4) loam, dark reddish brown (5YR 3/4) dry; weak medium and coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; few roots; many very fine pores; common patchy sugar-like coatings on ped surfaces; few highly weathered rocks (less than 10 percent); neutral (pH 7.3); gradual smooth boundary.
Cca RSL No. 6545	60 to 90 cm (24-36 inches), dusky red (10R 3/4) silt loam, reddish brown (2.5YR 4/4) dry; weak medium and coarse prismatic structure; hard, friable, nonsticky and slightly plastic; few roots; many very fine pores; common patchy shiny coatings on ped surfaces; weak effervescence with HCl; mildly alkaline (pH 7.6); abrupt wavy boundary.
IIR	90 cm (36 inches), hard pahoehoe lava.

SOIL FAMILY Hatallic Camborthid, medial, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kawaihae very stony very fine sandy loam SOIL Nos. 865Ha-1-6 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 6546 - 6549

Depth (cm)	Horizon	Total Chemical Analysis SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble SiO_2	Al_2O_3
		Percent of Whole Soil																
0-5	A1													9.6	13.7	-		
5-40	B2													10.7	15.3	-		
40-60	C1													11.6	16.6	tr.		
60-83	C2													14.3	20.4	tr.		

Depth (cm)	Horizon	8A Water at Saturation Pct.	Water extract from saturated paste 8A1: 6N1b Ca	6O1b Mg	6P1a Na	6Q1a K		6I1a CO_3	6J1a HCO_3	6K1a Cl	6L1b SO_4	8A1a Electrical conductivity mmho/cm
			meq/liter									
0-5	A1											
5-40	B2											
40-60	C1											
60-83	C2	61.7	1.7	2.9	16.9	0.7		-	0.6	19.6	1.1	2.4

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-5	0.41	0.051	8	8.6	8.1	0.5	2.8	20.0		19.9		-		100		7.1	6.1
5-40	0.61	0.057	11	4.4	5.0	0.9	1.4	11.7		15.5		0.5		75		6.5	5.7
40-60	0.61	0.052	12	4.1	5.4	3.5	0.8	13.8		16.3		0.4		85		7.0	6.3
60-83	0.70	0.059	12	4.6	6.1	6.2	1.4	18.3		14.6		1.1		100+		7.3	6.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-5	42.2	46.5	11.3								2.89		28.6	18.7		
5-40	40.5	51.0	8.5								2.95		40.3	19.3		
40-60	35.6	43.7	20.7								3.00		37.5	23.3		
60-83	21.9	54.5	23.6								3.10		39.8	24.4		

a/ 5.6 kg of organic carbon per square meter to a depth of 1 meter.

KAWAIHAE VERY STONY VERY FINE SANDY LOAM
S65Ha-1-6

Location: Island of Hawaii, Hawaii County, Hawaii; Kawaihae Quadrangle - 20°3'22" north latitude and 155°50'02" west longitude, about 90 m (100 yards) south of Honokaa gulch and 270 m (300 yards) east of new Kawaihae Road. Date of sampling: April 6, 1965.

Description by: H. Sato and L. D. Giese. Collectors: K. Flach, L. D. Giese, L. Swindale, H. Sato, R. Smythe, G. Yamamoto, and W. Subica.

Classification: **Ustollic Camborthid, medial, isohyperthermic.**

Vegetation: Kiawe-grass cover. Vegetation consists of kiawe (Prosopis chilensis), ilima (Sida fallax), piligrass (Heteropogon contortus), and uhaloa (Waltheria indica). Climate: Average annual precipitation is 13 to 50 cm (5-20 inches). Mean annual temperature is 24° C (76° F), mean January temperature is 23° C (73° F), and mean July temperature is 27° C (80° F). Parent material: Volcanic ash. Topography: Leeward mountain slopes of Kohala Mountain. Slope gradient 5 percent, convex slope, west aspect. Elevation: 120 m (400 feet). Drainage: Well drained; medium runoff; moderately rapid permeability. Soil moisture: Moist.

Remarks: Stones cover about 50 percent of surface. Some stones coated with calcium carbonate. Textures are apparent field textures.

HORIZON	DESCRIPTION
A1 RSL No. 6546	0 to 5 cm (0-2 inches), dark reddish brown (2.5YR 2/4) very fine sandy loam, (2.5YR 3/4) dry; weak very fine granular structure; loose, very friable, slightly plastic; many roots; many very fine pores; stones cover about 50 percent of the surface; neutral (pH 7.0); abrupt smooth boundary.
B2 RSL No. 6547	5 to 40 cm (2-16 inches), dark reddish brown (2.5YR 3/4) silt loam, (2.5YR 3/4) dry; weak coarse prismatic structure; soft, very friable, slightly sticky, slightly plastic; many roots; many very fine pores; about 10 percent stones by volume; neutral (pH 7.0); clear smooth boundary.
C1 RSL No. 6548	40 to 60 cm (16-24 inches), dark reddish brown (2.5YR 3/4) loam, (2.5YR 3/4) dry; weak medium and coarse prismatic structure; hard, very friable, slightly plastic; many roots; common very fine pores; common gray patchy coatings on ped faces; about 10 percent stones by volume; neutral (pH 7.3); gradual wavy boundary.
C2 RSL No. 6549	60 to 83 cm (24 to 33 inches), dusky red (10R 3/4) loam, reddish brown (2.5YR 4/4) dry; weak medium and coarse prismatic structure; hard, friable, slightly sticky, slightly plastic; few roots; common fine pores; many patchy gray coatings on ped faces; about 30 percent stones by volume; mildly alkaline (pH 7.6); abrupt wavy boundary.
IIR (No sample)	83 cm (33 inches), pahoehoe lava.

SOIL FAMILY **Ustollic Camborthid, fine-loamy, kaolinitic, isohyperthermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Holomua silt loam SOIL Nos. S62Ha-5-1 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 17388 - 17395

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-5	Ap1																	
5-23	Ap2																	
23-50	B21																	
50-65	B22																	
65-95	B23																	
95-110	IIB24b																	
110-135	IIB25b																	
135-165	IIB26b																	

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-5	Ap1													11.0	15.7			
5-23	Ap2													11.2	16.0			
23-50	B21													11.5	16.4			
50-65	B22													11.5	16.4			
65-95	B23													10.9	15.6			
95-110	IIB24b													9.0	12.9			
110-135	IIB25b													6.8	9.7			
135-165	IIB26b													5.3	7.6			

Depth (cm)	6A1a b/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	602a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-5	1.64	0.202	8	5.1	2.3	0.2	1.8	9.4		11.6		0.8	0.1	81		6.0	5.2
5-23	0.66	0.115	6	0.8	0.5	0.1	0.8	2.2		8.9		4.3	1.9	25 a/		4.3	3.6
23-50	0.49	0.103	5	3.0	1.7	0.2	0.5	5.4		7.7		2.4	tr.	70		5.6	5.0
50-65	0.41	0.099	4	3.0	2.7	0.3	0.2	6.2		7.7		1.8		80		6.7	5.9
65-95	0.28			3.4	3.1	0.5	0.4	7.4		7.8		2.4		95		6.7	6.0
95-110	0.18			3.3	3.0	1.5	1.3	9.1		9.4		1.4		97		6.8	5.9
110-135	0.10			3.0	2.6	2.1	1.5	9.2		8.8		0.7		104		6.8	5.8
135-165	0.16			2.4	2.4	2.1	1.1	8.0		8.5		0.9		94		6.6	5.7

Depth (cm)	Size class and particle diameter (mm) 3A1 Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits Plastic limit	Liquid limit	Plastic index	Bulk density 1/3 bar	Oven dry	Field moist	Particle density	Water content	1/3 bar	15 bar	Extensibility 4D1 COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-5				-						0.95	2.87		31.0	19.6		
5-23	30.3	35.6	34.1	-						1.11	2.91		30.1	19.4		
23-50				-						1.10	2.93		30.9	19.8		
50-65	24.3	42.7	33.0	-						1.18	2.94		31.5	19.1		
65-95				-						1.23	2.93		29.6	20.7		
95-110				-						1.22	2.92		31.8	21.8		
110-135				-						1.19	2.90		33.9	24.8		
135-165				-							2.90		33.9	25.4		

a/ The unusually low base saturation of the Ap2 horizon resulted from the use of soil amendments in pineapple culture.

b/ 5.4 kg of organic carbon per square meter to a depth of 1 meter.

HOLOMUA SILT LOAM
S62Ha-5-1

Location: Island of Molokai, Maui County, Hawaii. Approximately 1.2 km (3/4 mile) southeast of Holomua School in abandoned California Packing Corporation's pineapple land. From gate just west (makai) of Homelani Cemetery, proceed .32 km (0.2 mile) north on road in pasture; turn right and proceed .64 km (0.4 mile); turn left and proceed .16 km (0.1 mile) along fence. The site is 30 m (100 feet) north of the fence. Date of sampling: 1962.
Description by: S. Nakamura. Collectors: S. Nakamura.
Classification: **Ustollic Camborthid, fine-loamy, kaolinitic, isohyperthermic.**
Vegetation: Ilima (Sida sp.), kiawe (Prosopis chilensis), klu (Acacia farnesiana), koa haole (Leucaena glauca), feather fingergrass (Chloris virgata), Natal redtop (Tricholaena repens), uhaloa (Waltheria indica), and Hawaiian pili (Heteropogon contortus). Climate: Average annual precipitation is 38 to 50 cm (15-20 inches). The mean annual temperature is 23.3° C (74° F), the mean January temperature 21.7° C (71° F), and the mean July temperature 25° C (77° F). Parent material: Volcanic ash. Topography: Nearly level lower slopes. Elevation: 153 m (510 feet). Drainage: Well drained; moderately rapid permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S62Ha-5-2.

HORIZON	DESCRIPTION
Ap1 LSL No. 17388	0 to 5 cm (0-2 inches), dark reddish brown (2.5YR 3/5) moist and dry silt loam; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; violent effervescence with hydrogen peroxide; medium acid (pH 5.6); gradual smooth boundary.
AP2 LSL No. 17389	5 to 23 cm (2-9 inches), dark reddish brown (2.5YR 3/5) silt loam, dark red (2.5YR 3/6) dry; weak medium and coarse subangular blocky structure breaking into weak very fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; many interstitial pores; common black manganese stains; violent effervescence with hydrogen peroxide; medium acid (pH 5.8); clear wavy boundary.
B21 LSL No. 17390	23 to 50 cm (9-20 inches), dark reddish brown (2.5YR 3/4) silt loam, dark red (2.5YR 3/6) dry; weak coarse prismatic structure breaking into weak medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; many very fine and few fine tubular pores; violent effervescence with hydrogen peroxide; neutral (pH 6.6); gradual wavy boundary.
B22 LSL No. 17391	50 to 65 cm (20-26 inches), dark reddish brown (2.5YR 3/4) moist and dry silty clay loam; weak coarse prismatic breaking into moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; common roots; many very fine and fine tubular pores; violent effervescence with hydrogen peroxide; neutral (pH 6.7); clear smooth boundary.
B23 LSL No. 17392	65 to 95 cm (26-38 inches), dark reddish brown (2.5YR 3/4) moist and dry silty clay loam; moderate very fine subangular blocky structure; hard, friable, sticky and plastic; few roots, most of which are along vertical cleavage planes; many very fine pores, few glazed patches; many very fine black concretions; initially gritty when rubbed; firm in place; slight effervescence with hydrogen peroxide; neutral (pH 6.8); gradual wavy boundary.
IIB24b LSL No. 17393	95 to 110 cm (38-44 inches), dark reddish brown (5YR 3/4) silty clay loam, yellowish red (5YR 4/6) dry; strong very fine subangular blocky structure; hard, friable, sticky and plastic; few roots; many very fine tubular pores; few glazed patches; gritty feeling due to many hard earthy lumps that break down on rubbing; firm in place; slight effervescence with hydrogen peroxide; neutral (pH 6.8); gradual wavy boundary.
IIB25b LSL No. 17394	110 to 135 cm (44-54 inches), dark brown (10YR 3/3 and 7.5YR 3/2) silty clay loam, dark brown (7.5YR 4/4) dry; strong very fine subangular blocky structure; hard, friable, sticky and plastic; few roots; many very fine tubular pores; few glazed patches; compact in place; initially gritty when rubbed; neutral (pH 6.8); gradual wavy boundary.
IIB26b LSL No. 17395	135 to 165 cm (54-66 inches), very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate and strong fine and medium subangular blocky structure; hard, friable, sticky and plastic; few roots, most of which are along cleavage planes; many very fine and fine tubular pores; common thin patchy glaze; firm in place; initially gritty when rubbed; neutral (pH 6.8).

SOIL FAMILY Metallic Gamborthid, fine-loamy, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Holomua silty loam SOIL Nos. 862Ha-5-2 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 17396 - 17401

Depth (cm)	Horizon	Mineralogical Analysis																
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-30	Ap			10	50	3		20			10	5						
30-58	B21			10	50	4		20			10	5						
58-70	B22																	
70-80	IIB3b1			5	50	7		20			15	5						
80-108	IIB3b2			2	50	3		20			10	5						
108-163	IIB3b3			1	50	2		15			15	5						

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-30	Ap	27.8	5.2	30.1	21.9	0.30	0.73	0.06	0.15	0.66	0.37	12.7	100.0	11.2	16.0		11.41	12.36
30-58	B21	26.3	5.3	30.1	23.4	0.27	0.68	0.06	0.14	0.61	0.32	12.9	100.1	11.8	16.9		13.03	15.14
58-70	B22													11.8	16.9			
70-80	IIB3b1	23.3	5.7	30.2	26.2	0.14	0.59	0.04	0.15	0.26	0.35	13.1	100.0	11.6	16.6		11.45	15.23
80-108	IIB3b2	23.9	6.4	30.1	24.3	0.13	0.63	0.04	0.15	0.17	0.35	13.1	99.3	11.0	15.7		12.43	13.89
108-163	IIB3b3	26.1	6.4	28.9	24.6	0.18	0.79	0.06	0.11	0.10	0.39	12.4	100.0	9.0	12.9		15.16	14.20

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	6O2a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-30	0.90	0.13	7	4.4	1.2	0.30	1.10	7.0		14.1		0.2		50		6.8	5.5
30-58	0.70	0.11	6	2.0	2.1	0.20	0.90	5.2		10.9		0.7		48		6.8	5.8
58-70	0.50	0.08	6	1.9	1.9	0.40	0.70	4.9		10.2		1.1		48		7.1	6.1
70-80	0.49*	0.06	8	1.9	1.8	1.00	0.90	5.6		7.2		1.1		78		6.8	5.9
80-108	0.53*			2.2	1.6	1.50	1.20	6.5		11.1		0.9		58		6.8	5.8
108-163	0.41*			2.2	1.4	2.00	1.20	6.8		9.6		0.6		71		6.8	5.8

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility 4D1	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	Field moist			1/3 bar	15 bar	COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-30				-						1.03	2.94		30.4	18.5		
30-58				-						1.06	2.96		30.7	19.5		
58-70				-						1.23	3.00		28.3	20.7		
70-80				-						1.25	3.00		29.0	21.4		
80-108				-						1.21	3.05		29.9	23.1		
108-163				-						1.19	3.08		29.8	22.4		

a/ 7.5 kg of organic carbon per square meter to a depth of 1 meter.

* Assumed to be older than Holocene age.

HOLOMUA SILT LOAM
S62Ha-5-2

Location: Island of Molokai, Maui County, Hawaii. Approximately 2.4 km (1.5 miles) southeast of Molokai Airport. From junction 47 near Holomua School proceed west 8.8 km (5.5 miles) on Highway 46; turn left through Hawaiian Homes Commission gate and proceed 1.9 km (1.2 miles) on road leading toward Palaau; turn left just before Molokai Ranch boundary gate and proceed 1.3 km (0.8 mile) along the fence. The pit is perpendicular to the fence at a point .32 km (0.2 miles) from the fence. Date of sampling: 1962.
Description by: S. Nakamura. Collectors: S. Nakamura.
Classification: **Ustollic Camborthid, fine-loamy, kaolinitic, isohyperthermic.**
Vegetation: Kiawe (Prosopis chilensis), ilima (Sida sp.), uhaloa (Waltheria indica), piligrass (Heteropogon contortus), Natal redtop (Tricholaena repens), and Flora's paint brush (Emilia sanchifolia). Climate: Average annual precipitation is 38 to 50 cm (15-20 inches). The mean annual temperature is 23.3° C (74° F), the mean January temperature 21.7° C (71° F), and the mean July temperature 25° C (77° F). Parent material: Volcanic ash. Topography: Gently sloping lower slopes. Elevation: 81 m (270 feet). Drainage: Well drained; moderately rapid permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S62Ha-5-1. Colors are for moist soil.

HORIZON	DESCRIPTION
Ap LSL No. 17396	0 to 30 cm (0-12 inches), dark reddish brown (2.5YR 3/5) moist and dry silt loam; weak fine and medium subangular blocky structure breaking into weak very fine granular structure; upper 5 mm (¼ inch) has a weak medium platy structure; very friable, slightly sticky, slightly plastic; many roots; many very fine tubular pores; strong effervescence with hydrogen peroxide; clear wavy boundary.
B21 LSL No. 17397	30 to 58 cm (12-23 inches), dark reddish brown (2.5YR 3/5) moist and dry silt loam; weak coarse prismatic breaking into weak medium and coarse subangular blocky structure with pockets of weak very fine granular structure; soft, very friable, slightly sticky, slightly plastic; many roots; many very fine and fine and few medium tubular pores; strong effervescence with hydrogen peroxide; clear smooth boundary.
B22 LSL No. 17398	58 to 70 cm (23-28 inches), dark reddish brown (2.5YR 3/4) silty clay loam; weak coarse prismatic structure breaking into moderate fine and medium subangular blocky structure; friable, sticky, plastic; common roots; many very fine and common medium tubular pores; slight effervescence with hydrogen peroxide; few thin patchy glaze; clear smooth boundary.
IIB3b1 LSL No. 17399	70 to 80 cm (28-32 inches), dark reddish brown (5YR 3/3) silty clay loam; moderate fine and medium subangular blocky structure; friable, sticky, plastic; few roots, most of which are in cleavage planes; many very fine, fine and medium tubular pores; few thin patchy glaze; firm in place; slight effervescence with hydrogen peroxide; gritty feeling due to many hard earthy lumps; gradual wavy boundary.
IIB3b2 LSL No. 17400	80 to 108 cm (32-43 inches), very dark brown (10YR 2/2) silty clay loam; moderate and some strong fine and medium subangular blocky structure; friable, sticky, plastic; few roots, most of which are in cleavage planes; many very fine, fine and common medium tubular pores; common brown material less than 1 mm that looks like sand grains; common thin patchy glaze; compact in place; few saprolite; gradual smooth boundary.
IIB3b3 LSL No. 17401	108 to 163 cm (43-65 inches), very dark brown (10YR 2/2) silty clay loam; moderate fine and medium subangular blocky structure; friable, sticky, plastic; few roots, most of which are in cleavage planes; many very fine and fine and common medium tubular pores; common brown material less than 1 mm that looks like sand grains; few thin patchy glaze; not as compact as the above horizon; few saprolite.

SOIL FAMILY Ustollic Camborthid, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Ewa silty clay loam (taxadjunct) SOIL Nos. S63Ha-7-1 LOCATION Honolulu County, Hawaii

Lincoln Lab Nos. 18800 - 18803

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	Ap																	
20-48	B21																	
48-73	B22																	
73	IIR																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	Ap													7.2	10.3			
20-48	B21													8.5	12.2			
48-73	B22													7.6	10.9			
73	IIR																	

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-20	1.50	0.162	9	9.2	8.3	0.8	1.0	19.3		20.6		0.2		94		7.6	6.4
20-48	0.45	0.096	5	6.6	6.3	0.8	0.2	13.9		14.1		0.4		98		7.4	6.1
48-73	0.42	0.088	5	7.4	6.5	0.8	0.2	14.9		15.0		0.6		99		7.3	6.1
73																	

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-20				-						1.26	2.83	33.1		23.0		
20-48				-						1.16	2.85	37.6		23.5		
48-73				-						1.18	2.87	36.6		22.7		
73				-												

a/ 6.5 kg of organic carbon per square meter to a depth of 1 meter.

EWA SILTY CLAY LOAM (taxadjunct) 1/
S63Ha-7-1

Location: Island of Oahu, Honolulu County, Hawaii. Samples were taken from a pit on Ewa Plantation Company, field number 76, east of Federal highway number 760, 25 m (80 feet) north of the irrigation pump. Date of sampling: May 23, 1963.
Description by: E. Hill. Collectors: J. DeMent, J. M. Williams, and E. Hill.
Classification: **Ustollic Camborthid, fine, kaolinitic, isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: The mean annual temperature is 23.3° C (74° F). The average annual precipitation is 53 cm (21 inches).
Parent material: Alluvium weathered from basic igneous rock.
Topography: Nearly level coastal plain. 1 percent slope, flat. Relief normal.
Elevation: Approximately 10.5 m (35 feet). Drainage: Well drained. Moderate permeability. Slow runoff. Soil moisture: Moist in all horizons. Irrigated 1 week prior to sampling.
Remarks: Textures are apparent field textures. The depth to coral is exceedingly variable. The pit described was about 1.8 m (6 feet) long. The depth to coral varied from 25 to 100 cm (10-40 inches). Deep cultivation 25 to 45 cm (10-18 inches) has destroyed the B22 horizon if the solum is less than 48 cm (19 inches) deep. If the solum is thicker than 48 cm (19 inches), the B22 horizon is always present. The coral is massive and wavy with a karst surface. There is no visual evidence of the soil being formed from the underlying coral. Coral fragments 2.5 to 25 cm (1-10 inches) are scattered over the area, resulting in a patchy appearance. Paired sample number S63Ha-7-2.

HORIZON	DESCRIPTION
Ap LSL No. 18800	0 to 20 cm (0-8 inches), dark reddish brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few fine, medium and coarse roots; few fine tubular pores; compacted by recent cultivation; affected by mill waste from hydroseparator; about 1 percent coral fragments and sand grains; some mixing of horizon below by cultivation; moderate effervescence with hydrochloric acid on coral fragments and sand grains but none on soil mass; abrupt smooth boundary.
B21 LSL No. 18801	20 to 48 cm (8-19 inches), dark reddish brown (2.5YR 3/5) silty clay loam, dark red (2.5YR 3/6) dry; weak coarse subangular breaking to weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and medium roots; common very fine, fine and medium tubular pores; common worm casts and holes coated with organic stains; no coral fragments or coral sand grains present; no effervescence with dilute hydrochloric acid; moderate effervescence with 3 percent hydrogen peroxide; abrupt broken boundary.
B22 LSL No. 18802	48 to 73 cm (19-29 inches), dark reddish brown (2.5YR 3/5) silty clay loam, dark red (2.5YR 3/6) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine roots; many very fine and medium tubular pores, many are coated with dark organic stains; thin, continuous glaze that appears as clay films on ped surface; more compact in place than horizon above; few thin, weakly grooved slickensides oriented at 10 degrees from the horizontal; no coral fragments or sand grains present; no effervescence with dilute hydrochloric acid; slight effervescence with 3 percent hydrogen peroxide.
IIR LSL No. 18803	73 cm (29 inches), coral.

1/ The Ewa series is classified in the fine, kaolinitic, isohyperthermic family of Torroxic Haplustolls, and is defined as being more than 100 cm to coral. The soil represented by this pedon is not extensive enough to be recognized as a separate soil series.

SOIL FAMILY Ustollic Camborthid, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Ewa silty clay loam (tayed juvat) SOIL Nos. S63Ha-7-2 LOCATION Honolulu County, Hawaii

Lincoln Lab Nos. 18804 - 18807

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0 17	Ap			5	65	2		15			10	4						
17-45	B21			5	70	2		15			5	4						
45-73	B22			5	70	1		15			5	4						
73	IIR																	

Depth (cm)		Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-17	Ap	31.4	3.4	27.1	19.3	0.33	1.20	0.80	0.27	0.47	0.79	14.9	100.0	9.7	13.9	-	8.09	6.99
17-45	B21	31.9	3.4	29.3	19.2	0.28	1.19	0.16	0.23	0.38	0.64	13.3	100.0	10.2	14.6		8.68	8.11
45-73	B22	32.1	3.3	30.2	19.0	0.24	0.91	0.27	0.21	0.36	0.59	13.1	100.3	10.5	15.0		7.44	6.44
73	IIR																	

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-17	2.00	0.20	10	17.9	9.7	1.00	0.40	29.0		24.8		0.2		117		7.7	6.8
17-45	0.84	0.13	6	8.8	7.0	0.80	0.10	16.7		16.0		0.2		104		7.5	6.2
45-73	0.66	0.10	7	8.6	7.1	0.80	0.10	16.6		16.3		0.3		102		7.4	6.0
73																	

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-17				-						1.33	2.84	30.4		23.3		
17-45				-						1.27	2.84	33.5		23.5		
45-73				-						1.23	2.84	33.8		23.8		
73																

a/ 9.8 kg of organic carbon per square meter to a depth of 1 meter.

EWA SILTY CLAY LOAM (taxadjunct) 1/
S63Ha-7-2

Location: Island of Oahu, Honolulu County, Hawaii. Samples were taken from a pit on the Ewa Plantation Company, field number 79.1, 30 m (100 feet) south of Highway 764 and 30 m (100 feet) east of a new plantation access road. Date of sampling: May 23, 1963.

Description by: E. Hill Collectors: J. DeMent, J. M. Williams, and E. Hill.

Classification: **Ustollic Camborthid, fine, kaolinitic, isohyperthermic.**

Vegetation: Irrigated sugarcane. Climate: The average annual precipitation is 53 cm (21 inches). The mean annual temperature is 23.3° C (74° F), the mean January temperature is 21.7° C (71° F), and the mean July temperature is 25.6° C (78° F). Parent material: Alluvium weathered from basic igneous rock. Topography: Nearly level coastal plain; 1 percent slope, flat; relief normal. Elevation: 10.5 m (35 feet). Drainage: Well drained; moderate permeability; slow runoff. Soil moisture: Moist.

Remarks: The depth to coral is exceedingly variable. Textures are apparent field textures. Paired sample number S63Ha-7-1.

HORIZON	DESCRIPTION
Ap LSL No. 18804	0 to 17 cm (0-7 inches), dark reddish brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) dry; moderate fine and medium subangular blocky structure; very hard, firm, sticky and plastic; few fine, medium and coarse roots; few fine interstitial pores resulting from recent cultivation while wet; about 2 percent coral sand and fragments; slight mixing of B21 horizon; moderate effervescence with dilute hydrochloric acid on sand grains and fragments, none on soil material; abrupt smooth boundary.
B21 LSL No. 18805	17 to 45 cm (7-18 inches), dark reddish brown (2.5YR 3/5) silty clay loam, dark reddish brown (2.5YR 3/6) dry; weak coarse subangular breaking to weak fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; common fine and medium roots; many very fine, fine and medium tubular pores; common worm holes and casts coated with organic stains; no coral sand or fragments present; no effervescence with hydrochloric acid; moderate effervescence with hydrogen peroxide; abrupt smooth boundary.
B22 LSL No. 18806	45 to 73 cm (18-29 inches), dark reddish brown (2.5YR 3/5) silty clay loam, dark red (2.5YR 3/6) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine, fine and few medium tubular pores, many are coated with organic stains; thin, continuous glaze that appears as clay films on ped surfaces; more compact in place than B21 horizon; no coral fragments or sand grains present; no effervescence with dilute hydrochloric acid; slight to moderate effervescence with 3 percent hydrogen peroxide.
IIR LSL No. 18807	73 cm (29 inches), coral--karst surface with pockets to 100 cm (40 inches).

1/ The Ewa series is classified in the fine, kaolinitic, isohyperthermic family of Torroxic Haplustolls, and is defined as being more than 100 cm to coral. The soil represented by this pedon is not extensive enough to be recognized as a separate soil series.

SOIL FAMILY Tropic Fluvaquent, very fine, oxidic, nonacid, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Hanalei silty clay SOIL Nos. S62Ha-2-1 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 17267 - 17272

Depth (cm)	Horizon	Mineralogical Analysis																
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	Ap		2X	2	15	2		10			10	5						
15-25	A1g		2X	2	25	2		10			10	5						
25-33	A3g		2X	1	35	1		10			10	5						
33-45	B21g		1X	2	35	3		10			10	5						
45-65	B22g		1X	1	30	5		15			10	5						
65-90	C		1X	1	20	3		15			15	5						
		Total Chemical Analysis												Extractable		Carb-	0.5N NaOH	

HANALEI SILTY CLAY
S62Ha-2-1

Location: Island of Kauai, Kauai County, Hawaii; 2.4 km (1½ miles) east of Hanalei, Kauai, turn south at bridge that crosses Hanalei River and proceed .38 km (.26 mile), then turn west .16 km (.14 mile). Sample site is located in an abandoned taro patch. Date of sampling: 1962.
Description by: Donald E. Foote. Collectors: Donald E. Foote.
Classification: **Tropic Fluvaquent, very fine, oxidic,** nonacid, **isohyperthermic.**
Vegetation: Abandoned taro patch, native vegetation is Californiagrass (*Panicum purpurascens*), sensitive plant (*Mimosa pudica*), honohono (*Commelina diffusa*), and Java plum (*Eugenia cumini*). Climate: Average annual precipitation is 250 to 313 cm (100-125 inches). The mean annual temperature is 23.3° C (74° F), the mean January temperature is 21.1° C (70° F), and the mean July temperature 25.6° C (78° F). Parent material: Recent alluvium from high rainfall area weathered from basic igneous rock. Topography: Flood plains of Hanalei River. Elevation: 6 m (20 feet). Drainage: Poorly drained; moderate permeability; slow runoff. Soil material: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S62Ha-2-6.

HORIZON	DESCRIPTION
Ap LSL No. 17267	0 to 15 cm (0-6 inches), dark gray (10YR 4/1) silty clay, common distinct dark brown (7.5YR 4/4), red (2.5YR 5/6) and dark reddish brown (5YR 3/4) mottles; weak coarse and medium granular structure; very hard, friable, sticky, plastic; many fine and medium roots; many fine and medium pores; very strongly acid (pH 4.8); abrupt wavy boundary.
A1g LSL No. 17268	15 to 25 cm (6-10 inches), very dark gray (10YR 3/1) silty clay, many distinct dark reddish brown (5YR 3/4), yellowish brown (5YR 3/4), yellowish red (5YR 4/6), dark brown (7.5YR 4/4) and dark grayish brown (10YR 4/2) mottles; weak coarse prismatic structure; very hard, firm, sticky, plastic; many fine and medium roots; common fine and medium pores; strongly acid (pH 5.2); gradual smooth boundary.
A3g LSL No. 17269	25 to 33 cm (10-13 inches), mixed very dark gray (10YR 3/1) and dark gray (10YR 4/1) silty clay, many distinct yellowish red (5YR 4/6) and dark reddish brown (2.5YR 3/4) mottles; weak coarse prismatic structure; very hard, firm, sticky, plastic; common medium and fine roots; many fine and medium pores; slightly acid (pH 6.5); gradual smooth boundary.
B21g LSL No. 17270	33 to 45 cm (13-18 inches), mixed dark gray (10YR 4/1) and dark grayish brown (10YR 4/2) silty clay loam; many distinct strong brown (7.5YR 5/6) and dark red (2.5YR 3/6) mottles; structureless, massive, and a few pockets of weak medium angular blocky structure; hard, firm, sticky, plastic; few medium and fine roots; many fine and medium [illegible]

SOIL FAMILY Typic Dystrandept, medial, isomesic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Apakuie very fine sandy loam (taxadjunct) SOIL No. S65Ha-1-14 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 6514 - 6518

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-5	A11	3X		10	3			10			5	5	1X		3X	1X		
5-20	A12	3X		10				15			5	5	T		3X	1X		
20-38	A13	3X		10	1			10			5	5	T		3X	1X		
38-75	C1	3X		10				10			15	5	T		2X	1X		
75-125+	C2	3X		10				5			15	5	T		2X	1X		

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-5	A11	26.8	3.5	18.3	12.5	0.39	2.09	3.10	1.55	0.54	2.14	29.1	100.0	5.4	7.7		8.36	4.65
5-20	A12	25.6	3.8	24.5	17.3	0.49	1.89	3.09	1.85	0.58	1.35	20.9	101.4	8.3	11.9		6.48	7.47
20-38	A13	26.0	4.4	22.8	16.6	0.35	4.19	2.83	1.61	0.56	1.10	20.1	100.5	6.2	8.9		6.63	8.24
38-75	C1	32.1	3.7	23.5	16.2	0.29	5.52	3.78	2.25	0.57	0.74	12.8	101.4	5.0	7.1		5.79	7.52
75-125+	C2	37.4	3.7	22.8	13.5	0.26	5.91	5.28	3.05	0.80	0.86	7.0	100.6	3.7	5.3		4.05	5.53

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1b Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-5	14.22	1.04	14	21.6	3.6	0.10	1.80	27.1		51.2		0.1		53.0		6.7	5.8
5-20	6.48	0.56	12	11.9	2.2	0.20	0.50	14.8		39.0		-		38.0		6.3	5.5
20-38	5.48	0.41	13	11.5	1.4	0.20	0.40	13.5		37.3		-		36.0		6.4	5.6
38-75	3.17	0.24	13	8.8	1.0	0.20	0.40	10.4		25.3		-		41.0		6.6	5.7
75-125+	1.44	0.10	14	3.9	0.4	0.20	0.40	4.9		13.4		-		36.0		6.6	5.6

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 15 bar b/	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-5											2.407	41.6	80.92	43.29		
5-20											2.734	35.4	65.17	46.87		
20-38											2.722	34.6	63.81	46.95		
38-75											2.827	28.6	49.82	41.21		
75-125+											2.912	18.3	32.61	23.98		

a/ 31.1 kg of organic carbon per square meter to a depth of 1 meter.
b/ Air dry samples.

APAKUIE VERY FINE SANDY LOAM (taxadjunct) 1/
S65Ha-1-14

Location: Island of Hawaii, Hawaii County, Hawaii. Umikoa Quadrangle - 19°54'45" north latitude and 155°23'30" east longitude. Pit located about 1.9 km (1.5 miles) north of Puu Kihe on Kukaiau Ranch. Date of sampling: April 9, 1965.
Description by: H. Sato Collectors: K. Flach, H. Sato, and R. Smythe.
Classification: **Typic Dystrandept, medial, isomesic.**

SOIL FAMILY Typic Dystrandept, medial, isomesic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Hanipoe silt loam SOIL Nos. S61Ha-1-1 LOCATION Hawaii County, Hawaii

Beltsville Lab Nos. 61527 - 61535

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-10	A1																	
10-18	A3																	
18-30	B2																	
30-40	A1b																	
40-48	B2b																	
48-63	B3b																	
63-80	C1																	
80-90	C2																	
90-105	C3																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-10	A1													5.9	8.4			
10-18	A3													7.8	11.1			
18-30	B2													9.0	12.8			
30-40	A1b													9.9	14.2			
40-48	B2b													10.9	15.6			
48-63	B3b													9.9	14.1			
63-80	C1													6.4	9.2			
80-90	C2													3.8	5.4			
90-105	C3													7.3	10.4			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2d Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-10	12.9	1.122	11	13.5	3.1	0.23	0.70	17.5	51.5		69.0		<0.1		25	6.2	5.6
10-18	4.39	0.383	11	5.7	0.9	0.17	0.16	6.9	55.2		62.1				11	6.3	5.9
18-30	1.15	0.137	8	2.1	0.2	0.14	0.06	2.5	42.4		44.9		<0.1		6	6.7	6.4
30-40	6.59	0.529	12	8.8	1.2	0.15	0.05	10.2	62.3		72.5		<0.1		14	6.2	6.0
40-48	8.82	0.552	16	12.3	2.4	0.18	0.08	15.0	80.0		95.0		<0.1		16	6.2	5.9
48-63	8.85	0.684	13	7.9	2.4	0.19	0.12	10.6	89.9		100.5				11	6.0	5.6
63-80	6.50	0.485	13	3.6	0.9	0.11	0.03	4.6	68.6		73.2				6	6.0	5.6
80-90	2.68	0.189	14	0.9	0.4	0.11	0.01	2.5	35.5		36.9				4	6.4	5.9
90-105	6.23	0.526	12	2.8	0.9	0.15	0.01	3.9	70.2		74.1		<0.1		5	6.0	5.7

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: ~~4B2a~~ 15 bar moist	1/3 bar	~~4B2~~ 15 bar A.D.	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.			Pct. of whole soil				g/cc				Pct. of whole soil			cm/cm	
0-10												45.1		47.1		
10-18												46.1		45.2		
18-30												41.4		39.9		
30-40												46.7		42.5		
40-48												89.5		49.5		
48-63												118.4		50.0		
63-80												43.1		36.2		
80-90												93.8		46.4		
90-105												104.9		34.1		

MANIPOE SILT LOAM
S61Ha-1-1

Location: Island of Hawaii, Hawaii County, Hawaii. On Kukaiau Ranch, 1.13 km (0.7 mile) south of corral that is 6 km (3.6 miles) south of Umikoa. Date of sampling: April 14, 1961.
Description by: Warren Ikeda and Klaus Flach. Collectors: Warren Ikeda and Klaus Flach.
Classification: **Typic Dystrandept, medial, isomesic.**
Vegetation: Kikuyugrass with admixtures of white clover, sweet vernal grass, and paspalum grass under open koa forest. Climate: Average annual precipitation is 100 to 150 cm (40-60 inches). The mean annual temperature is 12.2° C (54° F), the mean January temperature 10.6° C (51° F), and the mean July temperature 14.4° C (58° F). Parent material: Volcanic ash. Topography: On an interfluve between shallow waterways, about 9 m (30 feet) from the steep termination of the interfluve. Elevation: 1,620 m (5,400 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil.

HORIZON	DESCRIPTION
A1 BSL No. 61527	0 to 10 cm (0-4 inches), dark reddish brown (5YR 2/2) silt loam; very weak, fine and very fine granular structure; friable, slightly sticky, slightly plastic; many very fine roots forming a dense mat which is difficult to penetrate with a spade; many fine pores; horizon extends in small pockets to depth of 17.5 cm (7 inches); abrupt wavy boundary.
A3 BSL No. 61528	10 to 18 cm (4-7 inches), dark reddish brown (5YR 3/3) silt loam; weak fine and very fine granular structure; very friable, slightly sticky, slightly plastic; common roots; many fine and very fine pores; gradual wavy boundary.
B2 BSL No. 61529	18 to 30 cm (7-12 inches), dark red (2.5YR 3/6-4/6) fine sandy loam; moderate, medium, fine and very fine granular structure; very friable, slightly sticky, slightly plastic; common roots; many fine and very fine pores; clear wavy boundary.
A1b BSL No. 61530	30 to 40 cm (12-16 inches), dark reddish brown (5YR 2/2) fine sandy loam; very fine and medium subangular blocky structure; very friable, slightly sticky, slightly plastic; common roots; many fine and very fine pores; abrupt wavy boundary.
B2b BSL No. 61531	40 to 48 cm (16-19 inches), dark reddish brown (5YR 3/4) silt loam; weak fine and medium subangular blocky structure; very friable, slightly sticky, plastic; common roots; many fine and very fine pores; gradual wavy boundary.
B3b BSL No. 61532	48 to 63 cm (19-25 inches), dark brown (7.5YR 3/2) heavy silt loam; weak medium subangular blocky structure; friable, slightly sticky, plastic; common roots; common, very fine tubular pores; gradual wavy boundary.
C1 BSL No. 61533	63 to 80 cm (25-32 inches), very dark grayish brown to dark brown (10YR 3/2-3/3) heavy silt loam; very weak medium subangular blocky structure, almost massive; slightly firm, slightly sticky, plastic; few roots; common, very fine tubular pores; clear wavy boundary.
C2 BSL No. 61534	80 to 90 cm (32-36 inches), very dark brown to black (10YR 2/2-2/1) nearly unweathered volcanic ash; massive; firm; few roots; common fine tubular pores lined with reddish and brownish material; gradual wavy boundary.
C3 BSL No. 61535	90 to 105 cm (36-42 inches), very similar to the C1 horizon, but there are only very few fine roots.

SOIL FAMILY Typic Dystrandept, medial, isomesic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kaipoioi loam SOIL Nos. 863Ha-4-1 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 18823 - 18828

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-13	A1																	
13-28	A3 or B1																	
28-40	B21																	
40-70	B22																	
70-110	B23																	
110-150	B24																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-13	A1													12.6	18.0			
13-28	A3 or B1													17.1	24.5			
28-40	B21													10.3	14.7			
40-70	B22													12.2	17.4			
70-110	B23													13.1	18.7			
110-150	B24													11.7	16.7			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-13	15.7 *	1.14	14	29.0	7.1	0.4	0.5	37.0		55.3		0.2	0.1	67		5.4	4.9
13-28	11.2	0.657	17	19.5	4.9	0.5	0.1	25.0		51.9		0.1	0.1	48		6.0	4.8
28-40	11.5	0.634	18	6.6	2.0	0.4	0.1	9.1		59.9		0.2	0.3	15		5.5	4.6
40-70	11.7	0.581	20	5.4	1.9	0.5	0.1	7.9		53.5		-	0.4	15		5.4	4.5
70-110	9.18	0.488	19	3.3	1.1	0.5	0.2	5.1		50.5		0.3	0.4	10		5.4	4.5
110-150	9.07	0.442	20	3.1	1.1	0.4	0.1	4.7		55.3		0.5	0.4	8		5.2	4.5

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEF	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-13	37.9	43.0	19.1	-						0.52	2.57	113.6		64.0		
13-28				-						0.52	2.81			111.5		
28-40				-						0.42	2.73	149.2		127.0		
40-70	26.8	43.2	30.0	-						0.38	2.66	168.5		136.4		
70-110				-						0.36	2.73	143.3		128.1		

KAIPOIOI LOAM
S63Ha-4-1

Location: Island of Maui, Maui County, Hawaii; 18 km (11.2 miles) south and east of Pukalani Post Office on the Haleakala National Park Road. Site is about 3 m (100 feet) northeast of road at this point. Date of sampling: May 24, 1963.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren, J. M. Williams, and J. A. DeMent.
Classification: **Typic Dystrandept, medial, isomesic.**
Vegetation: Sweet vernal (Anthoxanthum odoratum), rattail (Sporobolus capensis), kukaipuaa (Digitaria pruriens), gosmore (Hypochoeris radicata).
Climate: The mean annual temperature is 13.3° C (56° F). The average annual precipitation is 75 to 100 cm (30-40 inches). General afternoon fog contributes unknown amount to effective precipitation. Parent material: Volcanic ash. Topography: Rolling dissected midslopes of Haleakala Crater. Slope 15 percent to the west. Elevation: 1,440 m (4,800 feet). Drainage: Well drained. Permeability is moderately rapid. Surface runoff is rapid. Soil moisture: Profile moist when sampled.
Remarks: Textures are apparent field textures. Paired sample number S63Ha-4-2.

HORIZON	DESCRIPTION
A1 LSL No. 18823	0 to 13 cm (0-5 inches), black (5YR 2/1) loam, very dark brown (10YR 2/2) dry; strong very fine granular structure; soft, friable, nonsticky, nonplastic; many very fine hard earthy lumps which disappear with rubbing; many roots; mildly alkaline (pH 7.6); clear wavy boundary.
A3 or B1 LSL No. 18824	13 to 28 cm (5-11 inches), dark reddish brown (5YR 3/2) loam, very dark brown (10YR 2/2) dry; strong very fine granular structure; slightly hard, friable, nonsticky, nonplastic; many roots; many very fine hard earthy lumps which disappear with rubbing; many interstitial pores; mildly alkaline (pH 7.5); gradual wavy boundary.
B21 LSL No. 18825	28 to 40 cm (11-16 inches), dark brown (7.5YR 3/2 moist and dry) silt loam; weak medium and fine subangular blocky structure; hard, friable, slightly sticky, slightly plastic; many roots; many very fine tubular pores; weak patchy gelatinous coatings on ped faces; few very fine hard earthy lumps which crush on rubbing; mildly alkaline (pH 7.5); gradual wavy boundary.
B22 LSL No. 18826	40 to 70 cm (16-28 inches), dark brown (7.5YR 3/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak medium and fine subangular blocky structure; hard, very friable, slightly sticky, plastic; common roots; weak patchy gelatinous coatings on ped faces; many very fine and fine tubular pores; mildly alkaline (pH 7.4); gradual wavy boundary.
B23 LSL No. 18827	70 to 110 cm (28-44 inches), dark brown (7.5YR 3/2) silty clay loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky, plastic; few roots; many very fine and common fine tubular pores; weak patchy gelatinous glaze on ped faces; few very fine hard earthy lumps which disappear with rubbing; mildly alkaline (pH 7.4); gradual wavy boundary.
B24 LSL No. 18828	110 to 150 cm (44-60 inches), dark brown (7.5YR 3/2) silty clay loam, very dark brown (10YR 2/2) dry; moderate fine and very fine subangular blocky structure; hard, friable, slightly sticky, plastic; few roots; many very fine and common fine tubular pores; nearly continuous gelatinous glaze on ped faces; rather high aggregate stability gives an initial gritty feel which disappears with rubbing; somewhat more firm in place than above horizon; mildly alkaline (pH 7.4).

SOIL FAMILY Typic Dystrandept, medial, isomesic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kaipoioi loam SOIL Nos. S63Ha-4-2 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 18829 - 18834

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-13	A1	3X		5	5	1		15			5	5						
13-25	A3	3X		5	2	1		15			5	5						
25-43	B21	3X		3	2	1		15			5	5						
43-75	B22																	
75-113	B23	3X		5	3	1		20			10	5						
113-153	B24	3X		3	3	1		20			5	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-13	A1	13.4	4.4	17.3	19.7	0.50	1.48	1.75	0.18	0.30	1.01	40.4	100.4	10.7	15.3		5.31	4.46
13-25	A3	9.6	4.4	21.9	18.5	0.34	1.02	0.64	0.06	0.25	1.01	42.4	100.1	10.7	15.3		4.55	7.09
25-43	B21	10.8	4.6	23.3	17.8	0.33	1.08	0.74	0.05	0.20	1.02	39.9	99.8	10.3	14.7		6.11	9.91
43-75	B22	11.2	4.5	25.3	19.7	0.32	1.10	0.18	0.04	0.18	1.00	36.8	100.3	11.4	16.3		6.58	11.39
75-113	B23	14.5	4.7	24.0	22.3	0.41	1.11	0.05	0.06	0.35	0.90	31.8	100.2	11.9	17.0		6.79	9.83
113-153	B24	13.3	4.9	26.5	19.8	0.42	0.89	0.09	0.06	0.22	0.90	33.0	100.1	11.4	16.3		8.68	14.46

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-13	14.90	1.23	12	28.2	6.4	0.40	1.00	36.0		61.0		0.1	0.1	59.0		6.1	4.9
13-25	13.30	0.83	16	16.1	3.3	0.40	0.50	20.3		55.9		0.2	0.2	36.0		5.9	4.8
25-43	11.50	0.70	16	11.9	2.9	0.30	0.30	15.4		50.2		0.1	0.2	31.0		6.0	4.8
43-75	9.59	0.57	17	7.0	1.8	0.30	0.10	9.2		42.8		0.2	0.2	21.0		5.8	4.8
75-113	7.79			4.4	1.1	0.40	0.10	6.0		37.9		0.6	0.2	16.0		5.6	4.7
113-153	7.36			3.2	1.2	0.40	0.10	4.9		44.3		0.7	0.2	11.0		5.5	4.7

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-13				-						0.42	2.50	126.7		69.0		
13-25				-						0.36	2.62	149.4		116.8		
25-43				-						0.38	2.64	155.7		120.2		
43-75				tr.						0.38	2.67	167.4		123.3		
75-113				-						0.40	2.73	163.0		117.8		
113-153				-						0.44	2.75	158.9		124.6		

a/ 41.2 kg of organic carbon per square meter to a depth of 1 meter.

KAIPOIOI LOAM
S63Ha-4-2

Location: Island of Maui, Maui County, Hawaii; 16.5 km (10.3 miles) south and east of Pukalani Post Office on the Haleakala National Park Road. Site is 3 m (100 feet) east of road at this point. Date of sampling: May 24, 1963.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren, J. M. Williams, and J. A. DeMent.
Classification: **Typic Dystrandept, medial, isomesic.**
Vegetation: Sweet vernal (*Anthoxanthum odoratum*, rattail (*Sporobolus capensis*), kukaipuaa (*Digitaria pruriens*), gosmore (*Hypochoeris radicata*).
Climate: Mean annual temperature is 13.3° C (56° F). The average annual precipitation is 75 to 100 cm (30-40 inches). General afternoon fog contributes unknown amount to effective precipitation. Parent material: Volcanic ash. Topography: Rolling dissected midslopes of Haleakala Crater. Slope 14 percent to west. Elevation: 1,350 m (4,500 feet). Drainage: Well drained. Permeability is moderately rapid. Surface runoff is rapid. Soil moisture: Profile moist when sampled.
Remarks: Textures are apparent field textures. Paired sample number S63Ha-4-1.

HORIZON	DESCRIPTION
A1 LSL No. 18829	0 to 13 cm (0-5 inches), black (5YR 2/1) loam, very dark brown (10YR 2/2) dry; strong fine and very fine granular structure; soft, friable, nonsticky, [illegible] fine hard earthy lumps which disappear with rubbing; neutral (pH 7.0); clear wavy boundary.
A3 LSL No. 18830	13 to 25 cm (5-10 inches), dark brown (5YR 3/2) loam, very dark brown (10YR 2/2) dry; strong fine and very fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many roots; many very fine interstitial pores; many very fine hard earthy lumps which disappear slowly with rubbing; neutral (pH 7.3); clear wavy boundary.
B21 LSL No. 18831	25 to 43 cm (10-17 inches), very dark grayish brown (10YR 3/2 moist and dry) silt loam; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; many very fine and common fine tubular pores; thin scattered gelatinous glaze; mildly alkaline (pH 7.4); gradual wavy boundary.
B22 LSL No.	43 to 75 cm (17-30 inches), dark brown (7.5YR 3/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak medium and fine subangular blocky

SOIL FAMILY Oxic Dystrandept, medial, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Pane silt loam SOIL Nos. S65Ha-4-23 LOCATION Maui County, Hawaii

Riverside Lab Nos. 65144 - 65149

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	Ap	2X		10	15	1		20			5	5	5					
20-40	B21	3X		10	15	2		15			10	5	5					
40-73	B22	3X		5	15	5		15			10	5	3					
73-98	B23	2X		5	20	5		10			15	5	3					
98-143	B3	2X		5	35	5		10			10	5	3					
143-163	IIC																	

Depth (cm)		Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	Ap	20.1	4.5	23.5	20.7	0.63	1.35	0.73	0.09	0.69	1.11	27.0	100.4	11.4	16.3		8.52	6.71
20-40	B21	20.7	4.5	30.3	19.6	0.50	1.15	0.39	0.07	0.56	0.90	21.8	100.5	10.0	14.3		11.51	10.29
40-73	B22	21.4	3.8	31.5	20.0	0.50	1.20	0.18	0.07	0.48	0.93	20.2	100.3	9.9	14.2		11.44	10.55
73-98	B23	24.1	3.8	31.7	19.6	0.40	1.09	0.24	0.26	0.34	0.72	18.1	100.4	7.5	10.7		13.51	22.35
98-143	B3	28.0	3.7	32.8	17.2	0.34	1.31	0.05	0.15	0.28	0.55	16.1	100.5	6.0	8.6		15.71	22.88
143-163	IIC													3.6	5.1			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-20	8.87	0.69	13	17.5	6.3	0.30	1.70	25.8		53.7		-		48.0		6.2	5.4
20-40	3.51	0.30	12	11.8	5.4	0.40	1.80	19.4		40.6		-		23.0		6.6	5.8
40-73	2.57	0.21	12	7.8	4.7	0.70	0.90	14.1		36.6		-		38.0		7.1	5.8
73-98	1.59	0.13	12	6.1	2.4	1.50	0.50	10.5		25.6		-		41.0		6.1	5.4
98-143	0.86	0.07	12	3.0	3.6	2.20	1.60	10.4		29.8		0.2		35.0		6.2	5.2
143-163	0.29			0.2	4.3	1.4	4.0	9.9		20.3		0.4		49.0		6.2	5.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits b/: Plastic limit Pct.	Liquid limit Pct.	Plastic index Pct.	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-20					67	85	18			0.70	2.69		64.6	41.0		
20-40										0.70	2.79		67.1	49.1		
40-73					67	74	7			0.84	2.88		50.6	40.6		
73-98										0.94	2.87		51.5	38.6		
98-143											2.85		41.2	34.9		
143-163					41	51	10				2.90		38.6	28.7		

a/ 28.4 kg of organic carbon per square meter to a depth of 1 meter.

b/ These samples were not allowed to dry prior to analysis.

PANE SILT LOAM
S65Ha-4-23

Location: Island of Maui, Maui County, Hawaii. Kilohana Quadrangle - 20°49'30" north latitude and 156°18'40" west longitude, 45 m (150 feet) north of Upper Kula Road, State Highway 377, in hospital pasture on the Haleakala Ranch 4 km (2.5 miles) southeast of Pukalani Post Office. Date of sampling: April 12, 1965.
Description by: F. G. Stephens, L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, F. Stephens, and G. Yamamoto.
Classification: **Oxic Dystrandept, medial, isothermic.**
Vegetation: Noncultivated improved pasture with grass-herb cover. Vegetation consists of bur clover (Medicago hispida), dallisgrass (Paspalum dilatatum), gosmore (Hypochaeris radicata), natal redtop (Tricholaena repens), plantain (Plantago lanceolata), rattailgrass (Sporobolus capensis), vetch (Vicia spp.), and white clover (Trifolium repens). Climate: Average annual precipitation is 88 cm (35 inches). Mean annual temperature is 19° C (66° F), mean January temperature is 18° C (64° F), and mean July temperature is 21° C (70° F). Parent material: Volcanic ash over basic igneous rock. Topography: Midslope mountainous uplands; **the site has a** 10 percent slope gradient to the west. Elevation: 705 m (2,350 feet). Drainage: Well drained; permeability is moderately rapid; runoff is medium. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Paired sample number is S65Ha-4-24.

HORIZON	DESCRIPTION
Ap RSL No. 65144	0 to 20 cm (0-8 inches), dark reddish brown (5YR 3/3) silt loam, reddish brown (5YR 4/3) dry; strong fine and very fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic, weakly smeary; many fine and very fine roots; many fine pores; slight effervescence with hydrogen peroxide; slightly acid (pH 6.5); clear smooth boundary.
B21 RSL No. 65145	20 to 40 cm (8-16 inches), dark reddish brown (5YR 3/4) silt loam, reddish brown (5YR 4/4) dry; weak coarse prismatic structure; slightly hard, very friable, slightly sticky, slightly plastic, weakly smeary; many fine roots; many fine pores; neutral (pH 6.8); clear smooth boundary.
B22 RSL No. 65146	40 to 73 cm (16-29 inches), dark reddish brown (5YR 3/4) loam, reddish brown (5YR 4/4) dry; moderate fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic, weakly smeary; many fine and medium roots; many fine pores; many sand-size particles that are resistant to crushing; 2 to 3 percent pebbles; neutral (pH 7.0); gradual irregular boundary.
B23 RSL No. 65147	73 to 98 cm (29-39 inches), reddish brown (5YR 4/4) silt loam, (5YR 5/4) dry; weak fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic, weakly smeary; common fine and medium roots; many fine pores; neutral (pH 6.8); clear wavy boundary.
B3 RSL No. 65148	98 to 143 cm (39-57 inches), dark brown (7.5YR 3/2) loam, brown (7.5YR 5/4) dry; weak fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic, weakly smeary; few fine roots; many fine and medium pores; 20 by 30 percent by volume of gray pebble-size highly weathered fragments of rock; neutral (pH 6.6); abrupt wavy boundary.
IIC RSL No. 65149	143 to 163 cm (57-65 inches), brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic, weakly smeary; few fine roots; many fine pores; 50 to 70 percent by volume pebble and cobblestone size strongly weathered fragments of rock; neutral (pH 6.6).

SOIL FAMILY Oxic Dystrandept, medial, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Pane silt loam SOIL Nos. S65Ha-4-24 LOCATION Maui County, Hawaii

Riverside Lab Nos. 65150 - 65156

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	Ap																	
15-38	B21																	
38-65	IIB22																	
65-88	IIB23																	
88-118	IIB24																	
118-150	IIB3																	
150-188	IIC																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-15	Ap													13.3	19.0			
15-38	B21													8.9	12.7			
38-65	IIB22													7.9	11.3			
65-88	IIB23													7.3	10.4			
88-118	IIB24													5.7	8.2			
118-150	IIB3													4.4	6.3			
150-188	IIC													4.2	6.0			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-15	8.62	0.709	12	12.4	6.3	0.2	2.4	21.3		46.8		-	0.2	46		6.2	5.2
15-38	7.00	0.471	15	0.4	1.6	0.4	0.5	2.9		47.5		-	1.5	6		5.3	4.5
38-65	4.50	0.259	17	-	1.4	0.3	0.3	2.0		54.6		1.1	0.4	4		5.3	4.8
65-88	2.79	0.176	16	-	2.1	0.4	0.5	3.0		40.9		1.9	0.1	7		5.5	4.9
88-118	1.54	0.113	14	-	0.7	0.4	0.6	1.7		30.0		4.0	tr.	6		5.4	5.0
118-150	1.03	0.072	14	-	0.8	0.5	2.5	3.8		26.5		4.0	-	14		5.4	5.0
150-188	0.61	0.043	14	-	0.9	0.5	4.0	5.4		23.2		2.5	tr.	23		5.4	4.8

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar clod	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-15								0.78	0.94	0.67	2.72	63.0	65.0	38.1	0.025	0.025
15-38								0.59	0.89	0.57	2.64	89.1	82.1	64.3	*0.145	0.145
38-65										0.70	2.71		63.1	57.7		
65-88								0.84	1.06	0.78	2.76	66.2	59.8	54.5	*0.080	0.080
88-118											2.79		59.9	54.1		
118-150											2.86		59.3	50.9		
150-188								1.04	1.16		2.89	46.7	53.4	44.4	0.035	0.035

a/ 32.8 kg of organic carbon per square meter to a depth of 1 meter.

* Irreversible shrinkage.

PANE SILT LOAM
S65Ha-4-24

Location: Island of Maui, Maui County, Hawaii. Kilohana Quadrangle - 20°18'40" north latitude and 156°18'15" west longitude. A pit located 540 m (1,800 feet) east of Upper Kula Road, State Highway 377, in Pukea pasture on the Haleakala Ranch 5.8 km (3.6 miles) southeast of Pukalani Post Office. Date of sampling: April 13, 1965.

Description by: F. G. Stephens and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, F. Stephens, and G. Yamamoto.

Classification: **Oxic Dystrandept, medial, isothermic.**

Vegetation: Noncultivated improved pasture with grass-herb cover. Vegetation consists of bur clover (Medicago hispida), gosmore (Hypochoeris radicata), natal redtop (Tricholaena repens), paspalum (Paspalum dilatatum), plantain (Plantago lanceolata), rattailgrass (Sporobolus capensis), vetch (Vicia spp.), and white clover (Trifolium repens). Climate: Average annual precipitation is 88 cm (35 inches). Mean annual temperature is 19° C (66° F). Parent material: Volcanic ash over basic igneous rock. Topography: Midslope mountainous uplands that are complex; 10 percent slope gradient to the west. Elevation: 810 m (2,700 feet). Drainage: Well drained; permeability in moderately rapid; runoff is

Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Paired sample number is S65Ha-4-23. Colors are for moist soil.

HORIZON	DESCRIPTION
Ap RSL No. 65150	0 to 15 cm (0-6 inches), dark reddish brown (5YR 3/2) silt loam; weak fine granular; soft, very friable; slightly sticky and nonplastic; many roots; many pores; clear smooth boundary.
B21 RSL No. 65151	15 to 38 cm (6-15 inches), dark reddish brown (5YR 3/4) silt loam; weak medium prismatic breaking to weak medium subangular blocky with pockets of moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many roots; very porous; weakly smeary; clear wavy boundary.
IIB22 RSL No. 65152	38 to 65 cm (15-26 inches), dark reddish brown (5YR 3/3) silt loam; moderate fine and very fine subangular blocky structure; hard, very friable, slightly sticky and slightly plastic, weakly smeary; common roots; many pores; compact in place; many small hard earthy lumps; common cinders (2 to 5 mm); gradual wavy boundary.
IIB23 RSL No. 65153	65 to 88 cm (26-35 inches), dark reddish brown (5YR 3/3), dark reddish brown (5YR 3/4 rubbed) and yellowish red (5YR 4/6 crushed ped) silt loam; strong fine and very fine subangular blocky structure; hard, very friable, slightly sticky and slightly plastic, weakly smeary; few roots; many pores; compact in place; many small hard earthy lumps; 5 percent strongly weathered basalt gravel; gradual wavy boundary.
IIB24 RSL No. 65154	88 to 118 cm (35-47 inches), dark brown (7.5YR 3/2) silt loam; moderate fine and very fine subangular blocky structure; hard, very friable, slightly sticky and slightly plastic, weakly smeary; many pores; many fine hard earthy lumps; few white specks that appear to be clayey; 20 percent strongly weathered basalt gravel; gradual wavy boundary.

SOIL FAMILY Hydric Dystrandept, thixotropic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Paauhau silty clay loam SOIL Nos. S61Ha-1-3 LOCATION Hawaii County, Hawaii

Beltsville Lab Nos. 61544 - 61550

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-25	Ap																	
25-45	B1																	
45-70	B21																	
70-85	B22																	
85-118	B23																	
118-143	B24																	
143	R																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-25	Ap													10.4	14.9			
25-45	B1													10.6	15.2			
45-70	B21													10.6	15.2			
70-85	B22													10.9	15.6			
85-118	B23													9.9	14.2			
118-143	B24													11.2	16.0			
143	R													11.1	15.8			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-25	5.37	0.593	9	14.8	4.5	0.42	0.28	20.0	41.0		61.0		<0.1		33	5.8	5.3
25-45	4.36	0.510	8	9.9	3.5	0.44	0.10	13.9	47.8		61.7				22	6.4	6.3
45-70	3.16	0.326	10	7.2	3.3	0.28	0.09	10.9	40.8		51.7				21	6.4	6.3
70-85	2.21	0.241	9	4.9	2.2	0.24	0.08	7.4	32.3		39.7		<0.1		19	6.3	6.3
85-118	0.71	0.172	4	4.2	1.7	0.25	0.10	6.3	22.0		28.2				22	6.5	6.3
118-143	1.21	0.199	6	4.6	1.6	0.27	0.09	6.6	23.0		29.6				22	6.5	6.3
143	1.00	0.093	11	4.7	1.4	0.19	0.02	6.3	25.9		32.2				20		

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 4B2a 15 bar moist	1/3 bar	4B2 15 bar A.D.	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-25												39.9		36.4		
25-45												79.3		40.8		
45-70												97.3		36.8		
70-85												85.5		34.1		
85-118												61.9		34.6		
118-143												58.9		36.1		
143																

PAAUHAU SILTY CLAY LOAM
S61Ha-1-3

Location: Island of Hawaii, Hawaii County, Hawaii. About 3.2 km (2 miles) southeast of the town of Paauhau which is 1.6 km (1 mile) southeast of Honokaa. Date of sampling: 1961.

Description by: Harry Sato and Klaus Flach. Collectors: Harry Sato and Klaus Flach.

Classification: **Hydric Dystrandept, thixotropic, isohyperthermic.**

Vegetation: Sugarcane. Climate: Average annual precipitation is 150 to 200 cm (60-80 inches). The mean annual temperature is 22.2° C (72° F), the mean January temperature 20.6° C (69° F), and the mean July temperature 23.3° C (74° F). Parent material: Volcanic ash. Topography: Low windward slopes of Mauna Kea. Elevation: 210 m (600 feet). Soil moisture: Moist.

Remarks: Textures are apparent field textures. The degree of structure expression in the Ap horizon seems to depend on the time elapsed since the last cultivation; by the time the sugarcane is mature, the structure in the Ap is said to become strong, medium and fine granular. Slightly weathered basalt fragments as much as 25 cm (10 inches) in diameter can be found as shallow as 78 cm (31 inch) depth. Colors are for moist soil.

HORIZON	DESCRIPTION
Ap BSL No. 61544	0 to 25 cm (0-10 inches), very dark brown (10YR 2/2) silty clay loam; weak medium subangular blocky structure; friable, sticky, plastic; common roots; few very fine pores; abrupt smooth boundary.
B1 BSL No. 61545	25 to 45 cm (10-18 inches), dark yellowish brown (10YR 3/4) silty clay loam, dark yellowish brown (10YR 3/4-4/4) when crushed; weak fine and medium subangular blocky structure; friable, slightly sticky, plastic; common roots; common very fine and medium pores; clear irregular boundary.
B21 BSL No. 61546	45 to 70 cm (18-28 inches), dark brown (10YR 3/3) silty clay loam; strong fine and very fine subangular blocky structure; firm, sticky, plastic; common roots; few fine pores; continuous smooth pressure faces on ped surfaces; in places there are dark red (10.5YR 3/6-4/6) hard fragments, apparently cinder fragments; the horizon is discontinuous and occurs in about 2/3 of the excavation wall; gradual wavy boundary.
B22 BSL No.	70 to 85 cm (28-34 inches), dark brown (10YR 3/3) silty clay loam; strong fine and very fine subangular blocky structure; friable, slightly sticky, plastic;

SOIL FAMILY **Hydric Dystrandept, thixotropic, isomesic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Maile silt loam SOIL Nos. 865Ha-1-7 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 6590 - 65101

Depth (cm)	Horizon	Mineralogical Analysis (Percent of Whole Soil)															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
0-5	A11																	
5-10	A12																	
10-35	A13	3X		2	2			15			5	5	2X			1X		
35-43	B21																	
43-50	B22																	
50-60	B23																	
60-73	IIC																	
73-90	IIIB24b	3X		5	2			20			1	5	1X			1X		
90-120	IIIB25b																	
120-150	IIIB26b	3X		2				10			10	5	tr.			1X		
0-10	A11/A12																	
35-73	B21/IIC																	

Depth (cm)	Horizon	Total Chemical Analysis (Percent of Whole Soil)												Extractable Iron 6C2a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
0-5	A11													17.2	24.6			
5-10	A12													26.6	38.0			
10-35	A13	9.07	4.43	24.32	17.52	0.37	1.81	0.10	0.09	0.16	1.25	41.14	100.3	10.4	14.9		5.87	8.27
35-43	B21													10.4	14.9			
43-50	B22													10.9	15.6			
50-60	B23													12.5	17.9			
60-73	IIC													9.1	13.0			
73-90	IIIB24b	11.08	4.12	24.38	21.33	0.31	1.43	0.06	0.10	0.30	1.17	35.90	100.2	14.4	20.6		4.32	4.53
90-120	IIIB25b													8.6	12.3			
120-150	IIIB26b	15.15	4.27	29.19	17.51	0.29	3.48	0.67	0.19	0.14	1.49	28.04	100.4	6.5	9.3		8.61	6.02
0-10*	A11/A12													21.8	31.2			
35-73*	B21/IIC													11.1	15.9			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a (Meq./100 g.) 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity 5A1a NH_4OAc	Sum	NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation (Percent) 5C1 NH_4OAc	5C3	pH 8C1a H_2O 1:5	8C1c KCl 1:5
0-5	18.00	1.220	15	9.2	1.8	0.6	0.7	12.3		56.2		0.8	1.2	22		5.5	4.5
5-10	5.12	0.464	11	0.7	0.3	0.2	0.1	1.3		25.5		0.4	1.1	5		5.4	4.5
10-35	11.74	0.654	18	-	0.1	0.1	0.1	0.3		56.1		1.2	0.7	1		5.2	4.9
35-43	10.55	0.581	18	-	0.2	0.1	0.1	0.4		43.2		4.4	0.2	1		5.3	5.1
43-50	9.79	0.545	18	-	0.1	0.4	0.1	0.6		38.2		6.1	0.2	2		5.4	5.3
50-60	9.04	0.498	18	-	tr.	0.1	0.1	0.2		43.6		6.6	0.2	tr.		5.4	5.3
60-73	8.32	0.429	19	-	tr.	0.1	0.1	0.2		36.7		5.5	-	1		5.3	5.3
73-90	8.89	0.436	20	-	0.2	0.1	0.1	0.4		42.2		8.7	-	1		5.1	5.3
90-120	9.15	0.422	22	-	-	0.1	0.1	0.2		50.5		7.5	0.2	tr.		5.2	5.3
120-150	4.66	0.192	24	-	0.1	0.1	0.1	0.3		31.1		7.3	0.1	1		5.2	5.5
0-10		0.631		1.1	0.4	0.3	0.2	2.0		36.8		0.7	1.4	5		5.4	4.5
35-73		0.578		-	0.1	0.2	0.1	0.4		37.6		6.8	0.2	1		5.3	5.2

Depth (cm)	Size class and particle diameter (mm) 3A1 Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	b/ Atterberg limits Plastic limit Pct.	Liquid limit Pct.	Plastic index Pct.	Bulk density 1/3 bar	Oven dry	Field moist	Particle density	Water content 1/3 bar	15 bar	Extensibility 4D1 COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	
0-5										0.52	3.12	65.9	41.9		
5-10															
10-35										0.41	2.60	160.4	131.8		
35-43										0.32	2.56	198.1	161.1		
43-50										0.32					
50-60										0.34					
60-73					158	190	32			0.30					
73-90										0.26	2.62	242.4	193.9		
90-120					226	280	54			0.30	2.63	234.2	192.7		
120-150										0.45	2.73	159.0	126.4		
0-10					N.P.	N.P.	N.P.								
35-73					214	240	26								

* Composite bulk samples

a/ 34.3 kg of organic carbon per square meter to a depth of 1 meter.
b/ These samples were not allowed to dry prior to analysis.

MAILE SILT LOAM
S65Ha-1-7

Location: Island of Hawaii, Hawaii County, Hawaii. Umikoa Quadrangle - 19°59'00" north latitude and 155°32'32" west longitude; .8 km (½ mile) northeast of Kukaiau Ranch headquarters at a point about 90 m (100 yards) west of ranch road. Date of sampling: April 7, 1965.
Description by: H. Sato and L. Giese. Collectors: L. Giese, K. Flach, L. Swindale, H. Sato, R. Smythe, G. Yamamoto, and W. Subica.
Classification: Hydric Dystrandept, thixotropic, isomesic.
Vegetation: Ohia-grass cover. Kikuyu (Pennisetum clandestinum), white clover (Trifolium repens), ohia (Metrosideros collina), and tree fern (Cibotium menziesii).
Climate: Average annual precipitation is 150 to 225 cm (60 to 90 inches). The mean annual temperature is 14° C (57° F), the mean January temperature is 12° C (54°F), and the mean July temperature 17° C (63° F). Parent material: Volcanic ash.
Topography: Intermediate windward mountain slopes of Mauna Kea, convex, 10 percent slope, north aspect. Elevation: 1020 m (3,400 feet). Drainage: Well drained; runoff is slow; permeability is moderately rapid. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Paired sample number S65Ha-1-8.

HORIZON	DESCRIPTION
A11 RSL No. 6590	0 to 5 cm (0-2 inches), dark reddish brown (5YR 2/2) silt loam, black (2.5YR 2/1) dry; moderate fine subangular blocky structure; hard, friable, slightly plastic; many roots; many fine pores; medium acid (pH 6.0); abrupt smooth boundary.
A12 RSL No. 6591	5 to 10 cm (2-4 inches), dark reddish brown (5YR 2/2) cindery sandy loam, dark brown (10YR 3/3) dry; moderate fine subangular blocky structure; hard, friable; many roots; common fine black cinders and charcoal; medium acid (pH 6.0); abrupt smooth boundary.
A13 RSL No. 6592	10 to 35 cm (4-14 inches), very dark brown (10YR 2/2) silty clay loam, dark brown (10YR 3/3) dry; strong fine subangular blocky structure; extremely hard, friable, slightly sticky, plastic, smeary; many roots; many fine pores; slightly acid (pH 6.1); clear wavy boundary.
B21 RSL No. 6593	35 to 43 cm (14-17 inches), dark yellowish brown (10YR 3/4) silty clay loam, dark brown (7.5YR 3/3) dry; weak coarse prismatic structure breaking to moderate fine subangular blocky structure; very hard, friable, slightly sticky, plastic, weakly smeary; many roots; many fine pores; slightly acid (pH 6.2); clear smooth boundary.
B22 RSL No. 6594	43 to 50 cm (17-20 inches), dark brown (10YR 3/3) silty clay loam, very dark brown (10YR 2/2) dry; weak coarse prismatic structure breaking to moderate fine subangular blocky structure; very hard, friable, sticky, plastic, weakly smeary; common roots; many fine pores; slightly acid (pH 6.2); clear smooth boundary.
B23 RSL No. 6595	50 to 60 cm (20-24 inches), dark yellowish brown (10YR 3/4) silty clay loam, very dark brown (10YR 2/2) dry; weak coarse prismatic structure breaking to moderate fine subangular blocky structure; very hard, friable, sticky, plastic, weakly smeary; few roots; slightly acid (pH 6.5); clear smooth boundary.
IIC RSL No. 6596	60 to 73 cm (24-29 inches), dark brown (10YR 3/3) silty clay loam, very dark brown (10YR 2/2) dry; structureless, massive; hard, firm, slightly sticky, slightly plastic, weakly smeary; tuff band; few roots; many fine pores; slightly acid (pH 6.5); abrupt smooth boundary.
IIIB24b RSL No. 6597	73 to 90 cm (29-36 inches), dark brown (7.5YR 3/4) silty clay loam, very dark brown (10YR 2/2) dry; weak medium and fine subangular blocky structure; very hard, friable, sticky, plastic, moderately smeary; few roots; many fine pores; common patchy glaze; neutral (pH 6.6); abrupt smooth boundary.
IIIB25b RSL No. 6598	90 to 120 cm (36-48 inches), very dark brown (10YR 2/2) silty clay loam, (10YR 2/2) dry; weak coarse and medium prismatic structure breaking to moderate medium and fine subangular blocky structure; very hard, friable, sticky, plastic, moderately smeary; few roots; many fine pores; common patchy gelatin-like coatings on peds; tuff band about 5 cm (2 inches) thick; neutral (pH 6.6); abrupt smooth boundary.
IIIB26b RSL No. 6599	120 to 150 cm (48-60 inches), very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable, sticky, plastic, moderately smeary; few roots; many fine pores; neutral (pH 6.6).

SOIL FAMILY **Hydric Dystrandept, thixotropic, isomesic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Maile silt loam SOIL Nos. S65Ha-1-8 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 65102 - 65107

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-13	Ap1																	
13-30	Ap2																	
30-53	IIB21																	
53-68	IIIB22																	
68-123	IVB23																	
123-150	VC1																	

Depth (cm)		Total Chemical Analysis												Extractable iron 6C2a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-13	Ap1													16.0	22.9			
13-30	Ap2													10.4	14.9			
30-53	IIB21													9.9	14.2			
53-68	IIIB22													12.8	18.3			
68-123	IVB23													11.2	16.0			
123-150	VC1													10.5	15.0			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	602a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-13	15.50	1.116	14	2.6	1.4	0.3	1.0	5.3		60.4		-	1.3	9		5.7	4.6
13-30	10.59	0.699	15	-	0.1	0.1	0.4	0.6		49.5		-	0.6	1		5.3	4.9
30-53	10.04	0.553	18	-	0.2	0.2	0.2	0.6		48.2		4.8	0.2	1		5.1	5.3
53-68	8.26	0.474	17	-	-	0.3	0.2	0.5		37.4		16.2	tr.	1		5.3	5.4
68-123	7.91	0.401	20	-	-	0.1	0.1	0.2		41.9		18.3	tr.	0		5.3	5.3
123-150	6.77	0.318	21	-	tr.	0.1	0.1	0.2		43.0		15.8	0.2	0		5.0	5.3

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility 4D1	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	Field moist			1/3 bar	15 bar	COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-13										0.47	2.62		97.2	63.7		
13-30										0.34	2.53		174.3	142.9		
30-53										0.31	2.59		196.3	159.4		
53-68										0.30	2.70		210.0	173.3		
68-123										0.27	2.77		242.3	186.3		
123-150										0.33	2.75		253.8	191.2		

a/ 33.3 kg of organic carbon per square meter to a depth of 1 meter.

MAILE SILT LOAM
S65Ha-1-8

Location: Island of Hawaii, Hawaii County, Hawaii. Umikoa Quadrangle - 19°58'30" north latitude and 155°21'45" east longitude. Pit located about 3.2 km (2 miles) E. of Umikoa Village and 120 m (400 feet) N. of jeep road on Kukaiau Ranch. Date of sampling: April 7, 1965.

Description by: H. Sato and L. Giese. Collectors: K. Flach, L. Swindale, L. Giese, H. Sato, R. Smythe, G. Yamamoto, and W. Subica.

Classification: **Hydric Dystrandept, thixotropic, isomesic.**

Vegetation: **Ohia-grass cover.** Kikuyugrass (Pennisetum clandestinum), white clover (Trifolium repens), and ohia (Metrosideros collina). Climate: Average annual precipitation is 150 to 200 cm (60-80 inches). The mean annual temperature is 14° C (57° F). Parent material: Volcanic ash. Topography: Windward intermediate slopes of Mauna Kea, **7 percent convex, north slope. Elevation:** 1,110 m **(3,700 feet).** Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Color names are for moist soil. Paired sample number S65Ha-1-7.

HORIZON	DESCRIPTION
Ap1 RSL No. 65102	0 to 13 cm (0-5 inches), dark reddish brown (5YR 2/2) silt loam; weak very fine granular structure; friable, nonsticky and nonplastic; many roots; abrupt smooth boundary.
Ap2 RSL No. 65103	13 to 30 cm (5-12 inches), dark yellowish brown (10YR 3/4) silty clay loam; moderate fine subangular blocky structure; friable, slightly sticky and slightly plastic; many roots; many fine pores; gradual wavy boundary.
IIB21 RSL No. 65104	30 to 53 cm (12-21 inches), dark yellowish brown (10YR 3/4) silty clay loam; moderate fine subangular blocky structure; friable, slightly sticky, slightly plastic and weakly smeary; abundant roots; very porous; abrupt smooth boundary.
IIIB22 RSL No. 65105	53 to 68 cm (21-27 inches), dark reddish brown (5YR 3/4) silty clay loam; massive; friable, slightly sticky, plastic and weakly smeary; few roots; very porous; clear smooth boundary.
IVB23 RSL No. 65106	68 to 123 cm (27-49 inches), dark reddish brown (5YR 3/3) silty clay loam; weak medium and coarse prismatic structure; friable, slightly sticky, plastic and weakly smeary; few roots; many fine pores; common patchy glaze; clear smooth boundary.
VC1 RSL No. 65107	123 to 150 cm (49-60 inches), dark brown (7.5YR 3/2) silty clay loam; moderate fine subangular blocky structure; friable, slightly sticky, plastic and smeary; few roots; many fine pores; common patchy glaze; abrupt smooth boundary.
VC2	150 cm (60 inches), dark brown (7.5YR 3/4) and very dark grayish brown (10YR 3/2) silty clay loam; evenly divided banded horizon; moderate fine subangular blocky structure; friable, slightly sticky and plastic; few roots; many fine pores; common patchy glaze.

SOIL FAMILY Hydric Dystrandept, thixotropic over fragmental, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Honuaulu silty clay loam SOIL Nos. S58Ha-1-5 LOCATION Hawaii County, Hawaii

Beltsville Lab Nos. 59533 - 59536

Depth (cm)	Horizon	Mineralogical Analysis (Percent of Whole Soil)																
		7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
0-25	Ap																	
25-45	B21	2X			-	tr.							1X					
45-80	B22	2X			-	tr.							1X					
80-100	B23	tr.			-	6							1X					

Depth (cm)		Total Chemical Analysis (Percent of Whole Soil)												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
0-25	Ap	21.10	2.94	16.72	16.90	0.35						37.53	95.5	6.9	9.9			
25-45	B21	17.00	4.50	22.88	23.34	0.37						31.44	99.5	13.3	19.0			
45-80	B22	16.74	4.49	26.40	23.43	0.32						28.73	100.1	13.3	19.0			
80-100	B23	19.26	4.30	25.12	24.42	0.27						22.34	95.7	10.4	14.9			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	CEC 5A3a Sum of cations	CEC 5A4 By K saturation	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation 5C1 NH_4OAc	Base saturation 5C3 Sum	pH 8C1a H_2O 1:1	pH 8C1c KCl 1:1
				Meq./100 g.							pH 7.0			Percent			
0-25	13.06	1.185	11	7.7	8.2	0.3	0.3	16.5	70.6	87.0	76.0				19	5.5	5.5
25-45	7.19	0.666	11	4.1	2.3	0.1	0.5	7.0	86.3	93.3	77.4				8	6.4	5.9
45-80	5.28	0.462	11	1.4	1.8	0.1	0.1	3.4	89.6	93.1	82.0				4	6.2	6.1
80-100	2.82	0.243	12	2.5	2.3	0.1	0.1	5.0	55.5	60.5	54.7				8	6.2	6.6

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	4A3a Field moist	Particle density	Water content: 4B4 Field moist	4B1c 1/3 bar	4B2a 15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-25										0.52		82	84.8	58.4		
25-45												156	157.1	124.7		
45-80										0.32		192	184.7	149.6		
80-100												155	191.8	125.9		

a/ 29.3 kg of organic carbon per square meter to a depth of 1 meter.

HONUAULU SILTY CLAY LOAM
S58Ha-1-5

Location: Island of Hawaii, Hawaii County, Hawaii. Approximately .81 km (0.5 mile) north of Kainaliu town, .97 km (0.6 mile) east (mauka) of Highway 11 on Roy Wall's Ranch. Date of sampling: 1958
Description by: W. Ikeda. Collectors: W. Ikeda and M. Takehiro.
Classification: **Hydric Dystrandept, thixotropic over fragmental, isothermic.**
Vegetation: Yellow foxtail (Setaria geniculata), kikuyu (Pennisetum clandestinum), Glenwoodgrass (Sacciolepis contracta), honohono (Commelina diffusa), carpetgrass (Axonopus affinis), sedge (Carex sandwicensis), joee (Stachytarpheta cayannensis), sensitive plant (Mimosa pudica), Christmas berry (Schinus terebinthifolius), and guava (Psidium guayava). Climate: Average annual precipitation is 188 to 200 cm (75-80 inches). The mean annual temperature is 18.9° C (66° F), the mean January temperature 17.8° C (64° F), and the mean July temperature 20° C (68° F). Parent material: Volcanic ash. Topography: Undulating to rolling low leeward slopes of Mauna Loa Mountain. Elevation: 501 m (1,670 feet). Drainage: Well drained; moderately rapid permeability; runoff slow. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Colors are for moist soil unless otherwise noted. Paired sample number S58Ha-1-6. Soil at this location was at one time planted to sugarcane; surface and A horizon are relatively nonstony, but the rest of the profile is stony and become more stony with increase in depth. The soil is underlain by an Aa flow.

HORIZON	DESCRIPTION
Ap BSL No. 59533	0 to 25 cm (0-10 inches), very dark brown (10YR 2/3) silty clay loam, dark brown (10YR 3/3) dry; strong medium and fine granular structure; hard, friable, sticky, plastic and nonsmeary; many roots; few wormcasts; many fine and very fine interstitial pores; common very hard lava fragments of pebble size; material is moderately magnetic; abrupt wavy boundary.
B21 BSL No. 59534	25 to 45 cm (10-18 inches), dark brown (7.5YR 3/3) silty clay loam; weak coarse fine and very fine subangular blocky structure; friable, sticky, plastic, very weakly smeary; many roots; few wormcasts; many fine and very fine and few medium and coarse tubular pores; patchy thin gelatinous-like coatings on ped; common very hard lava fragments of pebble size; material is very weakly magnetic; clear wavy boundary.
B22 BSL No. 59535	45 to 80 cm (18-32 inches), dark brown (7.5YR 3/3) silty clay loam; moderate coarse fine and very fine subangular blocky structure; friable, sticky, plastic, weakly smeary; common roots; many fine and very fine and common medium and few coarse tubular pores; thin patchy gelatinous-like coatings on peds; common very hard lava fragments from pebble to cobble size; lower part of this horizon has pockets of dark reddish brown (5YR 3/4) material which is similar to the rest of the horizon except it is slightly more smeary and have many very fine olivine crystals embedded in matrix; abrupt wavy boundary.
B23 BSL No. 59536	80 to 100 cm (32-40 inches), dark brown (10YR 3/3) silty clay loam; weak and moderate medium fine and very fine subangular blocky structure; friable, sticky, plastic, weakly smeary; few roots; many fine and very fine and common medium tubular pores; thin patchy gelatinous-like coatings on peds; stronger structured material appears to have thicker gelatinous-like coatings and some shiny glazed coatings on peds; many very hard lava fragments from pebble to stone size, increasing in number with increasing depth; lava fragments have many olivine crystals embedded in the matrix.

SOIL FAMILY Hydric Dystrandept, thixotropic over fragmental, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Honuaulu silty clay loam SOIL Nos. S58Ha-1-6 LOCATION Hawaii County, Hawaii

Beltsville Lab Nos. 59537 - 59541

Depth (cm)	Horizon	Mineralogical Analysis															
		7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-23	Ap																	
23-40	B21	2X			-	tr.							1X					
40-65	B22	2X			-	2							1X					
65-73	B23b	2X			-	2							1X					
73-93	B24b	2X			-	tr.							1X					

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-23	Ap													7.1	10.2			
23-40	B21													12.6	18.0			
40-65	B22													13.3	19.0			
65-73	B23b													12.5	17.9			
73-93	B24b													11.8	16.9			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-23	11.80	1.114	11	13.2	6.1	0.4	0.3	20.0	65.1		85.1				24	5.9	5.7
23-40	6.92	0.535	13	7.4	2.9	0.3	0.1	10.7	89.0		99.8				11	6.0	6.2
40-65	5.84	0.416	14	4.6	2.6	0.3	0.1	7.6	87.5		95.1				8	6.0	6.3
65-73	4.80	0.343	14	6.5	1.7	0.2	0.1	8.5	76.3		84.8				10	6.0	6.5
73-93	4.72	0.348	14	6.2	1.6	0.3	0.1	8.2	68.5		76.7				11	6.2	6.6

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	4A3a Field moist	Particle density	Water content: 4B4 Field moist	4B1c 1/3 bar	4B2a 15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-23										0.48		78	90.4	57.1		
23-40												186	178.5	153.8		
40-65										0.33		188	177.0	149.0		
65-73												182	170.1	145.2		
73-93												169	169.8	142.8		

a/ 26.1 kg of organic carbon per square meter to a depth of 1 meter.

HONUAULU SILTY CLAY LOAM
S58Ha-1-6

Location: Island of Hawaii, Hawaii County, Hawaii; 1.6 km (1 mile) southwest of Kealakekua. Sample site located .35 km (1/4 mile) west of Konawaena School on Horseshow One Ranch. Date of sampling: 1958.
Description by: W. Ikeda. Collectors: W. Ikeda and M. Takehiro.
Classification: **Hydric Dystrandept, thixotropic over fragmental, isothermic.**
Vegetation: Californiagrass (Panicum purpurascens), Hilograss (Paspalum conjugatum), yellow foxtail (Setaria geniculata), sensitive plant (Mimosa pudica). Climate: Average annual precipitation is 188 cm (75 inches). The mean annual temperature is 18.9° C (66° F), the mean January temperature 17.8° C (64° F), and the mean July temperature 20° C (68° F). Parent material: Volcanic ash. Topography: Leeward undulating and rolling low slopes of Mauna Loa Mountain. Elevation: 504 m (1,680 feet). Drainage: Well drained; moderately rapid permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Soil is stony on surface and throughout profile. The soil appears to be underlain by pahoehoe lava. Colors are for moist soil unless otherwise noted. Paired sample number S58Ha-1-5.

HORIZON	DESCRIPTION
Ap BSL No. 59537	0 to 23 cm (0-9 inches), very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; strong medium fine and very fine granular structure, surface 25 mm (1 inch) of horizon is moderate fine and very fine granular; hard, friable, sticky, plastic, nonsmeary; many roots; few wormcasts; many fine and very fine interstitial pores; common hard lava fragments of pebble size; material is weakly magnetic; abrupt wavy boundary.
B21 BSL No. 59538	23 to 40 cm (9-16 inches), dark brown (7.5YR 3/3) silty clay loam; weak fine and very fine subangular blocky structure; friable, sticky, plastic, very weakly smeary; many roots; few wormcasts in upper part; many fine and very fine and common medium tubular pores; thin patchy gelatinous-like coatings on peds; few very hard lava fragments of pebble size; material is nonmagnetic; clear wavy boundary.
B22 BSL No. 59539	40 to 65 cm (16-26 inches), dark brown (7.5YR 3/4) silty clay loam; moderate coarse, fine and very fine subangular blocky structure; friable, sticky, plastic, very weakly smeary; common roots; many fine and very fine, common medium and few coarse tubular pores; thin patchy gelatinous-like coatings on peds; few very hard lava fragments of pebble size; few very fine olivine crystals in lower part of horizon; abrupt wavy boundary.
B23b BSL No. 59540	65 to 73 cm (26-29 inches), yellowish red (5YR 2/4) silty clay loam; moderate coarse, fine and very fine subangular blocky structure; slightly firm and friable, sticky, plastic, weakly smeary; common roots; many fine and very fine, common medium and few coarse tubular pores; parts of this horizon consist of very firm dark reddish brown (2.5YR 3/4) compacted ash which is weakly smeary when crushed; patchy gelatinous-like coatings on peds; many very fine olivine crystals embedded in matrix; abrupt wavy boundary.
B24b BSL No. 59541	73 to 93 cm (29-37 inches), very dark brown (10YR 2/3) silty clay loam; moderate medium fine and very fine subangular blocky structure; there are pockets of strong fine and very fine subangular blocky structure which is firm; friable, sticky, plastic, very weakly smeary; common roots; many fine and very fine, common medium and few coarse tubular pores; common patches of smooth gelatinous-like coatings on peds; very few very fine olivine crystals; many very hard lava fragments from pebble to stone size increasing in number with increase in depth, these lava fragments do not have olivine crystals.

SOIL FAMILY Typic Eutrandept, medial, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Naalehu silty clay loam SOIL Nos. S65Ha-1-11 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 65108 - 65112

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-50	Ap	2X		3	10	1		10			5	3						
50-78	B21	2X		3	10	1		10			10	3						
78-90	IIB22	3X		1	15			15			10	5						
90-133	IIIB23	3X		1	15			15			10	5						
133-163	IVC	3X		1	15	1		15			15	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-50	Ap	51.1	2.4	13.9	12.7	0.27	4.29	1.93	0.56	0.21	0.67	12.5	100.5	5.9	8.4		18.53	12.22
50-78	B21	44.1	3.0	15.9	16.1	0.26	6.11	2.13	0.51	0.22	0.64	11.6	100.6	7.5	10.7		16.32	7.83
78-90	IIB22	37.9	3.7	20.2	18.4	0.29	4.96	1.84	0.38	0.09	0.35	11.9	100.0	9.2	13.2		18.99	11.40
90-133	IIIB23	35.8	4.0	22.2	20.2	0.29	3.84	1.15	0.36	0.09	0.22	12.6	100.8	9.7	13.9		14.92	10.18
133-163	IVC	36.8	3.8	21.4	20.2	0.27	4.68	1.09	0.23	0.09	0.19	12.3	101.1	7.9	11.3		15.39	10.54

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-50	3.29	0.25	13	17.2	9.1	0.70	0.70	27.7		45.8		0.8	0.1	60.0		5.4	4.5
50-78	1.97	0.17	12	22.8	11.7	1.00	0.70	36.2		50.2		-	0.1	72.0		5.8	4.8
78-90	0.90	0.08	11	33.7	19.2	1.80	0.50	55.2		63.1		-	-	87.0		6.6	5.6
90-133	0.60	0.06	10	35.8	23.8	2.10	0.30	62.0		63.6		-		97.0		6.7	5.6
133-163	0.47			34.4	26.5	1.90	0.20	63.0		67.6		-		93.0		6.6	5.7

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	b/ Atterberg limits: Plastic limit Pct.	Liquid limit Pct.	Plastic index Pct.	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	15 bar	Extensibility 4D1: COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	
0-50					52	73	21			0.87	2.61	49.2	34.9		
50-78										0.85	2.76	53.1	39.5		
78-90					95	120	25			0.79	2.85	87.3	73.2		
90-133					N.P.	N.P.	N.P.			0.46	2.91	121.2	98.9		
133-163										0.52	2.94	100.6	78.7		

a/ 20.1 kg of organic carbon per square meter to a depth of 1 meter.
b/ These samples were not allowed to dry prior to analysis.

NAALEHU SILTY CLAY LOAM
S65Ha-1-11

Location: Island of Hawaii, Hawaii County, Hawaii. Naalehu Quadrangle - 19°03'15" north latitude and 155°35'30" west longitude, about 1.93 km (1.2 miles) northeast of Hutchinson Sugar Company Office in field 310. Date of sampling: April 8, 1965.
Description by: H. Sato and L. Giese. Collectors: K. Flach, L. Giese, L. Swindale, G. Yamamoto, R. Smythe, H. Sato and W. Subica.
Classification: **Typic Eutrandept, medial, isohyperthermic.**
Vegetation: Sugarcane (*Saccharum officinarum*), natural vegetation is Christmas berry (*Schinus terebinthifolius*), bermudagrass (Cynodon dactylon), guava (*Psidium guayava*), and kaimi clover (*Desmodium canum*). Climate: Average annual precipitation is 125 cm (50 inches). The mean annual temperature is 22° C (72° F), the mean January temperature 21° C (69° F), and the mean July temperature is 24° C (75° F). Parent material: Volcanic ash. Topography: Leeward low slopes of Mauna Loa, convex, **12 percent south slope. Elevation: 360 m** (1,200 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Paired sample number S65Ha-1-12.

HORIZON	DESCRIPTION
Ap RSL No. 65108	0 to 50 cm (0-20 inches), very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine granular structure; hard, friable, sticky, plastic; many roots; matted at base of horizon; many fine pores; slightly acid (pH 6.5); abrupt smooth boundary.
B21 RSL No. 65109	50 to 78 cm (20-31 inches), dark brown (10YR 3/3) silty clay loam, dark brown (7.5YR 4/4) dry; weak coarse prismatic structure; hard, firm, sticky, plastic, weakly smeary; upper 15 cm (6 inches) compact; few roots mostly along old root channels; many charcoal fragments; many wormcasts in old channels; neutral (pH 6.7); clear smooth boundary.
IIB22 RSL No. 65110	78 to 90 cm (31-36 inches), dark reddish brown (5YR 3/2) silt loam, dark reddish brown (5YR 3/4) dry; structureless, massive; hard, friable, slightly sticky, slightly plastic, weakly smeary; few roots; many very fine pores; tuff band nearly continuous; neutral (pH 6.7); clear wavy boundary.
IIIB23 RSL No. 65111	90 to 133 cm (36-53 inches), dark reddish brown (5YR 3/3) silt loam, dark red (2.5YR 3/6) dry; weak coarse prismatic structure; slightly hard, very friable, plastic, weakly smeary; few roots; many pores; neutral (pH 7.0); clear wavy boundary.
IVC RSL No. 65112	133 to 163 cm (53-65 inches), dark reddish brown (5YR 3/3) silt loam, dark reddish brown (2.5YR 3/4) dry; structureless, massive; very friable, slightly plastic, weakly smeary; few roots; many fine pores; neutral (pH 7.2).

SOIL FAMILY Typic Eutrandept, medial, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Naalehu silty clay loam SOIL Nos. S65Ha-1-12 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 65113 - 65118

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-28	Ap1																	
28-43	Ap2																	
43-70	B21																	
70-93	B22																	
93-113	IIB23																	
113-150	IIIB3																	

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C2a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-28	Ap1													4.4	6.3			
28-43	Ap2													6.1	8.7			
43-70	B21													9.3	13.3			
70-93	B22													10.6	15.2			
93-113	IIB23													11.1	15.9			
113-150	IIIB3													10.8	15.4			

NAALEHU SILTY CLAY LOAM
S65Ha-1-12

Location: Island of Hawaii, Hawaii County, Hawaii. Naalehu Quadrangle - 19°04'30" north latitude and 155°34'30" west longitude. A pit located about .8 km (1/2 mile) of the Naalehu graveyard in field 120, Hutchinson Sugar Company. Date of sampling: April 8, 1965.

Description by: H. Sato and L. Giese. Collectors: K. Flach, L. Swindale, L. Giese, G. Yamamoto, W. Subica, R. Smythe and H. Sato.

Classification: **Typic Eutrandept, medial, isohyperthermic.**

Vegetation: Sugarcane (Saccharum officinarum), natural vegetation is Christmas berry (Schinus terebinthifolius), bermudagrass (Cynodon dactylon), guava (Psidium guayava), and kaimi clover (Desmodium canum). Climate: Average annual precipitation is 100 to 125 cm (40-50 inches). The mean annual temperature is 22° C (72° F). Parent material: Volcanic ash. Topography: Leeward low slopes of Mauna Loa, **convex, 12 percent north slope. Elevation: 294 m** (980 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Colors are for moist soil. Paired sample number S65Ha-1-11.

HORIZON	DESCRIPTION
Ap1 RSL No. 65113	0 to 28 cm (0-11 inches), black (10YR 2/1) silty clay loam; strong medium and fine granular structure; friable, sticky and plastic; many roots; many fine pores; abrupt smooth boundary.
Ap2 RSL No. 65114	28 to 43 cm (11-17 inches), dark brown (7.5YR 3/4) silty clay loam; weak fine subangular blocky structure; friable, sticky and plastic; many roots; many fine pores; clear smooth boundary.
B21 RSL No. 65115	43 to 70 cm (17-28 inches), dark reddish brown (5YR 3/4) silt loam; weak coarse prismatic structure; very friable, slightly sticky, plastic and weakly smeary; many roots; many very fine pores; abrupt wavy boundary.
B22 RSL No. 65116	70 to 93 cm (28-37 inches), dark reddish brown (5YR 3/4) silty clay loam; weak coarse prismatic structure; very friable, sticky, plastic and weakly smeary; few roots; many very fine pores; abrupt wavy boundary.
IIB23 RSL No. 65117	93 to 113 cm (37-45 inches), dark reddish brown (2.5YR 3/4) silt loam; massive; friable, nonsticky, nonplastic and weakly smeary; few roots; many very fine pores; abrupt wavy boundary.
IIIB3 RSL No. 65118	113 to 150 cm (45-60 inches), dark reddish brown (5YR 3/4) silt loam; weak coarse prismatic structure; friable, slightly sticky, plastic and weakly smeary; few roots; many very fine pores.

SOIL FAMILY Typic Eutrandept, medial, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Pakini very fine sandy loam (taxadjunct) SOIL Nos. S65Ha-1-10 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 65137 - 65143

Depth (cm)	Horizon	Total Chemical Analysis SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble SiO_2	Al_2O_3
		Percent of Whole Soil																
0-5	Ap													4.6	6.6	-		
5-28	A12													5.3	7.6	-		
28-55	A3													5.2	7.4	-		
55-93	B21													4.2	6.0	-		
93-133	B22													3.9	5.6	-		
133-150	Cca													5.0	7.2	-		
3-38 (pocket	A3 of sand													0.6	0.9	-		

Depth (cm)	Horizon	8A Water at Saturation Pct.	Water extract from saturated paste 8A1: 6N1b Ca	6O1b Mg	6P1a Na	6Q1a K		6I1a CO_3	6J1a HCO_3	6K1a Cl	6L1b SO_4	8A1a Electrical conductivity mmho/cm
			meq/liter									
0-5	Ap	82.4	2.6	2.2	2.4	0.8		-	3.7	2.7		
5-28	A12											
28-55	A3											
55-93	B21											
93-133	B22	65.3	2.7	2.1	5.0	0.2		-	2.0	5.4		
133-150	Cca											
3-38 (pocket	A3 of sand											

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-5	5.54	0.379	15	28.4	13.9	1.2	4.2	47.7		52.1		-		92		6.8	5.8
5-28	2.97	0.215	14	33.8	16.2	2.1	2.6	54.7		58.8		-		93		7.2	5.9
28-55	1.49	0.119	13	45.6	19.9	3.1	0.3	68.9		64.9		-		100+		7.7	6.4
55-93	0.85	0.064	13	57.7	26.2	3.7	0.2	87.8		67.2		0.4		100+		7.9	6.5
93-133	0.60	0.044	14	42.7	21.7	5.4	0.3	70.1		60.9		-		100+		8.0	6.7
133-150	0.51			39.0	20.9	6.5	0.4	66.8		60.6		-		100+		8.2	6.8
3-38	0.20			6.8	3.0	0.7	0.3	10.8		9.9		-		100+		7.7	6.9

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-5	68.0	26.7	5.3							0.87	2.90		43.1	29.1		
5-28	66.5	31.1	2.4							0.85	2.85		39.6	33.7		
28-55	62.3	35.1	2.6							1.04	2.81		45.0	34.2		
55-93	48.8	48.8	2.4							0.84	2.90		51.3	35.0		
93-133	44.1	52.0	3.9							0.90	2.84		49.1	33.3		
133-150	53.2	42.3	4.5								2.80		47.9	30.3		
3-38	95.3	4.0	0.7													

a/ 15.5 kg of organic carbon per square meter to a depth of 1 meter.

PAKINI VERY FINE SANDY LOAM (taxadjunct) 1/
S65Ha-1-10

Location: Island of Hawaii, Hawaii County, Hawaii. Kalae Quadrangle - 18°57'30" north and 155°39'55" east longitude. A pit located about 2.4 km (1.5 miles) east of the tracking station at South Point near the SCS grass garden. Date of sampling: April 8, 1965.

Description by: H. Sato and L. D. Giese. Collectors: L. Giese, K. Flach, L. Swindale, H. Sato, R. Smythe, W. Subica, and G. Yamamoto.

Classification: **Typic Eutrandept, medial, isohyperthermic.**

Vegetation: **Grass cover.** Sandbur (Cenchrus echinatus), Japanese tea (Cassia leschenaultiana), indigo (Indigofera suffruticosa), buffelgrass (Pennisetum ciliare). Climate: Average annual precipitation is 50 to 75 cm (20-30 inches). The mean annual temperature is 24° C (75° F). Parent material: Volcanic ash and olivine sand. Topography: Leeward footslopes of Mauna Loa; convex, **3 percent south slope.** Elevation: 158 m (525 feet). Drainage: Well drained; rapid permeability; slow runoff. Soil moisture: Dry.

Remarks: Textures are apparent field textures. Paired sample number is S65Ha-1-9. Colors are for moist soil.

HORIZON	DESCRIPTION
Ap RSL No. 65137	0 to 5 cm (0-2 inches), dark brown (7.5YR 3/2) very fine sandy loam; weak medium platy structure; very friable, nonsticky and nonplastic; many roots; common coarse sand and rock fragments 1 to 2 mm; resists wetting; abrupt smooth boundary.
A12 RSL No. 65138	5 to 28 cm (2-11 inches), dark brown (7.5YR 3/2) very fine sandy loam; weak coarse prismatic structure; friable, nonsticky and nonplastic; many roots; common fine pores; common coarse sand and rock fragments 1 to 2 mm; clear wavy boundary.
A3 RSL No. 65139	28 to 55 cm (11-22 inches), dark brown (7.5YR 4/4) very fine sandy loam; weak coarse prismatic structure; friable, nonsticky and nonplastic; few roots; common fine and very fine pores; common pockets of gray sand; clear wavy boundary.
B21 RSL No. 65140	55 to 93 cm (22-37 inches), dark brown (7.5YR 4/4) loam; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few roots; common fine pores; gradual wavy boundary.
B22 RSL No. 65141	93 to 133 cm (37-53 inches), dark brown (7.5YR 4/4) loam; weak coarse prismatic structure; friable, slightly hard, slightly sticky and slightly plastic; few roots; common fine pores; gradual wavy boundary.
Cca RSL No. 65142	133 to 150 cm (53-60 inches), dark yellowish brown (10YR 4/4) very fine sandy loam; massive; slightly hard, friable, slightly sticky and slightly plastic; no roots; common fine pores.

1/ The Pakini series is classified as Entic Eutrandept. The A1 horizon of this pedon is too deep for the Entic subgroup.

SOIL FAMILY **Typic Eutrandept, medial, isothermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Waimea very fine sandy loam SOIL Nos. 858Ha-1-3 LOCATION Hawaii County, Hawaii

Beltsville Lab Nos. 59521 - 59526

Depth (cm)	Horizon	Mineralogical Analysis															
		7A2 Allophane	Montmorillonites	Micas	Kaolinites 7A3	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	7A2 Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-5	A11																	
5-13	A12	4X			1X	tr.							1X		1X			
13-20	A13																	
20-58	B21	4X			1X	tr.							1X		1X			
58-88	B22																	
88-118	B23	4X			1X	tr.							1X		1X			

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-5	A11	27.66	2.76	21.04	13.08	0.31						30.61	95.8	5.7	8.2			
5-13	A12	28.60	3.37	25.12	15.43	0.44						20.49	93.5	7.5	10.7			
13-20	A13	28.46	3.40	25.92	16.12	0.44						21.91	96.3	8.5	12.2			
20-58	B21	28.78	3.65	25.92	17.23	0.33						21.01	96.9	8.6	12.3			
58-88	B22	26.44	4.32	26.88	18.72	0.30						23.27	99.9	9.2	13.2			
88-118	B23	24.84	4.51	27.04	19.97	0.37						20.29	97.0	9.9	14.2			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a 6N2a Ca	602b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation 5C1 NH_4OAc	5C3 Sum	pH 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-5	13.00	1.186	11	34.4	6.6	0.4	5.5	46.9	33.9		80.8				58	6.2	5.7
5-13	5.06	0.613	8	32.8	7.2	0.3	5.8	46.1	25.7		71.8				64	7.5	6.6
13-20	4.76	0.528	9	37.7	5.7	0.3	6.3	50.0	24.2		74.1				67	7.6	6.9
20-58	4.30	0.382	11	43.4	7.3	0.4	6.4	57.5	23.3		80.8				71	7.6	6.8
58-88	3.21	0.268	12	32.9	22.6	1.2	2.5	59.2	31.7		90.8				65	7.4	6.7
88-118	2.87	0.262	11	33.5	13.2	1.0	3.7	51.4	27.8		79.2				65	7.4	6.7

Depth (cm)	Size class and particle diameter (mm) 3A1 Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits Plastic limit	Liquid limit	Plastic index	Bulk density 1/3 bar	Oven dry	4A3a Field moist	Particle density	Water content 4B4 Field moist	4B1c 1/3 bar	4B2 15 bar	Extensibility 4D1 COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-5	49.0b	47.0	4.0									13	47.1	29.9		
5-13	50.8b	48.8	0.4							0.71		23	41.5	29.1		
13-20												26	46.1	32.8		
20-58	53.6b	43.8	2.6									38	61.4	48.3		
58-88	38.2b	56.7	5.1							0.66		47	77.4	59.2		
88-118	37.2b	58.2	4.6									45	82.1	60.8		

a/ 29.3 kg of organic carbon per square meter to a depth of 1 meter.

WAIMEA VERY FINE SANDY LOAM
S58Ha-1-3

Location: Island of Hawaii, Hawaii County, Hawaii; 10.8 km (6.8 miles) northwest of Kamuela Post Office on Highway 250. Pit located about 45 m (50 yards) northeast of Kohala-Waimea Road on Parker Ranch. Date of sampling: 1958.
Description by: W. Ikeda. Collectors: H. Sato and W. Ikeda.
Classification: **Typic Eutrandept, medial, isothermic.**
Vegetation: Mostly bermudagrass (Cynodon dactylon); others are rattail (Sporobolus capensis), wild oats (Avena fatua), joee (Stachytarpheta cayannensis), ilima (Sida fallax), cactus (Opuntia megacantha), Formosan koa (Acacia confusa), aalii (Dodonaea eriocarpa). Climate: Average annual precipitation is 75 cm (30 inches). The mean annual temperature is 15.6° C (60° F), the mean January temperature 13.9° C (57° F), and the mean July temperature 16.7° C (62° F). Parent material: Volcanic ash. Topography: Leeward rolling intermediate slopes of Kohala Mountain. Elevation: 966 m (3,220 feet). Drainage: Well drained; moderately rapid to rapid permeability; medium to rapid runoff on sparsely vegetated areas, slow on areas with good cover of grass. Soil moisture: Dry.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted. Paired sample number S58Ha-1-4.

HORIZON	DESCRIPTION
A11 BSL No. 59521	0 to 5 cm (0-2 inches), very dark brown (7.5YR 2/2) very fine sandy loam, dark brown (7.5YR 3/2) dry; weak medium and fine platy breaking to very fine granular structure; soft, very friable, nonsticky, nonplastic; strongly magnetic; abrupt smooth boundary.
A12 BSL No. 59522	5 to 13 cm (2-5 inches), very dark brown (7.5YR 2/2) very fine sandy loam, dark brown (7.5YR 3/3) dry; weak very fine granular structure; slightly hard, very friable, nonsticky, nonplastic; many roots; many very fine interstitial pores; few very hard lava fragments of pebble size; material is strongly magnetic; clear smooth boundary.
A13 BSL No. 59523	13 to 20 cm (5-8 inches), very dark brown (7.5YR 2/2) silt loam, dark brown (7.5YR 3/4) dry; weak medium fine subangular blocky structure; slightly hard, very friable, nonsticky, very slightly plastic; many roots; many very fine tubular pores; few very hard lava fragments of pebble size; material is strongly magnetic; clear smooth boundary.
B21 BSL No. 59524	20 to 58 cm (8-23 inches), dark brown (7.5YR 3/3) silt loam, strong brown (7.5YR 4/5) dry; weak coarse and medium subangular blocky structure; soft, very friable, nonsticky, very slightly plastic; common roots; common very fine and few fine and medium tubular pores; occasional very firm lava fragments of pebble size; material is strongly magnetic; gradual smooth boundary.
B22 BSL No. 59525	58 to 88 cm (23-35 inches), dark brown (7.5YR 3/3) silt loam, brown (7.5YR 4/4) dry; few pockets of dark yellowish brown (10YR 3/3) material, slightly lighter colored (10YR 4/4) dry; weak, coarse and medium prismatic structure; slightly hard, very friable, nonsticky, very slightly plastic; few roots; common very fine and few fine and medium tubular pores; few very hard lava fragments from pebble to cobble size; material is strongly magnetic; clear wavy boundary.
B23 BSL No. 59526	88 to 118 cm (35-47 inches), dark brown (7.5YR 3/3) silt loam, slightly lighter colored (7.5YR 4/4) dry; few pockets of material which is slightly redder in hue; weak coarse and medium prismatic structure; slightly hard, very friable, very slightly sticky, very slightly plastic; few roots; common very fine and fine and few medium and coarse tubular pores; common very hard lava fragments from pebble to stone size, increasing in number with increasing depth; material is strongly magnetic.

SOIL FAMILY Typic Eutrandept, medial, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Waimea very fine sandy loam SOIL Nos. S58Ha-1-4 LOCATION Hawaii County, Hawaii

Beltsville Lab Nos. 59527 - 59532

Depth (cm)	Horizon	Mineralogical Analysis															
		7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	7A2 Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-3	A11																	
3-10	A12	4X			1X	tr.							1X		1X			
10-18	A13																	
18-55	B21	4X			1X	tr.							1X		1X			
55-78	B22																	
78-103	B23	4X			1X	tr.							1X		1X			

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-3	A11													5.3	7.6			
3-10	A12													5.5	7.9			
10-18	A13													7.4	10.6			
18-55	B21													7.8	11.2			
55-78	B22													8.1	11.6			
78-103	B23													8.9	12.7			

Depth (cm)	6A1a a/ Organic carbon	6B2a Nitrogen	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	602b Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	5A3a Sum			5C1 NH_4OAc	5C3 Sum	8C1a H_2O 1:1	8C1c KCl 1:1
	Pct.	Pct.		Meq./100 g.										Percent			
0-3	13.14	1.237	11	30.0	11.4	0.6	4.0	46.0	34.2		80.2				57	6.4	6.8
3-10	4.60	0.605	8	29.5	13.4	0.8	2.0	45.7	20.6		66.3				69	7.2	6.3
10-18	4.58	0.589	8	27.6	11.0	0.5	1.1	40.2	25.1		65.3				62	7.3	6.5
18-55	4.78	0.437	11	52.5	6.6	0.8	0.3	60.2	27.2		87.4				69	7.4	6.7
55-78	6.11	0.571	11	35.2	20.8	1.1	0.1	57.2	46.0		103.1				55	6.7	6.2
78-103	3.46	0.317	11	32.6	21.1	0.7	4.1	58.5	26.8		85.3				68	7.4	6.8

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility 4D1	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	4A3a Field moist		4B4 Field moist.	4B1c 1/3 bar	4B2a 15 bar	COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-3	39.0	56.9	4.1									17	50.6	42.3		
3-10	31.2	68.6	0.2							0.64		20	40.6	31.4		
10-18												24	35.7	33.8		
18-55												37	50.4	46.8		
55-78										0.61		56	75.6	69.6		
78-103												50	68.1	61.9		

a/ 30.9 kg of organic carbon per square meter to a depth of 1 meter.

WAIMEA VERY FINE SANDY LOAM
S58Ha-1-4

Location: Island of Hawaii, Hawaii County, Hawaii; 12.8 km (8 miles) northwest of Kamuela on Highway 250. Pit located 67 m (75 yards) northeast of Highway 250 on Parker Ranch. Date of sampling: 1958.
Description by: W. Ikeda. Collectors: H. Sato and W. Ikeda.
Classification: **Typic Eutrandept, medial, isothermic.**
Vegetation: Mostly bermudagrass (Cynodon dactylon); others are rattail (Sporobolus capensis), lantana (Lantana camara), aalii (Dodonaea eriocarpa), Formosan koa (Acacia confusa), cactus (Opuntia megacantha). Climate: Average annual precipitation is 75 cm (30 inches). The mean annual temperature is 15.6° C (60° F), the mean January temperature 13.9° C (57° F), and the mean July temperature 16.7° C (62° F). Parent material: Volcanic ash. Topography: Leeward rolling intermediate slopes of Kohala Mountain. Elevation: 975 m (3,250 feet). Drainage: Well drained; moderately rapid to rapid permeability; medium to rapid runoff on sparsely vegetated areas, slow on areas with good cover of grass. Soil moisture: Dry.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted. Paired sample number S58Ha-1-3.

HORIZON	DESCRIPTION
A11 BSL No. 59527	0 to 3 cm (0-1 inch), very dark brown (7.5YR 2/2) very fine sandy loam, dark brown (7.5YR 3/2) dry; weak fine and very fine granular structure; soft, very friable, nonsticky, nonplastic; many roots; many very fine interstitial pores; material is strongly magnetic; abrupt smooth boundary.
A12 BSL No. 59528	3 to 10 cm (1-4 inches), dark brown (7.5YR 3/2) very fine sandy loam, slightly lighter colored (7.5YR 3/3) dry; weak fine and very fine granular structure; loose, very friable, nonsticky, nonplastic; many roots; many very fine interstitial pores; few very hard lava fragments of pebble size; material is strongly magnetic; clear smooth boundary.
A13 BSL No. 59529	10 to 18 cm (4-7 inches), very dark brown (7.5YR 2/2) silt loam, dark brown (7.5YR 3/2) dry; few pockets of reddish brown (5YR 4/3) material, gray (5YR 5/1) dry that appears to have resulted from burning; weak, medium and fine subangular blocky structure; slightly hard, very friable, nonsticky, very slightly plastic; many roots; many very fine tubular pores; few very hard lava fragments of pebble size; material is strongly magnetic; clear smooth boundary.
B21 BSL No. 59530	18 to 55 cm (7-22 inches), dark brown (7.5YR 3/3) silt loam, brown (7.5YR 4/4) dry; weak medium and fine subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; common roots; common very fine tubular pores; few very hard lava fragments from pebble to cobble size; material is strongly magnetic; gradual wavy boundary.
B22 BSL No. 59531	55 to 78 cm (22-31 inches), dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/3) dry; weak medium and fine subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; common roots; common very fine and occasional medium and fine tubular pores; few very hard lava fragments from pebble to cobble size; material is strongly magnetic; gradual wavy boundary.
B23 BSL No. 59532	78 to 103 cm (31-41 inches), dark brown (8.5YR 3/2) silt loam, brown (7.5YR 4/3) dry; weak coarse and medium subangular blocky structure; slightly hard, very friable, very slightly sticky, very slightly plastic; common roots; common very fine and occasional medium and fine tubular pores; common very hard lava fragments from pebble to stone size, increasing in number with increasing depth; material is strongly magnetic.

SOIL FAMILY Typic Eutrandept, medial over cindery, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Io silt loam SOIL Nos. S65Ha-4-21 LOCATION Maui County, Hawaii

Riverside Lab Nos. 6519 - 6524

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonite	Illite	Halloysite	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-25	Ap																	
25-43	A12																	
43-63	B21																	
63-75	B22																	
75-98	IIC																	
98-113	IIIC																	

Depth (cm)		Total Chemical Analysis												Extractable iron 6C2a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-25	Ap													9.1	13.0			
25-43	A12													9.9	14.2			
43-63	B21													9.9	14.2			
63-75	B22													8.6	12.3			
75-98	IIC													1.7	2.4			
98-113	IIIC													7.9	11.3			

Depth (cm)	6A1a a/ Organic carbon	6B1a Nitrogen	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	602a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:1	8C1c KCl 1:1
	Pct.	Pct.		Meq./100 g.										Percent			
0-25	6.08	0.548	11	34.8	16.2	0.4	8.6	60.0		64.9		-		92		6.8	6.1
25-43	3.54	0.323	11	36.9	12.7	1.5	2.9	54.0		58.7		-		92		7.1	6.1
43-63	1.16	0.094	12	32.4	24.7	3.0	1.9	62.0		60.2		-		100+		7.5	6.5
63-75	0.79	0.069	11	32.6	30.6	3.0	0.4	66.6		61.3		0.1		100+		7.6	6.5
75-98	0.44	0.010	44	12.0	16.0	1.3	0.2	29.5		31.7		0.3		93		7.9	6.8
98-113	0.52	0.047	11	19.8	44.4	6.0	0.1	70.3		65.5		0.1		100+		7.8	6.8

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility 4D1	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	Field moist		Field moist	1/3 bar	15 bar	COLEf	COLE
	Pct. of 2mm.				Pct.	Pct.	Pct.	g/cc				Pct. of whole soil			cm/cm	
0-25					N.P.	N.P.	N.P.			0.80	2.76	47.6	52.4	37.5		
25-43										0.73	2.98	56.2	53.1	43.7		
43-63					46	61	15			0.88	3.07	50.9	54.3	46.9		
63-75									1.10	0.73	2.95	55.8	60.0	50.7		
75-98										0.74	2.59	51.6	19.7	14.7		
98-113											2.90		70.3	54.6		

a/ 20.4 kg of organic carbon per square meter to a depth of 1 meter.

IO SILT LOAM
S65Ha-4-21

Location: Island of Maui, Maui County, Hawaii; Makena Quadrangle - 20°39'20" north latitude and 156°24'40" west longitude, 30 m (100 feet) west of Makena Road in the northeast corner of Keanapuni number 2 pasture on the Ulupalakua Ranch 1.7 km (1.1 miles) southwest of State Highway 37 and Makena Road intersection. Date of [illegible]

sampling: April 13, 1965.

Description by: F. G. Stephens and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, F. Stephens, and G. Yamamoto.

Classification: **Typic Eutrandept, medial over cindery, isothermic.**

Vegetation: Noncultivated improved pasture. Principal plant species are: bermudagrass (Cynodon dactylon), buffelgrass (Pennisetum ciliare), burclover (Medicago hispida), cactus (Opuntia spp.), guineagrass (Panicum maximum), ilima (Sida fallax), lantana (Lantana camara), mao (Obuntilon molle), and natal redtop (Tricholaena repens). Climate: Average annual precipitation is 63 cm (25 inches). Mean annual temperature is 20° C (69° F), the mean January temperature is 19° C (67° F), and the mean July temperature 22° C (71° F). Parent material: Volcanic ash and cinders. Topography: Moderately sloping to moderately steep uplands; **12 percent** slope, west aspect. Elevation: 432 m (1,440 feet). Drainage: Well drained; runoff is medium; permeability is moderately rapid. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Paired sample number S65Ha-4-22.

HORIZON	DESCRIPTION
Ap RSL No. 6519	0 to 25 cm (0-10 inches), very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak and moderate fine and very fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; many pores; very weak effervescence with hydrogen peroxide; neutral (pH 7.0); clear wavy boundary.
A12 RSL No. 6520	25 to 43 cm (10-17 inches), dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; weak and moderate fine subangular blocky structure; hard, friable, sticky and plastic; many roots; many pores; mildly alkaline (pH 7.4); gradual wavy boundary.
B21 RSL No. 6521	43 to 63 cm (17-25 inches), dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; weak fine and medium subangular blocky structure; hard, friable, sticky and plastic; many roots; many fine pores; thin dark coatings on ped faces; compact in place; mildly alkaline (pH 7.6); clear smooth boundary.
B22 RSL No. 6522	63 to 75 cm (25-30 inches), dark reddish brown (5YR 3/3) and yellowish red (5YR 4/6) clay loam, reddish brown (5YR 4/4) and yellowish red (5YR 5/6) dry; weak and moderate fine subangular blocky structure; hard, friable, sticky and plastic; many roots; very porous; 20 percent fine cinders; mildly alkaline (pH 7.8); abrupt smooth boundary.

SOIL FAMILY Typic Eutrandept, medial over cindery, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

[redacted]

Riverside Lab Nos. 6525 - 6529

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-23	AP	2X		10	20			15			10	5						
23-40	A12	2X		5	20			15			5	5						
40-63	B2	2X		5	20			15			10	5						
63-75	IIC1	2X		10	5	1		5			20	5						
75-98	IIIC2	2X		2	20			15			10	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-23	Ap	29.3	4.1	20.9	17.9	0.32	4.68	2.53	0.47	0.06	0.75	19.1	100.1	8.7	12.4		11.54	8.05
23-40	A12	29.8	4.3	21.6	19.3	0.33	4.77	2.48	0.46	0.40	0.71	16.9	101.0	10.6	15.2		12.71	8.64
40-63	B2	29.6	4.6	22.5	19.9	0.28	4.29	2.03	0.46	0.23	0.61	15.9	100.4	9.6	13.7		12.94	9.10
63-75	IIC1	41.2	4.1	16.0	15.4	0.23	7.90	7.86	1.84	0.64	0.51	5.2	100.9	2.2	3.1		11.76	4.69
75-98	IIIC2	32.0	4.7	23.0	21.0	0.23	4.94	1.47	0.33	0.13	0.27	12.6	100.7	10.6	15.2		17.01	10.19

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1b Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-23	5.81	0.46	13	35.8	11.7	0.40	6.10	54.0		61.1		-		88.0		6.7	5.8
23-40	2.55	0.21	12	55.5	22.3	1.70	4.20	83.7		65.5		-		99.9		7.4	6.5
40-63	2.58	0.20	13	42.7	12.3	6.00	0.30	61.3		63.1		-		97.0		7.4	6.4
63-75	0.42			34.9	11.7	2.20	0.90	49.7		54.3		-		92.0		7.8	6.4
75-98	0.79			39.9	13.7	6.00	0.20	59.8		56.7		-		99.9		7.5	6.5

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEF	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-23	27.3	49.0	23.7							0.874	2.773	45.2	49.9	35.2		
23-40	21.6	62.2	16.2							0.834	2.875	50.3	50.0	38.1		
40-63	24.2	61.9	13.9							0.756	3.045	58.7	55.7	43.2		
63-75	88.1	10.2	1.7							0.778	2.540	67.3	17.7	14.1		
75-98	27.2	54.1	18.7							0.764	2.974	64.9	58.0	51.3		

a/ 21.6 kg of organic carbon per square meter to a depth of 1 meter.

IO SILT LOAM
S65Ha-4-22

Location: Island of Maui, Maui County, Hawaii. Makena Quadrangle - 20°40'00" north latitude and 156°24'10" west longitude. Pit located 15 m (50 feet) east of State Highway 37 and 165 m (550 feet) south of Makena Road and State Highway 37 intersection in northwest corner of pasture number 5 on the Ulupalakua Ranch 7.4 km (4.6 miles) from Kula. Date of sampling: April 13, 1965.

Description by: F. G. Stephens and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, F. Stephens, and G. Yamamoto.

Classification: **Typic Eutrandept, medial over cindery, isothermic.**

Vegetation: Noncultivated improved pasture under grass-herb cover.

Principal plant species are: burclover (Medicago hispida), kikuyugrass (Pennisetum clandestinum), plantain (Plantago lanceolata), rattailgrass (Sporobolus capensis), and white clover (Trifolium repens). Climate: Average annual precipitation is 75 cm (30 inches). The mean annual temperature is 20° C (68° F). Parent material: Volcanic ash over cinders. Topography: Midslopes of mountainous uplands that are complex; 12 percent slope gradient to the west. Elevation: 549 m (1,830 feet). Drainage: Well drained; runoff is medium; permeability is moderate. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Colors are for moist soil. Sample number of paired profile is S65Ha-4-21.

HORIZON	DESCRIPTION
Ap RSL No. 6525	0 to 23 cm (0-9 inches), dark brown (7.5YR 3/2) silt loam; moderate fine and very fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; abundant roots; many pores; clear smooth boundary.
A12 RSL No. 6526	23 to 40 cm (9-16 inches), dark brown (7.5YR 3/2) loam; moderate fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; abundant roots; many fine and very fine pores; gradual wavy boundary.
B2 RSL No. 6527	40 to 63 cm (16-25 inches), dark reddish brown (5YR 3/4) silty clay loam; weak medium and coarse prismatic structure; slightly hard, very friable, sticky and plastic; abundant roots; many pores; wormcasts and channels; abrupt wavy boundary.
IIC1 RSL No. 6528	63 to 75 cm (25-30 inches), black cinders (1 to 10 mm); single grain, extremely hard and loose; few roots; cinder layers occur intermittently; abrupt smooth boundary.
IIIC2 RSL No. 6529	75 to 98 cm (30-39 inches), dark brown (7.5YR 3/2) loam; massive; slightly hard, friable, slightly sticky and slightly plastic; few roots; many hard earthy lumps; abrupt wavy boundary.
IIIC3	98 cm (39 inches), black cinders (1 to 10 mm); single grain; extremely hard and loose; 10 to 20 percent cobble and stone-sized Aa lava.

SOIL FAMILY **Ustic Eutrandept, medial, isohyperthermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES **Pakini very fine sandy loam** SOIL Nos. **865Ha-1-9** LOCATION **Hawaii County, Hawaii**

Riverside Lab Nos. 65131 - 65136

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-8	Ap	2X		10	10			5			5	2						
8-20	A12	2X		5	5	1		10			5	3						
20-40	A3	3X		5	5	1		10			10	3						
40-73	B21	3X		5	10	1		10			10	3						
73-113	B22	3X		5	5			10			10	3						
113-150	Cca	3X		5	5	1		10			10	3						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-8	Ap	45.1	2.2	13.5	11.4	0.18	8.53	3.07	0.61	0.58	0.59	14.8	100.6	4.4	6.3	-	13.25	4.92
8-20	A12	43.6	3.0	14.6	12.4	0.23	9.35	3.01	0.61	0.52	0.63	12.9	100.9	5.5	7.9	-	12.37	5.59
20-40	A3	35.8	3.2	17.7	16.1	0.27	11.30	2.93	0.57	0.45	0.51	12.4	101.2	6.8	9.7	-	11.55	7.95
40-73	B21	37.9	3.2	20.4	16.5	0.22	6.85	3.88	0.68	0.46	0.30	10.0	100.4	5.7	8.1	-	13.12	5.30
73-113	B22	41.8	3.0	17.6	15.2	0.20	7.51	5.17	0.92	0.52	0.30	8.2	100.4	5.0	7.1	1	13.11	5.06
113-150	Cca	41.8	2.6	16.4	13.9	0.20	8.36	6.58	1.08	0.56	0.26	9.4	101.1	5.1	7.3	5	13.83	5.24

Depth (cm)	8A Water at Saturation	Water extract from saturated paste 8A1: 6N1b Ca	6O1b Mg	6P1a Na	6Q1a K		6I1a CO_3	6J1a HCO_3	6K1a Cl	6L1b SO_4	8A1a Electrical conductivity
	Pct.	meq/liter									mmho/cm
0-8	91.7	1.9	2.0	2.0	2.2		-	4.3	2.1		0.9
8-20											
20-40											
40-73											
73-113	69.9	1.6	2.2	6.6	0.5		-	2.4	6.9		1.3
113-150											

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-8	5.30	0.47	11	22.6	14.0	1.00	7.40	45.0		51.0		-		88		6.7	5.7
8-20	3.89	0.36	11	17.9	12.0	1.60	4.70	36.2		45.4		-		90		6.6	5.3
20-40	2.68	0.23	12	31.1	8.9	2.90	4.00	46.9		60.6		-		94		7.0	5.8
40-73	1.51	0.12	13	37.5	23.5	2.90	4.90	68.8		68.1		-		100+		7.6	6.4
73-113	0.83	0.07	12	36.4	28.7	6.10	5.20	76.4		61.3		-		100+		8.1	6.9
113-150	0.66	0.05	13	30.8	28.4	12.0	6.10	77.3		57.2		-		100+		8.1	7.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.				Pct.	Pct.	Pct.	g/cc				Pct. of whole soil			cm/cm	
0-8	47.1	45.3	7.6		N.P.	N.P.	N.P.			0.81	2.55		50.9	29.5		
8-20	47.4	47.1	5.5							0.74	2.77		55.2	31.3		
20-40	55.5	41.7	2.8							0.76	2.79		49.9	37.9		
40-73	48.8	48.5	2.7		N.P.	N.P.	N.P.			0.77	2.92		65.1	41.9		
73-113	52.2	45.2	2.6							0.91	2.90		57.0	35.8		
113-150	53.3	41.8	4.9		N.P.	N.P.	N.P.			0.97	2.84		55.0	33.3		

a/ 20.3 kg of organic carbon per square meter to a depth of 1 meter.

PAKINI VERY FINE SANDY LOAM
S65Ha-1-9

Location: Island of Hawaii, Hawaii County, Hawaii. Kalae Quadrangle - 18°56'30" north and 155°41'38" west; about 20 m (300 yards) east of the tracking station at South Point, Kau. Date of sampling: April 8, 1965.
Description by: L. Giese. Collectors: L. Giese, K. Flach, L. Swindale, H. Sato, R. Smythe, G. Yamamoto, and W. Subica.
Classification: **Entic Eutrandept, medial, isohyperthermic.**
Vegetation: **Grassland.** Sandbur (Cenchrus echinatus), Japanese tea (Cassia leschenaultiana), indigo (Indigofera suffruticosa), buffelgrass (Pennisetum ciliare). Climate: Average annual precipitation is 50 to 75 cm (20-30 inches). The mean annual temperature is 23° C (74° F), average January temperature is 22° C (72° F), and average July temperature is 24° C (76° F). Parent material: Volcanic ash and olivine sand. Topography: Leeward footslopes of Mauna Loa; convex, **3 percent south slope.** Elevation: 120 m (400 feet). Drainage: Well drained; rapid permeability; slow runoff. Soil moisture: Dry.
Remarks: Textures are apparent field textures. Paired sample number is S65Ha-1-10.

HORIZON	DESCRIPTION
Ap RSL No. 65131	0 to 8 cm (0-3 inches), very dark brown (10YR 2/2) very fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium platy structure; slightly hard, very friable; many roots; common 2 to 5 mm fragments of rock; neutral (pH 7.1); abrupt smooth boundary.
A12 RSL No. 65132	8 to 20 cm (3-8 inches), dark brown (7.5YR 3/3) very fine sandy loam, dark yellowish brown (10YR 4/4) dry; weak medium and coarse prismatic structure; slightly hard, friable; many roots along prism faces; common 2 to 5 mm fragments of rock; neutral (pH 7.1); clear wavy boundary.
A3 RSL No. 65133	20 to 40 cm (8-16 inches), dark brown (7.5YR 4/4) very fine sandy loam, yellowish brown (10YR 5/4) dry; weak coarse prismatic structure; slightly hard, friable; common roots; common 2 to 5 mm fragments of rock; neutral (pH 7.2); clear wavy boundary.
B21 RSL No. 65134	40 to 73 cm (16-29 inches), dark brown (7.5YR 4/4) loam, strong brown (7.5YR 5/6) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky, slightly plastic; few fine roots; common olivine sand particles; mildly alkaline (pH 7.6); gradual wavy boundary.
B22 RSL No. 65135	73 to 113 cm (29-45 inches), brown (7.5YR 5/4) loam, yellowish brown (10YR 5/6) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky, slightly plastic; few roots; few fine fragments of rock;

SOIL FAMILY Ustollic Eutrandept, medial, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Waikaloa very fine sandy loam SOIL Nos. 865Ha-1-1 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 65166 - 65174

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-10	Ap																	
10-25	A12																	
25-45	A3																	
45-68	B21																	
68-88	B22																	
88-113	B23tb																	
113-140	C1cab																	
140-175	C2cab																	
175-200	C																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-10	Ap													6.1	8.7			
10-25	A12													7.5	10.7			
25-45	A3													7.2	10.3			
45-68	B21													6.8	9.7			
68-88	B22													7.1	10.2	tr.		
88-113	B23tb													6.4	9.2	tr.		
113-140	C1cab													3.1	4.4	4		
140-175	C2cab													2.0	2.9	3		
175-200	C													2.0	2.9	2		

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-10	8.13	0.704	12	26.2	8.2	0.3	4.8	39.5		47.9		-		82		6.5	5.6
10-25	5.22	0.514	10	26.5	6.9	0.4	5.5	39.3		45.6		-		86		6.9	5.8
25-45	2.40	0.201	12	29.0	9.6	1.1	4.7	44.4		45.1		-		98		7.3	6.2
45-68	1.29	0.120	11	24.2	11.8	2.6	2.7	41.3		39.1		-		100+		7.5	6.4
68-88	0.70	0.069	10	21.8	16.6	5.9	0.2	44.5		40.6		-		100+		7.7	6.4
88-113	0.27			21.9	16.5	9.3	0.3	48.0		36.9		-		100+		8.2	6.8
113-140	0.19			26.5	16.5	14.8	0.6	58.4		36.4		-		100+		8.6	7.1
140-175	0.13			24.3	12.6	13.0	1.5	51.4		28.8		-		100+		8.7	7.2
175-200	0.13			24.3	14.3	14.5	2.4	55.5		42.3				100+		8.8	7.1

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar clod	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.				Pct.	Pct.	Pct.	g/cc				Pct. of whole soil			cm/cm	
0-10	50.4	47.5	2.1		N.P.	N.P.	N.P.	0.69	0.76	0.72	2.59	76.7	49.0	33.9	0.035	0.035
10-25	59.9	40.1	0.0							0.62	2.80		52.3	41.9		
25-45	59.7	40.1	0.2							0.66	2.76		54.9	41.2		
45-68	59.2	39.0	1.8		N.P.	N.P.	N.P.	0.82	0.88	0.77	2.83	46.9	55.2	34.6	0.027	0.027
68-88	55.4	39.2	5.4							0.84	2.83		51.6	32.9		
88-113	23.0	52.7	24.3		37	50	13	1.09	1.19	0.89	2.77	35.6	44.6	30.7	0.031	0.031
113-140	39.2	42.6	18.2							0.90	2.70		46.8	33.5		
140-175	47.6	41.0	11.4							0.97	2.66		39.1	22.7		
175-200	63.6	32.3	4.1		N.P.	N.P.	N.P.	1.06	1.06	0.97	2.59	34.8	33.1	20.7	0.003	0.003

a/ 17.6 kg of organic carbon per square meter to a depth of 1 meter.

WAIKALOA VERY FINE SANDY LOAM
S65Ha-1-1

Location: Island of Hawaii, Hawaii County, Hawaii. Puu Anahulu Quadrangle - 19°52'00" north latitude and 155°44'10" east longitude. Pit loated 300 m (1,000 feet) north of Popoo Gulch and 75 m (250 feet) west of Highway 19 on Parker Ranch, Keamuku section. Date of sampling: April 5, 1965.
Description by: H. Sato and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, H. Sato, R. Smythe, W. Subica, and G. Yamamoto.
Classification: **Ustollic Eutrandept, medial, isothermic.**
Vegetation: **Grass cover.** Bermudagrass (Cynodon dactylon), natal redtop (Tricholaena repens), burclover (Medicago hispida), ilima (Sida fallax), cactus (Opuntia megacantha), mountain dandelion (Taraxacum vulgare). Climate: Average annual precipitation is 75 to 100 cm (30-40 inches). The mean annual temperature is 17° C (62° F). Parent material: Volcanic ash. Topography: Leeward intermediate slopes of Mauna Kea. Slope gradient 2 percent; concave slope; west aspect. Elevation: 750 m (2,500 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number is S65Ha-1-2. Colors are for moist soil.

HORIZON	DESCRIPTION
Ap RSL No. 65166	0 to 10 cm (0-4 inches), dark reddish brown (5YR 2/2) very fine sandy loam, dark reddish gray (5YR 4/2) dry; weak very fine granular structure; friable, nonsticky and nonplastic; many roots; many fine and very fine pores; neutral (pH 6.9); abrupt smooth boundary.
A12 RSL No. 65167	10 to 25 cm (4-10 inches), dark reddish brown (5YR 3/2) very fine sandy loam; weak very fine granular structure; friable, nonsticky and nonplastic; many roots; many fine and very fine pores; neutral (pH 7.2); clear smooth boundary.
A3 RSL No. 65168	25 to 45 cm (10-18 inches), dark brown (7.5YR 3/4) very fine sandy loam; weak coarse prismatic structure; friable, nonsticky and nonplastic; many roots; many fine and very fine pores; neutral (pH 7.3); gradual wavy boundary.
B21 RSL No. 65169	45 to 68 cm (18-27 inches), dark brown (7.5YR 3/4) very fine sandy loam; weak coarse prismatic structure; slightly hard, friable, nonsticky and nonplastic; many roots; many fine and very fine pores; neutral (pH 7.3); gradual wavy boundary.
B22 RSL No. 65170	68 to 88 cm (27-35 inches), dark brown (7.5YR 3/2) very fine sandy loam; weak coarse prismatic structure; slightly hard, friable, nonsticky and nonplastic; many roots; many fine and very fine pores; mildly alkaline (pH 7.4); gradual wavy boundary.
B23tb RSL No. 65171	88 to 113 cm (35-45 inches), dark reddish brown (5YR 3/3) silty clay; weak coarse prismatic breaking to moderate medium and fine subangular blocky structure; hard, friable, sticky and plastic; common roots; many fine and very fine pores; continuous dark clay films on ped surfaces; mildly alkaline (pH 7.6); gradual wavy boundary.
C1cab RSL No. 65172	113 to 140 cm (45-56 inches), dark brown (7.5YR 3/4) silty clay loam; weak coarse prismatic structure; hard, friable, sticky and plastic; common roots confined to fracture faces; many fine and very fine pores; violent effervescence with hydrochloric acid; alkaline (pH 7.6); gradual wavy boundary.
C2cab RSL No. 65173	140 to 175 cm (56-70 inches), dark brown (7.5YR 4/2) silty clay loam; massive; hard, friable, slightly sticky and plastic; few roots; many very fine pores; violent effervescence with hydrochloric acid; **carbonates are in streaks of soft powdery material; mildly alkaline (pH 7.8); gradual wavy boundary.**
C RSL No. 65174	175 to 200 cm (70-80 inches), dark brown (7.5YR 3/4) loam; massive; hard, friable, nonsticky and nonplastic; few roots; many very fine pores; mildly alkaline (pH 7.8).

SOIL FAMILY Ustollic Eutrandept. medial. isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Waikaloa very fine sandy loam SOIL Nos. S65Ha-1-2 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 65175 - 65182

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-13	Ap	2X		10	5			10			10	5			2X			
13-25	A12	3X		10	5			10			5	5			1X			
25-50	A3	3X		10	5			15			5	5			1X			
50-63	B21	3X		10	5			15			5	5			1X			
63-78	IIB22b	3X		10	5			15			5	5			1X			
78-98	IIC1cab	2X		20	5			10			5	5			1X			
98-125	IIC2cab	2X		35	10			5			3	3			2X			
125-163	IIC3b	2X		35	10			3			2	2			2X			

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-13	Ap	32.3	3.7	21.1	14.5	0.44	3.30	3.44	1.76	0.80	0.63	18.3	100.3	6.6	9.4		9.80	7.21
13-25	A12	32.9	3.5	23.9	15.0	0.42	2.86	3.55	2.24	0.87	0.61	14.7	100.6	7.4	10.6		9.42	7.91
25-50	A3	36.1	3.2	24.6	15.4	0.43	2.03	3.45	2.26	0.88	0.44	11.7	100.5	7.9	11.3		11.78	9.08
50-63	B21	38.6	3.4	24.0	15.1	0.47	2.07	3.44	2.25	0.82	0.38	10.0	100.5	7.9	11.3		12.68	11.65
63-78	IIB22b	40.4	4.3	22.5	14.8	0.43	2.09	3.17	2.41	0.92	0.36	9.2	100.6	7.8	11.2		12.04	8.65
78-98	IIC1cab	44.8	3.2	20.9	13.9	0.40	2.08	2.11	2.42	1.42	0.26	8.6	100.1	7.3	10.4	4	14.72	8.36
98-125	IIC2cab	51.9	2.5	20.4	6.7	0.29	1.00	2.61	4.20	2.70	0.09	8.1	100.5	3.0	4.3	3	14.00	7.06
125-163	IIC3b	55.7	1.6	21.1	4.8	0.31	0.77	1.68	4.19	2.66	0.09	7.6	100.5	2.1	3.0	2	17.40	6.64

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-13	7.53	0.32	24	27.9	7.8	0.40	4.80	40.9		55.2		-		81.0		6.6	5.7
13-25	3.69	0.16	23	28.0	6.4	0.40	5.60	40.4		51.6		-		78.0		7.1	6.2
25-50	1.88	0.11	17	32.6	7.1	0.80	4.80	45.3		51.7		-		88.0		7.3	6.2
50-63	1.02	0.09	11	34.6	9.8	1.10	3.00	48.5		50.2		-		97.0		7.5	6.3
63-78	0.77			33.3	12.8	1.60	0.60	48.3		51.7		-		93.0		7.6	6.4
78-98	0.31			33.0	15.9	2.20	0.30	51.4		50.0		-		100+		7.8	6.5
98-125	0.15			34.0	12.4	5.40	0.50	52.3		39.9		-		100+		8.1	6.8
125-163	0.11			33.3	14.4	6.10	1.30	55.1		47.7		-		100+		8.2	6.9

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	15 bar	Extensibility 4D1: COLEF	COLE
	Pct. of 2mm							g/cc				Pct. of whole soil		cm/cm	
0-13	63.8	32.3	3.9							0.71	2.64	44.8	32.6		
13-25	58.7	39.7	1.6							0.70	2.74	51.4	38.2		
25-50	60.3	37.2	2.5							0.72	2.88	62.9	39.1		
50-63	60.4	36.8	2.8							0.75	2.89	61.4	39.2		
63-78	53.6	41.2	5.2							0.76	2.88	59.7	37.3		
78-98	37.8	51.3	10.9							0.81	2.81	50.5	32.2		
98-125	40.8	41.9	17.3							0.99	2.68	38.5	23.1		
125-163	57.0	34.9	8.1							0.95	2.61	39.5	24.8		

a/ 15.8 kg of organic carbon per square meter to a depth of 1 meter.

WAIKALOA VERY FINE SANDY LOAM
S65Ha-1-2

Location: Island of Hawaii, Hawaii County, Hawaii. Nohonaohae Quadrangle - 19°53'30" north latitude and 155°43'10" east longitude. A pit located about 5.6 km (3.5 miles) south of the Saddle Road junction and 90 m (300 feet) west of Highway 19 on Parker Ranch. Date of sampling: April 5, 1965.

Description by: H. Sato and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, H. Sato, R. Smythe, G. Yamamoto and W. Subica.

Classification: **Ustollic Eutrandept, medial, isothermic.**

Vegetation: **Grass cover.** Bermudagrass (Cynodon dactylon), natal redtop (Tricholaena repens), burclover (Medicago hispida), ilima (Sida fallax), cactus (Opuntia megacantha), and mountain dandelion (Taraxacum vulgare). Climate: Average annual precipitation is 50 to 100 cm (30-40 inches). Mean annual temperature is 17° C (62° F), mean January temperature is 16° C (60° F), and the mean July temperature is 19° C (67° F). Parent material: Volcanic ash. Topography: Leeward intermediate slopes of Mauna Kea. Slope gradient 2 percent; convex slope; west aspect. Elevation: 780 m (2,600 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Paired sample number is S65Ha-1-1.

HORIZON	DESCRIPTION
Ap RSL No. 65175	0 to 13 cm (0-5 inches), dark reddish brown (5YR 2/2) very fine sandy loam, dark brown (7.5YR 4/2) dry; weak fine granular structure; soft, very friable; many roots; many fine and very fine pores; neutral (pH 7.0); abrupt smooth boundary.
A12 RSL No. 65176	13 to 25 cm (5-10 inches), dark reddish brown (5YR 3/2) very fine sandy loam, dark brown (7.5YR 4/4) dry; weak fine granular structure; soft very friable; many roots; many fine and very fine pores; neutral (pH 7.3); clear smooth boundary.
A3 RSL No. 65177	25 to 50 cm (10-20 inches), dark brown (7.5YR 3/4) very fine sandy loam, (7.5YR 4/4) dry; weak coarse prismatic structure; slightly hard, very friable; many roots; many fine and very fine pores; neutral (pH 7.3); gradual wavy boundary.
B21 RSL No. 65178	50 to 63 cm (20-25 inches), dark brown (7.5YR 3/4) very fine sandy loam, (7.5YR 4/4) dry; weak coarse prismatic structure; slightly hard, friable; many roots; many fine pores; neutral (pH 7.3); gradual wavy boundary.
IIB22b RSL No. 65179	63 to 78 cm (25-31 inches), dark reddish brown (5YR 3/4) silty clay loam, dark brown (7.5YR 4/4) dry; weak coarse prismatic structure; hard, friable, slightly sticky, plastic; common roots; many very fine pores; neutral (pH 7.3); gradual wavy boundary.
IIC1cab RSL No. 65180	78 to 98 cm (31-39 inches), dark reddish brown (5YR 3/2) silty clay loam, strong brown (7.5YR 5/6) dry; weak coarse prismatic structure; hard, friable, slightly sticky, plastic; common roots; many very fine pores; violent effervescence with dilute hydrochloric acid; mildly alkaline (pH 7.5); clear wavy boundary.
IIC2cab RSL No. 65181	98 to 125 cm (39-50 inches), dark brown (7.5YR 3/4) silty clay loam, light yellowish brown (10YR 6/4) dry; weak coarse prismatic structure; hard, friable, slightly sticky, plastic; few roots; many very fine pores; a strong cemented layer about 1 inch thick is at 42 inches; strong effervescence with dilute hydrochloric acid; mildly alkaline (pH 7.5); abrupt wavy boundary.
IIC3b RSL No. 65182	125 to 163 cm (50-65 inches), dark brown (7.5YR 4/4) sandy loam, light yellowish brown (10YR 6/4) dry; weak coarse prismatic structure; hard, friable; few roots; many very fine pores; mildly alkaline (pH 7.4).

SOIL FAMILY Typic Hydrandept, thixotropic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Hilo silty clay loam SOIL Nos. S58Ha-1-1 LOCATION Hawaii County, Hawaii

Beltsville Lab Nos. 59495 - 59508

Depth (cm)	Horizon	Mineralogical Analysis (Percent of Whole Soil) 7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
0-40	Ap	4X			-	30							1X					
40-53	B21																	
53-58	B22																	
58-65	B23																	
65-75	B24	4X			-	30							1X					
75-80	B25																	
80-83	B26																	
83-93	B27																	
93-123	B28																	
123-128	B29																	
128-133	B210																	
133-140	B211	4X			-	20							1X					
140-145	B212																	
145-168	B213																	

Depth (cm)	Horizon	Total Chemical Analysis (Percent of Whole Soil) SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble SiO_2	Al_2O_3
0-40	Ap	12.90	5.24	24.32	27.56	0.15						27.30	97.5	15.4	22.0			
40-53	B21	8.78	5.58	34.40	26.26	0.25						25.82	101.1	16.2	23.2			
53-58	B22	7.32	4.68	37.68	25.96	0.24						23.76	99.6	18.8	26.9			
58-65	B23	9.84	5.59	34.16	26.25	0.44						24.75	101.0	16.0	22.9			
65-75	B24	8.96	5.18	34.08	26.42	0.29						25.64	100.6	17.5	25.0			
75-80	B25	8.12	5.42	36.00	26.82	0.23						25.16	101.8	18.2	26.0			
80-83	B26	9.42	5.18	35.44	26.02	0.36						24.44	100.9	16.5	23.6			
83-93	B27	11.40	5.43	32.72	25.77	0.38						26.37	102.1	17.1	24.5			
93-123	B28	11.64	5.53	33.20	27.35	0.34						24.60	102.7	17.7	25.3			
123-128	B29	11.90	5.68	32.56	24.48	0.29						25.72	100.6	13.8	19.7			
128-133	B210	9.40	5.18	33.76	26.82	0.18						25.58	100.9	17.8	25.5			
133-140	B211	10.90	5.95	31.36	28.61	0.29						25.12	102.2	19.0	27.2			
140-145	B212	10.04	5.54	29.84	29.34	0.16						24.10	99.0	18.6	26.6			
145-168	B213	11.32	5.83	30.24	28.57	0.34						24.76	101.1	17.4	24.9			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a 6N2a Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	CEC 5A3a Sum of cations	5A4 By K saturation pH7	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation 5C1 NH_4OAc	5C3 Sum	pH 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-40	5.30	0.408	13	2.0	1.8	0.1	0.1	4.0	63.6	67.6	46.2				6	5.8	5.6
40-53	3.06	0.223	14	2.2	0.6	Tr.	0.1	2.9	65.5	68.4					4	6.1	6.2
53-58	2.00	0.129	16	1.8	0.3	Tr.	Tr.	2.1	52.1	54.2					4	6.4	6.5
58-65	3.23	0.219	15	2.4	0.3	0.1	Tr.	2.8	63.8	66.6					4	6.3	6.4
65-75	3.08	0.220	14	1.3	1.0	Tr.	Tr.	2.3	64.4	66.7					4	6.2	6.3
75-80	2.26	0.160	14	1.2	0.3	Tr.	Tr.	1.5	57.6	59.2	52.4				3	6.4	6.5
80-83	2.28	0.159	14	1.4	0.3	Tr.	Tr.	1.7	55.2	57.0					3	6.4	6.4
83-93	2.90	0.213	14	1.8	0.4	Tr.	0.1	2.3	54.8	57.1					4	6.3	6.4
93-123	3.23	0.227	14	2.4	0.4	Tr.	Tr.	2.8	64.7	67.6					4	6.3	6.3
123-128	3.12	0.177	18	1.7	1.0	Tr.	Tr.	2.7	75.0	77.7					4	6.4	6.4
128-133	1.87	0.116	16	1.2	0.3	Tr.	Tr.	1.5	55.6	57.2					3	6.4	6.5
133-140	2.72	0.190	14	2.6	0.4	0.1	Tr.	3.1	58.6	61.7					5	6.3	6.4
140-145	2.28	0.136	17	2.6	0.3	Tr.	Tr.	2.9	66.6	69.6					4	6.3	6.5
145-168	2.21	0.160	14	2.5	0.7	Tr.	Tr.	3.2	69.1	72.4					4	6.4	6.4

Depth (cm)	Size class and particle diameter (mm) 3A1 Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits Plastic limit	Liquid limit	Plastic index	Bulk density 4A1c 1/3 bar	Oven dry	4A3a Field moist	Particle density	Water content 4B4 Field moist	4B1c 1/3 bar	4B2a 15 bar
	Pct. of 2mm.							g/cc				Pct. of whole soil		
0-40								0.61		0.33 b/		126	110.6	69.8
40-53												209	156.8	105.6
53-58												152	104.7	99.8
58-65												236	215.6	123.1
65-75												229	202.8	124.9
75-80												203	179.2	105.5
80-83												187	168.0	99.2
83-93												254	230.6	129.1
93-123								0.30		0.54 c/		302	283.3	149.5
123-128												240	238.6	132.6
128-133												202	180.3	153.1
133-140												273	256.4	206.2
140-145												225	212.7	175.9
145-168												254	238.9	196.6

a/ 16.3 kg of organic carbon per square meter to a depth of 1 meter.

b/ Water content 312 percent.

c/ Water content 114 percent.

HILO SILTY CLAY LOAM
S58Ha-1-1

Location: Island of Hawaii, Hawaii County, Hawaii. Approximately 2.8 km (1.8 miles) north of Hilo Post Office. Sample site is located 30 m (100 feet) south of road at a point .5 km (0.3 mile) west of Hasheo School which is at the north end of Wainaku Village. Date of sampling: 1958.
Description by: W. Ikeda. Collectors: W. Ikeda, H. Sato, and J. M. Williams.
Classification: Typic Hydrandept, thixotropic, isohyperthermic.
Vegetation: Originally ohia-tree fern vegetation, now cleared and in sugarcane. Climate: Average annual precipitation is 438 cm (175 inches). The mean annual temperature is 22.2° C (72° F), the mean January temperature 20.0° C (68° F), and the mean July temperature 23.9° C (75° F). Parent material: Volcanic ash. Topography: Undulating to rolling low windward slopes of Mauna Kea, 3 percent slope to east. Elevation: 105 m (350 feet). Drainage: Well drained; rapid permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Colors are for moist soil. Paired sample number S58Ha-1-2. **All horizons dehydrate irreversibly to sand and gravel size aggregates.**

HORIZON	DESCRIPTION
Ap BSL No. 59495	0 to 40 cm (0-16 inches), dark brown (10YR 3/3) silty clay loam mixed with dark reddish brown (5YR 3/4) by cultivation; weak very fine and fine granular structure; friable, sticky, plastic, moderately smeary; many roots; many very fine and fine interstitial pores; few to common firm ash nodules; abrupt smooth lower boundary.
B21 BSL No. 59496	40 to 53 cm (16-21 inches), dark reddish brown (5YR 3/3) silty clay loam; weak medium subangular blocky structure; friable, sticky, plastic, moderately smeary; many roots; many very fine and fine and common medium and few coarse tubular pores; thick gelatinous coating on ped surfaces, some surfaces appear like clay flow; few firm ash nodules; abrupt smooth boundary.
B22 BSL No. 59497	53 to 58 cm (21-23 inches), dark reddish brown (2.5YR 3/4) silty clay loam; weak fine and very fine subangular blocky structure; friable, sticky, plastic, moderately smeary; common roots; many very fine and fine and common medium and few coarse tubular pores; common firm ash nodules of 13 to 25 mm (1/2 to 1 inch) in diameter; ped surfaces have gelatinous appearance; abrupt smooth boundary.
B23 BSL No. 59498	58 to 65 cm (23-26 inches), dark brown (7.5YR 3/2) silty clay loam; moderate very fine subangular blocky structure; friable, sticky, plastic, moderately smeary; common fine roots; many very fine, fine and medium and few coarse tubular pores; ped surfaces have gelatinous appearance, some surfaces look like clay flows; few firm ash nodules; abrupt smooth boundary.
B24 BSL No. 59499	65 to 75 cm (26-30 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate very fine subangular blocky structure; friable, sticky, plastic, moderately smeary; common fine roots; many very fine, fine and medium and few coarse tubular pores; ped surfaces have translucent gelatinous appearance, some coatings appear like clay flows; few firm ash nodules; abrupt smooth boundary.
B25 BSL No. 59500	75 to 80 cm (30-32 inches), dark reddish brown (2.5YR 3/4) silty clay loam; moderate subangular blocky structure; friable, sticky, plastic, moderately smeary; few fine roots; many very fine, fine and common medium and few coarse tubular pores; ped surfaces have translucent gelatinous appearance; abrupt smooth boundary.
B26 BSL No. 59501	80 to 83 cm (32-33 inches), dark brown (7.5YR 3/2) silty clay loam; moderate very fine subangular blocky structure; friable, sticky, plastic, moderately smeary; few fine roots; many very fine, fine and common medium and few coarse tubular pores; thick translucent gelatinous coating on ped surfaces that appear like clay flows; few firm ash nodules; abrupt smooth boundary.
B27 BSL No. 59502	83 to 93 cm (33-37 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate very fine subangular blocky structure; friable, sticky, plastic, moderately smeary; few roots; many very fine, fine and medium and few coarse tubular pores; thick gelatinous coating on ped surfaces; few firm ash nodules of dark reddish brown (2.5YR 3/4); clear smooth boundary.
B28 BSL No. 59503	93 to 123 cm (37-49 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate fine and medium subangular blocky structure; friable, sticky, plastic, moderately smeary; few roots; many very fine, fine and medium and few coarse tubular pores; thick gelatinous coating on ped surfaces; clear smooth boundary.
B29 BSL No. 59504	123 to 128 cm (49-51 inches), dark brown (7.5YR 3/3) silty clay loam; strong very fine subangular blocky structure; friable, sticky, plastic, moderately smeary; no roots; many very fine, fine and common medium tubular pores; thick translucent gelatinous coating on ped surface; few firm ash nodules; abrupt smooth boundary.
B210 BSL No. 59505	128 to 133 cm (51-53 inches), dark reddish brown (2.5YR 3/4) silty clay loam; weak very fine and fine subangular blocky structure; friable, sticky, plastic, strongly smeary; no roots; many very fine, fine and medium and few coarse tubular pores; thick gelatinous coating on ped surfaces; common firm ash nodules of 6 to 18 mm (1/4-3/4 inch) in diameter; abrupt smooth boundary.
B211 BSL No. 59506	133 to 140 cm (53-56 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate very fine subangular blocky structure; firm, sticky, plastic, strongly smeary; no roots; many very fine, fine and medium and few coarse tubular pores; translucent gelatinous coating on ped surfaces; few firm ash nodules; abrupt smooth boundary.
B212 BSL No. 59507	140 to 145 cm (56-58 inches), dark reddish brown (2.5YR 3/4) silty clay loam; moderate very fine subangular blocky structure; friable, sticky, plastic, strongly smeary; no roots; many very fine, fine and common medium and few coarse tubular pores; ped surfaces have translucent gelatinous appearance; many firm ash nodules of 6 to 25 mm (1/4-1 inch) in diameter; abrupt smooth boundary.
B213 BSL No. 59508	145 to 168 cm (58-67 inches), dark reddish brown (5YR 3/4) silty clay loam; strong very fine subangular blocky structure; friable, sticky, plastic, strongly smeary; no roots; many very fine, fine and common medium and few coarse tubular pores; ped surfaces have gelatinous appearance; few firm ash nodules.

SOIL FAMILY Typic Hydrandept, thixotropic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Hilo silty clay loam SOIL Nos. S58Ha-1-2 LOCATION Hawaii County, Hawaii

Beltsville Lab Nos. 59509 - 59520

Depth (cm)	Horizon	Mineralogical Analysis: 7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-38	Ap																	
38-48	B21	4X			-	25							1X					
48-50	B22																	
50-58	B23																	
58-80	B24																	
80-85	B25																	
85-100	B26																	
100-108	B27	4X			-	15							1X					
108-133	B28																	
133-153	B29																	
153-158	B210																	
158-180	B211	1X			-	20							1X					

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-38	A1p													16.7	23.9			
38-48	B21													17.2	24.6			
48-50	B22													17.6	25.2			
50-58	B23													16.2	23.2			
58-80	B24													18.6	26.6			
80-85	B25													20.7	29.6			
85-100	B26													16.4	23.5			
100-108	B27													15.4	22.0			
108-133	B28													17.6	25.2			
133-153	B29													17.7	25.3			
153-158	B210													18.3	26.2			
158-180	B211													16.2	23.2			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	$NaHCO_3$ extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-38	6.95	0.546	13	2.6	2.2	Tr.	0.2	5.0	75.0		80.1	2.66			6	5.4	5.2
38-48	3.89	.292	13	1.4	0.3	0.1	0.1	1.9	72.0		73.9	5.41			2	5.9	5.9
48-50	2.93	.193	15	0.9	.1	Tr.	0.1	1.1	61.6		62.7	4.85			2	6.0	6.2
50-58	2.70	.190	14	.9	.1	.1	Tr.	1.1	56.6		57.7	4.81			2	5.9	6.1
58-80	3.01	.207	14	1.8	.3	.1	Tr.	2.2	59.9		62.1	4.93			4	6.1	6.2
80-85	3.24	.213	15	1.5	.1	Tr.	Tr.	1.6	77.9		79.6	6.73			2	6.4	6.2
85-100	2.71	.197	14	1.4	.1	Tr.	Tr.	1.5	66.6		68.2	4.72			2	6.2	6.2
100-108	2.94	.174	17	.6	.1	Tr.	Tr.	0.7	67.3		68.1	5.22			1	6.2	6.2
108-133	2.93	.188	16	1.6	.1	.1	Tr.	1.8	83.6		85.4	7.88			2	6.1	6.3
133-153	2.24	.132	17	1.3	.1	Tr.	Tr.	1.4	65.3		66.8				2	6.2	6.2
153-158	2.54	.171	15	1.4	.1	Tr.	Tr.	1.5	74.3		75.9				2	6.2	6.3
158-180	2.74	.180	15	1.6	.1	.1	Tr.	2.3	68.2		70.5				3	6.1	6.3

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	4A3a Field moist	Particle density	Water content: 4B4 Field moist	4B1c 1/3 bar	4B2a 15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-38										0.58		96	90.2	77.4		
38-48												240	220.8	196.3		
48-50												201	197.6	178.6		
50-58												198	191.3	173.1		
58-80												192	207.3	199.2		
80-85												280	263.8	151.4		
85-100												243	255.7	126.7		
100-108												228	228.0	121.6		
108-133										0.34		298	286.8	138.3		
133-153												228	216.1	113.1		
153-158												254	257.0	123.4		
158-180												297	240.8	123.8		

a/ 21.8 kg of organic carbon per square meter to a depth of 1 meter.

HILO SILTY CLAY LOAM
S58Ha-1-2

Location: Island of Hawaii, Hawaii County, Hawaii. Approximately 4.9 km (3.1 miles) north of Hilo, Hawaii. Sample site is located 30 m (100 feet) north of gravel road from a point that is .3 km (0.2 mile) west of Highway 19. Junction with Highway 19 is 4.8 km (2.95 miles) from the Wailoa Bridge at Hilo city limits. Date of sampling: 1958.
Description by: W. Ikeda. Collectors: W. Ikeda, H. Sato, and J. M. Williams.
Classification: Typic Hydrandept, thixotropic, isohyperthermic.
Vegetation: Cleared from ohia-tree fern vegetation, now in sugarcane. Climate: Average annual precipitation is 438 to 500 cm (175-200 inches). The mean annual temperature is 22.2° C (72° F), the mean January temperature 20° C (68° F), and the mean July temperature 23.9° C (75° F). Parent material: Volcanic ash. Topography: Low undulating to rolling windward slopes of Mauna Kea. Slope 5 percent convex to east. Elevation: 90 m (300 feet). Drainage: Well drained but soils never dry out because it rains almost every day; rapid permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Colors are for moist soil. The B horizon dries irreversibly to a darker color. The extreme banding in this soil is due to stratification or layering of volcanic ash. Paired sample No. S58Ha-1-1. **All horizons dry irreversibly to sand and gravel size aggregates.**

HORIZON	DESCRIPTION
Ap BLS No. 59509	0 to 38 cm (0-15 inches), dark brown (10YR 3/3) silty clay loam; weak very fine and fine granular structure; friable, slightly sticky, plastic, weakly to moderately smeary; common fine roots; common very fine and fine tubular pores; few firm ash nodules of dark reddish brown (2.5YR 3/4); clear abrupt lower boundary.
B21 BLS No. 59510	38 to 48 cm (15-19 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate very fine subangular blocky structure; friable, sticky, plastic, moderately smeary; common roots; many very fine, fine and medium and few coarse tubular pores; continuous gelatinous coating on ped surfaces; common fine firm ash nodules of dusky red (2.5YR 3/2) and dark reddish brown (2.5YR 3/4); abrupt wavy lower boundary.
B22 BSL No. 59511	48 to 50 cm (19-20 inches), dark reddish brown (2.5YR 3/4) silty clay loam; moderate very fine and fine subangular blocky structure; friable, sticky, plastic, moderately smeary; common roots; many very fine, fine and medium and few coarse tubular pores; many firm ash nodules from 6 to 18 mm (1/4-3/4 inch) in diameter; ped surfaces have gelatinous appearance; abrupt smooth lower boundary.
B23 BLS No. 59512	50 to 58 cm (20-23 inches), dark brown (7.5YR 3/2) silty clay loam; moderate very fine and fine subangular blocky structure; friable, sticky, plastic, moderately smeary; common fine roots; many very fine, fine and medium and few coarse tubular pores; occasional firm ash nodules 6 to 13 mm (1/4-1/2 inch) in diameter; ped surfaces have gelatinous appearance; abrupt smooth lower boundary.
B24 BLS No. 59513	58 to 80 cm (23-32 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate very fine subangular blocky structure; friable, sticky, plastic, moderately smeary; common roots; many very fine fine and medium and few coarse tubular pores; ped surfaces have gelatinous appearance; common firm ash nodules 6 to 13 mm (1/4-1/2 inch) in diameter; clear smooth boundary.
B25 BSL No. 59514	80 to 85 cm (32-34 inches), dark reddish brown (5YR 3/3) silty clay loam; moderate fine and very fine subangular blocky structure; friable, sticky, plastic, moderately smeary; few roots; many fine and very fine and common medium tubular pores; gelatinous glaze on ped surfaces; common firm ash nodules; clear wavy boundary.
B26 BSL No. 59515	85 to 100 cm (34-40 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate fine subangular blocky structure; friable to firm, sticky, plastic, moderately smeary; few roots; many very fine, fine and medium tubular pores; ped surfaces have gelatinous glaze coating; common firm ash nodules of 6 to 25 mm (1/4-1 inch) in diameter; abrupt irregular boundary.
B27 BSL No. 59516	100 to 108 cm (40-43 inches), very dark grayish brown (10YR 3/2) silty clay loam; moderate fine and medium subangular blocky structure; firm, sticky, plastic, moderately smeary; no roots; many very fine and fine, common medium tubular pores; few occasional firm ash nodules; abrupt broken boundary.
B28 BSL No. 59517	108 to 133 cm (43-53 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate very fine and fine subangular blocky structure; friable, sticky, plastic, moderately smeary; no roots; many very fine and fine and common medium tubular pores; gelatinous coating on ped surfaces; few firm ash nodules; clear smooth boundary.
B29 BSL No. 59518	133 to 153 cm (53-61 inches), dark reddish brown (5YR 3/3) silty clay loam; moderate very fine and fine subangular blocky structure; friable, sticky, plastic, moderately smeary; no roots; many very fine, fine and medium tubular pores; gelatinous coating on ped surfaces; many firm ash nodules; the reddish yellow gibbsite coatings appear in greatest abundance in this horizon; gradual wavy boundary.
B210 BSL No. 59519	153 to 158 cm (61-68 inches), dark brown (7.5YR 3/2) silty clay loam; moderate very fine, fine and medium subangular blocky structure; friable, sticky, plastic, moderately smeary; no roots; many very fine, fine and common medium tubular pores; occasional firm ash nodules; gelatinous coating on ped surfaces; gradual wavy boundary.
B211 BSL No. 59520	158 to 180 cm (68-72 inches), dark brown (9YR 3/3) silty clay loam; moderate, very fine and fine subangular blocky structure; firm, sticky, plastic, moderately smeary; no roots; many very fine, fine and medium tubular pores; gelatinous appearance on ped surfaces; common firm ash nodules.

SOIL FAMILY **Typic Hydrandept, thixotropic, isomesic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Akaka silty clay loam SOIL Nos. S61Ha-1-2 LOCATION Hawaii County, Hawaii

Beltsville Lab Nos. 61536 - 61543

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	A11																	
18-38	A12																	
38-58	B1																	
58-80	B21																	
80-95	B22																	
95-120	B23																	
120-130	B24																	
130-180	B25																	

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	A11													21.8	31.2			
18-38	A12													21.3	30.4			
38-58	B1													21.2	30.3			
58-80	B21													16.9	24.1			
80-95	B22													13.6	19.4			
95-120	B23													13.0	18.5			
120-130	B24													14.1	20.2			
130-180	B25													18.4	26.3			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	6O2b Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	5A3a Sum			5C1 NH_4OAc	5C3 Sum	8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-18	8.81	0.617	14	<0.1	0.6	0.24	0.11		66.4		67.4		0.2		1	5.5	5.0
18-38	6.42	.430	15	0.1	0.4	0.14	0.04		63.7		64.4				1	5.5	5.3
38-58	6.90	.407	17	0.3	0.4	0.20	0.03		71.9		72.8		0.1		1	5.4	5.2
58-80	6.57	.384	17	<0.1	0.2	0.16	0.05		60.3		60.7				1	5.4	5.4
80-95	4.22	.240	18	0.2	0.1	0.18	0.06		52.4		52.9				1	5.9	5.9
95-120	4.16	.246	17	<0.1	0.4	0.08	0.08		58.6		59.2				1	5.7	5.9
120-130	4.18	.255	16	<0.1	0.2	0.10	0.04		54.9		55.2		<0.1		<1	5.6	6.2
130-180	4.32	.264	16	<0.1	<0.1	0.30	0.26		80.1		80.7				1	5.7	6.0

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	Field moist		4B2a 15 bar moist	1/3 bar	4B2 15 bar A.D.	4D1 COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-18												114.3		32.5		
18-38												143.7		32.2		
38-58												188.3		32.6		
58-80												174.1		33.1		
80-95												181.0		28.7		
95-120												163.2		35.1		
120-130												148.7		34.5		
130-180												271.5		31.1		

AKAKA SILTY CLAY LOAM
S61Ha-1-2

Location: Island of Hawaii, Hawaii County, Hawaii; Piihonua Quadrangle - 19°44'52" north latitude and 155°10'25" west longitude, about 1.6 km (1 mile) above radio station tower above Amaulu in eucalyptus forest. Date of sampling: April 15, 1961
Description by: Warren Ikeda and Klaus Flach. Collectors: Klaus Flach and Warren Ikeda.
Classification: **Typic Hydrandept, thixotropic, isomesic.**
Vegetation: Eucalyptus (Eucalyptus sp.) and tree fern (Cibotium sp.), the natural vegetation is ohia (Metrosideros collina), koa (Acacia koa), tree fern (Cibotium sp.) and uluhe (Gleichenia linearis). Climate: Average annual precipitation is 375 cm (150 inches); the mean annual temperature is 14° C (58° F). Parent material: Volcanic ash. Topography: South slope of Mauna Kea, undulating to rolling uplands. Elevation: 570 m (1,900 feet). Drainage: Moderately well drained; slow runoff; rapid permeability. Soil moisture: Wet when sampled.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Colors are for moist soil.

HORIZON	DESCRIPTION
A11 BSL No. 61536	0 to 18 cm (0-7 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate medium and fine subangular blocky structure, upper 5 cm (2 inches) near massive; friable, slightly sticky, plastic, moderately smeary; common roots; common fine pores, few coarse pores; common wormcasts; strongly acid (pH 5.5); clear wavy boundary.
A12 BSL No. 61537	18 to 38 cm (7-15 inches), dark reddish brown (5YR 3/4) clay loam; moderate medium and fine subangular blocky structure; friable, slightly sticky, plastic, moderately smeary; few roots; common coarse and medium pores; few firm pebble-size fragments of volcanic ash; strongly acid (pH 5.5); gradual wavy boundary.
B1 BSL No. 61538	38 to 58 cm (15-23 inches), reddish brown (5YR 4/4) silty clay loam, few coarse faint mottles of dark brown (7.5YR 3/2) and reddish brown (2.5YR 4/4); moderate medium and fine subangular blocky structure; friable, slightly sticky, plastic, moderately smeary; few roots; common medium and fine pores; thick gelatin-like coatings on ped faces; strongly acid (pH 5.4); gradual wavy boundary.
B21	58 to 80 cm (23-32 inches), dark reddish brown (5YR 3/4) silty clay loam, common

SOIL FAMILY Typic Hydrandept, thixotropic, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Honokaa silty clay loam SOIL Nos. S62Ha-1-1 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 17356 - 17364

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	Ap	2X		10	5	2		20			5	5						
18-35	B21	2X		10	3	3		20			5	5						
35-50	B22	2X		5	2	2		20			5	5						
50-63	B23	2X		5	2	1		20			5	5						
63-70	B24	2X		5	2	2		20			5	5						
70-80	B25	3X		4	0	1		15			5	5						
80-85	IIB26	3X		2	0	1		20			3	5						
98-113	IVB28	2X		1	2	5		25			5	5						
148-163	VIIB211	2X		10	1	5		30			5	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	Ap	13.1	4.6	17.5	23.1	0.22	0.20	0.17	1.11	0.71	0.90	39.0	100.6	14.0	20.0		1.33	2.47
18-35	B21	12.2	4.6	20.6	24.3	0.20	0.24	0.08	0.05	0.70	0.64	36.1	99.7	14.4	20.6		1.11	3.14
35-50	B22	11.9	4.4	24.6	19.5	0.16	0.29	-	0.03	0.46	0.86	37.3	99.5	11.5	16.4		3.61	7.52
50-63	B23	10.5	4.8	24.0	21.4	0.18	0.27	-	tr.	0.38	0.96	36.8	99.3	12.3	17.5		3.93	7.83
63-70	B24	10.9	4.4	24.4	20.6	0.21	0.09	-	-	0.35	0.96	37.1	99.0	11.6	16.6		4.33	8.50
70-80	B25	12.2	3.9	30.7	16.6	0.19	0.19	-	-	0.26	0.10	36.7	100.8	9.0	12.9		7.74	13.17
80-85	IIB26	11.0	4.5	31.2	19.6	0.19	0.22	-	-	0.14	0.08	33.5	100.4	12.2	17.4		8.65	13.95
98-113	IVB28	10.2	5.4	23.9	26.9	0.10	0.20	-	-	0.41	0.07	32.7	99.9	16.6	23.7		2.27	5.42
148-163	VIIB211	13.1	4.6	22.8	29.7	0.05	tr.	-	0.10	0.72	0.05	30.2	101.3	18.8	26.9		1.22	2.77

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-18	11.70	0.90	13	9.4	2.6	0.3	0.5	12.8		53.1		1.1	0.5	24		5.4	4.5
18-35	6.55	0.45	15	0.8	0.3	0.2	0.2	1.5		33.7		3.1	0.6	4		5.2	4.5
35-50	9.36	0.44	21	0.5	0.3	0.2	0.1	1.1		39.3		3.2	0.3	3		5.4	4.7
50-63	8.49	0.43	20	-	0.1	0.2	0.1	0.4		29.9		6.8	0.2	1		5.4	5.0
63-70	7.80	0.39	20	-	1.2	0.1	0.2	1.5		25.3		10.2	0.1	6		5.5	5.2
70-80	7.01	0.35	20	-	0.6	0.1	0.1	0.8		24.3		13.5	tr.	3		5.6	5.4
80-85	5.14	0.21	24	-	0.4	0.2	0.1	0.7		23.0		21.0		3		5.7	5.6
98-113	4.92	0.29	17	-	0.7	0.1	0.2	1.0		21.2		24.2	tr.	5		5.5	5.3
148-163	3.33	0.31	11	-	0.6	0.2	0.2	1.0		14.4		32.6	tr.	7		5.2	5.1

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-18				-						0.51	2.506	122.9	133.4	101.9		
18-35				-						0.33	2.676	209.1	191.6	154.5		
35-50				-						0.30	2.614	220.1	212.0	166.9		
50-63				-						0.30	2.707	226.9	229.3	196.0		
63-70				-						0.27	2.693	253.7	244.8	193.9		
70-80				-						0.30	2.603	237.1	232.0	187.5		
80-85				-						0.27	2.727	262.4	200.3	165.8		
98-113				-						0.24	2.771	304.1	267.5	211.1		
148-163				-							2.874		263.8	199.6		

a/ 26.5 kg of organic carbon per square meter to a depth of 1 meter.

HONOKAA SILTY CLAY LOAM
S62Ha-1-1

Location: Island of Hawaii, Hawaii County, Hawaii. Proceed southeast 3.2 km (2 miles) on Highway 19 from junction of Highway 19 and Highway 240; then south on Paauhau Sugar Plantation Road until airstrip is reached; then right for about .16 km (0.1 mile); then left (uphill) until cane field boundary is reached. Profile site is in pasture about 45 m (50 yards) south from cane field boundary. Date of sampling: 1962.
Description by: Warren Ikeda. Collectors: Warren Ikeda and Harry Sato.
Classification: Typic Hydrandept, thixotropic, isothermic.
Vegetation: Pangola (Digitaria decumbens), glenwoodgrass (Sacciolepsis contracta), kikuyu (Pennisetum clandestinum), joee (Stachytarpheta cayannensis), hilograss (Paspalum conjugatum), guava (Psidium guayava), ohia (Metrosideros collina), amaumau fern (Sadleria cyatheoides), and tree fern (Cibotium sp.). Climate: The average annual precipitation is 300 to 375 cm (120-150 inches). Parent material: Volcanic ash. Topography: Rolling to hilly windward slopes of Mauna Kea Mountain; natural drainageways are common. Elevation: 660 m (2,200 feet). Drainage: Well drained; moderately rapid permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Colors are for moist soil. Paired sample number S62Ha-1-2. All horizons harden irreversibly upon drying.

HORIZON	DESCRIPTION
Ap	0 to 18 cm (0-7 inches), dark brown (7.5YR 3/2) clay that feels like silty clay loam; strong medium and [redacted]
17356 B21	18 to 35 cm (7-14 inches), dark brown (7.5YR 3/4) clay that feels like a silty clay loam, peds crush to a stronger chroma; moderate medium, fine and very fine subangular blocky structure; friable, sticky, plastic [redacted]
17357 B22	coatings on ped surfaces; abrupt smooth boundary. 35 to 50 cm (14-20 inches), dark brown (10YR 3/3) clay that feels like a silty clay loam, peds crush to a

SOIL FAMILY Typic Hydrandept, thixotropic, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Honokaa silty clay loam SOIL Nos. S62Ha-1-2 LOCATION Hawaii County, Hawaii

Lincoln Lab Nos. 17365 - 17375

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	Ap																	
18-35	B21																	
35-53	B22																	
53-75	B23																	
75-85	B24																	
85-95	B25																	
95-105	D1																	
105-113	B26																	
113-125	B27																	
125-140	B28																	
140-180	B29																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	Ap													16.8	24.0			
18-35	B21													15.3	21.9			
35-53	B22													15.2	21.7			
53-75	B23													12.3	17.6			
75-85	B24													14.2	20.3			
85-95	B25													11.4	16.3			
95-105	D1													15.6	22.3			
105-113	B26													13.9	19.9			
113-125	B27													19.0	27.2			
125-140	B28													15.3	21.9			
140-180	B29													11.9	17.0			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-18	10.9	0.950	11	12.4	3.0	0.3	0.3	16.0		41.6		0.4	0.2	38		5.0	4.5
18-35	9.29	0.592	16	6.8	1.6	0.2	0.1	8.7		34.5		1.0		25		6.0	5.0
35-53	8.86	0.499	18	3.1	1.3	0.2	0.1	4.7		27.1		2.7		17		5.9	5.2
53-75	6.95	0.374	18	2.6	0.8	0.1	0.1	3.6		30.6		4.5		12		6.2	5.6
75-85	6.72	0.377	18	1.8	0.8	0.1	0.1	2.8		30.3		11.2		9		6.1	5.6
85-95	6.75	0.350	19	1.4	1.1	0.2	0.1	2.8		28.1		9.4		10		6.2	5.7
95-105	4.90			0.7	0.5	0.1	tr.	1.3		17.8		16.0		7		6.1	5.8
105-113	6.16			1.2	1.0	0.1	0.2	2.5		18.4		15.3		14		6.2	5.9
113-125	5.68			1.4	0.9	0.2	0.1	2.6		16.7		17.1		16		6.1	5.7
125-140	5.69			0.8	1.0	0.1	0.1	2.0		17.5		18.4		11		6.0	5.7
140-180	1.92			1.0	0.5	0.1	0.1	1.7		9.4		3.6		18		5.9	5.1

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-18				-						0.42	2.79	143.7	116.2	90.4		
18-35				-						0.30	2.68	184.3	158.9	122.2		
35-53				-						0.27	2.03	228.5	193.8	151.2		
53-75				-						0.27	2.76	240.3	211.3	164.7		
75-85				-						0.26	2.83	272.0	254.7	194.1		
85-95				-						0.28	2.76	244.9	240.0	186.1		
95-105				-						0.29	2.73	239.2	231.2	182.8		
105-113				-						0.27	2.78	270.9	252.6	197.0		
113-125				-						0.29	3.00	243.1	241.8	183.2		
125-140				-						0.35	2.92	209.6	255.6	197.7		
140-180				tr.						0.48		138.9				

a/ 25.9 kg of organic carbon per square meter to a depth of 1 meter.

HONOKAA SILTY CLAY LOAM
S62Ha-1-2

Location: Island of Hawaii, Hawaii County, Hawaii. From junction of Highway 19 and Highway 240 at Honokaa, proceed 1.61 km (1.0 mile) west on Highway 19, then proceed 2.4 km (1.5 miles) south on dirt road until forest reserve boundary is reached; profile is about 1.7 km (1.1 miles) uphill (south) in Parker Ranch

SOIL FAMILY Typic Hydrandept, thixotropic, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kealakekua silty clay loam SOIL Nos. S62Ha-1-3 LOCATION Hawaii County, Hawaii

Lincoln Lab Nos. 17376 - 17381

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-10	Ap1	2X		5	10	1		15			5	5						
10-15	Ap2	2X		5	5	2		20			5	5						
15-25	B21	2X		5	5	3		30			5	5						
25-50	B22	2X		5	4	3		30			0	5						
50-58	B23	3X		2	2	1		20			2	5						
58-90	B24	3X		0	0	1		10			3	2						

Depth (cm)		Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-10	Ap1	15.2	3.3	15.7	17.6	0.20	2.94	1.12	0.17	0.30	0.99	41.9	99.4	9.7	13.9		5.79	5.91
10-15	Ap2	12.7	4.4	16.8	25.0	0.23	1.62	0.72	0.14	0.47	0.87	37.2	100.1	14.0	20.0		3.87	4.07
15-25	B21	12.4	5.8	16.7	30.4	0.19	1.13	0.32	0.07	0.54	0.19	32.6	100.3	18.6	26.6		2.04	1.52
25-50	B22	11.3	6.2	21.5	27.4	0.19	0.63	-	0.06	0.52	0.86	31.4	100.1	19.5	27.9		2.05	1.96
50-58	B23	10.3	4.1	25.0	21.1	0.13	0.59	-	-	0.14	0.91	37.8	100.1	13.6	19.4		6.38	10.39
58-90	B24	14.8	2.6	32.2	13.2	0.07	1.09	-	-	-	0.85	35.0	99.8	7.7	11.0		12.32	19.59

Depth (cm)	6A1a Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-10	17.10	1.20	14	13.7	13.1	0.4	0.7	27.9		55.7		2.2	0.3	50		6.1	5.0
10-15	11.40	0.86	13	9.4	9.1	0.2	0.3	19.0		60.5		1.4	-	31		6.0	4.9
15-25	7.26	0.60	12													5.7	4.6
25-50	6.24	0.54	12	1.2	1.8	0.2	0.1	3.3		34.8		5.1		9		5.4	4.7
50-58	9.25	0.54	17	1.4	1.3	0.2	0.2	3.1		34.0		8.6		9		5.6	5.0
58-90	6.47	0.43	15	0.4	2.0	0.2	0.1	2.7		30.5		12.1		9		5.8	5.4

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEF	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-10				tr.							2.46		138.5	99.8		
10-15				-							2.67		153.4	103.9		
15-25				-							2.80		153.5	113.1		
25-50				-							2.87		174.0	127.7		
50-58				-							2.67		221.9	166.3		
58-90				tr.							2.92		235.4	174.0		

a/ 24.5 kg of organic carbon per square meter to a depth of 1 meter.

KEALAKEKUA SILTY CLAY LOAM
S62Ha-1-3

Location: Island of Hawaii, Hawaii County, Hawaii. On Sherwood Greenwell Ranch, approximately 5.6 km (3.5 miles) southwest of Konawaena School, Kealakekua, Hawaii. Date of sampling: 1962.
Description by: Warren Ikeda. Collectors: Warren Ikeda.
Classification: **Typic Hydrandept, thixotropic, isothermic.**
Vegetation: Kikuyugrass (Pennisetum clandestinum), ricegrass (Paspalum orbiculare), sedge (Cyperus sp.), tree fern (Cibotium sp.), and ohia (Metrosideros collina).
Climate: Average annual precipitation is 250 to 375 cm (100-150 inches); fog prevalent throughout the year. Parent material: Volcanic ash. Topography: Undulating leeward intermediate slopes of Mauna Loa Mountain. Elevation: 650 m (2,500 feet). Drainage: Well drained; moderately rapid to rapid permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Colors are for moist soil. Paired sample number S62Ha-1-4. **All horizons harden irreversibly on drying.**

HORIZON	DESCRIPTION
Ap1 LSL No. 17376	0 to 10 cm (0-4 inches), dark brown (7.5YR 3/2) clay that feels like a silty clay loam, with few fine distinct dark reddish brown (2.5YR 3/6) and few fine faint very dark grayish brown (10YR 3/2) mottles; moderate (weak near the surface) medium, fine and very fine granular structure; friable, slightly sticky, plastic and moderately smeary; matted roots; few coarse and medium and common fine and very fine pores; few wormcasts and wormholes; abrupt smooth boundary.
Ap2 LSL No. 17377	10 to 15 cm (4-6 inches), dark brown (7.5YR 3/2) clay that feels like a silty clay loam, with common fine distinct dark reddish brown (2.5YR 3/6) and few fine faint very dark grayish brown (10YR 3/2) mottles, peds crush to slightly stronger chroma; moderate medium, fine and very fine subangular blocky structure; friable (some peds are firm), slightly sticky, plastic and weakly smeary; many roots; few coarse and medium and many fine and very fine pores; clear smooth boundary.
B21 LSL No. 17378	15 to 25 cm (6-10 inches), dark brown (7.5YR 3/2) clay that feels like a silty clay loam, peds crush to a slightly stronger chroma; moderate medium, fine and very fine subangular blocky structure; friable, slightly sticky, plastic and weakly smeary; many roots; few coarse and medium and many fine and very fine pores; a broken layer 8 to 10 cm (3 to 4 inches) thick slightly darker colored than rest of horizon with few to common hard, very dark brown (10YR 2/2) irreversibly hardened material, occurs at the lower boundary (this layer was not sampled); clear wavy boundary.
B22 LSL No. 17379	25 to 50 cm (10-20 inches), dark brown (7.5YR 3/4) with few small pockets of material with weaker chroma (3), clay that feels like a silty clay loam, peds crush to a stronger chroma; weak coarse subangular blocky breaking to weak medium fine and very fine subangular blocky structure; very friable, slightly sticky, plastic and weakly smeary; many roots; common coarse and medium and many fine and very fine pores; ped surfaces coated with gelatinous globules interspersed with few to common patches of smooth gelatinous coating; clear broken boundary.
B23 LSL No.	50 to 58 cm (20-23 inches), dark brown (7.5YR 3/2) clay that feels like a silty clay loam, peds crush to a [illegible]

SOIL FAMILY Typic Hydrandept, thixotropic, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Keslakekua silty clay loam SOIL Nos. S62Ha-1-4 LOCATION Hawaii County, Hawaii

Lincoln Lab Nos. 17382 - 17387

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-10	Ap1																	
10-18	Ap2																	
18-55	B21																	
18-55	B22																	
55-78	B23																	
78-118	B24																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-10	Ap1													16.1	23.0			
10-18	Ap2													19.7	28.2			
18-55	B21													18.8	26.9			
18-55	B22													13.1	18.7			
55-78	B23													13.1	18.7			
78-118	B24													8.3	11.9			

Depth (cm)	6A1g a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-10	15.7	1.34	12	17.9	5.9	0.6	0.4	24.8		68.1		2.4	0.4	36		6.0	4.8
10-18	10.4	0.903	12	7.8	2.9	0.4	0.2	11.3		52.6		1.2	0.9	21		5.6	4.4
18-55	9.7	0.556	17	2.3	1.5	0.3	0.4	4.5		36.4		4.2	0.5	12		5.0	4.4
18-55	11.8	0.657	18	2.7	1.3	0.4	0.2	4.6		35.0		4.6	0.4	13		5.0	4.4
55-78	9.8	0.518	19	0.5	0.4	0.3	0.3	1.5		37.0		9.4	0.2	4		5.2	4.7
78-118	5.7	0.356	16	0.6	0.5	0.1	0.1	1.3		18.8		14.8	0.1	7		5.6	5.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-10				-						0.31	2.49	247.9	170.2	114.2		
10-18				tr.						0.36	2.71	195.7	168.9	122.6		
18-55				-						0.32	2.68	190.4	178.8	133.3		
18-55				-							2.53		208.1	153.0		
55-78				-						0.32	2.55	210.3	211.0	165.4		
78-118				-						0.36	2.61	216.1	207.4	160.3		

a/ 32.4 kg of organic carbon per square meter to a depth of 1 meter.

KEALAKEKUA SILTY CLAY LOAM
S62Ha-1-4

Location: Island of Hawaii, Hawaii County, Hawaii. On Henry Greenwell (Horseshoe I) Ranch, approximately 2.4 km (1.5 miles) east of Konawaena School, Kealakekua, Hawaii. Date of sampling: 1962.
Description by: Warren Ikeda. Collectors: Warren Ikeda.
Classification: **Typic Hydrandept, thixotropic, isothermic.**
Vegetation: Kikuyugrass (Pennisetum clandestinum), yellow foxtail (Setaria geniculata), ricegrass (Paspalum orbiculare), tree fern (Cibotium sp.), and ohia (Metrosideros collina). Climate: Average annual precipitation is 250 to 375 cm (100-150 inches); fog prevalent throughout year. Parent material: Volcanic ash. Topography: Undulating leeward intermediate slopes of Mauna Loa Mountain. Elevation: 780 m (2,600 feet). Drainage: Well drained; moderately rapid to rapid permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Colors are for moist soil. Paired sample number S62Ha-1-3. **All horizons harden irreversibly on drying.**

HORIZON	DESCRIPTION
Ap1 LSL No. 17382	0 to 10 cm (0-4 inches), dark brown (7.5YR 3/2) clay that feels like a silty clay loam, with few fine distinct dark reddish brown (2.5YR 3/6) and few fine faint very dark grayish brown (10YR 3/2) mottles; moderate (weak near the surface) medium, fine and very fine granular structure; friable, slightly sticky, plastic and moderately smeary; matted roots; few coarse and medium and many fine and very fine pores; clear smooth boundary.
Ap2 LSL No. 17383	10 to 18 cm (4-7 inches), dark brown (7.5YR 3/2 and 10YR 3/3) clay that feels like a silty clay loam, with common fine distinct dark reddish brown (2.5YR 3/6) and few fine faint very dark grayish brown (10YR 3/2) mottles, peds crush to a slightly stronger chroma; moderate medium, fine and very fine subangular blocky structure; friable (some peds are firm), slightly sticky, plastic and weakly smeary; many roots; few coarse and medium and many fine and very fine pores; abrupt wavy boundary.
B21 LSL No. 17384	18 to 55 cm (7-22 inches), dark yellowish brown (10YR 3/4) clay that feels like a silty clay loam, peds crush to a slightly stronger chroma; weak coarse subangular blocky breaking to weak medium, fine and very fine subangular blocky structure; friable (some peds very friable), slightly sticky, plastic, and weakly smeary; many roots; common coarse and medium and many fine and very fine pores; ped surfaces coated with gelatinous globules interspersed with few to common patches of smooth gelatinous coating; clear broken boundary.
B22 LSL No. 17385	18 to 55 cm (7-22 inches), this broken horizon lies adjacent to the above horizon and occupies about the same area. Dark brown (7.5YR 3/2) clay that feels like a light silty clay loam, peds crush to a slightly stronger chroma; weak coarse subangular blocky breaking to weak medium, fine and very fine subangular blocky structure; very friable, slightly sticky, plastic and weakly smeary; many roots; few coarse and medium and many fine and very fine pores; ped surfaces coated with gelatinous globules interspersed with few to common patches of smooth gelatinous coating; clear broken boundary.
B23 LSL No. 17386	55 to 78 cm (22-31 inches), dark brown (7.5YR 3/3) clay that feels like a heavy silt loam, peds crush to a stronger chroma; moderate medium, fine and very fine subangular blocky structure; friable, slightly sticky, slightly plastic and moderately smeary; common roots; few coarse and many medium fine and very fine pores; ped surfaces coated with gelatinous globules interspersed with few to common patches of smooth gelatinous coating; few firm dark reddish brown (2.5YR 3/5) volcanic ash fragments; clear wavy boundary.
B24 LSL No. 17387	78 to 118 cm (31-47 inches), dark brown (7.5YR 3/3) clay that feels like a heavy silt loam, with many medium and fine faint strong brown (7.5YR 5/6 and 7.5YR 4/6) mottles (weathering Aa lava), peds crush to a stronger chroma; weak medium fine and very fine subangular blocky structure; friable, slightly sticky, slightly plastic and moderately smeary; few roots; few medium and many fine and very fine pores; ped surfaces coated with gelatinous globules interspersed with few to common patches of smooth gelatinous

SOIL FAMILY **Typic Vitrandept, medial, isomesic**

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Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-10	A1																	
10-20	B2																	
20-40	IIC																	
40-65	IIIAb																	
65-88	IIIB2b																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-10	A1													4.6	6.6			
10-20	B2													6.9	9.9			
20-40	IIC													2.3	3.3			
40-65	IIIAb													6.0	8.6			
65-88	IIIB2b													5.7	8.2			

Depth (cm)	6A1a Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-10	5.27	0.410	13	7.5	1.9	0.2	1.3	10.9		27.5		-		40		6.6	5.5
10-20	2.12	0.212	10	1.7	0.3	0.1	0.3	2.4		18.6		-		13		6.5	5.6
20-40	0.46	0.070	7	10.4	1.6	0.4	1.8	14.2		15.8		-		90		6.9	6.2
40-65	3.52	0.436	8	15.7	2.0	0.3	0.8	18.8		25.7		-		73		6.9	6.0
65-88	3.12	0.360	9	12.9	1.5	0.2	0.5	15.1		24.4		-		62		6.8	5.9

APAKUIE VERY FINE SANDY LOAM
S65Ha-1-13

Location: Island of Hawaii, Hawaii County, Hawaii. Umikoa Quadrangle - 19°54'30" north latitude and 155°23'30" east longitude. Pit located about 50 m (500 yards) below Puu Kihe on Kukaiau Ranch. Date of samping: April 9, 1965.
Description by: Harry Sato. Collectors: Harry Sato, K. Flach, and R. Smythe.
Classification: **Typic Vitrandept, medial, isomesic.**
Vegetation: Mamani tree-grass cover, natural vegetation is mamani (Sophora chrysophylla), sweet vernal (Anthoxanthum odoratum), heu pueo (Trisetum glomeratum), and plantain (Plantago lanceolata). Climate: The average annual precipitation is 50 to 75 cm (20-30 inches). The mean annual temperature is 13° C (55° F). Parent material: Volcanic ash. Topography: High windward slopes of Mauna Kea. Slope gradients 12 percent; convex slope; north aspect. Elevation: 2,190 m (7,300 feet). Drainage: Well drained; rapid permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Stones cover about 10 percent of surface. Colors are for the moist soil. Paired sample number S65Ha-1-14.

HORIZON	DESCRIPTION
A1 RSL No. 659	0 to 10 cm (0-4 inches), dark brown (7.5YR 3/3) very fine sandy loam; weak fine granular structure; loose, friable, nonsticky and nonplastic; abundant roots; many fine pores; abrupt roots; many fine pores; abrupt smooth boundary.
B2 RSL No. 6510	10 to 20 cm (4-8 inches), yellowish red (5YR 4/6) very fine sandy loam; massive; friable, nonsticky and nonplastic; few roots; many fine pores; 5 to 10 percent fragments of 18 mm (3/4 inch) diameter or larger; abrupt smooth boundary.
IIC RSL No. 6511	20 to 40 cm (8-16 inches), black (5YR 2/1) cinders; single grain; loose, nonsticky and nonplastic; few roots; abrupt wavy boundary.
IIIAb RSL No. 6512	40 to 65 cm (16-26 inches), dark reddish brown (5YR 2/2) very fine sandy loam; massive; friable, nonsticky and nonplastic; few roots; about 50 percent by volume of gravels, cobbles and stones larger than 18 mm (3/4 inch) diameter (not included in sample); abrupt smooth boundary.
IIIB2b RSL No. 6513	65 to 88 cm+ (26-35 inches), dark brown (7.5YR 3/2) very fine sandy loam; massive; friable, nonsticky and nonplastic; about 50 percent by volume of gravels, cobbles and stones larger than 20 mm (3/4 inch) diameter (not included in sample).

SOIL FAMILY Plinthic Tropaquept, fine, halloysitic, acid, isothermic

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SOIL SERIES Koolau silty clay SOIL Nos. S58Ha-2-105 LOCATION Kauai County, Hawaii

Beltsville Lab Nos. 59542 - 59547

Depth (cm)	Horizon	Mineralogical Analysis: 7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	A11																	
15-28	A12g	-			15	tr.							-					
28-40	A2g	-			45	2							-					
40-100	B21g	-			45	4							-					
100-130	B22g																	
130-180	C	-			35	2							-					

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-15	A11	28.64	13.60	26.32	4.64	0.05						26.40	99.7	0.7	1.0			
15-28	A12g	39.16	24.64	17.76	6.32	0.11						8.00	96.0	0.6	0.9			
28-40	A2g	33.52	10.08	39.36	3.84	0.02						16.10	102.9	1.1	1.6			
40-100	B21g	32.72	8.93	43.04	2.59	0.02						17.32	104.6	0.2	0.3			
100-130	B22g	27.96	7.20	44.96	1.92	0.01						20.32	102.4	0.3	0.4			
130-180	C	27.38	6.72	39.68	12.40	0.01						18.01	104.2	2.6	3.7			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-15	8.65	0.558	15	0.8	1.3	0.3	0.3	2.7	60.8		63.5				4	4.4	4.2
15-28	1.73	0.145	12	0.3	0.2	0.1	0.1	0.7	32.8		33.5				2	4.5	4.2
28-40	0.78	0.034	23	0.5	0.5	0.8	0.1	1.9	38.3		40.1				4	4.7	4.0
40-100	0.94	0.040	23	0.6	0.8	0.7	0.1	2.2	40.4		42.6				5	4.8	4.1
100-130	2.29	0.097	24	0.6	0.4	0.7	0.1	1.8	53.0		54.8				3	4.7	4.2
130-180	1.08	0.048	22	1.4	0.2	0.6	0.1	2.3	53.1		55.3				4	5.3	4.3

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	4A3a Field moist	Particle density	Water content: 4B4 Field moist.	4B1a 1/3 bar	4B2a 15 bar	Extensibility 4D1: COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-15	1.0	28.3	70.7							0.37		159	107.9	56.5		
15-28	0.7	40.4	58.9									57	58.4	34.7		
28-40	25.5	39.9	34.6									56	51.7	38.9		
40-100	34.4	40.5	25.1							0.86		61	54.8	36.7		
100-130	30.3	44.5	25.2									94	74.8	46.6		
130-180	43.4	39.6	17.0							0.78		69	76.9	42.4		

a/ 10.8 kg of organic carbon per square meter to a depth of 1 meter.

KOOLAU SILTY CLAY
S58Ha-2-105

Location: Island of Kauai, Kauai County, Hawaii; 46 km (28.5 miles) from Lihue along Macadam Highway 560 leading to northern end of the island and turn left onto secondary road leading through pasture. Go approximately south for 6.7 km (4½ miles) along what is known as Power Line Road. Sample site is 15 m (50 feet) to west of road along power line. Date of sampling: 1958.
Description by: D. Womack. Collectors: D. Womack and J. M. Williams.
Classification: **Plinthic Tropaquept, fine, halloysitic, acid, isothermic.***
Vegetation: Ohia (Metrosideros collina), tree fern (Cibotium chamissoi), ricegrass (Paspalum orbiculare), thimble berry (Rubus rosaefolius), hilograss (Paspalum conjugatum), yellow foxtail (Setaria geniculata). Climate: Average annual precipitation is 313 to 375 cm (125-150 inches). The mean annual temperature is 17.8° C (64° F), the mean January temperature 15.6° C (60° F), the mean July temperature 21.1° C (70° F). Parent material: Not known for certain, thought to be derived from melilite lava from the Koloa flow and strongly influenced by volcanic ash. Evidence of much "mud flow" activity of volcanic ash material. Topography: Rolling plateau, Hanalei heights. Slope 3 percent convex to north. Elevation: 318 m (1,060 feet). Drainage: Poorly drained. The soil is saturated with water for 4 to 5 months of the year. Permeability of upper solum is moderately slow; permeability of the C horizon is very slow. Surface runoff is slow. Soil moisture: Moist.
Remarks: Textures are apparent field textures. The soil does not exhibit the properties of smeariness nor is there any evidence that this soil dries irreversibly. This profile was sampled under extremely wet conditions. A portable pump was used to keep the water table lowered in the pit. Colors are for moist soil.

HORIZON	DESCRIPTION
A11 BSL No. 59542	0 to 15 cm (0-6 inches), grayish brown (10YR 5/2) silty clay loam; massive to very weak medium granular structure; firm, slightly sticky, plastic; matted roots; many wormholes and casts; many very fine and fine pores; clear wavy boundary.
A12g BSL No. 59543	15 to 28 cm (6-11 inches), gray (2.5Y 5/1) silty clay with many coarse distinct mottles of strong brown (7.5YR 3/2); massive to weak medium granular structure; firm, very sticky, very plastic; many roots; numerous large wormholes and casts; many very fine and fine tubular pores; clear wavy boundary.
A2g BSL No. 59544	28 to 40 cm (11-16 inches), pale yellow (2.5Y 7/4) silty clay with many coarse prominent mottles of strong brown (7.5YR 3/3), dark brown (7.5YR 4/4) and gray (10YR 5/1); wormholes coated with dark reddish brown (2.5YR 3/4); very weak coarse subangular blocky structure; firm, sticky, very plastic; common roots; many very fine and fine tubular pores, numerous wormholes and casts; clear wavy boundary.
B21g BSL No. 59545	40 to 100 cm (16-40 inches), pale yellow (5Y 7/3) silty clay loam with many coarse mottles of gray (10YR 5/1) and common prominent mottles of strong brown (7.5YR 3/2), the gray mottles are coatings on the ped faces and appear to be clay flows; weak medium prismatic breaking to weak coarse subangular blocky structure; firm, slightly sticky to sticky, plastic; very few roots; many very fine and fine tubular pores and common wormholes; gradual wavy boundary.
B22g BSL No. 59546	100 to 130 cm (40-52 inches), coarsely mottled pale yellow (5YR 7/3), gray (10YR 5/1), strong brown (7.5YR 3/2) and yellowish brown (10YR 5/8) silty clay loam with numerous very firm fine light gray lumps (probably gibbsite) that gives gritty feel to soil; weak coarse and medium prismatic breaking to weak medium subangular blocky structure; friable to firm, sticky, plastic; many very fine and fine tubular pores and common wormholes; common very firm nodules and thin lenses apparently due to iron segregation, these are firmer than the matrix; patchy coating on ped surfaces that appear like clay flows; gradual wavy boundary.
C BSL No. 59547	130 to 180 cm (52-72 inches), variegated strong brown (7.5YR 3/2), reddish brown (2.5YR 4/4), dark reddish brown (5YR 3/3), gray (10YR 5/1) with pockets and veins of light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4), probably

SOIL FAMILY Ustoxic Dystropept, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Hoolehua silty clay(taxad.junct) SOIL Nos. S63Ha-5-4 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 18779 - 18784

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	Ap1																	
20-30	Ap2																	
30-45	B11																	
45-63	B12																	
63-123	B21																	
123-155	B22																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	Ap1													9.4	13.4			
20-30	Ap2													8.8	12.6			
30-45	B11													8.8	12.6			
45-63	B12													8.6	12.3			
63-123	B21													8.8	12.6			
123-155	B22													11.9	17.0			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-20	1.22	0.148	8	1.5	0.7	0.1	0.3	2.6		13.7		3.8	2.3	19		3.9	3.5
20-30	1.08	0.135	8	2.1	0.5	0.1	0.2	2.9		13.9		3.2	1.9	21		4.2	3.6
30-45	0.40	0.090	4	6.6	1.4	0.1	0.4	8.5		11.2		1.6	-	76		5.9	5.1
45-63	0.20			6.8	2.1	0.2	0.4	9.5		11.8		1.2		80		7.1	6.0
63-123	0.05			5.5	3.2	0.2	0.5	9.4		9.8		1.1		96		7.1	6.0
123-155	0.04			5.8	4.5	0.2	0.6	11.1		10.4		1.3		107		6.9	6.0

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar clods	1/3 bar	15 bar	Extensibility 4D1: COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-20				tr.							3.15		26.0	21.6		
20-30				-							3.11		26.6	22.3		
30-45				-				1.25	1.32	1.26	3.01	26.0	26.4	22.4	0.02	0.02
45-63				-							3.01		24.6	21.4		
63-123				-				1.58	1.64	1.59	3.01	22.6	24.2	20.4	0.01	0.01
123-155				-				1.64	1.70	1.66	3.08	22.2	23.4	20.8	0.01	0.01

a/ 5.9 kg of organic carbon per square meter to a depth of 1 meter.

HOOLEHUA SILTY CLAY (taxadjunct) 1/
S63Ha-5-4

Location: Island of Molokai, Maui County, Hawaii. Approximately .36 km (1/4 mile) south southwest of Kualapuu Post Office in California Packing Corporation field 302. The site is approximately 60 m (200 feet) southeast of the northwest end of block 33. Date of sampling: May 14, 1963.
Description by: S. Nakamura. Collectors: J. DeMent, J. M. Williams, R. Malmgren, J. Linebaugh, and S. Nakamura.
Classification: **Ustoxic Dystropept, fine, kaolinitic, isohyperthermic.**
Vegetation: Pineapple. Climate: Average annual precipitation is 50 to 88 cm (20-35 inches), most of which occurs from November to April. The mean January temperature is 21.7° C (71° F) and the mean July temperature 25° C (77° F). Parent material: Old local alluvium. Topography: Nearly level depressional area. Slope 1 percent to west. Elevation: 243 m (810 feet). Drainage: Well drained; permeability moderately rapid; runoff medium. Soil moisture: Profile slightly moist when sampled.
Remarks: Textures are apparent field textures. Paired sample number S63Ha-5-3.

HORIZON	DESCRIPTION
Ap1 LSL No. 18779	0 to 20 cm (0-8 inches), dark reddish brown (5YR 3/3) silty clay, reddish brown (5YR 4/3 and 4/4) dry; cloddy and weak very fine granular structure; hard, friable, sticky and plastic; many roots; many interstitial pores; violent effervescence with hydrogen peroxide; extremely acid (pH 3.9); gradual smooth boundary.
Ap2 LSL No. 18780	20 to 30 cm (8-12 inches), dark reddish brown (5YR 3/3) silty clay, reddish brown (5YR 4/3) dry; structureless to weak very fine granular structure; few clods; very hard, friable, sticky and plastic; many roots; many interstitial pores; loose in place due to tillage; violent effervescence with hydrogen peroxide; extremely acid (pH 4.2); clear wavy boundary.
B11 LSL No. 18781	30 to 45 cm (12-18 inches), dark reddish brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) dry; structureless to weak fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; few roots; many very fine and fine tubular pores; common very fine manganese concretions; violent effervescence with hydrogen peroxide; medium acid (pH 5.9); clear wavy boundary.
B12 LSL No. 18782	45 to 63 cm (18-25 inches), dark reddish brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) dry; weak fine and medium subangular blocky structure with pockets of moderate very fine and fine subangular blocky structure; hard, friable, sticky and plastic; few roots; many very fine and fine tubular pores; many very fine manganese concretions; violent effervescence with hydrogen peroxide; neutral (pH 7.1); clear wavy boundary.
B21 LSL No. 18783	63 to 123 cm (25-49 inches), dark reddish brown (5YR 3/4) silty clay, reddish brown (5YR 4/3) dry; strong very fine subangular blocky structure; hard, friable, sticky and plastic; no roots noted; many very fine tubular pores; continuous thin pressure cutans; compact in place; many very fine manganese concretions; common manganese stains, mainly in pores; strong effervescence with hydrogen peroxide; many hard earthy lumps due to aggregate stability which breaks down after prolonged rubbing; neutral (pH 7.1); clear wavy boundary.
B22 LSL No. 18784	123 to 155 cm (49-62 inches), dark reddish brown (2.5YR 3/4) silty clay, reddish brown (2.5YR 4/4) dry; moderate to strong very fine and fine subangular blocky structure; hard, friable, sticky and plastic; no roots noted; many very fine and fine tubular pores; many hard earthy lumps due to aggregate stability which breaks down after prolonged rubbing; almost continuous pressure cutans; firm in place; many very fine manganese concretions; few manganese stains in pores; strong effervescence with hydrogen peroxide; neutral (pH 6.9).

1/ The Hoolehua series is classified in Oxic Ustropepts. The base saturation of the Ap2 horizon of this pedon has been decreased through pineapple culture and is now too low for Ustropepts.

SOIL FAMILY **Andic Humitropept, medial, isothermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES **Naiwa silty clay loam** SOIL Nos. S58Ha-4-18 LOCATION **Maui County, Hawaii**

Beltsville Lab Nos. 59548 - 59553

Depth (cm)	Horizon	Mineralogical Analysis: 7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-10	Ap																	
10-28	A12	-			-	tr.							1X					
28-35	B1																	
35-65	B2	2X			-	3							1X					
65-100	B3																	
100-130	IIC1	2X			-	10							-					

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-10	Ap	16.08	10.16	8.24	52.96	0.12						13.02	100.6	23.2	33.2			
10-28	A12	14.96	11.15	7.68	56.29	0.12						9.39	99.6	23.0	32.9			
28-35	B1	15.76	10.83	8.16	57.01	0.04						8.05	99.9	20.2	28.9			
35-65	B2	10.68	4.83	19.60	31.57	0.08						33.65	100.4	18.1	25.9			
65-100	B3	10.50	2.00	30.64	14.56	0.08						42.79	100.6	4.7	6.7			
100-130	IIC1	10.74	1.24	32.24	8.92	0.08						46.15	99.4	3.9	5.6			
130-150	IIC2	13.00	1.40	36.56	10.44	0.20						37.76	99.4					

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-10	5.05	0.400	13	3.3	2.7	0.2	0.9	7.1	20.1		27.1				26	5.5	5.2
10-28	4.10	0.272	15	2.1	1.8	0.1	0.7	4.7	21.6		26.3				18	5.3	5.0
28-35	3.99	0.246	16	0.5	0.6	0.2	0.2	1.5	41.3		42.7				3	4.6	4.6
35-65	9.66	0.519	17	0.6	0.6	0.2	0.1	1.5	78.9		80.4				2	4.6	4.6
65-100	10.26	0.473	22	0.7	0.3	0.3	0.1	1.4	88.2		89.6				2	4.8	4.7
100-130	10.34	0.463	22	0.7	0.3	0.4	Tr.	1.4	87.3		88.7				2	4.7	4.8

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	4A3a Field moist	Particle density	Water content: 4B4 Field moist.	4B1c 1/3 bar	4B2a 15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-10	2.9	57.1	40.0									18	23.6	20.5		
10-28	2.7	53.7	43.6							1.08		15	22.2	15.7		
28-35	11.5	40.3	48.2									23	31.9	26.6		
35-65	28.7	42.8	28.5							0.76		42	57.9	46.8		
65-100	37.2	40.3	22.5									22	93.2	72.7		
100-130	29.9	44.2	25.9									22	87.2	72.9		

a/ 64.9 kg of organic carbon per square meter to a depth of 1 meter.

NAIWA SILTY CLAY LOAM
S58Ha-4-18

Location: Island of Maui, Maui County, Hawaii; 2.4 km (1.45 miles) north of Waihee School, west .32 km (0.2 mile), then left .43 km (0.3 mile) on trail up side of hill in kikuyu pasture adjacent to Waihee Gulch. Date of sampling: 1958.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren and J. M. Williams.
Classification: **Andic Humitropept, medial, isothermic.**
Vegetation: Dominantly kikuyu (Pennisetum clandestinum), Japanese tea (Cassia leschenaultiana), guava (Psidium guayava), joee (Stachytarpheta cayannensis), yellow foxtail (Setaria geniculata), Java plum (Eugenia cumini). Climate: Average annual precipitation is 150 to 175 cm (60-70 inches). The mean annual temperature is 21.1°C

23.3° C (74° F). Parent material: Weathered from basic igneous rock. Topography: Rolling to sloping dissected low windward slopes of West Maui Mountain. Slope 8 percent to east. Elevation: 112 m (375 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted. Paired sample number S58Ha-4-19.

HORIZON	DESCRIPTION
Ap BSL No. 59548	0 to 10 cm (0-4 inches), dusky red (10R 3/3 moist and dry) silty clay loam; weak fine subangular blocky structure; slightly hard, firm, sticky, slightly plastic; many fine roots; many fine and medium pores; common wormcasts and channels; moderately high bulk density; strongly acid (pH 5.4); clear smooth boundary.
A12 BSL No.	10 to 28 cm (4-11 inches), dusky red (10R 3/4 moist and dry) silty clay loam; purplish cast when dry; moderate and strong fine and very fine subangular

SOIL FAMILY Andic Humitropept, medial, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Naiwa silty clay loam SOIL Nos. 858Ha-4-19 LOCATION Maui County, Hawaii

Beltsville Lab Nos. 59554 - 59559

Depth (cm)	Horizon	Mineralogical Analysis															
		7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-8	Ap1																	
8-25	Ap2	-			15	15							1X					
25-35	B1																	
35-63	B21	2X			tr.	20							1X					
63-95	B22																	
95-125	B3	2X			20	48							-					

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-8	Ap1													11.5	16.4			
8-25	Ap2													12.2	17.4			
25-35	B1													16.2	23.2			
35-63	B21													12.0	17.2			
63-95	B22													7.5	10.7			
95-125	B3													3.7	5.3			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	6O2b Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	5A3a Sum			5C1 NH_4OAc	5C3 Sum	8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-8	7.73	0.613	13	6.5	5.4	0.4	1.8	14.1	24.7		38.7				36	6.0	6.4
8-25	4.31	0.423	10	3.2	1.8	0.3	1.4	6.7	28.0		34.7				19	5.3	6.5
25-35	3.79	0.331	11	1.8	0.8	0.3	1.0	3.9	43.6		47.4				8	4.8	6.4
35-63	5.93	0.413	14	1.9	0.4	0.3	0.7	3.3	70.6		73.9				4	5.0	6.5
63-95	4.64	0.245	19	0.9	0.5	0.3	0.2	1.9	62.9		64.8				3	4.7	6.4
95-125	2.23	0.110	20	0.5	0.3	0.4	0.6	1.8	52.2		54.0				3	4.7	5.2

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility 4D1	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	4A3a Field moist		4B4 Field moist.	4B1c 1/3 bar	4B2a 15 bar	COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-8	15.2	41.6	43.2									31	31.9	29.9		
8-25	17.7	43.9	38.4							0.80		25	31.8	25.2		
25-35	30.2	40.1	29.7									30	39.9	30.6		
35-63	25.0	55.1	19.9							0.68		45	55.3	43.9		
63-95	32.5	43.5	24.0									55	59.0	53.6		
95-125	42.1	40.7	17.2									34	50.6	39.1		

a/ 35.5 kg of organic carbon per square meter to a depth of 1 meter.

NAIWA SILTY CLAY LOAM
S58Ha-4-19

Location: Island of Maui, Maui County, Hawaii; 4.3 km (2.7 miles) north of Waihee School, turn west off Highway 330 through gate and proceed .32 km (0.2 mile) southwest along farm road, then turn south and proceed .5 km (0.35 mile) along little used farm road. After crossing gulch, turn left and proceed .8 km (0.45 mile) to northeast. Sample site is in kikuyu pasture. Date of sampling: 1958.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren and J. M. Williams.
Classification: **Andic Humitropept, medial, isothermic.**
Vegetation: Dominantly kikuyugrass (Pennisetum clandestinum), Japanese tea (Cassia leschenaultiana), guava (Psidium guayava), joee (Stachytarpheta cayannensis). Climate: Average annual precipitation is 150 cm (60 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature is 20° C, and the mean July temperature 23.3° C (74° F). Parent material: Weathered from basic igneous rock. Topography: Low rolling to sloping windward slopes of West Maui Mountain. Slope about 10 percent to northeast. Elevation: 120 m (400 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted. Paired sample number S58Ha-4-18.

HORIZON	DESCRIPTION
Ap1 BSL No. 59554	0 to 8 cm (0-3 inches), dark reddish brown (2.5YR 3/4 moist and dry) silty clay loam; moderate medium granular structure; slightly hard, friable, slightly sticky, plastic; many roots; many fine and medium interstitial pores; common worm casts; moderately high bulk density; abrupt smooth boundary.
Ap2 BSL No. 59555	8 to 25 cm (3-10 inches), dark reddish brown (2.5YR 3/4 moist and dry) silty clay loam with purplish tinge; strong very fine subangular blocky structure; hard, firm, sticky, plastic; many fine roots; many very fine and fine and common medium tubular pores; common wormcasts; high bulk density; this horizon has the highest bulk density of the profile; abrupt smooth boundary.
B1 BSL No. 59556	25 to 35 cm (10-14 inches), dark red (2.5YR 3/6 moist or dry) silty clay loam with slight purplish tinge; weak coarse medium and fine subangular blocky structure; slightly hard, friable, sticky, plastic; many fine roots; many very fine, fine and few medium tubular pores; moderate bulk density; clear diffuse boundary.
B21 BSL No. 59557	35 to 63 cm (14-25 inches), dark red (2.5YR 3/6 moist and dry) silt loam; weak coarse and medium subangular blocky structure; soft, very friable, nonsticky, slightly plastic; many fine roots; many very fine and fine and common medium tubular pores; bulk density markedly lower than above horizon; few very fine highly weathered rock fragments; under pressure the peds seem to "explode" similar to rupture of a ped in a fragipan; clear wavy boundary.
B22 BSL No. 59558	63 to 95 cm (25-38 inches), dark red (2.5YR 3/6) gritty loam; weak very fine and fine subangular blocky structure; soft, friable, nonsticky, slightly plastic; many roots concentrated in layers between peds; many very fine and fine and few medium tubular pores; thin patchy gelatinous glaze on ped surface; clear wavy boundary.
B3 BSL No. 59559	95 to 125 cm (38-50 inches), yellowish red (5YR 3/6) gritty loam with many pockets of dark yellowish brown (10YR 3/4) and dark brown (7.5YR 4/2); weak fine and medium subangular blocky structure; soft, friable, nonsticky, slightly plastic; many roots; many very fine and fine and common medium pores; 50 to 60 percent weathered rock.
C No sample	125 to 140 cm (50-56 inches), soft weathered basic igneous rock which encases few hard cores; contains matted roots in cracks in rock.

SOIL FAMILY Ustic Humitropept, very fine, mixed, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kohala silty clay SOIL Nos. S65Ha-1-3 LOCATION Hawaii County, Hawaii

Riverside Lab Nos. 6567 - 6572

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	Ap1			15	30	10		25			10	5						
18-35	Ap2			15	20	5		25			10	5						
35-68	B21			15	20	10		30			10	10						
68-98	B22			15	15	10		35			10	10						
98-113	C1			5	10	15		30			15	10						
113-133	C2			2	10	20		15			20	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	Ap1	25.9	6.7	23.0	27.2	0.55	1.11	0.04	0.11	0.98	0.73	14.9	101.2	14.8	21.2		8.00	5.45
18-35	Ap2	25.2	6.5	23.3	27.3	0.58	1.04	0.04	0.19	0.98	0.77	14.4	100.3	15.0	21.4		6.60	5.34
35-68	B21	23.0	7.2	22.6	32.1	0.22	0.99	tr.	0.10	0.99	0.72	12.2	100.1	17.5	25.0		7.12	5.41
68-98	B22	18.2	9.8	20.6	37.1	0.19	0.90	-	0.10	1.00	0.79	11.6	100.3	21.5	30.7		4.91	4.11
98-113	C1	15.2	7.7	24.2	35.6	0.17	0.95	0.03	0.09	0.43	0.91	15.0	100.3	18.0	25.7		5.74	7.92
113-133	C2	17.3	6.2	31.9	25.5	0.25	0.90	tr.	0.10	0.18	0.93	16.9	100.2	9.0	12.9		7.67	10.52

Depth (cm)	6A1a Organic carbon Pct. a/	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 15
				Meq./100 g.										Percent			
0-18	2.68	0.26	10	7.0	3.8	0.40	0.50	11.7		32.3		-	0.3	36.0		5.6	4.9
18-35	2.40	0.24	10	7.0	3.6	0.60	0.10	11.3		34.4		-	0.1	33.0		5.6	5.0
35-68	0.97	0.15	6	4.9	2.3	1.00	0.10	8.3		23.8		-	0.1	35.0		6.1	5.6
68-98	0.66	0.10	7	3.3	1.4	0.60	0.10	5.4		19.1		0.6		28.0		6.1	5.8
98-113	0.80	0.08	10	6.5	3.4	0.80	0.10	10.8		27.4		0.9		39.0		6.5	5.9
113-133	0.30			6.4	3.0	0.90	0.10	10.4		31.6		1.5		33.0		6.6	5.9

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	b/ Atterberg limits: Plastic limit Pct.	Liquid limit Pct.	Plastic index Pct.	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-18					35	59	24			1.22	2.89		35.0	28.2		
18-35										1.18	3.05		33.6	27.6		
35-68					41	67	26			1.19	3.15		37.5	28.8		
68-98										1.33	3.29		33.1	28.8		
98-113										1.15	3.24		40.5	30.9		
113-133					N.P.	N.P.	N.P.				2.98		44.0	28.6		

a/ 17.3 kg of organic carbon per square meter to a depth of 1 meter.
b/ These samples were not allowed to dry prior to analysis.

KOHALA SILTY CLAY
S65Ha-1-3

Location: Island of Hawaii, Hawaii County, Hawaii. Hawi Quadrangle -- 20°14'30" north latitude and 155°49'50" east longitude. Pit located about 300 m (1,000 feet) N. of Hawi Town in field Alaalae 4, Kohala Sugar Company. Date of sampling: April 6, 1965.
Description by: H. Sato and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, H. Sato, R. Smythe, G. Yamamoto, and W. Subica.
Classification: **Ustic Humitropept, very fine, mixed, isohyperthermic.**
Vegetation: Sugarcane (Saccharum officinarum), natural vegetation consists of koa haole (Leucaena glauca), lantana (Lantana camara), guava (Psidium guayava), and Christmas berry (Schinus terebinthifolius). Climate: Average annual precipitation is 125 cm (50 inches). The mean annual temperature is 23° C (73° F). Parent material: Basalt influenced by volcanic ash. Topography: Windward foot slopes of Kohala Mountain. Slope gradient 2 percent; convex slope; north aspect. Elevation: 165 m (550 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Paired sample number S65Ha-1-4.

HORIZON	DESCRIPTION
Ap1 RSL No. 6567	0 to 18 cm (0-7 inches), very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; extremely hard, friable, sticky and plastic; many roots; many fine pores; moderate effervescence with hydrogen peroxide; slightly acid (pH 6.3); abrupt smooth boundary.
Ap2 RSL No. 6568	18 to 35 cm (7-14 inches), dark brown (10YR 3/3) silty clay, dark grayish brown (10YR 4/2) dry; weak coarse prismatic breaking to moderate medium and fine subangular and angular blocky structure; very hard, friable, sticky and plastic; many roots along prism faces; very compact in place; common pressure cutans; manganese coatings on root channels; common very fine red rock fragments; moderate effervescence with hydrogen peroxide; slightly acid (pH 6.4); abrupt smooth boundary.
B21 RSL No. 6569	35 to 68 cm (14-27 inches), dark brown (10YR 3/3) silty clay loam, (10YR 4/3) dry; moderate medium and coarse subangular blocky breaking to moderate fine subangular blocky structure; hard, friable, slightly sticky and plastic; few roots; many very fine pores; very compact in place; few pressure cutans; weak effervescence with hydrogen peroxide; slightly acid (pH 6.5); gradual smooth boundary.
B22 RSL No. 6570	68 to 98 cm (27-39 inches), dark yellowish brown (10YR 3/4) silty clay, dark brown (10YR 4/3) dry; strong fine and very fine subangular blocky structure; hard, friable, sticky and plastic; few roots; few thin patchy cutans; few saprolite fragments; few manganese coatings; no effervescence with hydrogen peroxide; neutral (pH 6.6); clear smooth boundary.
C1 RSL No. 6571	98 to 113 cm (39-45 inches), variegated colors; saprolite; firm, nonsticky and nonplastic; weakly smeary; no roots; no effervescence with hydrogen peroxide; neutral (pH 6.8); gradual wavy boundary.
C2 RSL No. 6572	113 to 133 cm (45-53 inches), variegated colors; saprolite; firm, nonsticky, nonplastic and weakly smeary; no roots; no effervescence with hydrogen peroxide; neutral (pH 6.9).

SOIL FAMILY Ustic Humitropept, very fine, mixed, isohypertherm

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Riverside Lab Nos. 6573 - 6578

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-28	Ap1																	
28-48	Ap2																	
48-70	B21																	
70-123	B22																	

KOHALA SILTY CLAY
S65Ha-1-4

Location: Island of Hawaii, Hawaii County, Hawaii. Hawi Quadrangle - 20°13'30" north latitude and 155°46'45" east longitude. Pit located about 50 m (500 yards) E. of Halaula School and 30 m (300 yards) S. of Highway 27 on Kohala Sugar Company. Date of sampling: April 6, 1965.

Description by: H. Sato and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, H. Sato, R. Smythe, G. Yamamoto, and W. Subica.

Classification: **Ustic Humitropept, very fine, mixed, isohyperthermic.**

Vegetation: Sugarcane (Saccharum officinarum), natural vegetation consists of koa haole (Leucaena glauca), lantana (Lantana camara), guava (Psidium guayava), and Christmas berry (Schinus terebinthifolius). Climate: Average annual precipitation is 150 cm (60 inches). The mean annual temperature is 23° C (73° F). Parent material: Basalt influenced by volcanic ash. Topography: Windward foot slopes of Kohala Mountain. Slope gradient 10 percent; convex slope; north aspect. Elevation: 105 m (350 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S65Ha-1-3.

HORIZON	DESCRIPTION
Ap1 RSL No. 6573	0 to 28 cm (0-11 inches), very dark grayish brown (10YR 3/2) silty clay; cloddy breaking to moderate fine granular structure; hard, friable, sticky and plastic; many roots; many fine pores; moderate effervescence with hydrogen peroxide; clear wavy boundary.
Ap2 RSL No. 6574	28 to 48 cm (11-19 inches), dark brown (10YR 3/3) silty clay; weak coarse prismatic structure; hard, friable, sticky and plastic; many roots; many fine pores; moderate effervescence with hydrogen peroxide; abrupt smooth boundary.
B21 RSL No. 6575	48 to 70 cm (19-28 inches), dark brown (10YR 3/3) silty clay loam; moderate fine subangular blocky structure; friable, sticky and plastic; few roots; many fine pores; patchy pressure cutans; weak effervescence with hydrogen peroxide; clear wavy boundary.
B22	70 to 123 cm (28-49 inches), dark yellowish brown (10YR 3/4) silty clay loam;
RSL No. 6576	strong fine subangular blocky structure; friable, sticky and plastic; few roots; many fine pores; few red rock fragments; few thin patchy cutans; no effervescence with hydrogen peroxide; gradual wavy boundary.
C1 RSL No. 6577	123 to 140 cm (49-56 inches), dark yellowish brown (10YR 3/4) silty clay loam; weak medium and fine subangular blocky structure; hard, friable, sticky and plastic; common pockets of saprolite; gradual wavy boundary.
C2 RSL No. 6578	140 to 165 cm (56-66 inches), dark yellowish brown (10YR 3/4) silty clay loam; massive; hard, friable, slightly sticky and slightly plastic; few roots; many vesicular pores; saprolite; original rock structure present.

SOIL FAMILY Oxic Ustropept, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Hoolehua silty clay SOIL Nos. 863Ha-5-3 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 18773 - 18778

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-23	Ap1			15	40	2		15			10	5	1X					
23-38	Ap2																	
38-53	B11			15	40	1		15			10	5	1X					
53-68	B12																	
68-123	B21			15	45			15			10	5	1X					
123-160	B22																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-23	Ap1	26.1	4.7	26.9	20.8	1.49	1.61	0.65	0.16	1.14	2.82	13.7	100.1	8.4	12.0		8.00	9.72
23-38	Ap2													8.9	12.7			
38-53	B11	26.9	4.6	27.5	21.2	1.31	1.75	0.73	0.15	1.10	2.52	12.3	100.1	8.6	12.3		7.72	9.48
53-68	B12													8.3	11.9			
68-123	B21	27.8	4.1	28.4	20.3	0.74	1.68	1.10	0.17	1.07	3.09	11.5	100.0	8.3	11.9		10.03	11.12
123-160	B22													8.8	12.6			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-23	1.30	0.15	9	1.9	0.9	0.10	0.80	3.7		15.6		4.7	2.2	24		4.0	3.5
23-38	0.88	0.13	7	6.0	1.8	0.10	0.70	8.6		14.6		1.9	0.2	59		5.1	4.4
38-53	0.44	0.09	5	7.8	1.8	0.20	0.60	10.4		11.2		1.0		93		6.6	5.6
53-68	0.08			7.2	2.5	0.20	0.60	10.5		10.4		1.4		101		6.8	5.8
68-123	0.06			5.2	2.9	0.20	0.60	8.9		10.1		1.5		88		6.8	5.8
123-160	0.12			3.9	2.9	0.10	0.60	7.5		9.8		1.7		76		6.2	5.4

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar clods	1/3 bar	15 bar	Extensibility 4D1: COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-23				-						1.18	2.99		29.2	21.4		
23-38				-						1.18	3.05		26.2	23.0		
38-53				-				1.18	1.24	1.20	3.03	29.5	26.1	22.4	0.02	0.02
53-68				-						1.25	3.05		24.2	21.7		
68-123				-				1.54	1.60	1.40	2.99	23.8	24.1	20.8	0.01	0.01
123-160				-				1.63	1.67	1.49	3.05	20.8	24.5	20.2	0.01	0.01

a/ 6.3 kg of organic carbon per square meter to a depth of 1 meter.

HOOLEHUA SILTY CLAY
S63Ha-5-3

Location: Island of Molokai, Maui County, Hawaii. Approximately 1.2 km (3/4 mile) west of Kualapuu Post Office in California Packing Corporation field 303. The site is in the northeast corner of block 66. Date of sampling: May 14, 1963.
Description by: S. Nakamura. Collectors: J. DeMent, J. Williams, R. Malmgren, J. Linebaugh, and S. Nakamura.
Classification: **Oxic Ustropept, fine, kaolinitic, isohyperthermic.**
Vegetation: Pineapple. Climate: Average annual precipitation is 50 to 88 cm (20-35 inches), most of which occurs from November to April. The mean January temperature is 21.7° C (71° F) and the mean July temperature 25° C (77° F). Parent material: Old local alluvium. Topography: Nearly level depressional area. Slope 1 percent to west. Elevation: 231 m (770 feet). Drainage: Well drained. Permeability moderately rapid. Runoff medium. Soil moisture: Fairly dry when sampled.
Remarks: Textures are apparent field textures. Paired sample number S63Ha-5-4.

HORIZON	DESCRIPTION
Ap1 LSL No. 18773	0 to 23 cm (0-9 inches), dark reddish brown (5YR 3/3) silty clay, dark reddish gray (5YR 4/2) dry; cloddy due to tillage; firm, hard, sticky and plastic; common roots; occasional medium and coarse tubular pores; compacted by agricultural machinery; violent effervescence with hydrogen peroxide; extremely acid (pH 3.9); clear smooth boundary.
Ap2 LSL No. 18774	23 to 38 cm (9-15 inches), dark reddish brown (5YR 3/3 moist and dry) silty clay; cloddy; hard, friable, sticky and plastic; few roots; few very fine tubular pores; violent effervescence with hydrogen peroxide; extremely acid (pH 4.4); clear wavy boundary.
B11 LSL No. 18775	38 to 53 cm (15-21 inches), dark reddish brown (5YR 3/3 moist and dry) silty clay loam; weak fine and medium subangular blocky structure; slightly hard, very friable, sticky and plastic; few roots; many very fine and fine and common medium tubular pores; many very fine manganese concretions; violent effervescence with hydrogen peroxide; few thin black material which is coated with reddish brown and which does not effervesce with hydrogen peroxide and is found in the upper part of this horizon; medium acid (pH 6.0); clear wavy boundary.
B12 LSL No. 18776	53 to 68 cm (21-27 inches), dark reddish brown (5YR 3/3) silty clay; hard when dry; weak fine and medium subangular blocky structure; friable, sticky and plastic; no roots noted; many very fine and fine and common medium tubular pores; many very fine manganese concretions; common manganese stains in pores; violent effervescence with hydrogen peroxide; slightly acid (pH 6.3); clear wavy boundary.
B21 LSL No. 18777	68 to 123 cm (27-49 inches), dark reddish brown (5YR 3/3 and 3/4 moist and dry) silty clay; strong very fine subangular blocky structure with few pockets of weak and medium very fine subangular blocky structure; very hard, firm, sticky and plastic; no roots noted; common very fine tubular pores; many very fine manganese concretions; common manganese stains on ped faces; almost continuous thin pressure cutans; compact in place; common hard earthy lumps due to aggregate stability which breaks down after prolonged rubbing; strong effervescence with hydrogen peroxide; slightly acid (pH 6.4); gradual wavy boundary.
B22 LSL No. 18778	123 to 160 cm (49-64 inches), dark reddish brown (5YR 3/4) silty clay; moderate to strong fine subangular blocky structure; very hard, firm, sticky and plastic; no roots noted; common very fine tubular pores; common very fine manganese concretions; few manganese stains on ped faces; common thin pressure cutans on ped faces; slightly firm in place; many hard earthy lumps due to aggregate stability which breaks down after prolonged rubbing; moderate effervescence with hydrogen peroxide; slightly acid (pH 6.2).

SOIL FAMILY Oxic Ustropept, very fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Lahaina silty clay loam (taxadjunct) SOIL Nos. 861Ha-7-6 LOCATION Honolulu County, Hawaii

Beltsville Lab Nos. 61486 - 61491

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-25	Ap1				40	4												
25-40	Ap2				30	4												
40-58	B21				53	3												
58-80	B22				55	2												
80-113	B23				48	tr.												
113-163	B3				52	-												

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-25	Ap1													9.7	13.8			
25-40	Ap2													9.9	14.2			
40-58	B21													10.8	15.5			
58-80	B22													11.6	16.6			
80-113	B23													11.3	16.1			
113-163	B3													11.0	15.8			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2d Ca	602b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-25	1.86	0.234	8	7.8	3.1	0.36	1.06	12.3	16.6		28.9		<0.1		42	5.3	4.9
25-40	1.55	0.192	8	7.0	3.6	0.24	0.27	11.1	10.7		21.8				51	6.2	5.4
40-58	0.48	0.118	4	4.4	3.4	0.30	0.10	8.2	7.7		15.9				52	6.3	5.9
58-80	0.38	0.092	4	4.4	3.2	0.34	0.10	8.0	7.4		15.4		<0.1		52	6.5	6.1
80-113	0.18			4.4	3.1	0.72	0.10	8.3	7.6		15.9				52	6.6	5.9
113-163				2.7	2.6	1.23	0.17	6.7	7.6		14.3				47	6.9	6.1

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	15 bar	Extensibility: 4D1 COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	
0-25													22.1		
25-40													22.9		
40-58													22.4		
58-80													22.7		
80-113													23.4		
113-163													24.6		

LAHAINA SILTY CLAY LOAM (taxadjunct) 1/
S61Ha-7-6

Location: Island of Oahu, Honolulu County, Hawaii. Sample site is approximately 8 km (5 miles) south-southwest of Wahiawa, turn east on Macadam Road leading to Malani Cemetery for 800 m (2,500 feet). At junction of road at site of Dole Pineapple loading station, turn south by southeast along dirt road for 430 m (1,300 feet). Pit located in pineapple field 15 m (50 feet) to west of road. Date of sampling: March 16, 1961.
Description by: K. Flach. Collectors: J. M. Williams, J. Cady, and K. Flach.
Classification: Oxic Ustropept, very fine, kaolinitic, isohyperthermic.
Vegetation: Pineapple. Climate: Average annual precipitation is 88 cm (35 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 20.0° C (68° F); and the mean July temperature 23.3° C (74° F). Parent material: Presumed to be weathered in place from basic igneous rock but may be from alluvium. Topography: Undulating slopes of West Koolau range; slope 2 percent to west. Elevation: 150 m (450 feet).
Remarks: After a few days of drying the Ap horizon develops cracks 1/2 to 1 cm wide. Textures given are apparent textures and do not reflect true particle size distribution.

HORIZON	DESCRIPTION
Ap1 BSL No. 61486	0 to 25 cm (0-10 inches), dark reddish brown (2.5YR 2/4), moist, same color when crushed, silty clay loam; moderate fine and very fine granular structure; extremely hard when dry, friable when moist, sticky and plastic when wet; few fine distinct black mottles, probably charcoal; abundant roots, roots concentrated in a layer of 2 cm (about 1 inch) thickness, near lower horizon boundary; common medium and very fine pores; strong effervescence with H_2O_2; lower boundary abrupt and wavy.
Ap2 BSL No. 61487	25 to 40 cm (10-16 inches), dark reddish brown (2.5YR 2/4), moist, same color when crushed, silty clay loam, with many coarse distinct dusky red (10R 3/4) mottles; very weak coarse subangular blocky structure, breaking to weak and very fine granular; extremely hard when dry, friable when moist, sticky and plastic when wet; common fine black bodies, presumably Mn concretions; common roots; common very fine tubular pores; strong effervescence with H_2O_2; lower boundary abrupt and wavy; horizon apparently had been plowed but has been compacted, probably by tillage operations.
B21 BSL No. 61488	40 to 58 cm (16-23 inches), dark reddish brown to dusky red (2.5YR 2/2 to 10R 3/4), moist, same color when crushed, silty clay loam; very weak coarse subangular blocky structure; firm when moist, slightly sticky and plastic when wet; common medium and fine tubular pores; common fine black mottles (concretions), few small black (Mn?) cutans; small pressure cutans, possibly very few, very thin illuviation cutans; violent effervescence with H_2O_2; lower boundary clear and wavy.
B22 BSL No. 61489	58 to 80 cm (23-32 inches), dusky red (10R 3/3 to 3/4), moist, same color when crushed, silty clay loam; weak coarse subangular blocky, breaking to strong firm and very fine subangular and angular blocky structure; friable when moist, slightly sticky and slightly plastic when wet; well expressed pressure cutans on all ped surfaces and few, very thin, patchy illuviation cutans; few slickensides, up to 2.5 cm (1 inch) long in greatest dimension; no roots; common fine and very fine tubular pores; pore peripheres are coated with thin, black Mn? coatings; few fine black mottles (Mn concretions?); slightly effervescence with H_2O_2; lower boundary clear and smooth.
B23 BSL No. 61490	80 to 113 cm (32-45 inches), dusky red (10R 3/3 to 3/4), moist, same color when crushed, silty clay loam; horizon appears to be slightly yellower in hue than B22; weak coarse subangular blocky, breaking to strong fine and very fine subangular and angular blocky structure; friable when moist, slightly sticky and slightly plastic when wet; well expressed pressure cutans on all ped surfaces; few small slickensides, few thin clay skins; no roots; common very fine tubular pores; weak effervescence with H_2O_2; lower boundary gradual and wavy.
B3 BSL No. 61491	113 to 163 cm (45-65 inches +), dark reddish brown (2.5YR 2/4), moist, same color when crushed, silty clay loam; weak coarse subangular blocky breaking to moderate fine subangular and angular blocky structure; friable when moist, slightly sticky and slightly plastic when wet; pressure cutans on many ped surfaces but not on as many surfaces as in B23; common distinct moderately thick clay skins, mainly on vertical surfaces; no roots; common very fine tubular pores; common small patches retaining rock structure.

1/ The Lahaina series is classified as a Tropeptic Haplustox, clayey, kaolinitic, isohyperthermic. This pedon is a taxadjunct to the Lahaina series because the cation exchange capacity of the B horizon is higher than permissible for Oxisols.

SOIL FAMILY Oxic Ustropept, very fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Uwala silty clay loam SOIL Nos. S62Ha-3-3 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 17413 - 17418

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	Ap1			4	55	1		20	2		10	5						
20-40	Ap2	1		4	50	2		20	10		10	4						
40-70	B2	5		1	55			15	10		10	4						
70-105	C1	3			60			10	10		10	3						
105-155	IIC2			1	65			15	5		10	4						
155-175	IIIC3																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	Ap1	28.9	4.6	24.8	25.2	0.16	0.67	0.18	0.07	0.29	0.33	14.8	100.0	12.7	18.2		12.96	8.59
20-40	Ap2	31.3	3.9	25.2	23.3	0.06	0.48	0.12	0.06	0.28	0.28	15.0	100.0	11.3	16.2		16.33	12.51
40-70	B2	31.3	3.6	27.5	22.6	0.06	0.49	0.13	0.04	0.08	0.27	14.0	100.1	10.7	15.3		17.61	13.89
70-105	C1	34.1	3.2	29.2	18.6	0.03	0.43	-	0.03	tr.	0.25	14.2	100.0	7.6	10.9		18.74	13.86
105-155	IIC2	33.2	3.7	28.4	20.0	0.03	0.76	-	0.09	0.06	0.22	13.6	100.1	8.8	12.6		16.69	13.60
155-175	IIIC3	36.5	2.4	32.3	14.3	0.03	0.60	-	0.12	0.07	0.33	14.4	101.1	4.5	6.4			

Depth (cm)	6A1a Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-20	2.13	0.22	10	5.1	1.6	0.10	0.90	7.7		14.0		1.8	0.3	55		4.7	4.0
20-40	1.42	0.16	9	5.3	1.4	0.20	1.50	8.4		14.0		2.7	0.2	60		4.8	4.1
40-70	0.78	0.09	9	5.6	2.2	0.50	0.30	8.6		13.2		2.2	0.1	65		5.0	4.0
70-105	0.46			5.2	3.4	0.40	0.10	9.1		14.5		3.1	1.7	63		4.4	3.3
105-155	0.54			4.5	2.6	0.90	0.10	8.1		16.5		1.9	2.6	49		4.4	2.9
155-175	0.24			1.5	0.6	0.70	0.10	2.9		8.5		1.6	1.0	34		4.4	2.9

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand	Silt (0.5-	Clay	Coarse fragments >2mm	Atterberg limits: Plastic	Liquid	Plastic	Bulk density: 1/3 bar	Oven dry	Field moist	Particle den-	Water content 4B1a: 1/3 bar	1/3 bar	15 bar	Extensibility 4D1: COLE	COLE

UWALA SILTY CLAY LOAM
S62Ha-3-3

Location: Island of Lanai, Maui County, Hawaii; 63 m (210 feet) west of the east end of Block B-5 in field 5425 which is approximately 7 km (4½ miles) south of Lanai City Post Office. After proceeding 7 km (4½ miles) south, turn east in field 5425 and proceed 1.7 km (1.1 miles), turn south for .16 km (0.1 mile). Pit site is 63 m (210 feet) west of this point located 8 lines from the south side of the block. Date of sampling: 1962.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren and S. Nakamura.
Classification: **Oxic Ustropept, very fine, kaolinitic, isohyperthermic.**
Vegetation: Pineapple. Climate: Average annual precipitation is 38 to 63 cm (15-25 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 20° C (68° F), and the mean July temperature 22.8° C (73° F). Parent material: Basic igneous rocks with some influence of volcanic ash and cinders. Topography: Low midslopes on the Central Plateau of Lanai. Elevation: 390 m (1,300 feet). Drainage: Well drained; moderate permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S62Ha-3-4.

HORIZON	DESCRIPTION
Ap1 LSL No. 17413	0 to 20 cm (0-8 inches), dark reddish brown (5YR 3/4) silty clay loam, dark reddish brown (5YR 3/4) dry; weak medium and fine subangular blocky structure; soft, friable, slightly sticky, plastic; few roots; common very fine and fine tubular pores; few black concretions; moderately strong effervescence with hydrogen peroxide; few fine hard earthy lumps; clear wavy boundary.
Ap2 LSL No. 17414	20 to 40 cm (8-16 inches), dark reddish brown (5YR 3/3) silty clay loam with common, medium, faint mottles of 5YR 3/4; weak fine and very fine subangular blocky structure; soft, friable, slightly sticky, plastic; few roots; many very fine and fine tubular pores; few black concretions; moderately strong effervescence with hydrogen peroxide; few very fine hard earthy lumps; abrupt wavy boundary.
B2 LSL No. 17415	40 to 70 cm (16-28 inches), dark reddish brown (5YR 3/3) silty clay loam; strong fine and very fine angular blocky structure; slightly hard, slightly firm, sticky and plastic; few roots; common very fine and fine tubular inped pores; no black concretions; no effervescence with hydrogen peroxide; strong aggregate stability which tends to impart a gritty feel; thick patchy glaze on ped faces; common clay flow-like material of 2.5YR 3/6 material in pores which gives somewhat of a mottled appearance; clear wavy boundary.
C1 LSL No. 17416	70 to 105 cm (28-42 inches), 75 to 90 percent of this horizon is highly weathered basic igneous rock of 10YR 3/4 color. This rock material is very porous and loose; it contains clay flow-like material on it. The rock material breaks into strong medium and fine angular blocky material. The soil material in the voids is dark reddish brown (5YR 3/4) silty clay loam; weak fine and very fine subangular blocky structure; soft, friable, slightly sticky, plastic; few roots; many very fine and fine tubular pores; no black concretions; no effervescence with hydrogen peroxide; clear wavy boundary.

SOIL FAMILY **Oxic Ustropept, very fine, kaolinitic, isohyperthermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES **Uwala silty clay loam** SOIL Nos. **S62Ha-3-4** LOCATION **Maui County, Hawaii**

Lincoln Lab Nos. 17419 - 17423

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	Ap1																	
18-38	Ap2																	
38-75	B2																	
75-110	B3																	
110-150	C																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	Ap1	30.12	4.6	26.0	23.5	0.20	0.39	-	-	tr.	0.28	14.6	99.6	10.4	14.9			
18-38	Ap2	30.4	3.8	29.6	21.3	0.10	0.70	-	-	tr.	0.28	14.1	100.3	10.1	14.4			
38-75	B2													10.5	15.0			
75-110	B3													8.8	12.6			
110-150	C													13.0	18.6			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation 5C1 NH_4OAc	5C3	pH 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-18	1.70	0.188	9	3.5	0.8	0.1	0.2	4.6		11.9		2.1	0.8	39		4.5	3.7
18-38	0.90	0.111	8	4.0	1.2	0.1	0.8	6.1		10.7		2.0	0.1	57		5.2	4.5
38-75	0.61	0.066	9	4.7	1.7	0.6	0.8	7.8		12.0		3.2	0.2	65		5.0	4.0
75-110	0.45			4.6	2.3	0.8	0.6	8.3		12.4		4.0	0.5	67		4.6	3.4
110-150	0.70			4.1	2.2	0.8	0.1	7.2		11.8		3.5	0.6	61		4.7	3.6

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: ~~4A1r~~ 1/3 bar	~~4A1n~~ Oven dry	Field moist	Particle density	Water content: ~~4B1c~~ 1/3 bar glad	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-18				-				1.23	1.35		2.91	31.0	32.0	22.7		0.032
18-38				-				1.18	1.27		2.92	33.3	33.3	25.2		0.025
38-75				tr.				1.26	1.34		2.95	33.6	35.0	29.2		0.021
75-110				tr.				1.15	1.24		2.93	35.1	39.5	32.1		0.025
110-150				tr.				1.11	1.19		3.03	36.8	40.1	29.0		0.023

a/ 10.0 kg of organic carbon per square meter to a depth of 1 meter.

UWALA SILTY CLAY LOAM
S62Ha-3-4

Location: Island of Lanai, Maui County, Hawaii; 22 m (75 feet) from the west end of Block A-9 in field 5425 of Dole Pineapple Co., Lanai. This site is approximately 7.6 km (4½ miles) south of Lanai City Post Office on Highway Hawaii 414. Date of sampling: 1962.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren and S. Nakamura.
Classification: **Oxic Ustropept, very fine, kaolinitic, isohyperthermic.**
Vegetation: Pineapple. Climate: Average annual rainfall is 38 to 63 cm (15-25 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 20° C (68° F), and the mean July temperature 22.8° C (73° F). Parent material: Basic igneous rocks with some influence of volcanic ash and cinders. Topography: Lower midslopes of the Central Plateau of Lanai. Elevation: 390 m (1,300 feet). Drainage: Well drained; moderate permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S62Ha-3-3.

HORIZON	DESCRIPTION
Ap1 LSL No. 17419	0 to 18 cm (0-7 inches), dark reddish brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) dry with common medium faint mottles of 5YR 3/4; weak medium and fine subangular blocky structure with common medium and fine clods; soft, friable, slightly sticky, plastic; common roots; common very fine and fine tubular pores; few black concretions; moderately strong effervescence with hydrogen peroxide; few fine hard earthy lumps; clear wavy boundary.
Ap2 LSL No. 17420	18 to 38 cm (7-15 inches), dark reddish brown (5YR 3/3) with common, medium, faint mottles of 5YR 3/4, silty clay loam; weak, medium and fine subangular blocky structure; soft, friable, slightly sticky, plastic; few roots; many very fine and fine tubular pores; few black concretions; moderately strong effervescence with hydrogen peroxide; few very fine hard earthy lumps; this is a zone of maximum incorporation of plant residue; abrupt wavy boundary.
B2 LSL No. 17421	38 to 75 cm (15-30 inches), dark reddish brown (5YR 3/4) silty clay loam; strong, fine and very fine angular blocky structure; slightly hard, slightly firm, sticky and plastic; few roots; many very fine and fine tubular pores, no black concretions; no effervescence with hydrogen peroxide; strong aggregate stability which tends to impart a gritty feeling; thick patchy glaze on ped faces; common clay flow-like material in pores of 2.5YR 3/6 color which gives somewhat of a mottled appearance under the hand lens; common very fine, dark mineral stains on ped faces; clear wavy boundary.
B3 LSL No. 17422	75 to 110 cm (30-44 inches), 75-90 percent of this horizon is highly weathered basic igneous rock of 10YR 3/4 color with weathered stains of 2.5YR 3/6, this rock is very porous and contains what appears to be clay flows on some faces, this rock is very loose and can be penetrated easily with an auger; the soil in the voids is dark reddish brown (5YR 3/4) silty clay loam; weak, medium and fine subangular blocky structure; soft, friable, sticky, plastic; few roots; many very fine and fine tubular inped pores; no black concretions; no effervescence with hydrogen peroxide; clear wavy boundary.
C LSL No. 17423	110 to 150 cm (44-60 inches), dark reddish brown (5YR 3/4) silty clay loam; weak, medium and fine subangular blocky structure, soft, friable, slightly sticky, slightly plastic; no roots; many very fine and fine and few medium tubular pores; no black concretions; no effervescence with hydrogen peroxide. This is an undulating horizon occurring as high in the profile as 75 cm (30 inches) and down as far as 150 cm (60 inches).

SOIL FAMILY Cumulic Haplaquoll, very fine, montmorillonitic, (calcareous), isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Nohili clay SOIL Nos. S63Ha-2-7 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 18697 - 18702

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-30	Ap																	
30-55	B21																	
55-75	B22																	
75-105	B23&IIC																	
105-128	IIICcam																	
128-153	IVC																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-30	Ap													8.2	11.7	2		
30-55	B21													8.5	12.2	tr.		
55-75	B22													8.2	11.7	1		
75-105	B23&IIC													3.0	4.3	12		
105-128	IIICcam													0.8	1.1	60		
128-153	IVC													2.8	4.0	13		

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-30	1.42	0.145	10	21.6	24.8	1.2	0.2			33.4		0.1				8.6	7.3
30-55	1.08	0.118	9	13.3	27.9	1.5	0.2			37.6		0.1				8.6	7.4
55-75	1.26	0.130	10	14.5	30.2	2.3	0.2			35.9		0.2				8.8	7.6
75-105	0.80	0.085	9	24.5	39.4	2.4	0.9			37.4		1.1				8.8	7.7
105-128	0.15			21.3	19.7	1.5	0.4			19.3		0.4				9.1	7.9
128-153	0.13			24.3	44.1	3.4	1.0			52.8		0.3				9.1	7.6

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-30				-						1.14	2.91		40.4	32.7		
30-55				-						1.11	2.92		50.7	35.0		
55-75				-						1.10	2.89		51.1	35.2		
75-105				tr.						1.07	2.83		52.8	40.3		
105-128				100 b/												
128-153				-												

a/ 12.8 kg of organic carbon per square meter to a depth of 1 meter.

b/ Analyses on crushed samples.

NOHILI CLAY
S63Ha-2-7

Location: Island of Kauai, Kauai County, Hawaii, 2.9 km (1.86 miles) north, 51° west of the junction of Highways 50 and 550 in the town of Kekaha. Date of sampling: May 9, 1963.
Description by: D. E. Foote. Collectors: D. E. Foote and J. A. DeMent.
Classification: **Cumulic Haplaquoll, very fine, montmorillonitic, (calcareous), isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: The average annual precipitation is 50 cm (20 inches). The mean annual temperature is 23.3° C (74° F). Parent material: Alluvium from area weathered from basic igneous rock. The material has been deposited over marshy lagoon deposits. Topography: Nearly level Mana coastal plain. Elevation: 3 m (10 feet). Drainage: Poorly drained; permeability moderately slow. Soil moisture: Profile was moist when sampled. Became wet with depth.

Remarks: Water table was at 90 cm (3 foot) depth from the surface. All colors identified when moist. Paired sample number S63Ha-2-8. Textures are apparent field textures.

HORIZON	DESCRIPTION
Ap LSL No. 18697	0 to 30 cm (0-12 inches), dark reddish brown (5YR 3/3) clay, same color rubbed, some fine light red specks; weak medium fine and very fine subangular blocky structure; extremely hard, firm, very sticky and very plastic; common very fine, fine and medium roots; many fine interstitial, common very fine, fine and medium tubular pores; moderate effervescence with hydrogen peroxide; moderate effervescence with hydrochloric acid; contaminated with pieces of coral rock; clear smooth boundary.
B21 LSL No. 18698	30 to 55 cm (12-22 inches), dark reddish brown (5YR 3/3) clay, same color rubbed, many fine distinct light red specks, some higher chroma sugar-like granules, and some 5YR 3/1 coatings; weak coarse subangular blocky structure; firm, very sticky and very plastic; few medium, common fine and very fine roots; very fine, fine, common medium tubular pores; thin discontinuous coatings; slight effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; clear smooth boundary.
B22 LSL No. 18699	55 to 75 cm (22-30 inches), dark reddish brown (5YR 3/3) clay, same color rubbed, some coatings with higher chroma and some black stains; very weak fine subangular blocky structure; firm, very sticky and very plastic; common very fine roots; many fine and very fine tubular pores; many very fine interstitial pores; thin nearly continuous coatings; slight effervescence with hydrochloric acid; slight effervescence with hydrogen peroxide; clear smooth boundary.
B23 & IIC LSL No. 18700	75 to 105 cm (30-42 inches), about 50-50 mixture of dark reddish brown (5YR 3/2) clay, 5YR 3/3 when rubbed, and dark gray (N 4/) clay, some coatings of gray on red soil and red on gray soil; moderate fine and very fine subangular blocky structure; firm, very sticky and very plastic; common very fine, many micro roots; many very fine and micro tubular pores; many very fine interstitial pores; slight effervescence with hydrogen peroxide; moderate effervescence with hydrochloric acid; abrupt smooth boundary.
IIICcam LSL No. 18701	105 to 128 cm (42-51 inches), grayish brown (2.5YR 5/2) indurated calcium carbonate, common 10YR 4/3 and 10YR 5/4 coatings; very hard; no roots; common fine, many very fine and micro tubular pores; strong effervescence with hydrochloric acid; on top of this was about 3 cm (1 inch) of softer material; abrupt smooth boundary.
IVC LSL No. 18702	128 to 153 cm (51-61 inches), gray (10YR 5/1) and light gray (10YR 2/1) marine clay; massive; very sticky and very plastic; no roots; moderate effervescence with hydrochloric acid.

SOIL FAMILY Cumulic Haplaquoll, very fine, montmorillonitic, (calcareous), isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Nohili clay SOIL Nos. S63Ha-2-8 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 18703 - 18709

Depth (cm)	Horizon	Mineralogical Analysis																
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-35	Ap1		50		15	1		6			7	2			8			5
35-55	Ap2		45		15		3	8			8	4			9			4
55-78	B2		70		15			4			4	1	1		4			1
78-93	IIC1		75		15		1	1			3		1		2			1
93-115	IIC2		75		10	1	1	1			2	1	1		3			1
115-138	IIIC cem		70		10	1	2	1			6		1		4			2
138-150	IVC		70		10	1	2	1			3	1	1		4			1

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-35	Ap1	36.9	3.8	20.7	19.6	0.25	2.94	1.95	0.31	0.20	0.32	13.3	100.3	5.8	8.3	2	9.17	5.28
35-55	Ap2	36.3	3.9	22.1	21.1	0.28	2.84	1.31	0.32	0.17	0.31	12.1	100.7	7.1	10.2	tr.	8.97	6.04
55-78	B2	38.7	3.1	21.5	15.8	0.10	3.86	4.24	0.28	0.16	0.27	15.9	103.9	3.4	4.9	8	8.08	3.57
78-93	IIC1													1.7	2.4	30	3.87	1.87
93-115	IIC2													0.8	1.1	59	3.07	1.31
115-138	IIIC cem													0.6	0.9	60	3.14	0.92
138-150	IVC													1.0	1.4	36	5.08	1.93

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch capacity		NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH		
				6N2a Ca	602a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:5	8C1c KCl 1:5	
				Meq./100 g.										Percent				
0-35	1.42	0.14	10	29.3	28.0	1.70	0.30			47.0		0.2				8.7	7.4	

NOHILI CLAY
S63Ha-2-8

Location: Island of Kauai, Kauai County, Hawaii, 5.8 km (3.6 miles) north, 48.5° west of the junction of Highways 50 and 550 in the town of Kekaha. Date of sampling: May 19, 1963.
Description by: D. E. Foote. Collectors: D. E. Foote and J. A. DeMent.
Classification: **Cumulic Haplaquoll, very fine, montmorillonitic, (calcareous), isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: The average annual precipitation is 50 cm (20 inches). The mean annual temperature is 23.3° C (74° F). Parent material: Alluvium from area weathered from basic igneous rock. The material has been deposited over marshy lagoon deposits. Topography: Nearly level Mana coastal plain. Elevation: 3 m (10 feet). Drainage: Poorly drained; permeability moderately slow. Soil moisture: Profile was saturated when sampled.
Remarks: Textures are apparent field textures. All colors identified when moist.

Ap1 LSL No. 18703 — 0 to 35 cm (0-14 inches), dark reddish brown (5YR 3/3) clay, same color rubbed, many light red, black, yellowish and whitish specks; weak coarse subangular blocky structure; firm, very sticky and very plastic; many fine, very fine and micro roots; common medium fine and very fine tubular pores; many very fine interstitial pores; small (sand to fine gravel size) pieces of 10YR 4/1 clay mixed with the soil; moderate effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; gradual smooth boundary.

Ap2 — 35 to 55 cm (14-22 inches), dark reddish brown (5YR 3/3) clay, same color

SOIL FAMILY Fluvaquentic Haplaquoll, very fine, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Hanalei silty clay (taxad.junct) SOIL Nos. S62Ha-2-6 LOCATION Kauai County, Hawaii
Lincoln Lab Nos. 17273 - 17277

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-10	Ap1																	
10-33	Ap2g																	
33-50	C1g																	
50-88	C2g																	
88-120	C3g																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-10	Ap1													6.0	8.6			
10-33	Ap2g													6.4	9.2			
33-50	C1g													6.2	8.9			
50-88	C2g													6.2	8.9			
88-120	C3g													6.4	9.2			

Depth (cm)	6A1a 2/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-10	3.05	0.221	14	8.6	21.2	0.7	0.3	30.8		32.4		-		95		5.9	4.8
10-33	2.23	0.154	14	9.6	22.4	0.5	0.1	32.6		33.7		-		97		6.0	5.0
33-50	1.28	0.111	12	10.0	22.3	0.4	tr.	32.7		34.6		-		94		6.6	5.2
50-88	0.88	0.89	10	8.8	24.0	0.4	tr.	33.2		33.5		-		99		6.7	5.2
88-120	0.41			7.5	21.5	0.6	0.1	29.7		30.6		-		97		6.9	5.4

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-10				-						0.85	2.90		55.0	35.6		
10-33				tr.						1.07	2.89		50.1	35.1		
33-50				-						1.15	2.98		45.6	31.4		
50-88				-						1.17	2.98		44.4	32.3		
88-120				-						1.09	3.05		44.9	28.0		

a/ 14.5 kg of organic carbon per square meter to a depth of 1 meter.

HANALEI SILTY CLAY (taxadjunct) 1/
S62Ha-2-6

Location: Island of Kauai, Kauai County, Hawaii. Approximately 3.9 km (2.4 miles) southeast of Hanalei, Kauai; 2.4 km (1.5 miles) east of Hanalei, turn south at bridge that crosses Hanalei River. Sample site is approximately .81 km (.5 mile) south along the river on the east side of the stream. It is located 60 m (200 yards) south of metal tower of Kauai Electric power line. Date of sampling: 1962.
Description by: Donald E. Foote. Collectors: Donald E. Foote.
Classification: **Fluvaquentic Haplaquoll, very fine, oxidic, isohyperthermic.**
Vegetation: Abandoned taro patch, native vegetation consists of Californiagrass (Panicum purpurascens), sensitive plant (Mimosa pudica), honohono (Commelina diffusa), and Java plum (Eugenia cumini). Climate: Average annual precipitation is 250 to 313 cm (100 to 125 inches). The mean annual temperature is 23.3° C (74° F), the mean January temperature 21.1° C (70° F), and the mean July temperature 25.6° C (78° F). Parent material: Recent alluvium from high rainfall area weathered from basic igneous rock. Topography: Flood plains of Hanalei River. Elevation: 6 m (20 feet). Drainage: Poorly drained; moderate permeability; slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S62Ha-2-1.

HORIZON	DESCRIPTION
Ap1 LSL No. 17273	0 to 10 cm (0-4 inches), very dark grayish brown (10YR 3/2) silty clay with few large faint mottles that are dark reddish brown; weak very fine subangular blocky structure; sticky, plastic; common very fine pores; many roots; numerous sand grains; abrupt smooth boundary.
Ap2g LSL No. 17274	10 to 33 cm (4-13 inches), very dark grayish brown (10YR 3/2) silty clay with many large distinct mottles of dark reddish brown (5YR 3/4) and dark gray (10YR 4/1); moderate very fine subangular blocky structure; sticky, plastic; many roots; many very fine and fine and common medium pores; common sand grains; abrupt smooth boundary.
LSL No. 17275	prominent mottles of dark reddish brown (5YR 3/4); weak coarse prismatic breaking to weak very fine subangular blocky structure; sticky, plastic; many fine pores; many roots; clear smooth boundary.
C2g LSL No. 17276	50 to 88 cm (20-35 inches), dark gray (10YR 4/1) silty clay loam with many large prominent mottles of dark reddish brown (2.5YR 3/4 and 2/4); weak coarse prismatic structure; sticky, plastic; many roots; many very fine and medium pores; mottles appear like thick patchy clay cutans; clear smooth boundary.
C3g LSL No. 17277	88 to 120 cm (35-48 inches), dark brown (7.5YR 3/2) clay loam with many prominent mottles of dark red (2.5YR 3/6), dark reddish brown (2.5YR 2/4) and strong brown (7.5YR 5/6); massive; stricky, plastic; many fine and medium pores; common roots; common sand grains.

1/ **The Hanalei series is classified in the very fine, oxidic,** nonacid, **isohyperthermic family of Tropic Fluvaquents. The Ap1 horizon of this pedon is slightly lower in**

SOIL FAMILY Aridic Haplustoll, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Waikoa silty clay loam (taxadjunct) SOIL Nos. 865Ha-4-20 LOCATION Maui County, Hawaii

Riverside Lab Nos. 65161 - 65165

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-5	Ap			5	50	3		10			15	5						
5-20	B21			5	50	4		10			15	5						
20-40	B22			4	50	4		10			15	5						
40-63	IIB23				50	5		10			20	5						
63-83	IIC																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-5	Ap	26.8	5.1	28.7	20.2	0.28	1.22	0.27	0.14	0.33	0.37	12.6	96.0	8.0	11.4		14.81	15.48
5-20	B21	26.2	5.0	29.9	20.1	0.28	1.11	0.18	0.14	0.33	0.34	11.9	95.5	7.5	10.7		15.95	14.06
20-40	B22	26.3	5.4	29.0	20.8	0.28	1.13		0.14	0.25	0.34	12.3	95.9	7.4	10.6		14.02	14.16
40-63	IIB23	26.2	4.4	29.6	20.4	0.24	1.32	-	0.18	0.03	0.44	12.4	95.2	5.2	7.4		17.93	18.56
63-83	IIC							-						3.6	5.1			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-5	1.59	0.13	12	7.8	4.0	0.2	2.50	14.5		16.0		-		91		6.1	5.3
5-20	0.82	0.07	12	6.6	3.1	0.3	2.30	12.3		14.7		-		84		6.2	5.2
20-40	0.80	0.07	11	6.1	2.9	0.5	0.90	10.4		13.8		-		75		6.1	5.2
40-63	0.57	0.05	11	5.6	2.8	1.3	0.20	9.9		14.7		-		67		6.6	5.2
63-83	0.28			8.2	3.9	2.5	0.1	14.7		19.2		-		76		7.1	5.8

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-5	11.8	50.6	37.6							1.30	2.94		27.2	20.9		
5-20	11.7	51.9	36.4							1.21	2.97		25.6	19.4		
20-40	12.5	52.3	35.2							1.12	2.97		26.4	20.2		
40-63	14.3	59.9	25.8							1.07	3.00		34.2	23.3		
63-83	22.6	55.9	21.5								3.08		40.6	23.3		

a/ 6.3 kg of organic carbon per square meter to a depth of 1 meter.

WAIAKOA SILTY CLAY LOAM (taxadjunct) 1/
S65Ha-4-20

Location: Island of Maui, Maui County, Hawaii. Puu O Kali Quadrangle - 20°47'20" north latitude and 156°24'30" west longitude. A pit located 15 m (50 feet) east of Waiakoa Road and about 1.61 km (1 mile) south of locked gate in Makai pasture of the Old Grove Ranch. Date of sampling: April 14, 1965.

Description by: F. G. Stephens and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, F. Stephens and G. Yamamoto.

Classification: **Aridic Haplustoll, fine, kaolinitic, isohyperthermic.**

Vegetation: **Revegetated area once cultivated and now used as pasture with grass, herb, shrub and scattered tree cover. Species:** buffelgrass (Cenchrus ciliaris), feather fingergrass (Chloris virgata), ilima (Sida fallax), kiawe (Prosopis chilensis), Spanish needle (Bidens pilosa), uhaloa (Waltheria indica), and zinnia (Zinnia

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL FAMILY Cumulic Haplustoll, very fine, mixed, isohyperthermic

SOIL SERIES Kekaha clay SOIL Nos. 865Ha-2-1 LOCATION Kauai County, Hawaii

Riverside Lab Nos. 6561 - 6566

KEKAHA CLAY
S65Ha-2-1

Location: Island of Kauai, Kauai County, Hawaii. Kekaha Quadrangle -21°59'00" north latitude and 159°43'19" west longitude. Kekaha Plantation, 1,329 m (4,430 feet) N. 8.5° W. of Highways 50 and 55 in Kekaha Town. Date of sampling: April 15, 1965.
Description by: L. D. Giese and D. E. Foote. Collectors: K. Flach, L. Swindale, H. Collins, L. Giese, D. Foote, and G. Yamamoto.
Classification: **Cumulic Haplustoll, very fine, mixed, isohyperthermic.**
Vegetation: **Cultivated. (Just cleared for sugarcane; was residential area),** natural vegetation is kiawe (Prosopis chilensis), klu (Acacia fornesiana), koa haole (Leucaena glauca), and fingergrass (Chloris spp.). Climate: Average annual precipitation is 55 cm (22 inches). The mean annual temperature is 24° C (75° F). Parent material: Alluvium from basic igneous rock sources including ash. Topography: Coastal plain overlain by alluvium. Plane slope; 1 percent slope; South aspect. Midslope of alluvial fan. Elevation: 6.3 m (21 feet). Drainage: Well drained; slow runoff; moderate permeability. Soil moisture: Moist.
Remarks: Textures are apparent field textures.

HORIZON	DESCRIPTION
Ap1 RSL No. 6561	0 to 18 cm (0-7 inches), dark reddish brown (5YR 3/2) silty clay, (5YR 3/3) dry; moderate fine and very fine granular structure; very hard, friable, sticky and plastic; common roots; strong effervescence with hydrogen peroxide; mildly alkaline (pH 7.5); clear smooth boundary.
Ap2 RSL No. 6562	18 to 35 cm (7-14 inches), dark reddish brown (5YR 3/3) silty clay, (5YR 3/3) dry; weak and moderate fine and very fine subangular blocky structure; very hard, friable, sticky and plastic; common roots; moderate effervescence with hydrogen peroxide; mildly alkaline (pH 7.5); clear smooth boundary.
A13 RSL No. 6563	35 to 53 cm (14-21 inches), dark reddish brown (5YR 3/3) silty clay, bands of dark reddish brown (5YR 2/2), reddish brown (5YR 4/4) dry; weak fine subangular blocky structure; hard, friable, sticky and plastic; common roots; many pores; coatings in coarser pores, thin patchy coatings on some peds; moderate effervescence with hydrogen peroxide; mildly alkaline (pH 7.6); abrupt smooth boundary.
B21 RSL No. 6564	53 to 70 cm (21-28 inches), dark reddish brown (5YR 3/3) silty clay, (5YR 3/4) dry; massive with some pockets of weak medium subangular blocky structure; very hard, firm, sticky and plastic; few roots; many pores; moderate effervescence with hydrogen peroxide; mildly alkaline (pH 7.6); gradual wavy boundary.
B22 RSL No. 6565	70 to 110 cm (28-44 inches), dark reddish brown (2.5YR 3/4) clay, reddish brown (2.5YR 4/3) dry; weak medium and coarse prismatic structure; very hard, firm, sticky and plastic; few roots; many pores; moderate effervescence with hydrogen peroxide; mildly alkaline (pH 7.5); gradual wavy boundary.
B23 RSL No. 6566	110 to 175 cm (44-70 inches), dark reddish brown (2.5YR 3/4) clay, weak red (2.5YR 4/2) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; few roots; many pores; common patchy cutans on peds; vertical channels with coatings; moderate effervescence with hydrogen peroxide; neutral (pH 7.3).

SOIL FAMILY Oxic Hapludoll, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Makawali silty clay loam SOIL Nos. S62Ha-2-2 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 17402 - 17406

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	Ap1			20	30	4	10	25			3	5						
18-30	Ap2			20	35	2	10	25			2	5						
30-63	B21			15	40	2	5	25			2	5						
63-90	B22			10	45	1	5	30				5						
90-150	B23			5	50	2		30			3	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	Ap1	23.3	4.2	29.3	23.9	0.98	1.33	0.21	0.20	1.38	0.57	14.7	100.1	14.9	21.3		6.23	6.64
18-30	Ap2	22.9	4.2	30.6	25.2	0.92	1.22	0.03	0.19	1.38	0.43	13.0	100.1	16.2	23.2		10.63	12.10
30-63	B21	24.2	4.7	31.5	25.0	0.48	0.85	tr.	0.19	1.20	0.37	11.6	100.1	16.6	23.7		8.79	10.14
63-90	B22	25.8	5.0	30.3	25.0	0.18	0.77	tr.	0.21	0.81	0.30	11.6	100.0	17.6	25.2		8.18	8.42
90-150	B23	25.7	5.0	27.9	27.3	0.10	0.51	tr.	0.20	0.37	0.31	12.5	99.9	17.7	25.3		12.78	11.75

Depth (cm)	6A1a a/ Organic carbon	6B1a Nitrogen	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
	Pct.	Pct.		Meq./100 g.										Percent			
0-18	2.44	0.27	9	7.8	7.2	0.40	1.10	16.5		11.5		0.4		100+		6.1	5.4
18-30	1.35	0.18	7	4.9	4.5	0.40	0.20	10.0		7.4		1.1		100+		6.4	5.7
30-63	0.59	0.10	6	3.6	3.5	0.50	0.20	7.8		9.0		0.9		87		7.0	6.1
63-90	0.37	0.08	5	3.9	4.2	1.10	0.10	9.3		9.5		1.0		98		7.5	6.4
90-150	0.53	0.20	3	3.7	4.2	2.20	0.10	10.2		11.8		1.3		86		7.1	6.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-18				tr.						1.09	3.01		36.8	24.4		
18-30				-						1.16	3.07		35.1	24.1		
30-63				-						1.22	3.11		35.3	22.7		
63-90				-						1.22	3.09		34.2	23.9		
90-150				-						1.23	3.09		35.1	24.8		

a/ 9.7 kg of organic carbon per square meter to a depth of 1 meter.

S62Ha-2-2

Location: Island of Kauai, Kauai County, Hawaii; .6 km (.38 mile) southwest of McBryde Sugar Mill. Sample site is located approximately 19.3 km (12 miles) southwest of Lihue. Date of sampling: 1962.
Description by: J. M. Williams and D. E. Foote. Collectors: J. M. Williams and D. E. Foote.
Classification: **Oxic Haplustoll, fine, kaolinitic, isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: Average annual precipitation is 88 cm (35 inches). The mean annual temperature is 23.3° C (74° F), the mean January temperature 21.7° C (71° F), and the mean July temperature 25.6° C (78° F). Parent material: Weathered from residuum from basic igneous rock. Topography: Low leeward slopes, slightly convex to west, 2 percent slope. Elevation: 48 m (160 feet). Drainage: Well drained; moderately rapid permeability; moderate runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S62Ha-2-3.

HORIZON	DESCRIPTION
Ap1 LSL No. 17402	0 to 18 cm (0-7 inches), dusky red (10R 3/2) silty clay loam, dark red (10R 3/6) dry; cloddy breaking to weak fine and medium and very fine granular structure; hard, friable, sticky, plastic; abundant very fine and fine roots; many very fine and fine pores; many very fine black concretions; moderately magnetic; numerous fragments of charcoal from burning cane; violent effervescence with hydrogen peroxide; slightly acid (pH 6.1); clear smooth boundary.
Ap2 LSL No. 17403	18 to 30 cm (7-12 inches), dusky red (10R 3/3) silty clay loam, material of (10R 3/2) mixed by tillage, dusky red (10R 3/4) dry; weak medium and coarse subangular blocky structure; hard, friable, slightly sticky, slightly plastic; abundant roots; common very fine and fine tubular pores; many black concretions; moderately magnetic; strong effervescence with hydrogen peroxide; slightly acid (pH 6.4); clear smooth boundary.
B21 LSL No. 17404	30 to 63 cm (12-25 inches), dusky red (10R 3/4) silt loam, red (10R 4/6) dry; weak coarse prismatic structure; slightly hard, very friable, slightly sticky, plastic; plentiful roots; many very fine and fine medium pores; common black concretions; moderately magnetic; black manganese dioxide staining along root channels; strong effervescence with hydrogen peroxide; neutral (pH 7.0); clear smooth boundary.
B22 LSL No. 17405	63 to 90 cm (25-36 inches), dusky red (10R 3/4) silty clay loam, dark red (10R 3/6) dry; weak coarse prismatic breaking to weak fine medium and coarse subangular blocky structure with pockets of moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky, plastic; plentiful roots; many very fine and fine and common medium pores; few black concretions; patchy glazed surfaces on peds that appear like pressure surfaces; root channels are lined with black manganese dioxide staining; moderately magnetic; slight effervescence with hydrogen peroxide; neutral (pH 7.3); gradual wavy boundary.
B23 LSL No. 17406	90 to 150 cm (36-60 inches), dusky red (10R 3/3) silty clay loam, dark red (10R 3/6) dry; weak medium and fine subangular blocky with pockets of moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, plastic; few fine and medium roots that tend to be confined between ped faces; many very fine and fine pores; few black manganese dioxide concretions; common very fine weathered mineral particles that tend to impart a gritty feel; few glazed coatings on ped surfaces that appear to be pressure faces; several large stones in this horizon; slight effervescence with hydrogen peroxide; neutral (pH 7.1).

SOIL FAMILY Oxic Haplustoll, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Makaweli silty clay loam SOIL Nos. S62Ha-2-3 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 17407 - 17412

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	Ap1																	
15-25	Ap2																	
25-45	B1																	
45-85	B21																	
85-105	B22																	
105-138	B23																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-15	Ap1													14.5	20.7			
15-25	Ap2													14.2	20.3			
25-45	B1													16.6	23.7			
45-85	B21													14.4	20.6			
85-105	B22													14.1	20.2			
105-138	B23													13.3	19.0			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-15	2.00	0.204	10	8.1	8.3	0.5	0.4	17.3		17.1		tr.		101		7.0	6.0
15-25	1.76	0.177	10	6.6	6.7	0.6	0.2	14.1		16.2		0.2		87		6.8	5.8
25-45	0.89	0.127	7	3.8	3.8	0.4	0.1	8.1		10.6		0.5		76		7.0	6.0
45-85	0.41	0.076	5	3.1	4.2	0.6	0.1	8.0		9.8		0.9		82		6.8	6.0
85-105	0.33			3.6	4.2	0.8	0.1	8.7		10.4		1.0		84		6.6	5.7
105-138	0.40			4.6	5.4	1.0	0.1	11.1		12.5		0.8		89		6.6	5.8

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-15				-						1.29	2.99		32.0	23.1		
15-25				-						1.24						
25-45				-						1.20	3.05		31.3	23.0		
45-85				-						1.27	3.08		29.1	23.2		
85-105				-						1.38	3.07		28.3	23.9		
105-138				-						1.37	3.06		29.3	24.6		

a/ 11.0 kg of organic carbon per square meter to a depth of 1 meter.

MAKAWELI SILTY CLAY LOAM
S62Ha-2-3

Location: Island of Kauai, Kauai County, Hawaii. McBryde Plantation field 2-A, .64 km (.4 mile) southeast of junction of Highways 50 and 591. Approximately 20.9 km (13 miles) southwest of Lihue. Date of sampling: 1962.
Description by: J. M. Williams and D. E. Foote. Collectors: J. M. Williams and D. E. Foote.
Classification: **Oxic Haplustoll, fine, kaolinitic, isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: Average annual precipitation is 63 cm (25 inches). The mean annual temperature is 23.3° C (74° F), the mean January temperature 21.7° C (71° F), and the mean July temperature 25.6° C (78° F). Parent material: Weathered from residuum from igneous rock. Topography: Low leeward slopes, slightly convex to southwest, 4 percent slope. Elevation: 30 m (100 feet). Drainage: Well drained; moderate permeability; moderate runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S62Ha-2-2.

HORIZON	DESCRIPTION
Ap1 LSL No. 17407	0 to 15 cm (0-6 inches), dusky red (10R 3/3) silty clay loam, (10R 3/4) dry; cloddy breaking to weak fine and medium granular structure; sticky, plastic, friable; common to fine roots; many very fine and fine pores; many black concretions; strong effervescence with hydrogen peroxide; moderately magnetic; abrupt smooth boundary.
Ap2 LSL No. 17408	15 to 25 cm (6-10 inches), dusky red (10R 3/3) silty clay loam; weak medium and coarse subangular blocky structure; sticky, plastic, friable; common fine roots; many very fine and fine and few coarse pores; common very fine black concretions; strong effervescence with hydrogen peroxide; moderately magnetic; abrupt smooth boundary.
B1 LSL No. 17409	25 to 45 cm (10-18 inches), dusky red (10R 3/4) silt loam; weak coarse prismatic structure; slightly sticky, plastic, very friable; common roots; many very fine and common coarse pores; common black concretions; moderate effervescence with hydrogen peroxide; this horizon appears to decrease markedly in bulk density from the horizon above; abrupt smooth boundary.
B21 LSL No. 17410	45 to 85 cm (18-34 inches), dusky red (10R 3/4) silty clay loam; weak coarse prismatic breaking to weak fine medium and coarse subangular blocky structure; sticky, plastic, friable; few roots; many very fine and fine pores; few patchy cutans that appear like clay flows; common glazed surfaces that appear like pressure faces; few black concretions; slight effervescence with hydrogen peroxide; gradual wavy boundary.
B22 LSL No. 17411	85 to 105 cm (34-42 inches), dusky red (10R 3/4) silty clay with patchy mottles of dark red (10R 3/6); strong very fine subangular blocky structure; sticky, very plastic, friable; common very fine and fine pores; few roots; continuous glazed coatings on ped surfaces, some appear like thick clay flows, a majority, however, are probably pressure surfaces; few black concretions; slight effervescence with hydrogen peroxide; few black manganese stainings on ped surfaces; abrupt wavy boundary.
B23 LSL No. 17412	105 to 138 cm (42-55 inches), dusky red (10R 3/4) silty clay with coarse mottles of dark red (10R 3/6); strong very fine subangular and angular blocky structure; sticky, very plastic, friable; no roots; common very fine and fine pores; numerous hard gritty lumps; continuous thick cutans on ped surfaces that in main look like clay flows.

SOIL FAMILY Oxic Hapludoll, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Paia silty clay SOIL Nos. 865Ha-4-17 LOCATION Maui County, Hawaii

Riverside Lab Nos. 65119 - 65124

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-28	Ap1			15	50	1		15			10	5						
28-48	Ap2																	
48-75	B1			15	50	1		15			10	5						
75-103	B21			15	50	1		15			10	5						
103-133	B22			15	50	1		15			15	5						
133-150	B23			15	50	1		15			15	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-28	Ap1	28.9	4.4	26.8	21.0	1.38	1.68	0.85	0.17	1.16	0.66	13.8	100.8	9.0	12.9	1	8.96	7.47
28-48	Ap2													9.1		tr.		
48-75	B1	29.5	4.5	29.2	20.9	1.01	1.33	0.35	0.18	1.13	0.51	11.8	100.4	9.0	12.9		10.11	8.62
75-103	B21	30.6	4.4	29.3	21.8	0.33	1.16	0.19	0.08	1.09	0.55	11.0	100.5	9.6	13.7		11.94	9.84
103-133	B22	29.6	6.1	28.7	21.8	0.31	1.20	0.14	0.15	1.04	0.56	10.8	100.5	9.0	12.9		11.73	9.14
133-150	B23	29.6	4.6	28.6	23.1	0.27	1.13	0.16	0.09	0.97	0.66	11.3	100.5	9.2	13.2		12.09	9.93

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-28	1.85	0.20	9	22.2	2.6	0.30	0.60	25.7		20.7		-		100+		7.5	6.9
28-48	1.63	0.19	9	19.5	2.2	0.3	0.3	22.3		19.8		-		100+		7.5	6.9
48-75	0.70	0.11	6	10.9	2.1	0.30	0.20	13.5		13.2		-		100+		7.4	6.7
75-103	0.21			7.4	1.8	0.30	0.20	9.7		10.6		0.4		97		7.1	6.7
103-133	0.12			8.5	2.2	0.40	0.20	11.3		11.2		0.6		100+		7.2	6.8
133-150	0.28			7.7	2.6	0.40	0.20	10.9		11.0		0.8		99		7.1	6.8

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar clod	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.				Pct.	Pct.	Pct.	g/cc				Pct. of whole soil			cm/cm	
0-28	3.0	33.6	63.4		34	56	22			1.12	2.94		32.5	27.3		
28-48								1.33	1.55	1.20	2.96	34.9	32.9	28.3	0.051	0.051
48-75	2.1	28.1	69.8							1.16	2.98		31.7	26.6		
75-103	0.7	19.8	79.5		32	53	21			1.25	3.00		30.3	25.3		
103-133	0.7	21.2	78.1					1.46	1.52		3.00	29.7	28.8	24.9	0.012	0.012
133-150	0.7	23.1	76.2		32	60	28	1.40	1.51		3.00	30.8	29.7	25.4	0.025	0.025

a/ 10.6 kg of organic carbon per square meter to a depth of 1 meter.

PAIA SILTY CLAY
S65Ha-4-17

Location: Island of Maui, Maui County, Hawaii; Paia Quadrangle - 20°55'10" north latitude and 156°21'10" west longitude; 5 m (15 feet) north of upper Hamakuapoko Road and 360 m (1,200 feet) west of Maui High School in field 101 of Hawaiian Commercial and Sugar Company plantation, 2.6 km (1.6 miles) northeast of Paia. Date of sampling: April 12, 1965.

Description by: F. G. Stephens and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, F. Stephens, and G. Yamamoto.

Classification: **Oxic Haplustoll, fine, kaolinitic, isohyperthermic.**

Vegetation: Cultivated - sugarcane (Saccharum officinarum), natural vegetation is ilima (Sida fallax walpers), kiawe (Prosopis chilensis), lantana (Lantana camara), natal redtop (Tricholaena repens), uhaloa (Waltheria indica), and yellow foxtail (Setaria geniculata). Climate: Average annual precipitation ranges from 63 to 100 cm (25 to 40 inches). Mean annual temperature is about 23° C (73° F), mean January temperature is 22° C (73° F), and mean July temperature is 24° C (75° F). Parent material: Andesite. Topography: Toe of interfluves that are convex; 4 percent slope gradient. Elevation: 87 m (290 feet). Drainage: Well drained; permeability is moderate; runoff is medium. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Sample number of paired profile is S65Ha-4-18.

HORIZON	DESCRIPTION
Ap1 RSL No. 65119	0 to 28 cm (0-11 inches), dark reddish brown (5YR 3/2) silty clay, (5YR 3/3) dry; weak fine granular structure; hard, friable, sticky, plastic; many fine roots; many fine pores; many 1/4 to 2 mm fragments of coral; few fine black concretions; violent effervescence with hydrogen peroxide; mildly alkaline (pH 7.6); gradual wavy boundary.
Ap2 RSL No. 65120	28 to 48 cm (11-19 inches), dark reddish brown (5YR 3/2) clay, (5YR 3/3) dry; weak fine subangular blocky structure; hard, firm, very sticky, very plastic; many roots; many fine and very fine pores; many 1/4 to 2 mm fragments of coral; few fine black concretions; violent effervescence with hydrogen peroxide; mildly alkaline (pH 7.5); clear smooth boundary.
B1 RSL No. 65121	48 to 75 cm (19-30 inches), dark reddish brown (5YR 3/3) clay, (5YR 3/4) dry; moderate fine subangular blocky structure; hard, firm, sticky, plastic; many roots that tend to follow lower boundary; many fine and very fine pores; few to common fine black stains; dusky red and black stains effervesce violently with hydrogen peroxide, dark reddish brown stains effervesce slightly with hydrogen peroxide; mildly alkaline (pH 7.5); clear smooth boundary.
B21 RSL No. 65122	75 to 103 cm (30-41 inches), dark reddish brown (5YR 3/2) clay, (5YR 3/3) dry; moderate fine angular and subangular blocky structure; hard, friable when removed, sticky, plastic; compact in place; few fine roots at top, none at bottom; many fine pores; continuous pressure faces on peds; common sand-size particles that are resistant to crushing; few to common black stains; slight effervescence with hydrogen peroxide in matrix, violent effervescence on black stains; mildly alkaline (pH 7.4); clear smooth boundary.
B22 RSL No. 65123	103 to 133 cm (41-53 inches), dark reddish brown (5YR 3/3) clay, (5YR 3/4) dry; moderate fine angular and subangular blocky structure; hard, friable when removed, sticky, plastic; many fine pores; continuous pressure faces on peds; 30 to 40 percent of matrix contains black stains that effervesce violently with hydrogen peroxide; mildly alkaline (pH 7.5); gradual wavy boundary.
B23 RSL No. 65124	133 to 150 cm (53-60 inches), dark reddish brown (5YR 3/3) clay, (5YR 3/4) dry; moderate fine angular and subangular blocky structure; hard, friable when removed, sticky, plastic; many fine pores; mildly alkaline (pH 7.6).

SOIL FAMILY Oxic Haplustoll, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Paia silty clay SOIL Nos. S65Ha-4-18 LOCATION Maui County, Hawaii

Riverside Lab Nos. 65125 - 65130

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0- 23	Ap1																	
23- 63	Ap2																	
63- 98	B21																	
98-148	B22																	
148-175	B3																	
175-188	C																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0- 23	Ap1													5.4	7.7	18		
23- 63	Ap2													6.3	9.0	12		
63- 98	B21													7.8	11.2	tr.		
98-148	B22													8.1	11.6			
148-175	B3													7.3	10.4			
175-188	C													6.8	9.7			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0- 23	1.31	0.117	11	26.1	4.9	0.6	1.7	33.3		13.6		1.0		100+		8.2	7.7
23- 63	1.30	0.131	10	20.1	4.7	0.5	0.3	25.6		15.6		0.3		100+		7.8	7.2
63- 98	1.35	0.148	9	14.5	3.6	1.9	0.4	20.4		17.4		0.3		100+		7.4	6.8
98-148	0.61	0.081	8	8.3	2.7	2.0	0.7	13.7		13.1		0.4		100+		7.2	6.7
148-175	0.30	0.035	9	6.2	2.5	2.5	3.4	14.6		14.6		0.7		100		7.0	6.4
175-188	0.24			5.5	2.3	3.9	0.3	12.0		15.8		0.7		76		6.8	6.0

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0- 23										1.30	2.92		23.7	17.8		
23- 63										1.24	2.93		25.0	20.1		
63- 98										1.19	2.92		27.8	22.1		
98-148											2.97		29.3	23.4		
148-175											3.03		32.2	26.1		
175-188											3.07		31.3	25.8		

a/ 19.1 kg of organic carbon per square meter to a depth of 1 meter.

PAIA SILTY CLAY
S65Ha-4-18

Location: Island of Maui, Maui County, Hawaii. Paia Quadrangle - 20°53'40" north latitude and 156°21'50" west longitude. A pit located 15 m (50 feet) south of Kaheka Road and 90 m (300 feet) southeast of Sunny Side and Kaheka Road intersection in field 205 of Hawaiian Commercial and Sugar Company plantation about 2.1 km (1.3 miles) southeast of Paia. April 12, 1965.
F. G. Stephens and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, F. Stephens, and G. Yamamoto.

Classification: **Oxic Haplustoll, fine, kaolinitic, isohyperthermic.**

Vegetation: Cultivated sugarcane (Saccharum officinarum), natural vegetation is ilima (Sida fallax walpers), kiawe (Prosopis chilensis), lantana (Lantana camara), natal redtop (Tricholaena repens), uhaloa (Waltheria indica), and yellow foxtail (Setaria geniculata). Climate: Average annual precipitation is 80 cm (32 inches). Mean annual temperature is 23° C (73° F). Parent material: Andesite. Topography: Toe of interfluve that is convex; 4 percent slope gradient. Elevation: 123 m (410 feet). Drainage: Well drained; permeability is moderate; runoff is medium. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Sample number of paired profile is S65Ha-4-17. Colors are for moist soil.

HORIZON	DESCRIPTION
Ap1 RSL No. 65125	0 to 23 cm (0-9 inches), dark reddish brown (5YR 3/2) silty clay; cloddy breaking to weak fine granular structure; hard, friable, sticky and plastic; many fine roots; many pores; many coral fragments (1/4 to 2 mm); violently effervescent with hydrogen peroxide; gradual smooth boundary.
Ap2 RSL No. 65126	23 to 63 cm (9-25 inches), dark reddish brown (5YR 3/2) clay; massive breaking to medium fine granular structure; hard, friable, very sticky and very plastic; many roots; many pores; many coral fragments (1/4 to 2 mm); many wormholes coated with gelatinous material; 3 to 5 percent gravel; common black stains; violently effervescent with hydrogen peroxide; clear smooth boundary.
B21 RSL No. 65127	63 to 98 cm (25-39 inches), dark reddish brown (5YR 3/3) clay; weak fine subangular blocky with pockets of moderate fine subangular blocky structure; hard, friable when removed, sticky and plastic; many fine and medium roots; many pores; few wormholes; few coral fragments (1/4 to 2 mm); 3 to 5 percent gravel; strongly effervescence with hydrogen peroxide; clear wavy boundary.
B22 RSL No. 65128	98 to 148 cm (39-59 inches), dark reddish brown (5YR 3/3) silty clay; weak fine subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many pores; common wormholes; wormholes and pores are coated with gelatinous material; gradual wavy boundary.
B3 RSL No. 65129	148 to 175 cm (59-70 inches), dark brown (10YR 3/3) silty clay; weak medium prismatic breaking to moderate fine subangular blocky structure; hard, friable, sticky and plastic; few coarse roots; many pores coated with gelatinous glaze; almost continuous stressed cutans; many hard earthy lumps; gradual wavy boundary.
C RSL No. 65130	175 to 188 cm (70-75 inches), dark brown (10YR 3/3) silty clay; moderate fine subangular blocky structure; hard, friable, sticky and plastic; many pores; patchy stressed cutans; weakly smeary.

SOIL FAMILY Torrertic Haplustoll, very fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Pamoa silty clay SOIL Nos. S63Ha-5-5 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 18808 - 18815

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
125-0	Ao																	
0-18	A1			5	60	2		15			10	5	1X					
18-38	B1			5	50	2		20			10	5	1X					
38-58	B21			5	50	1		20			10	5	1X					
58-80	B21																	
80-100	B22			5	50	2		20			10	5	1X					
100-125	B23			5	50	2		20			5	5	1X					
125-155	B23																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
125-0	Ao													6.4	9.2			
0-18	A1	29.8	4.4	25.8	22.3	0.81	0.70	0.24	0.17	0.99	0.41	15.5	101.1	10.8	15.4		9.98	9.04
18-38	B1	30.4	4.4	27.6	22.2	0.61	0.80	0.04	0.17	0.33	0.33	13.3	100.2	11.4	16.3		9.20	8.44
38-58	B21	30.7	4.8	27.1	22.4	0.49	0.54	0.04	0.14	0.28	0.31	12.7	99.5	11.4	16.3		10.54	10.62
58-80	B21													11.7	16.7			
80-100	B22	30.6	4.8	27.5	23.2	0.34	0.56	tr.	0.14	0.25	0.30	12.7	100.4	11.4	16.3		10.20	9.37
100-125	B23	30.7	4.9	27.2	23.3	0.48	0.59	tr.	0.14	0.21	0.33	12.4	100.3	11.4	16.3		9.50	8.82
125-155	B23													19.5	19.3			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1b Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
125-0	16.2	0.95	17														
0-18	2.29	0.25	9	11.5	5.2	0.20	1.60	18.5		21.8		0.1		85		6.9	5.5
18-38	1.06	0.13	8	7.8	4.1	0.20	1.20	13.3		16.3		0.4		82		4.7	5.4
38-58	0.65	0.09	7	6.2	3.7	0.30	0.70	10.9		14.6		2.0		75		4.3	5.5
58-80	0.49	0.07	7	5.4	4.2	0.4	0.3	10.2		13.9		5.5	tr.	73		3.4	4.7
80-100	0.48			4.9	5.1	0.40	0.20	10.6		16.0		8.1	0.8	66		4.7	3.9
100-125	0.28			3.3	4.8	0.50	0.20	8.8		16.7		7.2	1.3	53		4.6	3.7
125-155	0.28			3.2	6.0	1.0	0.2	10.4		14.9		7.9	1.2	70		4.6	3.7

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar clod	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
125-0																
0-18										0.95	2.89		37.4	29.7		
18-38										1.01	2.93		34.0	30.2		
38-58										1.11	2.97		34.4	29.9		
58-80								~~1.22~~	1.38	1.11	2.96	34.1	35.0	30.6	0.04	0.04
80-100										1.19	2.95		33.5	28.3		
100-125										1.27	2.97		32.9	28.2		
125-155										1.31	2.96		33.8	29.3		

a/ 9.8 kg of organic carbon per square meter to a depth of 1 meter.

PAMOA SILTY CLAY
S63Ha-5-5

Location: Island of Molokai, Maui County, Hawaii. Approximately 4.8 km (3 miles) east of Maunaloa in Molokai Ranch land. From the intersection of Highway 46 and Ilio Point Road go south past the FAA Omnirange station to gate which is 1.7 km (1.1 miles) south of the highway. The site is .8 km (0.5 mile) south of the gate. Date of sampling: May 15, 1963.

Description by: S. Nakamura. Collectors: J. DeMent, R. Malmgren, J. Linebaugh, and S. Nakamura.

Classification: **Torrertic Haplustoll, very fine, kaolinitic, isohyperthermic.**

Vegetation: Pitted beardgrass (Andropogon pertusus), lantana (Lantana camara), Japanese

SOIL FAMILY Torrertic Haplustoll, very fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Pamoa silty clay SOIL Nos. S63Ha-5-6 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 18816 - 18821

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	A1																	
20-35	B1																	
35-65	B21																	
65-103	B22																	
103-130	B23																	
130-158	B23																	
85-95																		

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	A1													11.3	16.2			
20-35	B1													11.7	16.7			
35-65	B21													12.1	17.3			
65-103	B22													11.7	16.7			
103-130	B23													11.7	16.7			
130-158	B23													11.7	16.7			
85-95														11.7	16.7			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-20	1.83	0.205	9	9.9	5.0	0.4	1.8	17.1		19.6		0.1		87		6.6	5.4
20-35	1.25	0.140	9	8.0	4.0	0.4	1.2	13.6		16.0		0.2		85		6.9	5.7
35-65	0.74	0.094	8	7.6	4.0	0.4	0.9	12.9		13.8		0.5		93		7.3	6.1
65-103	0.37	0.072	5	6.3	3.5	0.5	0.4	10.7		12.8		4.0		84		5.8	5.0
103-130	0.32			5.4	4.4	0.9	0.2	10.9		13.2		4.2	0.1	82		5.2	4.5
130-158	0.36			4.9	5.7	1.3	0.1	12.0		14.0		2.8	0.1	86		5.5	4.7
85-95	0.53																

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar clod	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-20				-						1.05	2.90		33.5	27.4		
20-35				-						1.09	2.92		33.3	27.3		
35-65				-				1.27	1.39	1.16	2.95	33.7	33.1	26.7	0.03	0.03
65-103				-						1.24	2.97		30.9	26.4		
103-130				-						1.24	2.99		30.6	26.6		
130-158				-						1.30	2.97		31.5	27.5		
85-95				-												

a/ 10.1 kg of organic carbon per square meter to a depth of 1 meter.

PAMOA SILTY CLAY
S63Ha-5-6

Location: Island of Molokai, Maui County, Hawaii. Approximately 5.6 km (3½ miles) east of Maunaloa on Molokai Ranch land. From intersection of Highway 46 and Ilio Point Road go south .97 km (0.6 mile) to gate, then .97 km (0.6 mile) through grove of trees to old corral. The site is 1.45 km (0.9 mile) south southwest of old corral. Date of sampling: May 15, 1963.

Description by: S. Nakamura. Collectors: J. DeMent, R. Malmgren, J. Linebaugh, and S. Nakamura.

Classification: **Torrertic Haplustoll, very fine, kaolinitic, isohyperthermic.**

Vegetation: Fuzzy top (Andropogon barbinodis), Japanese tea (Cassia leschenaultiana), pitted beardgrass (Andropogon pertusus), ilima (Sida spp.), and joee (Stachytarpheta cayennensis). Climate: Average annual rainfall is 50 to 75 cm (20-30 inches), most of which falls from November to April. The mean January temperature is 21.1° C (70° F) and the mean July temperature 25° C (77° F). Parent material: Old alluvium. Topography: Intermediate slopes. Slope 9 percent to southeast. Elevation: 322 m (1,075 feet). Drainage: Well drained. Permeability moderate to 103 cm (41 inches) and slow below 103 cm (41 inches). Runoff slow to medium. Soil moisture: Profile was moist when sampled.

Remarks: Textures are apparent field textures. During periods of heavy rain, there is some seepage over the B23 horizon. Some vertical holes which are a few inches to 1.50 m (5 feet) in diameter and up to 3 m (10 feet) deep may be found throughout the soil. Because of the thickness, the B23 horizon was split for sampling. Material from the vertical holes was sampled at the 85 to 95 cm (34-38 inch) depth for carbonate-nitrogen and magnesium analysis. Paired sample number S63Ha-5-5. **The soil has cracks as much as 5 cm (2 inches) and extend to a depth of 150 cm.**

HORIZON	DESCRIPTION
A1 LSL No. 18816	0 to 20 cm (0-8 inches), dark reddish brown (5YR 3/3 moist and dry) silty clay; weak fine and medium subangular blocky structure with some weak very fine granular structure; upper 2.7 cm (1½ inches) has some moderate medium and coarse platy structure; hard, friable, sticky and plastic; many roots; common very fine tubular pores; violent effervescence with hydrogen peroxide; neutral (pH 6.7); gradual smooth boundary.
B1 LSL No. 18817	20 to 35 cm (8-14 inches), dark reddish brown (5YR 3/3 moist and dry) clay; weak to moderate very fine subangular blocky structure; hard, friable, very sticky and very plastic; many roots; many very fine tubular pores; many very fine manganese concretions; violent effervescence with hydrogen peroxide; few thin patchy pressure cutans; neutral (pH 6.7); clear wavy boundary.
B21 LSL No. 18818	35 to 65 cm (14-26 inches), dark reddish brown (5YR 3/3 moist and dry) clay; moderate very fine subangular blocky structure; hard, friable, very sticky and very plastic; many roots; many very fine tubular pores; common pressure cutans; many very fine manganese concretions; violent effervescence with hydrogen peroxide; neutral (pH 6.6); clear wavy boundary.
B22 LSL No. 18819	65 to 103 cm (26-41 inches), dark reddish brown (5YR 3/4 moist and dry) clay; moderate very fine subangular blocky structure; hard, friable, sticky and plastic; many roots; many very fine and common fine tubular pores; common pressure cutans; common organic stains in root channels; many manganese concretions; strong effervescence with hydrogen peroxide; slightly acid (pH 6.1); gradual wavy boundary.
B23 LSL No. 18820 & 18821	103 to 158 cm (41-63 inches), dark reddish brown (5YR 3/4 moist and dry) clay, reddish brown (5YR 4/4) when crushed dry; moderate coarse subangular blocky structure breaking into moderate to strong very fine and fine angular and subangular blocky structure; hard, friable, very sticky and very plastic; many roots; many very fine tubular pores; many pressure cutans; continuous thick pressure cutans; many manganese stains in pores; strong effervescence with hydrogen peroxide; medium acid (pH 5.9).

SOIL FAMILY Torroxic Haplustoll, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Keahua silty clay SOIL Nos. S58Ha-5-1 LOCATION Maui County, Hawaii

Beltsville Lab Nos. 59560 - 59566

Depth (cm)	Horizon	Mineralogical Analysis: 7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	Ap1																	
18-30	Ap2	1X		1X	40	-							-					
30-43	B21	1X		1X	40	-							-					
43-80	B22	1X		1X	40	-							-					
80-133	B23	1X		1X	35	-							-					
133-160	B24	1X		1X	35	-							-					
160-180	B25	1X		1X	30	-							-					

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	Ap1	30.52	4.94	27.76	25.70	0.40						11.48	100.8	11.9	11.9			
18-30	Ap2	29.66	5.28	28.64	26.32	0.16						10.78	100.8	13.0	18.6			
30-43	B21	30.76	4.78	28.40	24.34	0.36						11.70	100.3	12.7	18.2			
43-80	B22	29.96	5.44	27.84	27.20	0.28						10.19	100.9	13.5	19.3			
80-133	B23	29.68	5.52	27.92	26.96	0.24						10.43	100.8	13.8	19.7			
133-160	B24	28.92	5.76	28.88	25.92	0.12						11.48	101.1	13.9	19.9			
160-180	B25	29.68	5.76	30.56	24.80	0.08						11.96	102.8	12.2	17.4			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2d Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-18	0.93	0.144	6	4.6	3.2	0.5	2.1	10.4	11.3		21.7				48	6.3	6.0
18-30	0.60	0.111	5	5.1	3.3	0.4	0.8	9.6	9.2		18.8				51	6.6	6.3
30-43	0.74	0.135	5	4.7	3.0	0.4	1.1	9.2	11.1		20.2				45	6.1	5.7
43-80	0.31	0.079	4	4.8	5.5	0.4	0.8	11.5	7.4		18.8				61	6.9	6.9
80-133	0.24	0.075		4.5	4.9	0.7	1.3	11.4	8.4		19.8				58	7.0	6.9
133-160	0.18	0.063		4.4	4.4	1.1	1.5	11.4	9.6		21.0				54	6.9	6.6
160-180	0.24	0.048		3.3	3.8	2.0	1.9	11.0	10.7		21.7				51	6.8	6.5

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm, pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	4A3a Field moist	Particle density	Water content: 4B4 Field moist	4B1c 1/3 bar	4B2a 15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-18	21.2	47.9	30.9									4	25.4	19.9		
18-30	25.4	42.2	32.4							1.04		19	24.8	20.4		
30-43	18.3	45.3	36.4									21	24.3	20.4		
43-80	29.9	33.3	36.8							0.95		19	25.4	20.5		
80-133	35.4	32.6	32.0									23	28.4	23.5		
133-160	38.9	28.0	33.1									25	31.3	25.0		
160-180	45.9	24.3	29.8									27	32.3	26.6		

a/ 4.9 kg of organic carbon per square meter to a depth of 1 meter.

KEAHUA SILTY CLAY
S58Ha-5-1

Location: Island of Molokai, Maui County, Hawaii; 2.5 km (1.6 miles) west of Hoolehua Post Office on Highway 480 (Farrington Avenue), then turn north .81 km (0.5 mile) on field road, then turn west .2 km (0.15 mile) along dirt field road adjacent to pineapple field, then turn north .81 km (0.5 mile) along field road. Sample site is 15 m (50 feet) west of road. Date of sampling: 1958.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren and J. M. Williams.
Classification: Torroxic Haplustoll, fine, kaolinitic, isohyperthermic.
Vegetation: Cleared, used for growing pineapple. Natal redtop along roadside. Climate: The average annual precipitation is about 38 to 63 cm (15-25 inches). The mean annual temperature is 22.8° C (73° F), the mean January temperature 21.7° C (71° F), and the mean July temperature 25° C (77° F). Parent material: Weathered from basic igneous rock. Topography: Gently sloping low slopes of Maunaloa. Site is on 6 percent slope to west. Elevation: 127 m (425 feet). Drainage: Well drained; moderately rapid permeability; slow runoff. Soil moisture: Dry.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted. Paired sample number S58Ha-5-2.

HORIZON	DESCRIPTION
Ap1 BSL No. 59560	0 to 18 cm (0-7 inches), dusky red (10R 3/3) silty clay, weak red (10R 4/2) dry; weak very fine granular structure; slightly hard, friable, sticky, very plastic; few roots; many very fine and fine interstitial pores; violent effervescence with hydrogen peroxide; common very fine black manganese shot; abrupt wavy boundary.
Ap2 BSL No. 59561	18 to 30 cm (7-12 inches), dusky red (10R 3/3) silty clay; weak very fine granular structure; slightly hard, friable, sticky, very plastic; common fine decomposing roots; many very fine and fine interstitial pores; common very fine black manganese shot; violent effervescence with hydrogen peroxide; clear wavy boundary.
B21 BSL No. 59562	30 to 43 cm (12-17 inches), dusky red (10R 3/4) silty clay, weak red (10R 4/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, sticky, very plastic; common fine decaying roots; many very fine and fine tubular pores; common black very fine manganese shot; violent effervescence with hydrogen peroxide; few fine black manganese coating on ped surfaces; few patchy gelatinous glaze on ped surfaces that appear like clay flows; clear wavy boundary.
B22 BSL No. 59563	43 to 80 cm (17-32 inches), dusky red (10R 3/4) silty clay; weak fine and medium subangular blocky structure; slightly hard, friable, sticky, very plastic; few roots; many very fine and fine tubular pores; few fine black manganese shot; violent effervescence with hydrogen peroxide; few fine manganese coatings on ped surfaces; common thick patchy gelatinous glaze on ped surfaces; compact in place; gradual wavy boundary.
B23 BSL No. 59564	80 to 133 cm (32-53 inches), dusky red (10R 3/4) silty clay; moderate very fine and fine subangular blocky structure; hard, friable, sticky, very plastic; no roots; many very fine, fine and medium tubular pores; common black manganese coating on ped surfaces; thin continuous glaze like coating on ped surfaces; compact in place; gradual wavy boundary.
B24 BSL No. 59565	133 to 160 cm (53-64 inches), dusky red (10R 3/4) silty clay loam; moderate very fine and fine subangular blocky structure with many pockets of strong very fine subangular blocky structure; hard, friable, sticky, very plastic; no roots; many fine and medium tubular pores; common black manganese coatings on ped surfaces; effervescence with hydrogen peroxide is slight on matrix, violent on manganese coatings; continuous glaze like coating on ped surfaces; very compact in place; gradual wavy boundary.
B25 BSL No. 59566	160 to 180 cm (64-72 inches), dark reddish brown (2.5YR 3/4) clay loam; strong very fine subangular blocky structure; slightly hard, friable, sticky, plastic; no roots; many very fine and common fine tubular pores; continuous glaze like coatings on ped surfaces; many very fine earthy lumps that resist breaking down; no effervescence with hydrogen peroxide; few pockets of gray very highly weathered rock fragments; compact in place.

SOIL FAMILY Torroxic Haplustoll, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Keahua silty clay SOIL Nos. S58Ha-5-2 LOCATION Maui County, Hawaii

Beltsville Lab Nos. 59567 - 59573

Depth (cm)	Horizon	Mineralogical Analysis															
		7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-13	Ap1																	
13-30	Ap2	1X		-	45	-							-					
30-50	B21																	
50-88	B22																	
88-123	B23	1X		-	40	-							-					
123-170	B24																	
170-200	B25	1X		-	55	10							-					

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-13	Ap1													11.6	16.6			
13-30	Ap2													12.2	17.4			
30-50	B21													12.5	17.9			
50-88	B22													13.2	18.9			
88-123	B23													16.4	23.5			
123-170	B24													15.7	22.5			
170-200	B25													11.2	16.0			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A4 by K Sat. pH7	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-13	1.28	0.156	8	6.7	4.5	0.5	2.0	13.7	9.2	22.3	22.9				60	6.8	6.3
13-30	1.04	0.165	6	6.6	4.0	0.5	1.5	12.6	9.9		22.4				56	6.6	6.2
30-50	0.55	0.105	5	5.2	4.5	0.5	1.2	11.4	9.3		20.7				55	6.8	6.5
50-88	0.44	0.095	5	5.4	3.7	0.7	1.0	10.8	8.0	15.8	18.8				57	6.9	6.5
88-123	0.26	0.080	3	4.5	8.7	1.0	0.8	15.0	8.6		23.5				63	7.0	6.5
123-170	0.08	0.058		4.6	4.0	2.1	1.2	11.9	10.8		22.7				52	7.1	6.6

KEAHUA SILTY CLAY
S58Ha-5-2

Location: Island of Molokai, Maui County, Hawaii; 5.1 km (3.2 miles) west of Hoolehua Post Office on Highway 400 (Farrington Avenue), then south about 120 m (135 yards) with sample pit about 9 m (30 feet) west of field road in pineapple field. Date of sampling: 1958.

Description by: R. C. Malmgren. Collectors: R. C. Malmgren and J. M. Williams.

Classification: **Torroxic Haplustoll, fine, kaolinitic, isohyperthermic.**

Vegetation: Cultivated, used for growing pineapple. Climate: Average annual precipitation

(37° F). Parent material: Weathered from [illegible]

SOIL FAMILY Torroxic Haplustoll, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Keahua silty clay loam SOIL Nos. S63Ha-4-3 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 18785 - 18791

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-13	Ap1																	
13-25	Ap2																	
25-45	B1																	
45-70	B21																	
70-95	B22																	
95-155	C1																	
155-165	C2																	

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-13	Ap1													8.9	12.7			
13-25	Ap2													9.3	13.3			
25-45	B1													8.8	12.6			
45-70	B21													9.0	12.9			
70-95	B22													9.0	12.9			
95-155	C1													6.3	9.0			
155-165	C2																	

Depth (cm)	6A1g a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	602a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-13	1.30	0.123	10	8.9	2.7	0.2	0.4	12.2		15.2		tr.		80		6.6	5.2
13-25	1.29	0.122	10	9.3	3.0	0.2	0.2	12.7		16.7		tr.		76		6.3	5.1
25-45	1.07	0.112	10	8.4	2.1	0.3	0.1	10.9		15.0		0.1		73		6.5	5.1
45-70	0.69	0.083	8	7.1	1.9	0.2	0.3	9.5		12.2		0.1		78		6.6	5.6
70-95	0.40			6.2	2.1	0.7	0.1	9.1		13.6		0.2		67		7.0	5.8
95-155	0.24			7.2	2.5	2.3	tr.	12.0		16.0		0.1		75		7.3	5.9
155-165																	

Depth (cm)	Size class and particle diameter (mm) 3A1 Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits Plastic limit	Liquid limit	Plastic index	Bulk density 1/3 bar	Oven dry	Field moist	Particle density	Water content Field moist	1/3 bar	15 bar	Extensibility 4D1 COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-13				-						1.14	2.94	30.5		21.3		
13-25				-						1.20	2.95	30.6		21.9		
25-45				-						1.16	2.95	34.2		21.9		
45-70				-						1.25	2.95	33.0		21.8		
70-95				-						1.30	3.11	32.5		24.4		
95-155				-						1.28	3.13	35.3	31.5	27.5		
155-165				-												

a/ 9.8 kg of organic carbon per square meter to a depth of 1 meter.

KEAHUA SILTY CLAY LOAM
S63Ha-4-3

Location: Island of Maui, Maui County, Hawaii; 15 m (50 feet) south and 6 m (20 feet) east of Section G, Field 402, Hawaiian Commercial Company, Puunene, Maui. Date of sampling: May 24, 1963.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren, J. M. Williams, and J. A. DeMent.
Classification: **Torroxic Haplustoll, fine, kaolinitic, isohyperthermic.**
Vegetation: Sugarcane (Saccharum officinarum). Climate: Average annual precipitation is 50 to 88 cm (20-35 inches). Parent material: Basic igneous rock. Topography: Low rolling leeward slopes of central Maui. Slope 4 percent to west. Elevation: 180 m (600 feet). Drainage: Well drained. Permeability is moderate. Surface runoff is medium. Soil moisture: Profile moist when sampled.
Remarks: Textures are apparent field textures. Paired sample number S63Ha-4-4.

HORIZON	DESCRIPTION
Ap1 LSL No. 18785	0 to 13 cm (0-5 inches), dark reddish brown (5YR 3/2) silty clay loam, dark reddish brown (5YR 3/3) dry; weak very fine granular and weak very fine subangular blocky structure with common clods up to 5 cm (2 inches) in diameter; soft, friable, slightly sticky and plastic; many roots; many very fine tubular and interstitial pores; common black iron-manganese concretions; strong effervescence with hydrogen peroxide; common very fine hard earthy lumps which crush with rubbing; slightly acid (pH 6.3); gradual wavy boundary.
Ap2 LSL No. 18786	13 to 25 cm (5-10 inches), dark reddish brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) dry; moderate very fine granular structure with clods up to 5 cm (2 inches) in diameter; soft, friable, slightly sticky, plastic; many roots; many very fine tubular and interstitial pores; common very fine hard earthy lumps which crush with difficulty; common black iron-manganese concretions; strong effervescence with hydrogen peroxide; slightly acid (pH 6.2); clear wavy boundary.
B1 LSL No. 18787	25 to 45 cm (10-18 inches), dark reddish brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) dry; weak medium and fine subangular blocky structure; soft, very friable, slightly sticky and plastic; common roots; many very fine and common fine tubular pores; few black iron-manganese concretions; strong effervescence with hydrogen peroxide; common very fine hard earthy lumps which crush slowly upon rubbing; slightly acid (pH 6.4); gradual wavy boundary.
B21 LSL No. 18788	45 to 70 cm (18-28 inches), dark reddish brown (5YR 3/4 dry and moist) silty clay loam; weak medium breaking to moderate fine and very fine subangular blocky structure; soft, friable, slightly sticky and plastic; firm in place; few roots; many very fine and fine and few medium tubular pores; few black iron-manganese concretions; strong effervescence with hydrogen peroxide; few very fine hard earthy lumps; neutral (pH 6.6); clear wavy boundary.
B22 LSL No. 18789	70 to 95 cm (28-38 inches), dark reddish brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) dry; moderate fine and very fine subangular blocky structure; slightly hard, slightly firm, slightly sticky and plastic; few roots; many very fine and fine tubular pores; nearly continuous pressure cutans; firm in place; neutral (pH 6.6); gradual wavy boundary.
C1 LSL No. 18790	95 to 155 cm (38-62 inches), very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate fine and very fine subangular blocky structure; hard, slightly firm, slightly sticky and slightly plastic; no roots; many hard earthy lumps which crush with difficulty; moderately firm in place; nearly continuous pressure cutans; neutral (pH 6.7); gradual wavy boundary.
C2 LSL No. 18791	155 to 165 cm (62-66 inches), very similar to above horizon but contains an estimated 40 to 60 percent saprolite.
R	165 cm (66 inches), highly weathered basic igneous rock.

SOIL FAMILY **Torroxic Haplustoll, fine, kaolinitic, isohyperthermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Keahua silty clay loam SOIL Nos. S63Ha-4-4 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 18792 - 18799

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-13	Ap1			5	55	1		15	2		15	5						
13-25	Ap2			5	60	1		15			10	5						
25-38	B1			5	60	1		15			10	5						
38-60	B21			5	60	1		15			10	5						
60-83	B22	1		3	60	2		15	2		15	5						
83-130	C1			1	65	1		10	2		20	5						
130-155	C1			1	65	1		5			20	5						
155-175	C2																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-13	Ap1	29.6	5.3	29.1	21.2	0.49	1.20	0.02	0.19	0.37	0.43	12.1	100.0	8.6	12.3		12.99	12.26
13-25	Ap2	29.9	5.3	29.0	21.0	0.51	0.99	0.03	0.17	0.31	0.46	12.3	100.0	9.7	13.9		10.78	10.93
25-38	B1	29.1	5.2	30.0	21.7	0.47	1.19	0.03	0.17	0.30	0.28	11.6	100.0	9.9	14.2		12.00	11.98
38-60	B21	28.8	5.4	30.2	21.7	0.37	1.13	0.02	0.18	0.29	0.43	11.4	99.9	9.7	13.9		11.45	11.61
60-83	B22	28.8	5.5	30.1	22.1	0.34	1.20	0.02	0.16	0.21	0.35	11.3	100.1	8.8	12.6		13.46	13.40
83-130	C1	31.5	6.9	26.2	22.3	0.30	1.14	0.02	0.16	0.05	0.20	11.2	100.0	6.3	9.0		14.87	14.02
130-155	C1	30.6	6.6	27.7	22.0	0.28	1.34	0.01	0.18	0.07	0.24	11.0	100.0	4.7	6.7		17.46	15.76
155-175	C2																	

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-13	1.09	0.138	8	6.2	2.0	0.20	0.50	9.5		15.6		0.1	0.1	61		5.6	4.7
13-25	1.10	0.129	8	6.4	2.7	0.20	0.20	9.5		14.3		0.0	-	66		5.7	4.8
25-38	0.58	0.094	6	5.1	1.8	0.10	0.01	7.0		10.2		0.1		69		6.3	5.4
38-60	0.45	0.080	6	4.2	1.7	0.20	0.01	6.1		8.8		0.2		69		6.4	5.6
60-83	0.28			4.6	2.2	0.50	0.01	7.3		10.2		0.4		72		6.7	5.8
83-130	0.17			5.1	2.8	2.00	0.01	9.9		14.4		0.3		69		6.7	5.5
130-155	0.23			4.3	3.2	2.60	0.01	10.1		13.7		0.3		74		6.3	5.4
155-175																	

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-13				-						1.12	2.95	31.4	26.7	22.2		
13-25				-						1.15	2.95	34.2	25.8	22.1		
25-38				-						1.24	3.02	34.0	27.5	22.3		
38-60				-						1.27	3.03	33.3	28.9	22.1		
60-83				-						1.35	3.06	30.7	28.0	23.6		
83-130				-						1.32	3.13	31.9	29.3	25.1		
130-155				-						1.25		31.0				
155-175				-												

a/ 6.6 kg of organic carbon per square meter to a depth of 1 meter.

KEAHUA SILTY CLAY LOAM
S63Ha-4-4

Location: Island of Maui, Maui County, Hawaii; 1.29 km (.8 mile) from southeast corner of field 402, 15 m (50 feet) west of ditch and 7.5 m (25 feet) north from flume, Hawaiian Commercial and Sugar Company, Puunene, Maui. Date of sampling: May 24, 1963. Description by: R. C. Malmgren. Collectors: R. C. Malmgren, J. M. Williams, A. DeMent.

SOIL FAMILY Torroxic Haplustoll, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Waiakoa silty clay loam SOIL Nos. S65Ha-4-19 LOCATION Maui County, Hawaii

Riverside Lab Nos. 65157 - 65160

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	A1																	
20-40	B21																	
40-60	IIB22																	
60-80	IIC																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	A1													7.2	10.3			
20-40	B21													6.4	9.2			
40-60	IIB22													4.0	5.7			
60-80	IIC													4.0	5.7			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-20	0.83	0.071	12	7.2	4.2	0.3	2.6	14.3		15.5		-		92		6.2	5.2
20-40	0.59	0.060	10	4.9	2.7	0.6	1.9	10.1		12.6		-		80		6.4	5.5
40-60	0.53	0.046	12	3.3	1.8	0.6	1.3	7.0		9.1		-		77		7.0	6.0
60-80	0.43			3.5	1.7	3.1	0.7	9.0		10.8		0.6		83		7.0	6.1

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit Pct.	Liquid limit Pct.	Plastic index Pct.	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-20					23	35	12			1.19	2.93		24.2	17.2		
20-40					25	39	14			1.14	2.97		24.8	17.9		
40-60										1.15	3.09		30.6	20.8		
60-80					32	42	10				3.09		33.2	22.8		

a/ 5.5 kg of organic carbon per square meter to a depth of 1 meter.

WAIAKOA SILTY CLAY LOAM
S65Ha-4-19

Location: Island of Maui, Maui County, Hawaii. Puu O Kali Quadrangle - 20°18'00" north latitude and 156°25'50" west longitude. A pit located 60 m (200 feet) west of sugarcane field number 812 of Hawaiian Commercial and Sugar Company plantation. Date of sampling: April 14, 1965.

Description by: F. G. Stephens and L. D. Giese. Collectors: K. Flach, L. Swindale, L. Giese, F. Stephens and G. Yamamoto.

Classification: **Torroxic Haplustoll, fine, kaolinitic, isohyperthermic.**

Vegetation: Noncultivated with grass, herb, shrub and scattered tree cover. Natural vegetation consists of buffelgrass (Cenchrus ciliaris), feather fingergrass (Chloris virgata), ilima (Sida fallax), kiawe (Prosopis chilensis), Spanish needle (Bidens pilosa), uhaloa (Waltheria indica), and zinnia (Zinnia pauciflora). Climate: Average annual precipitation is 38 cm (15 inches). Mean annual temperature is 24° C (76° F). Parent material: Volcanic ash over basic igneous rock. Topography: Midslope of interfluves with plane slopes; **site has a** 5 percent slope gradient towards the west. Elevation: 102 m (340 feet). Drainage: Well drained; permeability is moderately rapid; runoff is medium. Soil moisture: Dry.

Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Paired sample number is S65Ha-4-20. Colors are for moist soil.

HORIZON	DESCRIPTION
A1 RSL No. 65157	0 to 20 cm (0-8 inches), dark reddish brown (5YR 3/3) silty clay loam; weak coarse prismatic structure; hard, friable with pockets that are very friable, sticky and plastic; many roots; common fine and very fine pores; strongly effervescent with hydrogen peroxide; clear wavy boundary.
B21 RSL No. 65158	20 to 40 cm (8-16 inches), dark reddish brown (5YR 3/3) silty clay loam; weak medium subangular blocky structure; hard, friable with pockets that are very friable, sticky and plastic; many roots; many pores; 3 to 4 percent strongly weathered rock fragments; strongly effervescent with hydrogen peroxide; clear wavy boundary.
IIB22 RSL No. 65159	40 to 60 cm (16-24 inches), dark brown (10YR 3/3) silty clay loam; weak medium and fine subangular blocky structure; hard, friable, sticky and plastic, weakly smeary; many roots; many medium and fine pores with glazed coatings; 20 to 30 percent highly weathered rock fragments; gradual wavy boundary.
IIC RSL No. 65160	60 to 80 cm (24-32 inches), very dark grayish brown (10YR 3/2) silty clay loam; massive; hard, friable, sticky and plastic; few roots; many pores; 5 to 10 percent soil material occurring as pockets in cracks; 85 to 90 percent grayish brown (2.5Y 5/2) highly weathered basic igneous rock; 5 percent hard rock fragments.

SOIL FAMILY Humoxic Tropohumult, clayey, ferritic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Haiku clay SOIL Nos. 862Ha-4-1 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 17304 - 17310

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	Ap1																	
18-35	Ap2																	
35-55	B21t																	
55-78	B22t																	
78-98	B23t																	
98-113	B3																	
113-165	C																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	Ap1													22.0	31.5			
18-35	Ap2													23.2	33.2			
35-55	B21t													31.6	45.2			
55-78	B22t													27.0	38.6			
78-98	B23t													23.7	33.9			
98-113	B3													13.8	19.7			
113-165	C													4.7	6.7			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-18	3.21	0.212	15	-	0.6	0.2	0.2	1.0		14.8		1.1	1.1	7		4.7	3.6
18-35	2.58	0.191	14	-	0.5	0.1	0.2	0.8		14.7		1.4	1.3	5		4.8	3.6
35-55	2.32	0.150	15	-	0.1	0.1	tr.	0.2		16.5		1.6	1.2	1		4.4	3.8
55-78	2.19	0.121	18	-	0.2	0.1	tr.	0.3		17.2		1.3	0.7	2		4.5	4.0
78-98	2.15	0.102	21	-	-	0.1	tr.	0.1		13.6		2.1	0.8	1		4.5	4.0
98-113	0.83			-	-	0.4	0.2	0.6		8.7		2.6	0.6	7		4.6	4.0
113-165	0.44			-	0.1	0.2	0.2	0.5		4.7		2.4	0.2	11		4.8	4.3

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	
0-18				-						1.26	3.41	31.6	21.3		
18-35				-						1.40	3.46	28.9	20.9		
35-55				-						1.33	3.55	36.3	32.0		
55-78				-						1.25	3.56	36.4	32.5		
78-98				tr.						1.17	3.36	50.1	40.6		
98-113				-						1.11	3.13	46.5	32.9		
113-165				-						1.04	2.97				

a/ 31.1 kg of organic carbon per square meter to a depth of 1 meter.

HAIKU CLAY
S62Ha-4-1

Location: Island of Maui, Maui County, Hawaii; Haiku Quadrangle - 20°54'04" north latitude and 156°17'36" west longitude; 45 m (150 feet) west of Ulumalu Road and 1.5 km (0.9 mi.) south of Ulumalu Village, 45 m (150 feet) west of telephone pole number 81. Date of sampling: 1962.
Description by: Robert C. Malmgren. Collectors: Robert C. Malmgren.
Classification: **Humoxic Tropohumult, clayey, ferritic, isohyperthermic.**
Vegetation: The present vegetation is bermudagrass (Cynodon dactylon), californiagrass (Panicum purpurascens), guava (Psidium guayava), Japanese tea (Cassia leschenaultiana), lantana (Lantana camara), and ricegrass (Paspalum orbiculare). Climate: The average annual precipitation is 150 to 175 cm (60-70 inches). The mean annual temperature is 21° C (70° F), the mean January temperature is 20° C (68° F), and the mean July temperature is 22° C (72° F). Parent material: Basic igneous rocks. Topography: Gently to moderately sloping uplands. Elevation: 306 m (1,020 feet). Drainage: Well drained; runoff is medium; permeability is moderately rapid. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S62Ha-4-2.

HORIZON	DESCRIPTION
Ap1 LSL No. 17304	0 to 18 cm (0-7 inches), dark brown (7.5YR 4/4) clay, light brown (7.5YR 6/4) dry; strong fine and very fine angular blocky structure and some strong medium and fine granular structure; slightly hard, firm, sticky, plastic; many fine roots; many fine pores, few coarse pores; many very fine glistening specks; common sand size aggregates that are resistant to crushing; common wormcasts; high bulk density; very strongly acid (pH 4.7); gradual wavy boundary.
Ap2 LSL No. 17305	18 to 35 cm (7-14 inches), same color, texture, structure and consistence as above; common roots; more firm in place than Ap1 horizon; common fine and medium pores; many very fine glistening specks; common sand size aggregates that are resistant to crushing; common wormcasts; high bulk density; thin massive layer near base; very strongly acid (pH 4.8); abrupt wavy boundary.
B21t LSL No. 17306	35 to 55 cm (14-22 inches), yellowish red (5YR 4/6) clay, (5YR 4/8) dry; weak and moderate fine and very fine angular blocky structure; soft, friable, sticky, plastic; few roots; many fine and medium pores; thin patchy clay films on peds; few sand size aggregates that are resistant to crushing; extremely acid (pH 4.4); gradual wavy boundary.
B22t LSL No. 17307	55 to 78 cm (22-31 inches), dark reddish brown (2.5YR 3/4) clay, (2.5YR 3/4) dry; moderate fine and very fine angular blocky structure; slightly hard, friable, sticky, plastic; few fine roots; many fine pores; thin patchy clay films on peds; common sand size aggregates that are resistant to crushing; few pebble size gibbsite nodules; very strongly acid (pH 4.5); gradual wavy boundary.
B23t LSL No. 17308	78 to 98 cm (31-39 inches), dark red (2.5YR 3/6) moist and dry clay; moderate and strong medium and fine angular and subangular blocky structure; slightly hard, firm, sticky, plastic; few fine roots; many fine and medium pores; thin patchy clay films on peds; many pebble size gibbsite nodules; very strongly acid (pH 4.5); gradual wavy boundary.
B3 LSL No. 17309	98 to 113 cm (39-45 inches), dark red (2.5YR 3/6) and reddish brown (5YR 4/4) silty clay, reddish brown (5YR 4/4) dry; weak medium and fine subangular and angular blocky structure; hard, friable, slightly sticky, slightly plastic; few fine roots; many fine pores; thin patchy clay films on peds; 60 to 80 percent of very dark brown (10YR 2/2) highly weathered basic igneous rock easily cut with knife; very strongly acid (pH 4.6); gradual wavy boundary.
C LSL No. 17310	113 to 165 cm (45-66 inches), very dark brown (10YR 2/2) and dark brown (10YR 3/3) highly weathered basalt dark red continuous thick coatings that look like oxide coatings on rock surfaces; very little soil material in the voids; very strongly acid (pH 4.8).

SOIL FAMILY Humoxic Tropohumult, clayey, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Lolekaa silty clay SOIL Nos. S63Ha-7-3 LOCATION Honolulu County, Hawaii

Lincoln Lab Nos. 18759 - 18765

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-23	Ap																	
23-33	B1																	
33-48	B21																	
48-83	B22																	
83-110	B23																	
110-138	B31																	
138-173	B32																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-23	Ap													16.5	23.6			
23-33	B1													15.9	22.7			
33-48	B21													15.7	22.5			
48-83	B22													13.2	18.9			
83-110	B23													11.2	16.0			
110-138	B31													10.9	15.6			
138-173	B32													11.8	16.9			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-23	3.84	0.321	12	2.5	2.4	0.1	0.6	5.6		18.7		1.0	0.7	30		4.7	4.2
23-33	1.86	0.135	14	1.5	1.5	0.2	0.3	3.5		17.5		3.0	1.4	20		4.9	4.0
33-48	1.21	0.096	13	1.3	1.4	0.4	0.3	3.4		17.3		4.1	3.1	20		4.8	3.9
48-83	0.84	0.062	14	0.9	1.1	0.6	0.1	2.7		17.9		4.8	5.8	15		4.7	3.8
83-110	0.58	0.046	13	0.7	1.0	0.6	0.1	2.4		18.3		5.4	8.3	13		4.6	3.7
110-138	0.54	0.043	12	0.8	1.1	0.7	0.2	2.8		16.9		6.2	7.0	16		4.6	3.7
138-173	0.44			0.6	0.9	0.6	0.2	2.3		16.8		6.6	7.6	14		4.6	3.7

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-23				-						0.99	3.02	56.3	43.7	34.2		
23-33				-						1.00	3.06	52.7		41.2		
33-48				-						1.00	3.10	53.1		41.9		
48-83				-						1.08	3.07	47.7	43.0	38.5		
83-110				-						1.10	2.98	47.7		40.2		
110-138				-						1.07	2.98	49.2	43.2	37.0		
138-173				tr.						1.09	3.06	48.0	42.4	34.6		

a/ 16.7 kg of organic carbon per square meter to a depth of 1 meter.

LOLEKAA SILTY CLAY
S63Ha-7-3

Location: Island of Oahu, Honolulu County, Hawaii. Hygienic Dairy. North of Kaneohe on Federal Highway Number 83 to Haiku Valley Road. Proceed west .97 km (0.6 mile), then turn north on the road to the city and county garbage dump. The pit location is about 45 m (150 feet) northwest of the entrance gate to the pasture at the west end of the dump. Date of sampling: May 24, 1963.
Description by: Ernest Robello. Collectors: J. DeMent, J. M. Williams, and E. Robello.
Classification: **Humoxic Tropohumult, clayey, kaolinitic[1/], isohyperthermic.**
Vegetation: Improved pasture (nonirrigated). Climate: The mean annual temperature is 21.7° C (71° F). The average annual precipitation is 170 cm (68 inches). Parent material: Poorly sorted alluvium weathered from basic igneous rock. Topography: Nearly level upland terrace or fan, 2 percent slope, slightly convex. Elevation: 48 m (160 feet). Drainage: Well drained. Moderate permeability. Slow runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. This pasture area is used in a rotated grazing system. No stoniness was observed in the surface; however, highly weathered gravel occurs in strata at varying depths below about 75 cm (30 inches). Colors are for moist soil. Paired sample number S63Ha-7-4.

HORIZON	DESCRIPTION
Ap LSL No. 18759	0 to 23 cm (0-9 inches), dark grayish brown (10YR 4/2) silty clay; strong medium granular and very fine and fine subangular blocky structure; firm, sticky and plastic; many fine and medium roots; many fine and very fine interstitial and tubular pores; evidence of much worm activity; many hard earthy lumps; abrupt smooth boundary.
B1 LSL No. 18760	23 to 33 cm (9-13 inches), brown (10YR 4/3) silty clay; moderate very fine, fine and medium subangular blocky structure; friable, sticky and plastic; common fine roots; many very fine and fine and few medium tubular pores; evidence of much ant and worm activity; many hard earthy lumps; thin continuous clay films on ped surfaces; trace of reddish brown (5YR 4/4) weathered rock fragments; clear smooth boundary.
B21 LSL No. 18761	33 to 48 cm (13-19 inches), dark brown (7.5YR 4/4) silty clay; moderate very fine and medium subangular and blocky structure; friable, sticky and plastic; common fine roots; many very fine and fine and few medium tubular pores; compact in place; many hard earthy lumps; reddish brown (5YR 4/4) thin continuous clay films on ped surfaces and in pores; dark brown (7.5YR 4/4) clay films in root channels; clear smooth boundary.
B22 LSL No. 18762	48 to 83 cm (19-33 inches), dark brown (10YR 3/3) silty clay; strong very fine and fine blocky and subangular blocky structure; friable, sticky and plastic; few fine roots; many very fine and fine and few medium tubular pores; compact in place; reddish brown (5YR 4/4) thick continuous clay films on ped surfaces and in pores; dark brown (7.5YR 4/4) thick clay films in root channels; trace of weathered gray, yellow and red rock fragments; clear irregular boundary.
B23 LSL No. 18763	83 to 110 cm (33-44 inches), brown (10YR 4/3) silty clay; moderate to strong very fine and fine blocky and subangular blocky structure; friable, sticky and plastic; common fine roots; many very fine and fine and common medium tubular pores; compact in place; reddish brown (5YR 4/4) thin continuous clay films on ped surfaces and in pores; dark brown (7.5YR 4/4) thick clay films in root channels; 5 percent weathered rock fragments which appear less weathered than above; common krotovinas; clear smooth boundary.
B31 LSL No. 18764	110 to 138 cm (44-55 inches), brown (10YR 4/3) loam; weak very fine and fine subangular blocky structure; friable, sticky and plastic; few fine roots; many very fine and fine and common medium tubular pores; compact in place; 15 to 20 percent of weathered rocks which appear less weathered than above; gradual wavy boundary.
B32	138 to 173 cm (55-69 inches), brown (10YR 4/3) loam; weak fine subangular

SOIL FAMILY Humoxic Tropohumult, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Pauwela clay SOIL Nos. S62Ha-4-3 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 17329 - 17336

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	Ap1																	
15-30	Ap2																	
30-43	B21t																	
43-63	B22t																	
60-63	B22t																	
63-83	B23t																	
83-105	C1																	
105-135	C2																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-15	Ap1													12.9	18.4			
15-30	Ap2													12.9	18.4			
30-43	B21t													23.5	33.6			
43-63	B22t													26.2	37.5			
60-63	B22t													25.5	36.5			
63-83	B23t													23.0	32.9			
83-105	C1													14.0	20.0			
105-135	C2													7.5	10.7			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-15	2.72	0.226	12	0.2	0.7	0.1	0.3	1.3		15.0		0.8	1.4	9		4.8	3.7
15-30	2.35	0.195	12	-	0.2	0.1	0.1	0.4		13.0		1.5	2.4	3		4.4	3.7
30-43	1.98	0.161	12	-	0.3	0.1	0.1	0.5		15.4		2.5	2.5	3		4.2	3.6
43-63	1.84	0.144	13	0.3	0.6	0.1	0.1	1.1		15.4		1.6	0.5	7		4.7	4.0
60-63	2.43	0.230	10	0.5	1.2	0.2	0.1	2.0		19.2		1.3	0.7	10		4.8	3.9
63-83	1.81	0.104	17	0.6	0.8	0.4	0.1	1.9		14.6		2.6	0.5	13		4.8	4.0
83-105	1.41	0.090	16	0.4	0.3	0.8	0.1	1.6		13.3		5.4	0.3	12		4.8	4.0
105-135	0.90	0.052	17	0.5	0.2	0.9	0.1	1.7		12.0		6.1	0.3	14		4.9	4.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-15				tr.						1.07	3.09		36.0	24.9		
15-30				-						1.17	3.15		32.4	23.3		
30-43				-						1.10	3.17		40.7	35.3		
43-63				-						1.14	3.27		45.5	39.5		
60-63				-						1.02						
63-83				-						1.14	3.23		47.5	40.2		
83-105				tr.						1.16	3.15		50.2	36.7		
105-135				tr.							3.06		31.3	23.4		

a/ 22.5 kg of organic carbon per square meter to a depth of 1 meter.

PAUWELA CLAY
S62Ha-4-3

Location: Island of Maui, Maui County, Hawaii. Approximately 38.7 km (24.1 miles) east of the Federal Building in Wailuku on Highway 36. Turn north for 150 m (500 feet); site is 30 m (100 feet) east of this roadway. Date of sampling: 1962.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren.
Classification: Humoxic Tropohumult, clayey, oxidic, isohyperthermic.
Vegetation: Ricegrass (Paspalum orbiculare), californiagrass (Panicum purpurascens), guava (Psidium guayava), Japanese tea (Cassia leschenaultiana). Climate: Average annual precipitation is 150 to 200 cm (70-80 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 20.0° C (68° F), and the mean July temperature 22.2° C (72° F). Parent material: Basic igneous rock with possibly some influence of volcanic ash. Topography: Low rolling windward (north) slopes of Haleakala. Elevation: 165 m (550 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S62Ha-4-4. Colors are for moist soil unless indicated.

HORIZON	DESCRIPTION
Ap1 LSL No. 17329	0 to 15 cm (0-6 inches), dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; moderate fine subangular blocky structure; hard, firm, sticky, plastic; many fine roots; many fine pores; common sand-size particles that are resistant to crushing; many very fine glistening specks; high bulk density; few yellowish red (5YR 4/6) particles from upper part of the B horizon; slight effervescence with hydrogen peroxide; very strongly acid (pH 4.8); clear wavy boundary.
Ap2 LSL No. 17330	15 to 30 cm (6-12 inches), same as above, except few small pockets of very dark brown (10YR 2/2) and black (10YR 2/1) massive heavy mineral concentration; extremely acid (pH 4.4); abrupt wavy boundary.
B21t LSL No. 17331	30 to 43 cm (12-17 inches), dark reddish brown (5YR 3/3) clay, reddish brown (5YR 4/4) dry; moderate very fine and fine subangular blocky structure; slightly hard, friable, sticky, plastic; few fine roots; many very fine and fine tubular pores; many sand-size particles that are resistant to crushing; moderately thick patchy clay films; slight effervescence with hydrogen peroxide; extremely acid (pH 4.2); gradual wavy boundary.
B22t LSL No. 17332	43 to 63 cm (17-25 inches), dark reddish brown (5YR 3/4) clay, reddish brown (5YR 4/4) dry; strong fine and very fine angular blocky structure with some initial indication of weak, thin, platy structure; slightly hard, slightly firm, sticky and plastic; few roots; common very fine and fine and few medium tubular pores; nearly continuous illuviation cutans; after prolonged drying, a 2.5YR 2/4 color is obtained; common 5YR 4/6 and 7.5YR 4/6 very fine "crumbs" on some ped faces; common hard earthy lumps; more firm in place than above horizon; contains occasional sheets (5-30 mm thick) one of which is described as the next horizon; clear wavy boundary.
B22t* LSL No. 17333	60 to 63 cm (24-25 inches), yellowish red (5YR 4/6) with some tendency toward a dark brown (7.5YR 4/4) silty clay; weak fine and very fine subangular blocky structure; soft, friable, slightly sticky, slightly plastic; few roots with a tendency for them to concentrate on the more massive upper surface of the sheet; many very fine and fine tubular pores; abrupt smooth boundary.
B23t LSL No. 17334	63 to 83 cm (25-33 inches), dark reddish brown (5YR 3/4) clay, reddish brown (5YR 4/4) dry; strong very fine and fine angular blocky structure; hard, firm, sticky, plastic; few fine roots; common very fine and fine tubular pores; nearly continuous moderately thick clay films; common very fine yellowish red (5YR 4/6) and brown (7.5YR 4/4) crumbs on some peds; common sand-size particles that are resistant to crushing; few fine very dark

SOIL FAMILY Humoxic Tropohumult, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Pauwela clay SOIL Nos. S62Ha-4-4 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 17337 - 17343

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	Ap1			15	5	15		25			20	10	5					
18-30	Ap2			15	5	15		25			25	10	5					
30-43	B21t			15	5	15		40			10	10						
43-60	B22t			10	3	15		50				5						
60-75	B23t			10	5	20		45			10	5						
75-103	B3t			5	15	20		25			20	5						
103-138	C1			1	15	30		20			20	5	3					

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	Ap1	16.1	10.0	19.1	37.2	0.18	1.59	-	0.08	1.04	0.30	15.5	101.1	15.3	21.9		0.51	7.00
18-30	Ap2	16.0	10.7	15.7	39.6	0.16	1.64	-	0.07	1.16	0.30	15.3	100.6	15.4	22.0		0.61	6.39
30-43	B21t	9.0	6.7	19.2	42.9	0.06	0.78	-	0.06	1.06	0.38	20.3	100.4	24.6	35.2		0.46	6.15
43-60	B22t	7.8	6.5	25.1	39.4	0.05	0.67	-	0.02	0.87	0.33	19.5	100.2	30.9	44.2		0.63	5.65
60-75	B23t	7.5	6.4	20.2	44.8	0.06	0.70	-	0.05	0.64	0.37	19.1	99.8	27.1	38.7		1.29	7.32
75-103	B3t	9.5	6.3	24.9	39.7	0.13	0.97	-	0.05	0.36	0.25	18.1	100.3	16.7	23.9		1.29	12.09
103-138	C1	12.2	5.4	32.1	30.3	0.14	1.42	-	0.03	0.09	0.26	18.6	100.5	12.9	18.4		2.23	20.37

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-18	2.88	0.23	13	-	0.6	0.1	0.2	0.9		14.5		0.9	1.3	6		5.0	3.8
18-30	2.86	0.20	14	-	0.2	0.1	0.2	0.5		13.3		1.0	1.3	4		4.8	3.8
30-43	2.58	0.15	17	-	-	0.1	0.1	0.2		13.6		2.0	1.5	1		4.5	4.0
43-60	1.66	0.11	15	-	0.1	0.1	0.1	0.3		12.8		2.6	0.3	2		4.6	4.2
60-75	1.68	0.11	15	-	0.3	0.1	0.1	0.5		11.9		3.7	0.3	4		4.6	4.2
75-103	0.82			0.3	0.1	0.5	0.3	1.2		8.0		5.9	0.6	15		4.6	4.0
103-138	0.61			0.2	0.1	0.4	0.5	1.2		5.9		6.1	0.5	20		4.7	4.0

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-18				tr.						1.14	3.22		30.5	23.1		
18-30				tr.						1.14	3.27		31.8	24.0		
30-43				tr.						1.05	3.19		43.9	33.5		
43-60				tr.						1.10	3.33		41.2	35.4		
60-75				tr.						1.23	3.31		40.3	35.8		
75-103				tr.						1.20	3.23		36.6	31.2		
103-138				tr.						1.18	2.94		29.7	21.5		

a/ 22.0 kg of organic carbon per square meter to a depth of 1 meter.

PAUWELA CLAY
S62Ha-4-4

Location: Island of Maui, Maui County, Hawaii. Approximately 37 km (23.0 miles) east of the Federal Building in Wailuku on Highway Hawaii 36. Turn south for .8 km (0.5 mile). Pit site is about 150 m (500 feet) north of K. Honda residence (about 45 m (150 feet) south of large eucalyptus tree). Date of sampling: 1962.
Description by: R. C. Malmgren. Collectors: R. C. Malmgren.
Classification: **Humoxic Tropohumult, clayey, oxidic, isohyperthermic.**
Vegetation: Ricegrass (Paspalum orbiculare), californiagrass (Panicum purpurascens), guava (Psidium guayava), Japanese tea (Cassia leschenaultiana). Climate: Average annual precipitation is 175 to 200 cm (70-80 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 20.0° C (68° F), and the mean July temperature 22.2° C (72° F). Parent material: Basic igneous rock with possibly some influence of volcanic ash. Topography: Low rolling windward (northwest) slopes of Haleakala. Elevation: 192 m (640 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S62Ha-4-3. Colors are for moist soil.

HORIZON	DESCRIPTION
Ap1 LSL No. 17337	0 to 18 cm (0-7 inches), dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; strong fine and very fine subangular and angular blocky with some strong fine and very fine granular structure; hard, slightly firm, sticky and plastic; many roots; common very fine and fine tubular and many interstitial pores; common very fine glistening specks; common fine hard earthy lumps; common wormcasts; moderately high bulk density; few fine distinct mottles of 5YR 4/6 due to mixing by tillage; clear wavy boundary.
Ap2 LSL No. 17338	18 to 30 cm (7-12 inches), same color as above; clay; moderate fine and very fine subangular blocky structure; slightly hard, friable, sticky and plastic; many roots; common very fine and fine and few medium and coarse tubular pores; common very fine glistening specks; moderately high bulk density; common wormcasts; occasional areas without structure (massive) apparently due to accumulation of heavy minerals just above the B2 horizon; common medium distinct mottles of 5YR 4/6 due to mixing by tillage; abrupt wavy boundary.
B21t LSL No. 17339	30 to 43 cm (12-17 inches), yellowish red (5YR 4/6) clay, yellowish red (5YR 5/6) dry; weak medium and fine subangular blocky structure; soft, friable, sticky and plastic; common roots; many very fine and fine and few medium tubular pores; common patchy glaze on ped faces; few fine hard earthy lumps; normal bulk density; gradual wavy boundary.
B22t LSL No. 17340	43 to 60 cm (17-24 inches), same color as above; clay; strong fine and very fine angular blocky structure; slightly hard, slightly firm, sticky and plastic; common roots; many very fine and fine and few medium tubular pores; nearly continuous illuviation cutans; common very fine "crumbs" of 5YR 4/6 and 7.5YR 4/6 color on some ped faces as observed under hand lens; moderately firm in place; after prolonged drying, a redder color of 2.5YR 2/4 is obtained; contains occasional sheets varying from 2-10 mm in thickness; these sheets are comprised of 5YR 4/6 soil material tending toward a 7.5YR 4/4 color immediately adjacent to the contact; both the top and bottom of these sheets exhibit somewhat of a massive appearance; they have shown a temporary restriction in downward water movement immediately following heavy rains; gradual wavy boundary.
B23t LSL No. 17341	60 to 75 cm (24-30 inches), dark reddish brown (5YR 3/4) clay; moderate and strong fine and very fine angular blocky structure; slightly hard, slightly firm, sticky and plastic; few roots; common very fine and fine tubular pores; nearly continuous illuviation cutans; common fine hard earthy lumps; few fine highly weathered pebbles and rock fragments; after prolonged drying, a redder color of 2.5YR 2/4 is obtained; contains occasional sheets as described in above horizon; gradual wavy boundary.
B3t LSL No. 17342	75 to 103 cm (30-41 inches), dark reddish brown (5YR 3/4) clay; moderate and strong fine and very fine angular blocky and subangular blocky structure; slightly hard, friable, sticky and plastic; few roots; common very fine and fine and few medium tubular pores; common highly weathered rock particles, few veins of what appear like gibbsite (1-5 mm thick); gradual wavy boundary.
C1 LSL No. 17343	103 to 138 cm (41-55 inches), dark brown to strong brown (7.5YR 4/4 and 5/6) silty clay; weak fine and very fine subangular blocky structure; soft, friable, slightly sticky, slightly plastic; no roots; many very fine tubular pores; many highly weathered basic igneous pebbles and cobbles (40-70 percent by volume); few veins of gibbsite oriented horizontally and diagonally.

SOIL FAMILY Humoxic Tropohumult, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Haiku clay (taxadjunct) SOIL Nos. S62Ha-4-2 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 17311 - 17317

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	Ap1			15		10		40			15	10	1X					
18-33	Ap2			20	5	10		40			10	10	1X					
33-45	B21			15	10	10		35			15	10						
45-70	B22			10	15	15		40			2	10						
70-98	B23			5	25	20		25			10	5						
98-155	B3			2	20	20		20			10	5						
155-175	C1				5	10		20			10	5	1X					

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	Ap1	16.8	11.6	7.6	46.3	0.15	0.97	-	0.06	1.15	0.55	15.9	101.1	24.8	35.5		0.88	1.04
18-33	Ap2	16.8	11.2	11.1	43.0	0.12	0.77	-	0.07	1.23	0.51	15.5	100.3	23.9	34.2		0.69	1.39
33-45	B21	14.1	7.9	15.2	42.7	0.07	0.66	-	-	0.99	0.57	17.6	99.8	22.0	31.5		2.01	2.66
45-70	B22	11.9	6.5	23.2	36.9	0.09	0.78	-	0.02	0.65	0.52	19.1	99.7	24.9	35.6		2.69	6.96
70-98	B23	18.9	5.2	27.4	28.4	0.12	0.98	-	-	0.31	0.39	18.1	99.8	16.0	22.9		6.99	14.57
98-155	B3	17.3	5.7	30.1	26.4	0.12	1.62	-	-	0.11	0.42	17.6	99.4	13.9	19.9		6.11	16.44
155-175	C1	17.0	5.2	32.9	24.7	0.15	1.54	-	-	-	0.32	18.0	99.8	13.4	19.2		0.89	0.87

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-18	3.08	0.26	12	-	0.6	0.1	0.3	1.0		15.9		1.7	0.5	6		5.1	4.1
18-33	2.79	0.23	12	-	0.6	0.1	0.2	0.9		14.3		1.6	0.5	6		5.0	4.0
33-45	1.97	0.16	12	0.2	0.8	0.2	0.1	1.3		15.5		1.3	0.4	8		4.9	4.1
45-70	1.78	0.13	14	0.6	0.7	0.4	0.1	1.8		12.2		1.4	0.2	15		5.2	4.4
70-98	1.08	0.08	14	1.0	0.8	1.0	0.1	2.9		12.7		2.0	0.8	23		5.1	4.0
98-155	0.91	0.06	15	0.6	0.2	0.8	0.1	1.7		12.0		4.4	1.1	14		5.0	4.0
155-175	0.74	0.04	18	0.4	0.3	0.8	0.1	1.6		12.4		4.1	0.8	13		4.9	4.0

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-18				-						1.10	3.23		34.7	25.5		
18-33				-						1.11	3.31		30.4	24.4		
33-45				-						1.12	3.25		44.2	38.4		
45-70				tr.						1.06	3.16		44.4	39.0		
70-98				tr.						1.09	3.06		40.4	33.2		
98-155				tr.						1.10	2.98		43.2	33.5		
155-175				tr.							2.99		36.2	24.9		

a/ 21.6 kg of organic carbon per square meter to a depth of 1 meter.

HAIKU CLAY (taxadjunct) 1/
S62Ha-4-2

Location: Island of Maui, Maui County, Hawaii. Approximately 32.3 km (20.2 miles) east of the Federal Building in Wailuku, Maui, on Highway Hawaii 36. Turn south for 4.7 km (2.9 miles) through Pauwela Village and enter pasture west of road. Pit site is .48 km (0.3 mile) north of pasture site 75 m (250 feet) west of highway.
Date of sampling: 1962
Description by: Robert Malmgren. Collectors: Robert Malmgren.
Classification: **Humoxic Tropohumult, clayey, oxidic, isohyperthermic.**
Vegetation: Ricegrass (*Paspalum orbiculare*), californiagrass (*Panicum purpurascens*), guava (*Psidium guayava*), Japanese tea (*Cassia leschenaultiana*).
Climate: The mean annual temperature is 21.1° C (70° F). The average annual precipitation is 150 to 175 cm (60-70 inches). Parent material: Basic igneous rock with possibly some influence of volcanic ash. Topography: Low, rolling, windward slopes of Haleakala. Elevation: 285 m (950 feet).
Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number is S62Ha-4-1.

HORIZON	DESCRIPTION
Ap1 LSL No. 17311	0 to 18 cm (0-7 inches), dark brown (7.5YR 4/4) clay, light brown (7.5YR 6/4) dry; strong fine and very fine angular blocky with some strong medium and fine granular structure; hard, slightly firm, sticky and plastic; many roots; common very fine and few coarse tubular and many interstitial pores; many very fine glistening specks; common hard earthy lumps; common worm-casts; moderate high bulk density; this soil crushes to a slightly higher chroma; gradual wavy boundary.
Ap2 LSL No 17312	18 to 33 cm (7-13 inches), dark brown (7.5YR 4/4) clay, light brown (7.5YR 6/4) dry; strong fine and very fine angular blocky with some strong fine and very fine granular structure; slightly hard, slightly firm, sticky and plastic; common roots; many very fine and fine common medium and few coarse tubular pores with many interstitial pores; many very fine glistening specks; common hard earthy lumps; somewhat more firm in place than above horizon; common wormcasts; moderate high bulk density; this soil crushes to a slightly higher chroma; abrupt wavy boundary.
B21 LSL No. 17313	33 to 45 cm (13-18 inches), yellowish red (5YR 4/6) clay, yellowish red (5YR 4/8) dry; weak medium breaking to moderate fine and very fine subangular blocky structure; soft, friable, sticky and plastic; common roots; many very [illegible]
B22 LSL No. 17314	45 to 70 cm (18-28 inches), yellowish red (5YR 4/6) clay, yellowish red (5YR 4/8) dry; strong medium and fine angular blocky and subangular blocky structure; slightly hard, slightly firm, sticky and plastic; few roots; [illegible]

SOIL FAMILY **Hydroxic Tropohumult, clayey, oxidic, isothermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Leilehua silty clay SOIL Nos. S61Ha-7-9 LOCATION Honolulu County, Hawaii

Beltsville Lab Nos. 61507 - 61512

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-30	Ap				14	15												
30-43	B21				7	8												
43-55	B22				7	13												
55-78	B23t				30	18												
78-103	B24t				26	18												
103-120	B25t				30	25												
120-155	C1				25	20												
155-188	C2				34	15												

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1g		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-30	Ap													13.6	19.5			
30-43	B21													13.6	19.4			
43-55	B22													13.7	19.6			
55-78	B23t													18.2	26.0			
78-103	B24t													16.8	24.0			
103-120	B25t													13.7	19.6			
120-155	C1													11.2	16.0			
155-188	C2													12.3	17.6			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-30	3.04	0.261	12	0.4	0.1	0.09	0.15		24.6		25.3				3	4.5	4.1
30-43	2.61	0.245	11	0.1	<0.1	0.08	0.24		23.8		24.2				2	4.4	4.0
43-55	2.90	0.246	12	0.1	<0.1	0.07	0.22		23.8		24.2				2	4.4	4.1
55-78	2.03	0.142	14	0.2	0.2	0.11	0.18		30.2		30.9				2	4.7	4.5
78-103	0.84	0.078	11	<0.1	<0.1	0.08	0.13		21.0		21.2				1	4.6	4.3
103-120	0.79	0.063	12	<0.1	0.1	0.08	0.10		17.1		17.4				2	4.5	4.1
120-155	0.39	0.044	9	0.1	0.1	0.08	0.17		13.3		13.8				3	4.7	4.2
155-188	0.52	0.040	13	0.3	0.1	0.07	0.18		16.0		16.6				4	4.6	4.3

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	

LEILEHUA SILTY CLAY
S61Ha-7-9

Location: Island of Oahu, Honolulu County, Hawaii. Upper north corner of Dole Pineapple field 4221-22. Approximately 4 km (2½ miles) northeast of Pineapple Research Institute Field station.
Date of sampling: 1961.
Described by: D. Womack. Collectors: D. Womack and J. M. Williams.
Classification: Humoxic Tropohumult, clayey, oxidic, isothermic.

Vegetation: Pineapple. Climate: Average annual precipitation is 163 to 188 cm (65-75 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 20.0° C (68° F), and the mean July temperature 23.3° C (74° F). Parent material: Presumed to be alluvium washed from higher pediments. Numerous chunks of gray titanium material that appear to be relic fragments from older landscape. Topography: On west slopes of a geomorphological land surface of the Koolau Range. Approximately middle of long pediment. Appears to be old eroded land surface, 4 to 6 percent to west. Elevation: 294 m (980 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted.

HORIZON	DESCRIPTION
Ap BSL No. 61507	0 to 30 cm (0-12 inches), dark reddish brown (5YR 3/3) silty clay, reddish brown (5YR 4/3) dry; moderate fine, medium and coarse granular structure; very hard, firm, sticky, very plastic; plentiful roots; common very fine and many fine interstitial pores; many very fine glistening specks; common fine particles of gray (5YR 5/1) presumed to be titanium oxide; few chunks and pockets of dusky red (10R 3/4) material mixed by tillage from a lower horizon; decomposing pineapple trash throughout horizon; bottom of horizon has 2.5 cm (1 inch) layer of pineapple trash; extremely acid (pH 4.1); abrupt smooth boundary.
B21 BSL No. 61508	30 to 43 cm (12-17 inches), dark reddish brown (2.5YR 3/4) moist and dry silty clay; weak medium and coarse subangular blocky structure; hard, firm, sticky, plastic; plentiful roots; common very fine and fine tubular pores; few fragments and pockets of dusky red (10R 3/3) material mixed by tillage; many very fine glistening specks; common fine gray (5YR 5/1) when moist material; compacted by tillage; extremely acid (pH 4.0); abrupt smooth boundary.
B22 BSL No. 61509	43 to 55 cm (17-22 inches), same color and texture as above; weak coarse subangular blocky breaking to moderate very fine and fine subangular blocky structure; hard, firm, sticky, plastic; few fine roots; many very fine and fine tubular pores; many very fine glistening specks; common fine fragments of gray (5YR 5/1) material; numerous very firm earthy lumps; extremely acid (pH 4.1); abrupt smooth boundary.
B23t BSL No. 61510	55 to 78 cm (22-31 inches), dusky red (10R 3/3) silty clay, dusky red (10R 3/4) dry; weak coarse and medium moderate subangular blocky structure with few pockets of moderate very fine subangular blocky structure; hard, friable, sticky, very plastic; very few roots; many very fine and fine and common medium tubular pores; thin patchy clay films and weak pressure cutans on peds; extremely acid (pH 4.5); clear smooth boundary.
B24t BSL No. 61511	78 to 103 cm (31-41 inches), dark reddish brown (2.5YR 3/4, 3/3 crushed) clay, reddish brown (2.5YR 4/4) dry; weak coarse subangular blocky breaking to moderate very fine and fine subangular blocky structure; hard, firm, sticky, very plastic; many very fine and fine tubular pores; nearly continuous pressure cutans on ped faces; many thin patchy clay

SOIL FAMILY Humoxic Tropohumult, clayey, oxidic, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Paaloa silty clay SOIL Nos. S58Ha-7-1 LOCATION Honolulu County, Hawaii

Beltsville Lab Nos. 59574 - 59578

Depth (cm)	Horizon	Mineralogical Analysis (Percent of Whole Soil)															
		7A2 Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
0-23	Ap	-		1X	15	15							1X					
23-53	B21	-		1X	25	15							1X					
53-95	B22	-		-	35	10							-					
95-155	B3	-		-	45	10							-					
155-165	C																	

Depth (cm)	Horizon	Total Chemical Analysis (Percent of Whole Soil)												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
0-23	Ap	24.26	11.44	17.92	37.84	0.09						14.22	105.8	17.8	25.5			
23-53	B21	13.62	5.84	26.32	42.24	0.08						16.90	105.0	21.2	30.3			
53-95	B22	19.76	6.48	31.28	31.04	0.09						14.86	103.5	12.8	18.3			
95-155	B3	17.24	6.56	31.52	31.92	0.09						15.33	102.7	15.3	21.9			
155-165	C	20.84	7.23	27.92	33.97	0.04						12.70	102.7	11.2	16.0			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a (Meq./100 g.) 6N2d Ca	602b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	CEC 5A3a Sum of Cation	5A4 by K Sat. pH7	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation (Percent) 5C1 NH_4OAc	5C3 Sum	pH 8C1a H_2O 1:1	8C1c KCl 1:1
0-23	3.19	0.261	12	0.8	0.3	0.2	0.2	1.5	27.8	29.2	24.2				5	4.8	4.5
23-53	1.26	0.090	14	0.4	0.1	0.2	0.1	0.8	27.5	28.2					2	4.8	4.6
53-95	0.42	0.048	9	0.6	0.1	0.1	Tr.	0.8	14.9	15.8	13.6				6	5.0	4.6
95-155	0.46	0.038	12	1.4	0.1	0.1	Tr.	1.6	15.7	17.3					10	5.1	4.7
155-165	0.54	0.034	16	1.0	0.1	0.1	Tr.	1.2	24.3	25.5	17.0				5	5.2	5.3

PAALOA SILTY CLAY
S58Ha-7-1

Location: Island of Oahu, Honolulu County, Hawaii; .81 km (1/2 mile) northwest of Wahiawa, turn northeast from Highway 80 on to Highway 804 leading to Wahiawa Naval Radio Station. Sample pit is located in Naval Reservation about 1.2 km (3/4 mile) east of main gate, 60 m (200 feet) south on road to Poamoho Tunnel. Date of sampling: 1958.
Description by: D. Womack. Collectors: D. Womack and J. M. Williams.
Classification: **Humoxic Tropohumult, clayey, oxidic, isothermic.**
Vegetation: Broomsedge (Andropogon virginicus), hilograss (Paspalum conjugatum), ricegrass (Paspalum orbiculare), Glenwoodgrass (Sacciolepis contracta). Along edges of drainageways on both sides of upland is cover of koa (Acacia koa), Molucca albizzia (Albizia falcata), and staghorn fern (Gleichenia linearis). Climate: Average annual precipitation is **about 175 to 250 cm (70-100 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 19.4°C(67° F), the mean July temperature** 22.8° C (73° F). Parent material: Weathered olivine basalt. Topography: Nearly level, narrow medial upland slopes of Koolau Range. Slope 2 percent convex to southwest. Elevation: 354 m (1,180 feet). Drainage: Well drained; moderately rapid permeability; slow runoff. Soil moisture: *Moist.*
Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S58Ha-7-2.

HORIZON	DESCRIPTION
Ap BSL No. 59574	0 to 23 cm (0-9 inches), dark reddish brown (5YR 3/2) silty clay; strong medium granular structure; firm, sticky, plastic; many roots; many fine and very fine interstitial pores; common wormholes and casts; few small highly weathered pebbles; few small pieces of charcoal; very slight reaction with hydrogen peroxide; abrupt wavy boundary.
B21 BSL No. 59575	23 to 53 cm (9-21 inches), dusky red (10R 3/3) silty clay; strong very fine subangular blocky structure; firm, sticky, very plastic; many roots; many fine and very fine tubular pores; continuous thin glaze on all peds (possibly oxide coating); no reaction with hydrogen peroxide; abrupt wavy boundary.
B22 BSL No. 59576	53 to 95 cm (21-38 inches), dark red (2.5YR 3/6) silty clay; strong very fine subangular blocky structure; firm, sticky, very plastic; few roots, mostly following cleavage planes; root mat on top of this horizon; many fine and very fine tubular pores; this horizon is firm in place; dusky red (10R 3/3) glaze on most peds and in pores, some of which look like clay film; many small fragments of highly weathered rock; no reaction with hydrogen peroxide; gradual wavy boundary.
B3 BSL No. 59577	95 to 155 cm (38-62 inches), reddish brown (5YR 4/4) silty clay; moderate fine subangular blocky structure; friable, sticky, very plastic; very few roots; many fine and very fine tubular pores; dark red and dusky red glaze on most peds and in pores, some look like clay film and some appear to be oxide coatings; many small highly weathered rock fragments; no reaction with hydrogen peroxide; clear wavy boundary.
C BSL No. 59578	155 to 165 cm (62-66 inches), yellowish brown and brown highly weathered rock. This appears to be highly weathered material around a solid boulder core; abrupt boundary.
R Not sampled	165 cm (66 inches), basic igneous rock.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL FAMILY **Humoxic Tropohumult, clayey, oxidic, isothermic**

SOIL SERIES **Paalua silty clay** SOIL Nos. **S58Ha-7-2** LOCATION **Honolulu County, Hawaii**

Beltsville Lab Nos. 59579 - 59583

Depth (cm)	Horizon	Mineralogical Analysis															
		7A2 Allophane	Montmorillonites	7A2 Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	7A2 Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	Ap	-		1X	-	3							1X					
20-60	B21	-		1X	15	15							1X					
60-110	B22	-		-	40	15							-					
110-180	B31	-		-	40	10							-					
180-210	C	-		-	10	3							-					

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	Ap													16.7	23.9			
20-60	B21													22.0	31.5			
60-110	B22													13.1	18.7			
110-180	B31													12.1	17.3			
180-210	C													9.4	13.4			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	6O2b Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	5A3a Sum			5C1 NH_4OAc	5C3 Sum	8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-20	3.04	0.248	12	0.6	0.9	0.2	0.2	1.9	26.7		28.5				6	5.2	4.4
20-60	1.48	0.110	13	0.6	0.1	0.1	Tr.	0.8	29.5		30.4				3	5.0	4.7
60-110	0.53	0.053	10	0.4	0.4	0.2	0.1	1.1	14.7		15.8				6	5.2	4.7
110-180	0.31	0.039	8	0.6	0.3	0.1	0.1	1.1	17.4		18.5				6	5.2	4.6
180-210	0.50	0.037	14	0.6	0.1	0.2	Tr.	0.9	14.0		14.9				6	5.0	4.5

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility 4D1	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	4A3a Field moist		4B4 Field moist	4B1c 1/3 bar	4B2a 15 bar	COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-20	3.8	28.7	67.5							1.06		48	46.0	35.6		
20-60	3.1	13.3	83.6							0.82		47	45.6	40.4		
60-110	7.1	24.7	68.2							1.14		46	45.2	41.5		
110-180	11.4	32.4	56.2									50	55.1	41.9		
180-210	9.6	33.6	56.8									52	54.4	42.6		

a/ 0.6 kg of organic carbon per square meter to a depth of 1 meter.

PAALOA SILTY CLAY
S58Ha-7-2

Location: Island of Oahu, Honolulu County, Hawaii. Located in the east range of Schofield Barracks. Sample site is located 15 m (50 feet) north of road to Ku Tree Reservoir about 9.6 km (6 miles) east of intersection with [illegible]

[illegible]

at northern boundary of Leilehua Golf Course. 1958.
D. Womack. Collectors: D. Womack and J. M. Williams.

Classification: **Humoxic Tropohumult, clayey, oxidic, isothermic.**

Vegetation: Broomsedge (Andropogon virginicus), hilograss (Paspalum conjugatum), ricegrass (Paspalum orbiculare), and white ironbark (Eucalyptus sideroxylon). Along edges of drainageways on both sides of upland, the cover is koa (Acacia koa) and staghorn fern (Gleichenia linearis). Climate: Average annual precipitation is **about 175 to 250 cm (70-100 inches). The mean annual temperature is 21.1° C (70° F), the mean January** temperature 19.4° C (67° F), and the mean July temperature 22.8° C (73° F). Parent material: Weathered olivine basalt. Topography: Nearly level, narrow medial upland slopes of Koolau Range. Slope 1 percent convex to southwest. Elevation: 330 m (1,100 feet). Drainage: Well drained; moderately rapid permeability; slow runoff. Moist.

Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S58Ha-7-1.

HORIZON	DESCRIPTION
Ap BSL No. 59579	0 to 20 cm (0-8 inches), dark reddish brown (5YR 3/4) silty clay; strong medium granular structure; firm, sticky, plastic; many roots; many fine and very fine interstitial pores; common worm holes and casts; a small amount of the dusky red material from horizon below mixed in by cultivation; slight reaction with hydrogen peroxide after short delay; abrupt wavy boundary.
B21 BSL No. 59580	20 to 60 cm (8-24 inches), dusky red (10R 3/4) silty clay; moderate very fine subangular blocky structure; firm, sticky, very plastic; many roots; many fine and very fine tubular pores; few worm holes and casts; thin shiny coating on most peds (possibly oxide coating); few small highly weathered rock fragments; no reaction with hydrogen peroxide; abrupt wavy boundary.
B22 BSL No. 59581	60 to 110 cm (24-44 inches), dark red (2.5YR 3/6) silty clay; strong very fine subangular blocky structure; firm, sticky, very plastic; few roots with thin root mat on top of this horizon; many fine and very fine tubular pores; horizon is firm in place; thin, continuous dusky red glaze on all peds, some of which look like clay films; many small highly weathered rock fragments; no reaction with hydrogen peroxide; gradual wavy boundary.
B31 BSL No. 59582	110 to 180 cm (44-72 inches), dark brown (7.5YR 3/2) silty clay; weak, moderate fine subangular blocky structure; friable, sticky, very plastic; few roots; many fine and very fine tubular pores; almost continuous thin dusky red glaze on peds and in pores, some of which look like clay film; many soft clayey rock fragments; no reaction with hydrogen peroxide; gradual wavy boundary.
C BSL No. 59583	180 to 210 cm (72-84 inches), very dark grayish brown (10YR 3/2) silty clay; weak very fine subangular blocky structure; firm, very sticky, very plastic; many fine and very fine tubular pores; almost continuous thin dusky red and [illegible]

SOIL FAMILY **Humoxic Tropohumult. clayey. oxidic. isothermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES **Paaloa silty clay** SOIL Nos. **S61Ha-7-1** LOCATION **Honolulu County, Hawaii**

Beltsville Lab Nos. 61459 - 61465

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-8	Ap1				4	13												
8-28	Ap2																	
28-48	B21				7	28												
48-75	B22				12	34												
75-103	B23				7	45												
103-150	B24				20	28												
150-165	C				38	19												

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-8	Ap1													20.7	29.6			
8-28	Ap2																	
28-48	B21													22.0	31.4			
48-75	B22													20.0	28.6			
75-103	B23													14.0	20.0			
103-150	B24													16.1	23.0			
150-165	C													13.5	19.3			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-8	3.39	0.240	14	6.0	0.2	0.17	0.17		22.0		28.5		0.3		23	5.7	4.8
8-28																	
28-48	1.62	0.112	14	0.1	<0.1	0.13	0.05		28.5		28.8		3.3		1	4.9	4.4
48-75	1.24	0.091	14	<0.1	<0.1	0.09	0.05		23.8		23.9				<1	4.7	4.2
75-103	0.76	0.060	13	0.1	0.1	0.08	0.05		17.3		17.6		2.3		2	4.8	4.3
103-150	0.49	0.066	7	0.4	0.2	0.12	0.12		18.4		19.2				4	5.0	4.4
150-165	0.67	0.051	13	0.3	0.2	0.10	0.09		16.4		17.1		1.6		4	5.1	4.4

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	15 bar	Extensibility 4D1: COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	
0-8													26.6		
8-28															
28-48													30.2		
48-75													29.0		
75-103													27.6		
103-150													28.7		
150-165													30.3		

PAALOA SILTY CLAY
S61Ha-7-1

Location: Island of Oahu, Honolulu County, Hawaii. Sample site in paddock 270 m (800 feet) makai of Crosley's new home on Koa Ridge Road, 50 m (150 feet) Pearl Harbor way from ranch road. 18 m (60 feet) toward Wahiawa from lone koa tree. Date of sampling: March 14, 1961.
Description by: W. M. Johnson. Collectors: W. M. Johnson, J. M. Williams, K. W. Flach, and D. Womack.
Classification: Humoxic Tropohumult, clayey, oxidic, isothermic.
Vegetation: Pangolagrass pasture (Digitaria decumbens). Probably originally a koa (Acacia koa) forest. Climate: Average annual precipitation is 152 to 165 cm (60-65 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 20.0° C (68° F), and the mean July temperature 23.3° C (74° F). Parent material: Presumed to be weathered olivine basalt (not necessarily in situ), maybe with admixture of some cinders and ash. Topography: On a west-facing slope of a high mountain surface of the Koolau Range. Slope gradient 6 to 8 percent, slightly convex. On the lower 1/3 of a slope connecting two distinct geomorphic surfaces. Elevation: 370 m (1,125 feet).
Remarks: Profile moist when examined. The paddock has been cultivated and ripped at some time in the past. Four tons of lime have been applied.

HORIZON	DESCRIPTION
Ap1 BSL No. 61459	0 to 8 cm (0-3 inches), dark reddish brown (2.5YR 3/4) moist on ped surface, dark reddish brown (2.5YR 3/3) crushed (rubbed), silty clay*; moderate and medium fine granular structure; firm, plastic, slightly sticky; matted with roots; common fine and very fine tubular and interstitial pores; appears to have been compacted, probably by grazing livestock; few black specks, probably charcoal; common fine and medium rounded segregations that may be MnO_2 concretions, but are the same color as the soil matrix; clear, smooth lower boundary.
Ap2 BSL No. 61460	8 to 28 cm (3-11 inches), dark reddish brown (2.5YR 3/4) moist on ped surface, dark reddish brown (2.5YR 3/3) crushed (rubbed), silty clay; strong medium and fine granular structure; friable, plastic, slightly sticky; matted with roots; fine specks of charcoal; common firm earthy lumps; many fine and medium tubular and interstitial pores; in lower part there are flecks or mottles of dusky red (10R 3/4) moist material (doubtless from B) resulting from tillage or burrowing animals; 15 to 30 cm (6 to 12 inches) thick; abrupt, wavy lower boundary.
B21 BSL No. 61461	28 to 48 cm (11-19 inches), dusky red (10R 3/4) moist on ped surfaces, dusky red (10R 3/3) rubbed, silty clay; strong fine subangular blocky structure; friable, plastic, slightly sticky; common roots, mainly segregated along vertical planes, but in places along horizontal planes; common fine and very fine tubular pores in peds and along ped surfaces; there are many shiny cutans that look like clay skins; 13 to 28 cm (5 to 11 inches) thick; abrupt, wavy lower boundary.
B22 BSL No. 61462	48 to 75 cm (19-30 inches), dusky red (10R 3/4) moist on ped surfaces, dusky red (10R 3/3) rubbed, silty clay; moderate medium subangular blocky structure that upon air drying becomes strong, very fine and fine subangular blocky; firm, plastic, sticky; this horizon is bounded by root mats at top and bottom; in a few places has a root mat along a vertical crack; nearly continuous cutans of which the redder ones look like clay skins; common very fine and fine tubular inped and exped pores; seems to have distinctly higher bulk density than overlying horizons; abrupt, wavy lower boundary.
B23 BSL No. 61463	75 to 103 cm (30-41 inches), dusky red (10R 3/3) moist, ped surface and rubbed, silty clay; moderate medium subangular blocky which becomes strong, fine subangular blocky structure on air drying; firm, plastic, sticky; continuous cutans that look like pressure cutans for the most part; no roots except in a few vertical cracks; pores as in horizon above; in one place in this horizon there is an acutely angular vertical wedge that looks like a filled crack 2 cm (about

SOIL FAMILY Humoxic Tropohumult, clayey, oxidic, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Paaloa silty clay SOIL Nos. S65Ha-7-1 LOCATION Honolulu County, Hawaii

Riverside Lab Nos. 6550 - 6554

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-43	Ap			25	20	10		40				10						
43-63	B21t			10	20	35		50				5						
63-90	B22t				20	35		30			5	5						
90-113	B23t				40	30		35				5						
113-150	B24t				40	25		25			15	5						

Depth (cm)		Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-43	Ap	20.4	10.0	22.3	29.8	0.09	0.84	tr.	0.12	1.66	0.36	14.6	100.2	18.1	25.9		3.11	6.62
43-63	B21t	13.6	5.9	34.3	25.3	0.08	0.33	tr.	0.04	0.39	0.24	19.5	99.7	14.0	20.0		4.43	20.42
63-90	B22t	13.0	5.5	36.6	24.5	0.10	0.30	tr.	0.06	0.23	0.28	19.5	100.1	12.2	17.4		4.97	24.31
90-113	B23t	16.0	5.9	33.7	25.3	0.08	0.38	-	0.03	0.20	0.33	18.2	100.1	13.5	19.3		4.41	24.12
113-150	B24t	17.0	5.9	30.9	27.9	0.06	0.36	-	0.03	0.17	0.34	17.3	100.0	14.6	20.9		6.63	16.35

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-43	2.43	0.17	14	2.0	0.2	0.20	0.20	2.6		14.2		0.3	0.8	18.0		4.8	4.4
43-63	0.95	0.05	19	-	-	0.20	0.10	0.3		7.6		1.0	1.8	4.0		4.7	4.4
63-90	0.75	0.03	25	0.2	tr.	0.20	0.10	0.5		6.2		13.9	1.3	8.0		4.8	4.3
90-113	0.78			0.7	0.1	0.20	0.10	1.1		7.2		3.4	1.2	15.0		4.6	4.3
113-150	0.79			0.8	0.4	0.40	0.10	1.7		14.6		1.6	1.2	12.0		4.7	4.3

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	b/ Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.				Pct.	Pct.	Pct.	g/cc				Pct. of whole soil			cm/cm	
0-43					37	60	23			1.27	3.11		32.4	26.4		
43-63					36	58	22			1.28	3.09		30.5	25.5		
63-90										1.20	2.94		36.1	30.5		
90-113					40	74	34			1.15	2.93		36.1	31.3		
113-150										1.08	2.97		39.1	33.4		

a/ 19.0 kg of organic carbon per square meter to a depth of 1 meter.
b/ These samples were not allowed to dry prior to analysis.

PAALOA SILTY CLAY
S65Ha-7-1

Location: Island of Oahu, Honolulu County, Hawaii. Waialua Agricultural Company, from Kawailoa Camp, 6.7 km (4.15 miles) toward the mountains on Kawailoa Road to the intersection of Pupukea Road that turns south; thence on Kawailoa Road 1.5 km (0.3 mile) to a plantation road, north 1.5 km (0.3 mile) on plantation road, 15 m (50 feet) west of road. Date of sampling: April 19, 1965.
Description by: E. Hill and L. D. Giese. Collectors: K. Flach, L. Giese, E. Hill, L. Swindale, and G. Yamamoto.
Classification: **Humoxic Tropohumult, clayey, oxidic, isothermic.**
Vegetation: Dryland sugarcane (Saccharum officinarum), natural vegetation is ohia (Metrosideros collina), koa Acacia confusa), guava (Psidium guayava), fern and californiagrass (Panicum purpurascens). Climate: Average annual precipitation is 175 cm (70 inches). The mean annual temperature is 21° C (70° F), the mean January temperature 19° C (67° F), and the mean July temperature is 23° C (73° F). Parent material: Material weathered from olivine basalt. Topography: Gently sloping to sloping uplands with convex slopes, **site has 4 percent slope.** Elevation: 360 m (1,200 feet). Drainage: Well drained; moderately rapid permeability; runoff is slow to medium. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S65Ha-7-2.

HORIZON	DESCRIPTION
Ap RSL No. 6550	0 to 43 cm (0-17 inches), about 50 percent dark brown (7.5YR 3/2) and 50 percent dark reddish brown (2.5YR 3/3) silty clay, dark brown (7.5YR 4/4) and dark reddish brown (2.5YR 3/4) dry; strong fine and very fine subangular blocky structure; hard, firm, sticky, plastic; many roots; few fine and very fine tubular and interstitial pores; strongly acid (pH 5.4); abrupt smooth boundary.
B21t RSL No. 655[illegible]	43 to 63 cm (17-25 inches), dark reddish brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) dry; moderate fine and very fine subangular blocky structure; hard, friable, sticky, plastic; few roots; root mat caps this horizon; common fine tubular pores; dusky red (10R 3/4) moist clay films in pores, moderately thick nearly continuous clay films on ped faces; strongly acid (pH 5.1); clear wavy boundary.
B22t RSL No. 6552	63 to 90 cm (25-36 inches), dark reddish brown (2.5YR 3/4) moist and dry silty clay; moderate fine and very fine subangular blocky structure; hard, friable, sticky, plastic; few very fine roots; many fine and medium tubular pores; thin nearly continuous dark red (10R 3/6) moist clay films in pores, thin patchy films on ped faces; 30 to 50 percent dark reddish brown (5YR 3/3) moist saprolite pebbles coated with clay films; very strongly acid (pH 4.7); clear wavy boundary.
B23t RSL No. 6553	90 to 113 cm (36-45 inches), dark reddish brown (2.5YR 3/4) clay, dark red (2.5YR 3/6) dry; moderate, medium fine and very fine subangular blocky structure; hard, firm, sticky, very plastic; few very fine roots; few very fine and fine tubular pores; thin continuous dark red (10R 3/6) moist clay films in pores, thin patchy films on ped faces; very strongly acid (pH 4.8); clear smooth boundary.
B24t RSL No. 6554	113 to 150 cm (45-60 inches), dark reddish brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) dry; moderate fine and very fine subangular blocky structure; hard, friable, sticky, very plastic; few fine roots; common tubular pores; thin continuous dark red (10R 3/6) moist clay films in pores, thin patchy clay films on ped faces; very strongly acid (pH 4.7).

SOIL FAMILY Humoxic Tropohumult, clayey, oxidic, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Paalua silty clay SOIL Nos. S65Ha-7-2 LOCATION Honolulu County, Hawaii

Riverside Lab Nos. 6555-6560

Depth (cm)	Horizon	Mineralogical Analysis																
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0- 30	Ap																	
30- 55	B21t																	
55- 75	B22t																	
75- 98	B23t																	
98-118	B24t																	
118-168	B25t																	

PAALOA SILTY CLAY
S65Ha-7-2

Location: Island of Oahu, Honolulu County, Hawaii. Waialua Agricultural Company, from Kawailoa Camp 8 km (5.0 miles) toward the mountains to the intersection of Kawailoa and Pupukea Roads which turns north. Proceed 1.7 km (1.1 miles) to Ashby. Road. Turn north on Cane Road .24 km (.15 mile). Pit located 15 m (50 feet) east of Cane Road. Date of sampling: April 19, 1965.
Description by: Elmer Hill and L. D. Giese. Collectors: K. Flach, L. Giese, L. Swindale, E. Hill, and G. Yamamoto.
Classification: **Humoxic Tropohumult, clayey, oxidic, isothermic.**
Vegetation: Dryland sugarcane (Saccharum officinarum), natural vegetation is ohia (Metrosideros collina), koa (Acacia confusa), guava (Psidium guayava), fern and californiagrass (Panicum purpurascens). Climate: Average annual precipiation is 175 cm (70 inches). The mean annual temperature is 22° C (71° F). Parent material: Material weathered from olivine basalt. Topography: Gently sloping to sloping uplands with convex slopes; site has 3 percent slope. Elevation: 360 m (1,200 feet). Drainage: Well drained; moderately rapid permeability; runoff is slow to medium. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S65Ha-7-1.

HORIZON	DESCRIPTION
Ap RSL No. 6555	0 to 30 cm (0-12 inches), dark reddish brown (5YR 3/4) and dark reddish brown (2.5YR 3/4) silty clay, mixture of about 50 percent of reddish brown (5YR 4/4) and red (2.5YR 4/6) dry; massive except surface 8 or 10 cm (3 or 4 inches) that has strong fine and very fine subangular blocky structure; hard, firm, sticky and plastic; many roots; few fine and very fine tubular and interstitial pores; strongly acid (pH 5.2); abrupt smooth boundary.
B21t RSL No. 6556	30 to 55 cm (12-22 inches), dark reddish brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) dry; moderate fine and very fine subangular blocky structure; hard, friable, sticky and plastic; few fine roots; root mat caps this horizon; few very fine tubular pores; thin continuous dark red (10R 3/6 moist) clay films in pores and on ped faces; 5 to 10 percent gravel-size saprolite fragments; strongly acid (pH 5.1); gradual smooth boundary.
B22t RSL No. 6557	55 to 75 cm (22-30 inches), dark red (2.5YR 3/6) silty clay, red (2.5YR 4/6) dry; moderate fine and very fine subangular blocky structure; hard, friable, sticky and very plastic; few very fine roots; common fine and very fine pores; thin continuous dark red (10R 3/6 moist) clay films in pores and on ped faces; 10 to 15 percent gravel-size fragments of saprolite; strongly acid (pH 4.8); gradual wavy boundary.
B23t RSL No. 6558	75 to 98 cm (30-39 inches), dark red (2.5YR 3/6) silty clay, red (2.5YR 4/6) dry; weak medium fine and very fine subangular blocky structure; hard, friable, sticky and very plastic; no roots; common fine and very fine tubular pores; thin continuous dark red (10R 3/6 moist) clay films in pores and on ped faces; 5 to 10 percent gravel-size saprolite fragments; very strongly acid (pH 4.8); gradual wavy boundary.
B24t RSL No. 6559	98 to 118 cm (39-47 inches), dark reddish brown (5YR 3/3) clay, reddish brown (5YR 4/4) dry; moderate medium prismatic breaking to moderate fine and very fine subangular and angular blocky structure; hard, friable, sticky and plastic; no roots; common fine and very fine tubular pores; thin continuous dark red (10R 3/6 moist) clay films in pores and on ped faces; very strongly acid (pH 4.8); clear smooth boundary.
IIB25t RSL No. 6560	118 to 168 cm (47-67 inches), dark reddish brown (5YR 3/3) clay, yellowish red (5YR 4/6) dry; moderate medium prismatic breaking to strong fine and very fine subangular and angular blocky structure; hard, firm, very sticky and very plastic; no roots; common very fine tubular pores; thin continuous dark red (10R 3/6 moist) clay films in pores and on ped faces; very strongly acid (pH 4.8).

SOIL FAMILY Orthoxic Tropohumult, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Manana silty clay loam SOIL Nos. S61Ha-7-2 LOCATION Honolulu County, Hawaii

Beltsville Lab Nos. 61466 - 61470

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites 7A1	Gibbsite 7A3	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	Ap				8	8												
20-38	B21				15	10												
38-68	B22				32	14												
68-105	B23				33	14												
105-125	B3				38	11												

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	Ap													21.5	30.7			
20-38	B21													21.3	30.4			
38-68	B22													12.4	17.8			
68-105	B23													12.1	17.3			
105-125	B3													12.5	17.9			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2d Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-20	2.98	0.209	14	5.2	0.2	0.10	0.16	5.7	24.9		30.5		0.7		19	5.2	4.7
20-38	1.90	0.103	18	0.6	0.3	0.12	0.03	1.1	28.0		29.0				3	5.1	4.5
38-68	1.20	0.054	22	0.5	0.4	0.14	0.07	1.1	22.8		23.9		2.7		5	5.1	4.3
68-105	0.65	0.051	13	0.4	0.2	0.15	0.05	0.8	20.9		21.7				4	5.0	4.3
105-125	0.48	0.044	11	0.2	0.4	0.16	0.05	1.0	20.5		21.3		3.0		4	5.0	4.3

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	482 15 bar A.D.	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	
0-20													24.7		
20-38													30.1		
38-68													33.8		
68-105													32.7		
105-125													34.6		

MANANA SILTY CLAY LOAM
S61Ha-7-2

Location: Island of Oahu, Honolulu County, Hawaii. Sample site is 0.4 km (0.2 miles) mauka of old Koa Ridge ranch house, 50 m (150 feet) east of road. Date of sampling: 1961.
Description by: J. Melvin Williams. Collectors: J. M. Williams, K. W. Flach and G. Uehara.
Classification: Orthoxic Tropohumult, clayey, oxidic, isohyperthermic.
Vegetation: Pangola pasture (Digitaria decumbens). Climate: Average annual precipitation is 175 to 200 cm (70-80 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 20.0° C (68° F), and the mean July temperature 23.3° C (74° F), Parent material: Presumed to be weathered from ash or alluvium. Topography: Undulating transected land surfaces of west slopes of Koolau Range; 7 percent slope to west, slightly convex. Sample on lower 1/3 part of land surface. Elevation: 306 m (1,020 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted.

HORIZON	DESCRIPTION
Ap BSL No. 61466	0 to 20 cm (0-8 inches), dark red (2.5YR 2/4) silty clay loam; moderate fine and medium granular structure; friable with many firm aggregates, slightly sticky, slightly plastic; abundant roots; many fine and very fine interstitial pores; common glistening specks presumed to be ilmenite; bulk density estimated to be higher in horizon below; few dusky red fragments from B horizon mixed by tillage; abrupt smooth boundary; moderately magnetic. 18 to 20 cm (7-8 inches) thick.
B21 BSL No. 61467	20 to 38 cm (8-15 inches) dusky red (10R 3/4) light silty clay; moderate very fine subangular blocky structure; sticky, plastic, friable; many roots; many very fine and fine pores; few thin coatings on ped surfaces that look like pressure cutans; few pockets of wormcasts; matted roots at bottom; moderately magnetic; abrupt smooth boundary. 15 to 20 cm (6-8 inches) thick.
B22 BSL No. 61468	38 to 68 cm (15-27 inches), dark red (2.5YR 3/4), dark reddish brown (5YR 3/4) crushed, gritty silty clay; strong very fine subangular blocky structure; slightly sticky, plastic, firm; 3 to 6 mm (1/8-1/4 inch) root mat capping this horizon; many very fine and fine pores; many patchy dark red coatings on ped surfaces, many look like pressure cutans and some appear to be clay flows; some coatings are capped with a pseudo frost-like material; common highly weathered pebbles that appear to have gibbsite; compact in place; moderately magnetic; gradual wavy boundary. 25 to 35 cm (10-14 inches) thick.
B23 BSL No. 61469	68 to 105 cm (27-42 inches), dark red (2.5YR 3/4), dark reddish brown (5YR 3/4) crushed, silty clay; strong very fine subangular blocky structure; firm, slightly sticky, plastic; essentially no roots except in vertical cleavage planes; common very fine pores; continuous glazed coatings on ped surfaces, many of which look like pressure cutans and many like clay flows; increase of coatings that appear like clay flows from the horizon above; compact in place; few highly weathered gravel fragments; moderately magnetic; gradual wavy boundary. 37 to 45 cm (15-18 inches) thick.
B3 BSL No. 61470	105 to 125 cm (42-50 inches +), dark reddish brown (5YR 3/3), dark brown (7.5YR 3/3) crushed, silty clay; strong very fine subangular blocky structure; friable, slightly sticky, plastic; no roots except in vertical cleavage; many very fine and fine pores; continuous coatings on ped surfaces, many of which look like clay flows; common highly weathered gravel; moderately magnetic.

SOIL FAMILY Orthoxic Tropohumult, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Manana silty clay SOIL Nos. S61Ha-7-11 LOCATION Honolulu County, Hawaii

Beltsville Lab Nos. 61520 - 61526

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites 7A3	Gibbsite 7A3	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	Ap				12	8												
20-28	B21				20	8												
28-48	B22				20	13												
48-55	B23				33	17												
55-80	B24				32	14												
80-105	C1				38	10												
105-163	C2				54	10												

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	Ap													16.2	23.1			
20-28	B21													19.2	27.5			
28-48	B22													18.3	26.1			
48-55	B23													12.2	17.5			
55-80	B24													11.0	15.8			
80-105	C1													11.1	15.9			
105-163	C2													10.1	14.4			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2d Ca	602b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-20	2.82	0.224	13	0.1	0.4	0.10	0.22	0.8	24.8		25.6				3	4.8	4.3
20-28	1.74	0.130	13	0.1	0.2	0.09	0.16	0.6	29.8		30.4				2	4.7	4.4
28-48	1.28	0.101	13	1.0	0.3	0.08	0.15	1.5	28.1		29.6				5	4.9	4.4
48-55	1.05	0.077	14	1.3	0.4	0.09	0.27	2.1	19.7		21.8				10	4.9	4.4
55-80	0.49	0.051	10	1.5	0.4	0.09	0.31	2.3	15.0		17.3				13	5.0	4.3
80-105	0.37	0.025	15	1.7	0.5	0.09	0.20	2.5	14.6		17.1				15	5.0	4.3
105-163	0.43	0.045	10	1.2	0.6	0.16	0.17	2.1	14.2		16.3				13	5.0	4.3

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	

MANANA SILTY CLAY
S61Ha-7-11

Location: Island of Oahu, Honolulu County, Hawaii. Sample site in abandoned pineapple field 30 m (100 feet) east of Macadam Road at a point 3.1 km (1.8 miles) mauka of junction of Highways 80 and 808. Date of sampling: 1961.
Description by: D. Womack. Collectors: D. Womack and J. M. Williams.
Classification: **Orthoxic Tropohumult, clayey, oxidic, isohyperthermic.**
Vegetation: Abandoned pineapple. Climate: Average annual precipitation is 175 to 200 cm (70-80 inches). The mean annual temperature is 21.1° C (70° F), the mean January temperature 20.0° C (68° F), and the mean July temperature 23.3° C (74° F). Parent material: Weathered from ash or alluvium. Topography: Undulating land surface of West Koolau Range; slightly convex, 4 percent to west. Elevation: 342 m (1,140 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted.

HORIZON	DESCRIPTION
Ap BSL No. 61520	0 to 20 cm (0-8 inches), dark reddish brown (2.5YR 2/4) silty clay, reddish brown (2.5YR 4/4) dry; moderate fine and medium granular structure; sticky, plastic, friable; many fine roots; many very fine and fine tubular and interstitial pores; few black very fine concretions that will not effervesce with hydrogen peroxide; common very fine glistening specks; has high apparent bulk density feel in hand; in lower part there are mottles of dark red (10R 3/6) material that are caused by mixing of the B horizon by tillage; abrupt smooth boundary.
B21 BSL No. 61521	20 to 28 cm (8-11 inches), dusky red (10R 3/4) silty clay; moderate very fine and fine subangular blocky structure; firm, sticky, plastic; many fine roots; common very fine and fine pores; nearly continuous coatings that appear to be pressure surfaces; noticeable decrease in bulk density from above; many very firm earthy lumps that resist breaking down on rubbing; few glistening specks; clear smooth boundary.
B22 BSL No. 61522	28 to 48 cm (11-19 inches), dusky red (10R 4/4) silty clay; strong very fine subangular blocky structure; firm, sticky, plastic; common fine roots; common very fine and fine pores; continuous coatings on ped surfaces that appear to be pressure cutans; many very fine earthy lumps; abrupt smooth boundary.
B23 BSL No. 61523	48 to 55 cm (19-22 inches), dusky red (10R 3/4) silty clay, with many fine mottles of dark reddish brown (5YR 3/3), crushes to dark reddish brown (2.5YR 3/4); strong very fine subangular and angular blocky structure; firm, slightly sticky, plastic; top of this horizon capped by a 5 to 10 mm (1/4-1/2 inch) root mat; no apparent roots; common very fine tubular pores; continuous coatings that appear like pressure surfaces; very compact in place; clear wavy boundary.
B24 BSL No. 61524	55 to 80 cm (22-32 inches), dusky red (10R 3/4) silty clay with pockets of reddish brown (5YR 4/4) material of weathered saprolite; strong very fine subangular blocky structure; firm to very firm, slightly sticky, plastic; continuous coatings that for the most part look like pressure cutans; many resistant, very firm earthy lumps; compact in place; abrupt wavy boundary.
C1 BSL No. 61525	80 to 105 cm (32-42 inches), dark reddish brown (5YR 3/3) silty clay with many large mottles of dusky red (10R 3/4); strong fine and medium subangular and angular blocky structure; very firm, sticky, plastic; common very fine pores; common large slickensides that are deeply striated; many large stringy coatings on ped surfaces that look like clay films; few pockets of weathered saprolite; compact in place; clear wavy boundary.
C2 BSL No. 61526	105 to 163 cm (42-65 inches), dark reddish brown (2.5YR 3/4) silty clay with many large mottles of dusky red (10R 3/4), crushes to dark brown (7.5YR 3/2); moderate medium and coarse subangular blocky structure; very firm, sticky, plastic; continuous coatings part of which appear to be pressure cutans and many that appear to be thick patchy clay films; many very firm earthy lumps; few small pockets of weathered saprolite.

SOIL FAMILY **Ustoxic Tropohumult, clayey, oxidic, isothermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kalae silty clay SOIL No. 863Ha-5-1 LOCATION Maui County, Hawaii

[redacted]

Lincoln Lab Nos. 18710 - 18716

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-23	Ap1			20	15	3		25			25	10						
23-38	Ap2			20	10	2		30			30	10						
38-65	B21t			10	30	5		30			10	10						
65-103	B22t			15	30	10		30			2	5						
103-133	B31			10	25	10		20			5	5						
133-155	B32			3	40	15		10			10	5						
155-168	C			0	60	10		10			10	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-23	Ap1	17.0	11.5	11.6	42.5	0.40	2.49	tr.	0.07	1.31	0.90	12.7	100.5	16.6	23.7		3.49	4.02
23-38	Ap2	16.2	11.6	14.6	46.0	0.35	2.16	tr.	0.05	1.38	0.76	7.7	100.8	18.7	26.7		4.12	3.92
38-65	B21t	20.7	7.2	19.1	38.2	0.15	1.20	tr.	0.07	1.33	0.96	11.5	100.4	22.7	32.5		6.33	7.22
65-103	B22t	22.1	4.2	25.5	30.4	0.09	0.92	tr.	0.05	1.03	0.92	15.1	100.3	20.0	28.6		11.12	14.81
103-133	B31	22.6	4.0	30.1	21.4	0.09	0.67	-	0.05	0.54	0.95	19.5	99.9	11.6	16.6		13.24	20.61
133-155	B32	23.7	4.5	32.3	18.9	0.16	0.91	-	0.03	0.24	0.61	18.5	99.9	7.9	11.3		19.03	22.65
155-168	C	28.3	4.1	33.8	15.4	0.14	0.69	-	-	-	0.59	16.9	99.9	5.2	7.4		16.05	23.04

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-23	3.35	0.36	9	5.6	2.2	0.10	0.60	8.5		17.6		0.3		48.0		6.3	5.3
23-38	0.61	0.13	5	2.6	1.5	0.10	0.60	4.8		7.9		0.3		61.0		6.5	5.5
38-65	0.58	0.10	6	3.3	3.1	0.50	1.20	8.1		11.7		0.3		69.0		6.6	5.5
65-103	0.87	0.11	8	2.0	3.1	0.60	1.30	7.0		14.8		1.5	0.2	47.0		5.4	4.3
103-133	1.52	0.11	14	0.7	1.6	0.70	0.90	3.9		21.1		2.8	1.6	18.0		4.7	4.0
133-155	1.07	0.07	15	0.5	1.1	1.10	0.30	3.0		15.6		3.3	2.2	19.0		4.5	3.7
155-168	0.62	0.04	15	0.6	1.1	1.50	0.20	3.4		13.8		2.4	2.4	25.0		4.5	3.4

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar clods	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-23	10.1	54.5	35.4	-						1.29	3.45		29.8	19.3		
23-38				-						1.58	3.57		20.2	16.1		
38-65				tr.				1.68	1.74	1.53	3.32	23.4	27.9	23.4	0.01	0.01
65-103	9.5	17.6	72.9	-						1.25	3.10		32.3	28.6		
103-133				-						1.12	2.92		47.2	38.9		
133-155				tr.				1.18	1.23	1.15	2.92	32.4	40.6	33.9	0.01	0.01
155-168				tr.							2.86		34.7	28.1		

a/ 17.6 kg of organic carbon per square meter to a depth of 1 meter.

KALAE SILTY CLAY

S63Ha-5-1

Location: Island of Molokai, Maui County, Hawaii. Approximately 1.7 km (1 ¼ miles) north northwest of Kualapuu in California Packing Corporation field B1. The site is 23 m (78 feet) west of east end of block 8 (near two concrete water tanks). Date of sampling: May 13, 1963.
Description by: S. Nakamura. Collectors: James DeMent, J. M. Williams, R. C. Malmgren, and S. Nakamura.
Classification: **Ustoxic Tropohumult, clayey, oxidic, isothermic.**
Vegetation: Pineapple. Climate: The average annual precipitation is 75 to 125 cm (30 to 50 inches); most of which occurs from November to April. The mean January temperature is 20.6° C (69° F) and the mean July temperature is 24.4° C (76° F). Parent material: Residuum from basic igneous rock. Topography: Gently sloping intermediate slope. Elevation: 300 m (1,000 feet). Drainage: Well drained; permeability moderate; runoff medium. Soil moisture: Profile fairly dry when described.
Remarks: Textures are apparent field textures. Paired sample number S63Ha-5-2.

HORIZON	DESCRIPTION
Ap1 LSL No. 18710	0 to 23 cm (0-9 inches), dark reddish brown (2.5YR 3/4) silty clay, weak red (2.5YR 4/2) dry; cloddy breaking into moderate very fine, fine and medium granular structure; hard, friable, sticky and plastic; few roots; many interstitial pores; common wormholes and casts; moderately high apparent bulk density; common hard earthy lumps which break down when rubbed; weak effervescence with hydrogen peroxide; strongly acid (pH 5.2); abrupt smooth boundary.
Ap2 LSL No. 18711	23 to 38 cm (9-15 inches), dark reddish brown (2.5YR 3/4) silty clay, weak red (2.5YR 4/2) dry; cloddy breaking into weak fine medium and coarse subangular blocky structure; hard, friable, sticky and plastic; few roots; many very fine and fine and few medium tubular pores; firm in place; moderately high apparent bulk density; weak effervescence with hydrogen peroxide; strongly acid (pH 5.5); clear wavy boundary.
B21t LSL No. 18712	38 to 65 cm (15-26 inches), dark red (2.5YR 3/6) silty clay, red (2.5YR 4/6) dry; strong very fine and fine subangular blocky structure; very hard, firm, sticky and plastic; few roots; few very fine tubular pores; many hard earthy lumps due to aggregate stability which break down after prolonged rubbing; thin continuous clay films; compact in place; upper part of this horizon has tongues up to 7.5 cm (3 inches) deep which has a darker color of 2.5YR 3/4 (dark reddish brown); weak effervescence with hydrogen peroxide; strongly acid (pH 5.4); gradual wavy boundary.
B22t LSL No. 18713	65 to 103 cm (26-41 inches), dark red (2.5YR 4/6 moist and dry) silty clay; strong very fine and fine subangular blocky structure; very hard, firm, sticky and plastic; few roots; few very fine tubular pores; thin continuous clay films on peds; many hard earthy lumps due to aggregate stability which break down after prolonged rubbing; weak effervescence with hydrogen peroxide; compact in place; strongly acid (pH 5.1); clear wavy boundary.
B31 LSL No. 18714	103 to 133 cm (41-53 inches), dark red (2.5YR 3/6) silt loam, yellowish red (5YR 4/6) dry; moderate fine and very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few roots; common very fine and few fine tubular pores; few patchy clay films; saprolite makes up about 2 percent of the volume; no effervescence with hydrogen peroxide; strongly acid (pH 5.1); gradual wavy boundary.
B32 LSL No. 18715	133 to 155 cm (53-62 inches), reddish brown (5YR 4/4) silt loam, dark reddish brown (2.5YR 3/6) dry; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; no roots; many very fine and common fine tubular pores; few patchy clay films; saprolite makes up about 5 percent of the volume; no effervescence with hydrogen peroxide; strongly acid (pH 5.1); gradual irregular boundary.
C LSL No. 18716	155 to 168 cm (62-67 inches), dark brown (10YR 3/3 and 7.5YR 3/4 moist) silt loam; weak fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; no roots; many very fine tubular pores; no effervescence with hydrogen peroxide; about 30 percent of this horizon is made up of saprolite.

SOIL FAMILY **Ustoxic Tropohumult, clayey, oxidic, isothermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kalae silty clay SOIL Nos. S63Ha-5-2 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 18717 - 18724

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	Ap1																	
15-30	Ap2																	
30-60	B21																	
60-88	B21																	
88-108	B22																	
108-120	B31																	
120-140	B32																	
140-175	C																	

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-15	Ap1													20.5	29.3			
15-30	Ap2													10.4	14.9			
30-60	B21													26.0	37.2			
60-88	B21													27.0	38.6			
88-108	B22													23.8	34.0			

KALAE SILTY CLAY
S63Ha-5-2

Location: Island of Molokai, Maui County, Hawaii. Approximately .81 km (½ mile) north of Kualapuu in California Packing Corporation field 319. The site is 45 m (150 feet) east of west end of block 5. Date of sampling: May 13, 1963.
Description by: S. Nakamura. Collectors: J. A. DeMent, R. C. Malmgren, S. Nakamura, and J. M. Williams.
Classification: **Ustoxic Tropohumult, clayey, oxidic, isothermic.**
Vegetation: Pineapple. Climate: The average annual precipitation is 75 to 125 cm (30 to 50 inches); most of which occurs from November to April. The mean January temperature is 21° C (69° F) and the mean July temperature 24° C (76° F). Parent material: Residuum from basic igneous rock. Topography: Gently sloping intermediate slopes. Elevation: 300 m (1,000 feet). Drainage: Well drained; moderate permeability; medium runoff. Soil moisture: Profile fairly dry when sampled.
Remarks: Textures are apparent field textures. Because of its thickness, the B21 horizon was split in sampling. Paired sample number S63Ha-5-1.

HORIZON	DESCRIPTION
Ap1 LSL No. 18717	0 to 15 cm (0-6 inches), dark reddish brown (2.5YR 3/4) silty clay, reddish brown (2.5YR 4/4) dry; moderate very fine, fine and medium granular structure; hard, friable, sticky and plastic; many roots; many interstitial pores; loose in place due to tillage; common wormholes and casts; weak effervescence with hydrogen peroxide; clear smooth boundary.
Ap2 LSL No. 18718	15 to 30 cm (6-12 inches), dark reddish brown (2.5YR 3/4) silty clay, reddish brown (2.5YR 4/4) dry; moderate very fine, fine and medium granular structure and some clods; hard, friable, sticky and plastic; many roots; [illegible]

SOIL FAMILY Typic Aerohumox, clayey, oxidic, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Mahana silty clay loam SOIL Nos. 865Ha-2-2 LOCATION Kauai County, Hawaii

Riverside Lab Nos. 6579 - 6584

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-18	A1			5	25	0		35			10	10						
18-28	B21			5	30	2		30			5	5						
28-50	B22			5	25	5		30			5	5						
50-88	B23			2	40	3		20			5	5						
88-120	IIB3			1	35	1		20			10	5						
120-153	IIC			1	50	1		20			10	5						

Depth (cm)		Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-18	A1	17.4	7.6	16.5	38.5	0.11	0.82	0.1	0.04	0.39	0.05	18.1	99.5	21.7	31.0		5.31	5.52
18-28	B21	17.1	5.7	23.7	31.8	0.04	0.57	tr.	0.05	0.34	0.45	20.2	100.0	19.1	27.3		5.43	7.36
28-50	B22	17.8	4.9	24.6	28.0	0.06	0.55	tr.	0.05	0.28	0.44	23.4	100.1	17.9	25.6		6.79	9.17
50-88	B23	22.8	4.4	28.6	21.7	0.08	0.43	tr.	0.04	0.13	0.38	22.1	100.1	12.0	17.2		8.59	11.67
88-120	IIB3	25.9	3.8	29.3	21.4	0.08	0.49	tr.	0.03	0.08	0.37	18.5	100.0	11.2	16.0		10.44	12.60
120-153	IIC	28.9	3.6	28.9	22.9	0.05	0.52	tr.	0.04	0.07	0.29	14.6	99.9	11.6	16.6		11.15	11.56

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-18	6.14	0.41	15	6.1	2.8	0.20	1.00	10.1		27.1		0.2	0.3	37.0		5.6	4.7
18-28	5.18	0.29	18	1.1	0.6	0.20	0.40	2.3		22.6		0.2	0.9	10.0		5.4	4.7
28-50	5.40	0.27	20	0.2	0.1	0.20	0.20	0.7		19.4		-	1.0	4.0		5.2	4.8
50-88	3.78	0.20	19	-	tr.	0.10	0.10	0.2		17.3		0.7	0.8	1.0		4.7	4.7
88-120	2.04	0.11	19	-	tr.	0.10	0.10	0.2		15.4		0.7	1.3	1.0		4.9	4.6
120-153	0.94	0.05	19	0.2	0.3	0.20	0.10	0.8		15.5		0.7	5.6	5.0		5.0	4.3

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	b/ Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.				Pct.	Pct.	Pct.	g/cc				Pct. of whole soil			cm/cm	
0-18					48	67	19			1.22	3.06	43.1	41.7	36.7		
18-28										0.82	2.98	49.8	48.5	38.9		
28-50					N.P.	N.P.	N.P.			0.73	2.88	65.8	58.3	42.6		
50-88										0.70	2.81	76.9	65.6	44.6		
88-120										0.98	2.85	53.3	49.8	39.4		
120-153					45	62	17				2.93		39.1	35.1		

a/ 38.9 kg of organic carbon per square meter to a depth of 1 meter.
b/ These samples were not allowed to dry prior to analysis.

MAHANA SILTY CLAY LOAM
S65Ha-2-2

Location: Island of Kauai, Kauai County, Hawaii; Kekaha Quadrangle - 22°01'30" north latitude and 159°41'11" west longitude, 6.7 km (4.2 miles) N. 4° E. of junction of highways 50 and 55 in Kekaha Town. Date of sampling: April 15, 1965.
Description by: L. D. Giese and D. E. Foote. Collectors: K. Flach, L. Giese, D. Foote, and G. Yamamoto.
Classification: **Typic Acrohumox, clayey, oxidic, isothermic.**
Vegetation: Noncultivated. Silver oak-brush cover. Over 90 percent cover. Principal species: puakeawe (Stuphelia tameiameiae), aalii (Dodonaea eriocarpa), ricegrass (Paspalum orbiculare), molassesgrass (Melinis minutiflora), silver oak (Grevillea robusta), yellow foxtail (Setaria geniculata), lantana (Lantana camara), joee (Stachytarpheta cayannensis), Japanese tea (Cassia leschenaultiana), passion flower (Passiflora sp.). Climate: Average annual precipitation is 75 to 113 cm (30-45 inches). The mean annual temperature is 16° C (70° F), the mean January temperature is 18° C (64° F), and the mean July temperature is 21° C (70° F). Parent material: Residuum from volcanic ejecta and basic igneous rocks and volcanic ash. Topography: On gently sloping **uplands, 4 percent convex slope,** southwest aspect. Elevation: 570 m (1,900 feet). Drainage: Well drained; runoff is medium; permeability is moderately rapid.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Paired sample number S65Ha-2-3.

HORIZON	DESCRIPTION
A1 RSL No. 6579	0 to 18 cm (0-7 inches), dusky red (10R 3/4) silty clay loam, dark reddish brown (2.5YR 3/4) dry; strong fine and very fine subangular blocky structure; very hard, friable, sticky and plastic; many roots; moderate effervescence with hydrogen peroxide; medium acid (pH 6.0); clear wavy boundary.
B21 RSL No. 6580	18 to 28 cm (7-11 inches), dark red (2.5YR 3/6) silt loam; reddish brown (2.5YR 4/4) dry; weak coarse prismatic structure; slightly hard, very friable, nonsticky and nonplastic; many roots; many pores; no effervescence with hydrogen peroxide; slightly acid (pH 6.2); gradual smooth boundary.
B22 RSL No. 6581	28 to 50 cm (11-20 inches), dark red (2.5YR 3/6) silt loam, reddish brown (2.5YR 4/4) dry; weak coarse prismatic structure; soft, very friable, slightly sticky, slightly plastic, weakly smeary; many roots; many pores; no effervescence with hydrogen peroxide; medium acid (pH 6.0); gradual smooth boundary.
B23 RSL No. 6582	50 to 88 cm (20-35 inches), dark red (2.5YR 3/6) silt loam, reddish brown (2.5YR 4/4) dry; weak coarse prismatic structure; soft, very friable, slightly sticky, slightly plastic, and smeary; few roots; many pores; no effervescence with hydrogen peroxide; medium acid (pH 6.0); gradual smooth boundary.
IIB3 RSL No 6583	88 to 120 cm (35-48 inches), dark red (2.5YR 3/6) silty clay loam, reddish brown (2.5YR 5/4) dry; weak, fine and medium subangular blocky structure; slightly hard, friable, sticky, plastic and weakly smeary; few roots; many pores; no effervescence with hydrogen peroxide; slightly acid (pH 6.2); clear smooth boundary.
IIC RSL No. 6584	120 to 153 cm (48-61 inches), dark reddish brown (5YR 3/3) silty clay loam, some coatings of dark red (10R 3/8), reddish brown (2.5YR 4/4) dry; moderate, fine and medium angular and subangular blocky structure; compact in place, hard, firm, sticky and plastic; few roots; many pores; continuous stress cutans, dark red (10R 3/8) coatings that look like clay films, thin patchy slickensides; no effervescence with hydrogen peroxide; medium acid (pH 6.0).

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL FAMILY Typic Acrohumox, clayey, oxidic, isothermic

SOIL SERIES Mahana silty clay loam SOIL Nos. S65Ha-2-3 LOCATION Kauai County, Hawaii

Riverside Lab Nos. 6585 - 6589

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-13	A1																	
13-30	B21																	
30-58	B22																	
58-88	B23																	
88-138	IIC																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-13	A1													24.5	35.0			
13-30	B21													21.1	30.2			
30-58	B22													19.7	28.2			
58-88	B23													15.8	22.6			
88-138	IIC													12.2	17.4			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation 5C1 NH_4OAc	5C3	pH 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-13	5.45	0.306	18	1.4	1.0	0.2	0.2	2.8		19.3		0.6	1.1	14		5.6	4.5
13-30	4.06	0.162	25	-	-	0.1	tr.	0.1		13.5		0.7	1.1	1		4.8	4.6
30-58	3.55	0.158	22	-	0.2	0.2	0.1	0.5		11.0		1.0	0.7	4		5.0	4.8
58-88	3.25	0.161	20	0.3	0.1	0.1	tr.	0.5		13.7		1.0	0.5	4		5.1	4.8
88-138	1.04	0.062	17	-	0.2	0.2	0.1	0.5		16.8		1.2	2.2	3		4.4	4.4

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-13										0.89	3.27	44.7	40.3	26.7		
13-30										0.93	3.13	47.2	51.5	37.0		
30-58										0.89	3.02	56.4	61.0	39.2		
58-88										0.98	2.87	54.2	60.4	44.2		
88-138										1.16	2.93	38.4	42.5	34.2		

a/ 32.6 kg of organic carbon per square meter to a depth of 1 meter.

MAHANA SILTY CLAY LOAM
S65Ha-2-3

Location: Island of Kauai, Kauai County, Hawaii. Makaha Pt. Quadrangle - 22°03'13" north latitude and 159°41'14" west longitude. North 9,630 m (32,100 feet), 20.2° E. of junction of Highways 50 and 55 in Kekaha Town. Date of sampling: April 15, 1965.
Description by: L. D. Giese, D. E. Foote. Collectors: K. Flach, L. Giese, D. Foote, and G. Yamamoto.
Classification: **Typic Acrohumox, clayey, oxidic, isothermic.** 1/
Vegetation: Noncultivated. Silver oak brush cover. Over 90 percent cover. Principal species: silver oak (Grevillea robusta), puakeawe (Styphelia tameiameiae), Java plum (Eugenia cumini), lantana (Lantana camara), molassesgrass (Melinis minutiflora), aalii (Dodonaea eriocarpa), lilikoi (Passiflora sp.), guava (Psidium cattleianum lucidum), and ferns. Climate: Average annual precipitation is 88 cm (35 inches). The mean annual temperature is 21° C (69° F). Parent material: Weathered basalt and/or volcanic ash. Topography: Upland; convex **6 percent** slope; southwest aspect; midslope. Elevation: 747 m (2,490 feet). Drainage: Well drained; medium internal drainage; moderate permeability; medium runoff. Soil moisture: All horizons moist at the time of sampling.
Remarks: Textures are apparent field textures. Texture and terms for description

"smeariness" are explained in the methods section of this report. Paired sample number S65Ha-2-2. Colors are for moist soil.

HORIZON	DESCRIPTION
A1 RSL No. 6585	0 to 13 cm (0-5 inches), dusky red (2.5YR 3/3) silty clay loam; weak fine and medium granular structure; very friable, slightly sticky and slightly plastic; many roots; weak effervescence with hydrogen peroxide; clear wavy boundary.
B21 RSL No. 6586	13 to 30 cm (5-12 inches), dark reddish brown (2.5YR 3/4) silt loam; weak coarse prismatic structure; very friable, slightly sticky, slightly plastic and slightly smeary; many roots; many fine and very fine pores; no effervescence with hydrogen peroxide; gradual smooth boundary.
B22 RSL No. 6587	30 to 58 cm (12-23 inches), dark red (2.5YR 3/6) silt loam; weak coarse prismatic structure; very friable, slightly sticky, slightly plastic and smeary; many roots; many fine and very fine pores; no effervescence with hydrogen peroxide; gradual smooth boundary.
B23 RSL No. 6588	58 to 88 cm (23-35 inches), dark red (2.5YR 3/8) silt loam; weak fine and medium subangular blocky structure; very friable, slightly sticky, slightly plastic and smeary; common roots; many fine and very fine pores; no effervescence with hydrogen peroxide; abrupt smooth boundary.
IIC RSL No. 6589	88 to 138 cm (35-55 inches), dark reddish brown (5YR 3/4) silty clay loam; many coatings of dark red (2.5YR 3/6); moderate fine and medium angular blocky and subangular blocky structure; compact in place, firm, sticky and plastic; few roots; common fine and medium pores; coatings of dark red (2.5YR 3/6) [illegible]

SOIL FAMILY Tropeptic Eutrorthox, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Puhi silty clay loam SOIL Nos. S63Ha-2-1 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 18736 - 18740

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-30	Ap																	
30-53	B21																	
53-83	B22																	
83-103	B23																	
103-150	B24																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-30	Ap													19.1	27.3			
30-53	B21													24.7	35.3			
53-83	B22													24.6	35.2			
83-103	B23													22.0	31.5			
103-150	B24													22.0	31.5			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-30	3.18	0.229	14	12.4	2.2	0.2	0.1	14.9		14.9		0.3		100		6.6	5.8
30-53	1.75	0.111	16	5.6	1.2	0.2	0.1	7.1		9.6		0.8		74		6.7	6.1
53-83	1.25	0.077	16	2.4	0.8	0.2	0.1	3.5		5.0		1.8		70		6.7	6.1
83-103	0.91	0.053	17	1.1	0.5	0.2	tr.	1.8		4.2		2.8		43		6.6	6.1
103-150	0.79	0.046	17	1.6	0.7	0.3	0.1	2.7		5.6		5.4		48		6.3	6.1

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-30				tr.						1.23	3.04	41.6	36.4	28.1		
30-53				-						1.17	3.16	45.0	39.2	33.2		
53-83				-						1.18	3.20	48.0	38.3	33.7		
83-103				tr.						1.25	3.23	44.1	36.2	33.2		
103-150				-						1.19	3.32	47.8	43.2	38.8		

a/ 22.8 kg of organic carbon per square meter to a depth of 1 meter.

PUHI SILTY CLAY LOAM
S63Ha-2-1

Location: Island of Kauai, Kauai County, Hawaii; 4.2 km (2.6 miles) northwest of the junction of Highway 56 and Wailua Falls Road in Kapaia. Between the Wailua Falls Road and the dam for the small reservoir northeast of the road. Approximately 47 m (157 feet) in from the road. Date of sampling: May 6, 1963.
Description by: D. E. Foote. Collectors: D. E. Foote, J. A. DeMent, and J. M. Williams.
Classification: **Tropeptic Eutrorthox, clayey, oxidic, isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: Average annual precipitation is 175 cm (70 inches) with about 50 percent falling from November through March. The mean annual temperature is 23° C (73° F). Parent material: Formed in residuum from nephaline basalt, melatite nephaline basalt, olivine basalt, and picrite basalt. Topography: Smooth upland. Slope 2 percent. Elevation: 102 m (340 feet). Drainage: Well drained. Permeability of the B2, C, and underlying weathered rock is moderate. Runoff is slow to moderate. Soil moisture: Profile at field capacity when sampled.
Remarks: Textures are apparent field textures. Channels filled with A material extend down into the B23. Cane roots follow these channels. Paired sample number S63Ha-2-2.

HORIZON	DESCRIPTION
Ap LSL No. 18736	0 to 30 cm (0-12 inches), brown (10YR 3/4) silty clay loam, same color when rubbed, yellowish brown (10YR 5/4) dry; moderate very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many roots; many very fine and fine tubular pores and common interstitial pores; many gritty, hard to break down particles; delayed reaction with hydrogen peroxide; very strongly acid (pH 5.0); abrupt wavy boundary.
B21 LSL No. 18737	30 to 53 cm (12-21 inches), reddish brown (5YR 4/4) silty clay loam, yellowish red (5YR 4/6) dry; weak very fine and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many very fine and common fine pores; nearly continuous shiny glaze on peds; medium acid (pH 5.9); gradual smooth boundary.
B22 LSL No. 18738	53 to 83 cm (21-33 inches), dark reddish brown (5YR 3/4) silty clay loam, yellowish red (5YR 4/6) dry; moderate very fine and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many very fine and common fine pores; nearly continuous shiny glaze on peds; common black specks; slightly acid (pH 6.1); gradual smooth boundary.
B23 LSL No. 18739	83 to 103 cm (33-41 inches), dark reddish brown (2.5YR 3/4) silty clay loam, yellowish red (5YR 4/6) dry; moderate very fine and extremely fine subangular blocky structure; hard, friable, slightly sticky and plastic; few very fine roots; many very fine and common medium pores; continuous shiny glaze on peds; patchy film-like coatings on peds; many shiny particles, many very fine black specks; medium acid (pH 6.0); gradual smooth boundary.
B24 LSL No. 18740	103 to 150 cm (41-60 inches), dark reddish brown (5YR 3/3) silty clay, yellowish red (5YR 4/8) dry; strong very fine and fine subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; many very fine and fine, common medium pores; continuous shiny glaze on peds; many very fine black specks and shiny particles; medium acid (pH 6.0).

SOIL FAMILY Typic Gibbsiorthox, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kapaa silty clay SOIL Nos. 865Ha-2-4 LOCATION Kauai County, Hawaii

Riverside Lab Nos. 6530 - 6535

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonite	Illite	Halloysite	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-35	Ap																	
35-55	B21																	
55-78	B22																	
78-95	B23																	
95-113	B24																	
113-150	B25																	

Depth (cm)		Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-35	Ap													23.1	33.0			
35-55	B21													24.1	34.5			
55-78	B22													22.7	32.5			
78-95	B23													21.3	30.5			
95-113	B24													20.1	28.7			
113-150	B25													20.5	29.3			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 5L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-35	3.77	0.227	17	0.4	0.1	0.2	0.1	0.8		16.6		2.8	1.0	5		4.8	4.4
35-55	1.53	0.072	21	0.3	tr.	0.1	0.1	0.5		3.4		3.1		15		5.8	6.1
55-78	0.98	0.041	24	0.1	tr.	0.2	0.1	0.4		1.8		4.7		22		6.3	6.3
78-95	0.93	0.040	23	0.4	0.1	0.1	0.1	0.7		4.2		6.3	0.2	17		5.8	6.1
95-113	0.74	0.034	22	0.7	0.1	0.2	0.1	1.1		4.3		8.9		26		5.8	5.8
113-150	0.64	0.024	27	0.1	tr.	0.2	0.1	0.4		1.9		13.9		21		5.6	5.7

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	b/ Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar clod	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.				Pct.	Pct.	Pct.	g/cc				Pct. of whole soil			cm/cm	
0-35					39	59	20	1.21	1.30	1.24	3.10	37.5	34.7	28.4	0.026	0.026
35-55										1.21	3.23		39.6	34.1		
55-78					40	58	18	1.14	1.20	1.20	3.17	44.6	37.7	31.5	0.016	0.016
78-95										1.18	3.18		42.6	35.1		
95-113										1.17	3.13		43.0	38.1		
113-150					38	47	9	1.22	1.19	1.14	3.14	41.3	37.4	30.3	0.007	0.007

a/ 25.1 kg of organic carbon per square meter to a depth of 1 meter.

b/ These samples were not allowed to dry prior to analysis.

KAPAA SILTY CLAY
S65Ha-2-4

Location: Island of Kauai, Kauai County, Hawaii. Kapaa Quadrangle - 22°02'42" north latitude and 159°23'31" west longitude. North 1,980 m (6,600 feet), 7.3° west of road corner of HSPA Variety Test Station. Date of sampling: April 16, 1965.
Description by: D. E. Foote and L. D. Giese. Collectors: K. Flach, L. Swindale, H. Collins, L. Giese, D. Foote, and G. Yamamoto.
Classification: **Typic Gibbsiorthox, clayey, oxidic, isohyperthermic.**
Vegetation: Cultivated sugarcane (Saccharum officinarum), natural vegetation consists of ricegrass (Paspalum orbiculare), hilograss (Paspalum conjugatum), yellow foxtail (Setaria geniculata), Christmas berry (Schinus terebinthifolius), false staghorn fern (Dicranopteris linearis), kikuyugrass (Pennisetum clandestinum), rhodomyrtus (Rhodomyrtus tomentosa), melastoma (Melastoma malabathricum), guava (Psidium guayava), ohia (Metrosideros collina). Climate: Average annual precipitation is 225 cm (90 inches). Mean annual temperature is 23° C (74° F). Parent material: Weathered basalt. Topography: Gently sloping upland; convex slope; 2 percent slope; east-southeast aspect; midslope. Elevation: 117 m (390 feet). Drainage: Medium runoff; moderate permeability; well drained. Soil moisture: Moist.

[illegible]

"smeariness" are explained in the methods section of this report. Paired sample number S65Ha-2-5.

HORIZON	DESCRIPTION
Ap RSL No. 6530	0 to 35 cm (0-14 inches), dark yellowish brown (10YR 4/4) silty clay, dark yellowish brown (10YR 4/4) dry; weak fine granular structure; slightly hard, friable, sticky and plastic; many roots; many pores; about 10 percent of volume made up of yellowish red (5YR 4/6) material turned up by plowing; hard earthy lumps that break down with prolonged rubbing; slight reaction to hydrogen peroxide; strongly acid (pH 5.5); definite matting of roots between Ap and B21; abrupt smooth boundary.
B21 RSL No. 6531	35 to 55 cm (14-22 inches), yellowish red (5YR 4/6) silty clay, reddish brown (5YR 4/4) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; very few roots; many fine and medium pores; thin coatings in pores, patchy coatings on ped faces; about 5 percent weathered gravels impregnated with gibbsite; no reaction to hydrogen peroxide; slightly acid (pH 5.6); clear smooth boundary.
B22	55 to 78 cm (22-31 inches), yellowish red (5YR 4/6) light clay loam with [illegible]
RSL No. 6532	gritty feel, strong brown (7.5YR 4/6) dry; weak, medium and fine subangular blocky structure; friable, sticky and plastic, smeary; very few roots; many medium, fine and very fine pores; gelatinous coatings in pores, patchy on ped faces; about 25 percent weathered gravels impregnated with gibbsite; no reaction to hydrogen peroxide; medium acid (pH 5.8); clear smooth boundary.
B23 RSL No. 6533	78 to 95 cm (31-38 inches), reddish brown (5YR 4/4) silty clay, strong brown (7.5YR 5/6) dry; weak medium and fine subangular blocky structure; slightly hard, friable, sticky and plastic; very few roots; many medium, fine and very fine pores; gelatinous coatings in pores, patchy on ped faces; about 10 percent weathered gravels impregnated with gibbsite; bands and lens of yellowish material that is presumed to be gibbsite; no reaction to hydrogen peroxide; medium acid (pH 5.8); between B23 and B24 is a band of gibbsite in places; clear smooth boundary.
B24	95 to 113 cm (38-45 inches), yellowish red (5YR 4/6) silty clay (5YR 4/6) [illegible]

SOIL FAMILY Typic Gibbsiorthox, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Kapaa silty clay SOIL Nos. S65Ha-2-5 LOCATION Kauai County, Hawaii

Riverside Lab Nos. 6536 - 6541

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-30	Ap			5	10	25		40			5	10						
30-40	B21			2	0	30		35			10	10						
40-63	B22			1	0	30		35			10	10						
63-90	B23			1	0	35		30			10	10						
90-123	B24			1	10	30		30			15	10						
123-150	B25			1	20	10		30			20	10						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C2a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-30	Ap	6.9	7.6	24.6	38.5	0.06	0.32	tr.	0.03	0.28	0.63	21.7	100.0	24.1	34.5		1.80	7.51
30-40	B21	4.4	7.2	28.1	39.3	0.09	0.25	-	0.03	0.11	0.55	19.9	99.9	23.3	33.3		1.50	11.08
40-63	B22	4.1	8.1	28.8	38.5	0.08	0.08	-	0.03	0.07	0.58	19.7	100.0	21.3	30.5		1.95	11.58
63-90	B23	4.3	7.5	32.9	34.3	0.17	0.13	-	0.03	0.07	0.63	20.0	100.0	18.5	26.5		2.28	20.49
90-123	B24	7.1	7.5	30.9	35.2	0.15	0.11	-	0.03	0.07	0.57	18.9	100.5	17.1	24.4		3.08	18.17
123-150	B25	13.2	8.4	24.8	36.8	0.15	0.38	tr.	0.03	0.07	0.61	15.5	99.9	17.2	24.6		5.82	10.29

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-30	3.92	0.22	18	0.7	0.4	0.20	0.40	1.7		15.9		1.8	0.6	11		5.0	4.5
30-40	1.46	0.07	21	0.2	0.0	0.10	0.20	0.5		3.7		4.7		14		5.5	5.7
40-63	1.09	0.04	27	0.4	0.1	0.20	0.10	0.8		2.6		7.6		31		5.5	5.7
63-90	0.64	0.02	32	0.1	0.1	0.20	0.10	0.5		1.9		12.0		26		5.8	5.7
90-123	0.46	0.02	23	0.8	0.1	0.20	0.10	1.2		3.7		4.4	0.1	32		5.3	5.4
123-150	0.48	0.02	24	1.0	0.1	0.30	0.10	1.5		6.1		11.6		24		5.5	4.9

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-30										1.14	3.12		36.3	30.0		
30-40										1.09	3.21		40.1	35.6		
40-63										1.04	3.29		37.3	30.5		
63-90										1.13	3.13		38.4	32.1		
90-123										1.16	3.18		38.9	31.7		
123-150										1.18	3.26		40.5	34.8		

a/ 20.2 kg of organic carbon per square meter to a depth of 1 meter.

KAPAA SILTY CLAY
S65Ha-2-5

Location: Island of Kauai, Kauai County, Hawaii. Kapaa Quadrangle - 22°01'34" north latitude and 159°23'50" west longitude. West 77 m (255 feet), 7.7° south of road corner by HSPA Variety Test Station. Date of sampling: April 16, 1965.
Description by: D. E. Foote and L. D. Giese. Collectors: K. Flach, H. Collins, L. Swindale, L. Giese, D. Foote, and G. Yamamoto.
Classification: **Typic Gibbsiorthox, clayey, oxidic, isohyperthermic.**
Vegetation: Cultivated sugarcane (Saccharum officinarum), natural vegetation consists of ricegrass (Paspalum orbiculare), hilograss (Paspalum conjugatum), yellow foxtail (Setaria geniculata), Christmas berry (Schinus terebinthifolius), false staghorn fern (Dicranopteris linearis), kikuyugrass (Pennisetum clandestinum), rhodomyrtus (Rhodomyrtus tomentosa), melastoma (Melastoma malabathricum), guava (Psidium guayava), ohia (Metrosideros collina). Climate: [illegible]

SOIL FAMILY **Typic Gibbsiorthox, clayey, oxidic, isohyperthermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Pooku silty clay SOIL Nos. S62Ha-2-4 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 17344 - 17349

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-28	Ap1																	
28-35	Ap2																	
35-70	B21																	
70-83	B22																	
83-108	B23																	
108-155	B24																	

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-28	Ap1													29.0	41.5			
28-35	Ap2													35.8	51.2			
35-70	B21													27.0	38.6			
70-83	B22													29.2	41.8			
83-108	B23													29.1	41.6			
108-155	B24													30.0	42.9			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	6O2a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:5	8C1c KCl 1:5
				Meg./100 g.										Percent			
0-28	3.89	0.231	17	0.6	0.9	0.2	0.2	1.9		16.6		0.5	0.5	11		4.2	4.1
28-35	2.45	0.118	21	-	0.2	0.1	0.1	0.4		9.4		1.5	0.2	4		5.6	5.2
35-70	1.65	0.070	24	0.1	-	tr.	0.1	0.2		4.7		6.8	0.2	4		5.3	5.4
70-83	1.04	0.042	25	-	0.1	0.1	0.1	0.3		3.4		14.8	0.2	9		5.1	5.4
83-108	0.83	0.030	28	-	-	tr.	0.1	0.1		2.5		17.2	0.1	4		4.9	5.3
108-155	0.66	0.019	35	-	-	0.1	tr.	0.1		1.2		20.3	0.1	8		4.8	5.1

Depth (cm)	Size class and particle diameter (mm) 3A1 Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits Plastic limit	Liquid limit	Plastic index	Bulk density 1/3 bar	Oven dry	Field moist	Particle density	Water content	1/3 bar	15 bar	Extensibility 4D1 COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-28				-						0.99	3.20		47.8	34.7		
28-35				tr.						1.21						
35-70				tr.						1.25	3.41		45.5	37.3		
70-83				tr.						1.20	3.40		45.5	34.1		
83-108				tr.						1.20	3.45		48.6	36.3		
108-155				tr.							3.43		43.1	32.4		

a/ 23.4 kg of organic carbon per square meter to a depth of 1 meter.

POOKU SILTY CLAY
S62Ha-2-4

Location: Island of Kauai, Kauai County, Hawaii; .4 km (¼ mile) south of Pooku Hill, 31 m (105 feet) east of fence. Approximately 7.2 km (4.5 miles) west of Kilauea and 24 km (15 miles) northwest of Lihue. Date of sampling: 1962.
Description by: J. M. Williams and D. E. Foote. Collectors: J. M. Williams and D. E. Foote.
Classification: **Typic Gibbsiorthox, clayey, oxidic, isohyperthermic.**

Vegetation: Pangolagrass (*Digitaria decumbens*), kaimi clover (*Desmodium canum*), sensitive plant (*Mimosa pudica*), and hilograss (*Paspalum conjugatum*).

The mean annual temperature is 22.8° C (73° F), the mean January temperature is 20.6°C (69° F), and the mean July temperature 24.4° C (76° F). Parent material: Residuum from basic igneous rock. Topography: A convex slope to northwest, 1 percent slope. Elevation: 96 m (320 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S62Ha-2-5.

HORIZON	DESCRIPTION
Ap1 LSL No. 17344	0 to 28 cm (0-11 inches), dark brown (10YR 4/3) silty clay, yellowish brown (10YR 5/4) dry; strong very fine subangular blocky structure; hard, friable sticky and plastic; abundant roots; many very fine and fine pores; many ironstone-gibbsite pebbles that have a dense outer shell with a softer yellowish center; extremely acid (pH 4.2); clear smooth boundary.
Ap2 LSL No. 17345	28 to 35 cm (11-14 inches), dark brown (10YR 4/3) silty clay, dark reddish brown (2.5YR 3/4) mixed in cultivation, yellowish brown (10YR 5/4) and dark reddish brown (2.5YR 3/4) dry; moderate very fine subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many very fine and fine pores; few ironstone-gibbsite pebbles; medium acid (pH 5.6); abrupt wavy boundary.
B21 LSL No. 17346	35 to 70 cm (14-28 inches), dark reddish brown (2.5YR 3/4) silty clay loam, dark red (2.5YR 3/6) dry; moderate very fine subangular blocky structure; hard, friable, sticky and plastic; abundant fine roots; many very fine and fine pores; nearly continuous pressure cutans; few cutans that look like illuviated sesquioxides; few non-magnetic warm firm nodules that appear to be segregated iron; strongly acid (pH 5.3); abrupt smooth boundary.
B22 LSL No. 17347	70 to 83 cm (28-33 inches), dark reddish brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) dry; moderate very fine subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many very fine and fine pores; nearly continuous pressure cutans; patchy glazed coating that appears to be sesquioxide coatings; a few gravel-size pieces of saprolite; this horizon is capped by a thin discontinuous ironstone seam 1 to 2 mm thick; a root mat has built up in places on this ironstone seam; strongly acid (pH 5.1); clear smooth boundary.
B23 LSL No. 17348	83 to 108 cm (33-43 inches), dark red (2.5YR 3/6) silty clay, yellowish red (5YR 5/6) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many very fine and fine pores;

SOIL FAMILY Typic Gibbsiorthox, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Pooku silty clay SOIL Nos. S62Ha-2-5 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 17350 - 17355

Depth (cm)	Horizon	Mineralogical Analysis																
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-38	Ap1			3	5	40		40			15	10	5					
38-48	Ap2			3	2	35		50			2	10	2					
48-75	B21			1		25		40			15	10	1					
75-100	B22					35		40			10	10						
100-155	C1					45		40			10	10						
155-225	C2					45		30			15	10						

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-38	Ap1	8.5	8.7	31.3	45.5	0.07	-	-	0.06	0.23	0.70	5.0	100.1	24.5	35.0		0.29	5.26
38-48	Ap2	2.9	8.0	20.6	48.2	0.07	-	-	0.07	0.23	0.63	19.7	100.4	32.5	46.5		0.22	5.04
48-75	B21	1.0	8.3	20.8	46.4	0.04	-	-	0.07	0.10	0.60	20.5	97.8	26.2	37.5		0.06	10.16
75-100	B22	0.4	7.3	28.5	42.3	0.09	-	-	0.07	-	0.61	20.7	100.0	26.1	37.3		-	15.57
100-155	C1	0.4	6.8	30.1	41.3	0.08	tr.	-	tr.	-	0.64	20.2	99.5	23.5	33.6		-	18.89
155-225	C2	0.6	7.1	31.1	40.9	0.16	tr.	-	tr.	-	1.18	19.4	100.4	20.5	29.3		-	20.99

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc 6I2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	6O2a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-38	3.88	0.27	14	0.5	0.6	0.1	0.1	1.3		14.6		1.6	0.3	9		5.2	4.2
38-48	2.43	0.14	17	-	-	0.1	0.1	0.2		9.6		5.0	0.1	2		4.7	4.4
48-75	1.58	0.07	23	-	0.6	tr.	tr.	0.6		4.8		6.5	0.1	12		5.0	5.1
75-100	1.10	0.05	22	-	-	tr.	tr.	-		2.6		11.3	0.1	tr.		4.8	5.3
100-155	0.66	0.23	3	0.2	0.1	0.1	0.1	0.5		1.9		14.5	0.1	26		4.8	5.4
155-225	0.16	0.11	1	-	-	0.1	tr.	0.1		0.5		14.4	0.1	20		4.9	5.3

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility 4D1	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	Field moist			1/3 bar	15 bar	COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-38				tr.						1.12	3.17		41.2	30.9		
38-48				tr.						1.10	3.38		40.9	33.8		
48-75				tr.						1.12	3.29		41.1	33.4		
75-100				tr.						1.26	3.22		42.8	29.3		
100-155				tr.						1.19	3.23		41.6	26.6		
155-225				tr.							3.24		37.6	18.8		

a/ 27.5 kg of organic carbon per square meter to a depth of 1 meter.

POOKU SILTY CLAY
S62Ha-2-5

Location: Island of Kauai, Kauai County, Hawaii; 75 m (250 feet) south of highway at a point 1.7 km (1.1 miles) southwest of Bailey Bridge at Kalihiwai, approximately 6.4 km (4 miles) west of Kilauea. Approximately 22.5 km (14 miles) northwest of Lihue. Date of sampling: 1962.
Description by: J. M. Williams and D. E. Foote. Collectors: J. M. Williams and D. E. Foote.
Classification: **Typic Gibbsiorthox, clayey, oxidic, isohyperthermic.**
Vegetation: Pangola pasture. Climate: Average annual precipitation is 200 to 225 cm (80-90 inches). The mean annual temperature is 22.8° C (73° F), the mean January temperature is 20.6° C (69° F), and the mean July temperature 24.4° C (76° F). Parent material: Residuum from basic igneous rock. Topography: Low windward slopes, slightly convex to southwest, 1 to 2 percent slopes at sample site. Elevation: 96 m (320 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Texture and terms for describing "smeariness" are explained in the methods section of this report. Colors are for

Ap1 LSL No. 17350	0 to 38 cm (0-15 inches), dark yellowish brown (10YR 4/4) silty clay mottled with reddish brown (5YR 4/4) material by tillage; strong very fine subangular blocky structure; sticky, plastic, friable; many roots; many very fine and fine pores; many iron concretions that have a dense dark outer shell with softer yellowish center; abrupt smooth boundary.
Ap2 LSL No. 17351	38 to 48 cm (15-19 inches), dark yellowish brown (10YR 4/4) silty clay mottled with reddish brown (5YR 4/4) material by cultivation; weak fine subangular blocky structure; sticky, plastic, friable; common fine and very fine roots; many fine and common fine pores; many iron concretions similar to first horizon; clear smooth boundary.
B21 LSL No. 17352	48 to 75 cm (19-30 inches), dark reddish brown (5YR 3/4) silty clay loam; weak fine subangular blocky structure; sticky, plastic, friable; common fine and very fine pores; nearly continuous pressure surfaces; few very firm particles that appear to be segregated iron, these particles are non-magnetic; clear smooth boundary.
B22 LSL No. 17353	75 to 100 cm (30-40 inches), dark reddish brown (5YR 3/4) silty clay; moderate fine subangular blocky structure; sticky, plastic, friable; common fine and very fine roots; common very fine and fine pores; nearly continuous pressure surfaces; few patchy cutans that have a metallic sheen; few saprolite fragments; this horizon is underlain by discontinuous iron seam on which there is a buildup of roots; abrupt wavy boundary.
C1 LSL No. 17354	100 to 155 cm (40-62 inches), variegated dark reddish brown (5YR 3/3), yellowish red (5YR 3/6), red (5YR 4/6), dusky red (2.5YR 2/2) loam; weak coarse platy structure; slightly sticky, slightly plastic, friable with pockets of firm material; few very fine and fine roots; few very fine and fine pores; near bottom is a pan that appears to have a fine platy structure; the thin plates appear to be hematite and gibbsite and are very firm and

SOIL FAMILY Tropeptic Umbriorthox, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Lawai silty clay SOIL Nos. 863Ha-2-5 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 18725 - 18729

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-28	Ap			15	15	10		20			15	10						
28-55	Ap2			10	15	10		25			10	5						
55-98	B21			5	20	10		25			10	5						
98-145	B22			5	25	10		30			3	5						
145-160	C			2	25	15		25			5	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-28	Ap	19.4	8.4	23.9	29.6	0.07	0.79	-	0.07	1.05	0.31	16.4	100.0	14.3	20.4		3.70	5.45
28-55	Ap2	18.3	5.9	26.5	30.5	0.10	0.66	0.06	0.07	0.83	0.28	17.0	100.2	16.9	24.2		5.66	7.10
55-98	B21	19.4	4.6	28.1	29.6	0.11	0.64	-	0.04	0.50	0.28	16.5	99.8	16.9	24.2		7.14	7.96
98-145	B22	22.5	4.1	27.3	28.4	0.08	0.62	tr.	0.04	0.30	0.25	16.3	99.9	18.4	26.3		8.89	9.67
145-160	C	21.6	4.1	30.7	25.6	0.09	0.58		0.03	0.15	0.30	17.0	100.2	15.5	22.2		8.60	13.56

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation 5C1 NH_4OAc	5C3	pH 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-28	3.00	0.24	13	-	0.6	0.10	0.10	0.8		15.6		2.8	2.2	5.0		4.3	3.8
28-55	1.91	0.17	11	-	1.0	0.10	0.10	1.2		13.7		2.1	0.6	9.0		4.8	4.1
55-98	1.18	0.11	11	0.8	1.4	0.20	0.10	2.5		15.9		2.8	1.2	16.0		4.9	4.1
98-145	0.83	0.77	1	0.8	1.4	0.40	0.10	2.7		15.6		4.5	3.6	17.0		4.9	3.9
145-160	0.58	0.05	12	0.7	1.1	0.70	0.10	2.6		14.1		6.1	4.9	18.0		4.8	3.8

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-28				-						0.94	3.10	64.0	49.6	36.0		
28-55				-						0.93	3.06	72.2	63.6	48.6		
55-98				-						0.92	3.10	74.1	64.9	51.3		
98-145				-						0.93	3.05	73.7	68.1	51.7		
145-160				tr.							3.05		55.0	39.7		

a/ 17.5 kg of organic carbon per square meter to a depth of 1 meter.

LAWAI SILTY CLAY
S63Ha-2-5

Location: Island of Kauai, Kauai County, Hawaii; 1.7 km (1.04 miles) north 63.4° west of junction of Highways 50 and 520. Date of sampling: May 8, 1963.
Description by: D. E. Foote. Collectors: D. E. Foote, J. A. DeMent, and J. M. Williams.
Classification: **Tropeptic Umbriorthox, clayey, oxidic, isohyperthermic.**
Vegetation: Pineapple. Climate: Average annual precipitation is 250 cm (100 inches) which is well distributed throughout the year. Mean annual temperature is 22° C (72° F). Parent material: Colluvium from moderately high rainfall area weathered from basic igneous rock. Topography: Mountain foot slope. Slope gradient 11 percent. Elevation: 225 m (750 feet). Drainage: Imperfectly drained; permeability of the B2 and C is slow; runoff is rapid. Soil moisture: Profile saturated when sampled.
Remarks: Textures are apparent field textures. All colors identified when moist. Water seeped into sample pit and stood at about 90 cm (3 feet) from the surface. The Ap1 horizon has a gritty feel. The Ap2 horizon is a mixture of B and A material. Paired sample number S63Ha-2-6.

HORIZON	DESCRIPTION
Ap LSL No. 18725	0 to 28 cm (0-11 inches), very dark grayish brown (2.5Y 3/2) clay with common fine light red mottles; moderate fine and very fine subangular blocky structure; firm, sticky and plastic; common medium, many fine and very fine roots; common fine and very fine tubular pores; many very fine interstitial pores; included are pieces of B material brought up by tillage; clear smooth boundary.
Ap2 LSL No. 18726	28 to 55 cm (11-22 inches), dark brown (7.5YR 3/4) silty clay, 10YR 4/3 when rubbed; weak fine and very fine subangular blocky structure; firm, sticky and plastic; common fine and very fine roots; common micro and very fine tubular pores; many very fine interstitial pores; A material same as described for Ap horizon and makes up about 30 percent of this horizon; abrupt smooth boundary.
B21 LSL No. 18727	55 to 98 cm (22-39 inches), dark brown (7.5YR 3/4) silty clay, 10YR 4/3 when rubbed, common fine light red mottles; moderate fine and very fine subangular blocky structure; firm, sticky and plastic; common fine and very fine roots in upper part, none in lower part; common micro, very fine, few fine and medium tubular pores; many very fine interstitial pores; some coatings of very pale brown (10YR 7/4); gradual smooth boundary.
B22 LSL No. 18728	98 to 145 cm (39-58 inches), dark brown (7.5YR 4/4) silty clay, many fine bright light red mottles; moderate medium angular blocky breaking to fine and very fine angular blocky structure; firm, sticky and plastic; no roots; common micro and very fine tubular pores; many very fine interstitial pores; some coatings are yellowish red (5YR 4/6); about 50 percent of volume is saprolite gravels; clear wavy boundary.
C LSL No. 18729	145 to 160 cm (58-64 inches), strong brown (7.5YR 5/6) silty clay, many fine bright light red mottles; this material is filled in around hard and soft saprolite gravels; saprolite is impregnated with yellowish to white material (goethite and gibbsite).

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL FAMILY **Tropeptic Umbriorthox, clayey, oxidic, isohyperthermic**

SOIL SERIES **Lawai silty clay** SOIL Nos. **S63Ha-2-6** LOCATION **Kauai County, Hawaii**

Lincoln Lab Nos. 18730 - 18735

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-20	Ap1																	
20-35	Ap2																	
35-65	B21																	
65-105	B22																	
105-133	B23																	
133-150	B24																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-20	Ap1													21.6	30.9			
20-35	Ap3													23.0	32.9			
35-65	B21													20.8	29.7			
65-105	B22													17.3	24.7			
105-133	B23													16.4	23.5			
133-150	B24													16.0	22.9			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-20	2.76	0.176	16	-	1.1	0.1	0.3	1.5		14.1		3.2	1.3	11		4.4	3.9
20-35	1.88	0.115	16	-	1.0	0.1	0.1	1.2		12.4		3.4	1.5	10		4.6	4.0
35-65	1.28	0.088	14	0.4	1.2	0.2	0.1	1.9		12.2		4.8	1.7	16		4.6	4.1
65-105	0.66	0.054	12	0.4	1.0	0.2	0.1	1.7		12.5		8.4	3.6	14		4.4	3.8
105-133	0.40			0.4	1.0	0.2	0.1	1.7		12.9		11.4	4.4	13		4.4	3.8
133-150	0.37			0.4	0.9	0.1	0.1	1.5		9.0		13.7	2.5	17		4.4	3.9

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-20				tr.						1.20	3.29	43.9	34.8	31.5		
20-35				tr.						0.97	3.30	69.2	59.0	47.7		
35-65				tr.						0.93	3.20	72.4	68.3	50.5		
65-105				-						0.95	3.10	71.4	64.6	51.1		
105-133				-						0.93	3.13	73.3	67.6	52.8		
133-150				-						0.96	3.15	70.6	58.0	49.5		

a/ 15.1 kg of organic carbon per square meter to a depth of 1 meter.

LAWAI SILTY CLAY
S63Ha-2-6

Location: Island of Kauai, Kauai County, Hawaii; 1.2 km (0.76 mile) north 52.6° east [illegible]

of the junction of Highways 50 and 520. Date of sampling: May 9, 1963.
Description by: D. E. Foote. Collectors: D. E. Foote and J. A. DeMent.
Classification: **Tropeptic Umbriorthox, clayey, oxidic, isohyperthermic.**
Vegetation: Pineapple (disced). Climate: Average annual precipitation is 188 cm (75 inches) which is distributed evenly throughout the year. Mean annual temperature is 22° C (72° F). Parent material: Colluvium from moderately high rainfall area weathered from basic igneous rock. Topography: Mountain foot slopes. Slope 8 percent. Elevation: 168 m (560 feet). Drainage: Imperfectly drained; permeability of the B2 and C is slow; runoff is rapid. Soil moisture: Profile saturated when sampled.
Remarks: Textures are apparent field textures. Water seeped into sample pit and stood [illegible]

Augered 75 cm (2½ feet) below 150 cm (60 inches); B3 started at about 175 cm (70 inches). Paired sample number S63Ha-2-5.

HORIZON	DESCRIPTION
Ap1 LSL No. 18730	0 to 20 cm (0-8 inches), very dark grayish brown (10YR 3/2) silty clay, (10YR 3/2) dry; weak fine and very fine subangular blocky structure; hard, friable, sticky and plastic; many very fine, fine and medium roots; many fine and very fine interstitial pores; common very fine, fine and medium pores; about 40 percent of the material is from the Ap2 mixed by tillage; strongly acid (pH 5.5); clear broken boundary.
Ap2 LSL No. 18731	20 to 35 cm (8-14 inches), dark brown (7.5YR 4/4) silty clay, (7.5YR 3/2) dry; weak very fine subangular blocky structure; very hard, firm, sticky and plastic; many micro, very fine, fine and medium roots; common micro and very fine tubular, many very fine interstitial pores; about 20 percent is material from the Ap1 horizon mixed by tillage; medium acid (pH 6.0); clear wavy boundary.
B21 LSL No. 18732	35 to 65 cm (14-26 inches), dark brown (7.5YR 4/4) silty clay, (7.5YR 3/2) dry; weak fine and very fine subangular blocky structure; very hard, firm, sticky and plastic; many micro, very fine, fine and medium roots; common micro and very fine tubular, many very fine interstitial pores; some yellowish sugar-like granules in pores and on ped faces; medium acid (pH 6.0); gradual smooth boundary.

SOIL FAMILY Tropeptic Umbriorthox, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Makapili silty clay SOIL Nos. S63Ha-2-3 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 18747 - 18752

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-25	Ap																	
25-33	B1																	
33-53	B21																	
53-83	B22																	
83-125	B23																	
125-163	B24																	

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-25	Ap													22.1	31.6			
25-33	B1													26.3	37.6			
33-53	B21													28.1	40.2			
53-83	B22													29.4	42.0			
83-125	B23													24.6	35.2			
125-163	B24													23.6	33.7			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch capacity		NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	602a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-25	4.53	0.388	12	1.8	2.0	0.2	0.3	4.3		19.1		0.6	tr.	22		5.9	4.6
25-33	2.31	0.173	13	1.0	0.5	0.1	0.1	1.7		11.7		1.7	0.2	14		5.4	4.9
33-53	1.83	0.130	14	0.9	0.4	0.1	tr.	1.4		11.0		1.7	tr.	13		5.5	5.3
53-83	1.53	0.098	16	0.5	0.3	0.1	0.1	1.0		10.0		0.9		10		5.9	5.7
83-125	0.82	0.038	22	0.2	-	0.1	tr.	0.3		3.6		2.0		8		6.0	6.2
125-163	0.57	0.029	20	0.1	-	0.1	tr.	0.2		3.6		1.5		6		6.0	6.4

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility 4D1	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	Field moist		Field moist	1/3 bar	15 bar	COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-25				tr.						0.99	3.14	65.0	43.1	31.7		
25-33				tr.						1.13		46.5				
33-53				-						1.05	3.41	50.3	42.6	36.1		
53-83				tr.						1.17	3.45	46.4	40.5	34.8		
83-125				tr.						1.34	3.51	39.8	49.0	28.6		
125-163				tr.							3.54		31.7	28.0		

a/ 24.4 kg of organic carbon per square meter to a depth of 1 meter.

MAKAPILI SILTY CLAY
S63Ha-2-3

Location: Island of Kauai, Kauai County, Hawaii; 3.2 km (1.97 miles) east northeast of the mouth of the Hanalei River. On Princeville Ranch, go northeast 1.1 km (.7 mile) from highway down lane west of the ranch headquarters, then 90 m (300 feet) west of the land and about 45 m (150 feet) north of the fence. Date of sampling: May 7, 1963.

Description by: D. E. Foote. Collectors: D. E. Foote, J. M. Williams, and J. A. DeMent.

Classification: **Tropeptic Umbriorthox, clayey, oxidic, isohyperthermic.**

Vegetation: Nonirrigated pasture (kikuyugrass). Climate: Average annual precipitation is 188 cm (75 inches) which is distributed throughout the year. Mean annual temperature is 22.2° C (72° F). Parent material: Formed in residuum from nephaline basalt, melatite nephaline basalt, olivine basalt and picrite basalt. Topography: Smooth upland. Slope 1 percent. Elevation: 72 m (240 feet). Drainage: Well drained. Permeability of the B2, C and of the underlying weathered rock is moderate. Runoff is slow to moderate. Soil moisture: Profile at field capacity when sampled.

Remarks: Textures are apparent field textures. The soil is magnetic throughout. Colors are for moist soil. Paired sample number S63Ha-2-4.

HORIZON	DESCRIPTION
Ap LSL No. 18747	0 to 25 cm (0-10 inches), brown (10YR 4/3) silty clay, 10YR 4/4 when rubbed; strong fine subangular blocky structure; friable, sticky and plastic; many very fine, fine and medium roots; few very fine tubular, many fine interstitial pores; abrupt wavy boundary.
B1 LSL No. 18748	25 to 33 cm (10-13 inches), dark reddish brown (5YR 3/4) loam, 5YR 4/4 when rubbed; massive; friable, slightly sticky and slightly plastic; many micro, very fine, fine and medium roots; many micro, very fine, and common fine tubular pores; higher chroma sugar-like particles; clear wavy boundary.
B21 LSL No. 18749	33 to 53 cm (13-21 inches), dark reddish brown (5YR 3/4) clay loam, 5YR 4/4 when rubbed; weak fine and very fine subangular blocky structure; firm, slightly sticky and slightly plastic; many micro, very fine, fine and medium roots; many micro, very fine, fine and common medium tubular pores, many very fine interstitial pores; higher chroma sugar-like granules; gradual wavy boundary.
B22 LSL No. 18750	53 to 83 cm (21-33 inches), dark reddish brown (5YR 3/4) clay loam, 5YR 4/4 when rubbed; moderate coarse subangular blocky breaking to weak fine and very fine subangular blocky structure; firm, slightly sticky and slightly plastic; common micro, very fine, fine, few medium roots; many micro, very fine, common fine, few medium tubular pores, many very fine interstitial pores; higher chroma sugar-like granules; hard earthy lumps; clear very irregular boundary.
B23 LSL No. 18751	83 to 125 cm (33-50 inches), dark reddish brown (2.5YR 3/4) silty clay loam, 2.5YR 4/4 when rubbed; moderate fine and very fine subangular blocky structure; firm, slightly sticky and plastic; common micro, very fine, fine, few medium roots; many micro, common very fine, fine, few tubular pores; higher chroma sugar-like granules; few fine gravel-size concretions (probably gibbsite); pieces of saprolite impregnated with white and yellowish white secondary minerals; saprolite over 2.5 cm (1 inch) in diameter make up about 5 percent of the volume; gradual smooth boundary.
B24 LSL No. 18752	125 to 163 cm (50-65 inches), dark reddish brown (5YR 3/4) silty clay, 5YR 4/4 when rubbed; weak fine and very fine subangular blocky structure; firm, sticky and plastic; few micro, very fine and fine roots; common micro, very fine and fine tubular pores; many very fine interstitial pores; sugar-like granules stringy in places; few fine gravel-size concretions (probably gibbsite); pieces of saprolite impregnated with white and yellowish white secondary minerals; saprolite makes up over 50 percent of the volume, with 10 percent larger than 2.5 cm (1 inch) in diameter.

SOIL FAMILY Tropeptic Umbriorthox, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Makapili silty clay SOIL Nos. S63Ha-2-4 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 18753 - 18758

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-30	Ap			15	5	20		35			3	10						
30-35	B1																	
35-55	B21			10	5	20		45			10	5						
55-70	B22			10	3	25		50			1	5						
70-110	B23			3	5	35		40			5	5						
110-150	B24																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-30	Ap	11.7	7.1	23.7	34.2	0.09	0.69	0.03	0.10	1.12	0.61	22.1	101.4	22.2	31.7		0.26	6.29
30-35	B1													27.2	38.9			
35-55	B21	8.0	6.2	20.1	46.1	0.06	0.40	tr.	0.09	0.84	0.63	19.8	102.2	28.1	40.2		0.15	3.89
55-70	B22	4.4	6.4	23.6	43.6	0.05	0.30	tr.	0.08	0.61	0.58	20.2	99.8	30.2	43.2			6.23
70-110	B23	2.0	6.2	30.0	39.4	0.09	0.32	tr.	0.05	0.25	0.59	21.3	100.2	24.6	35.2			18.34
110-150	B24													27.0	38.6			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-30	4.90	0.39	13	1.5	2.3	0.30	0.30	4.4		21.0		0.6	0.2	21.0		5.9	4.5
30-35	2.60	0.17	16	0.5	0.9	0.20	0.10	1.7		15.3		1.2	0.2	11.0		5.1	4.4
35-55	2.51	0.15	17	0.6	0.8	0.20	0.10	1.7		14.2		1.6	0.1	12.0		5.1	4.5
55-70	2.11	0.12	18	0.4	0.8	0.20	tr.	1.4		12.3		2.8	tr.	11.0		5.3	4.9
70-110	0.98			-	0.4	0.10	tr.	0.5		5.8		9.4	tr.	9.0		4.9	5.3
110-150	0.78			-	0.2	0.10	tr.	0.3		3.7		16.2	tr.	8.0		4.5	4.8

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-30				-						1.09	3.06	58.0	41.5	31.8		
30-35				-						1.09		47.9				
35-55				-						1.01	3.33	54.0	39.2	34.8		
55-70				tr.						1.20	3.28	46.3	40.4	33.7		
70-110				tr.						1.29	3.20	39.4	32.7	24.6		
110-150				tr.						1.19	3.27	49.2	34.4	30.1		

a/ 30.1 kg of organic carbon per square meter to a depth of 1 meter.

MAKAPILI SILTY CLAY
S63Ha-2-4

Location: Island of Kauai, Kauai County, Hawaii; 1.29 km (0.8 mile) north, northeast of the mouth of the Hanalei River. Approximately 1.7 km (1.15 miles) north 39° west of the junction of Highway 560 and the road to the Plantation House Hotel. Date of sampling: May 7, 1963.
Description by: D. E. Foote. Collectors: D. E. Foote, J. M. Williams, and J. A. Dement.
Classification: **Tropeptic Umbriorthox, clayey, oxidic, isohyperthermic.**
Vegetation: Nonirrigated pasture (kikuyugrass). Climate: Average annual precipitation is 188 cm (75 inches) which is distributed throughout the year. Mean annual temperature is about 22.2° C (72° F). Parent material: Formed in residuum from basic igneous rock. Topography: Smooth upland. Slope 1 percent. Elevation: 42 m (140 feet). Drainage: Well drained. Permeability of the B2, C and of the underlying rock is moderate. Runoff is slow to moderate. Soil moisture: Profile at field capacity when sampled.
Remarks: Textures are apparent field textures. Paired sample number S63Ha-2-3.

HORIZON	DESCRIPTION
Ap LSL No. 18753	0 to 30 cm (0-12 inches), brown (10YR 4/3) silty clay, same color when rubbed, (10YR 5/3) dry; strong fine subangular blocky structure; very hard, friable, sticky and plastic; many micro, very fine, fine and medium roots; many micro, very fine tubular, many very fine interstitial pores; few gravels (hard saprolite); strongly acid (pH 5.1); abrupt smooth boundary.
B1 LSL No. 18754	30 to 35 cm (12-14 inches), reddish brown (5YR 4/3) clay loam, 5YR 4/4 when rubbed, dark reddish brown (5YR 3/4) dry; weak medium subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; many micro, very fine, fine and medium roots; many micro, very fine, common fine and medium tubular pores; thin patchy pressure cutans; higher chroma sugar-like granules in pores; many worm channels and wormcasts; strongly acid (pH 5.1); clear smooth boundary.
B21	35 to 55 cm (14-22 inches), dark reddish brown (5YR 3/3) clay loam, reddish
LSL No 18755	brown (5YR 4/4) when rubbed, dark brown (7.5YR 4/4) dry; moderate fine and very fine subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; common micro, very fine, fine and few medium roots; many micro, and very fine tubular and many very fine interstitial pores; nearly continuous pressure cutans; higher chroma sugar-like granules in pores; very strongly acid (pH 4.8); clear wavy boundary.
B22 LSL No. 18756	55 to 70 cm (22-28 inches), reddish brown (5YR 4/4) clay loam, 5YR 4/4 when rubbed, dark reddish brown (5YR 3/3) with sugary coatings of reddish brown (5YR 5/4) dry; weak fine and very fine subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; common micro, very fine, few fine and medium roots; many micro, very fine, common fine tubular, many very fine interstitial pores; continuous pressure cutans; higher chroma sugar-like granules in pores; very strongly acid (pH 4.8); clear wavy boundary.
B23 LSL No. 18757	70 to 110 cm (28-44 inches), yellowish red (5YR 3/6) clay loam, 5YR 4/6 when rubbed; dark reddish brown (5YR 3/4) dry; moderate fine and very fine subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few micro and very fine roots; many micro, very fine, few fine tubular pores, many very fine interstitial pores; continuous pressure cutans; higher chroma sugar-like granules; about 40 percent of volume is saprolite impregnated with white and yellowish white secondary minerals; about 2 percent of the saprolite is over 2.5 cm (1 inch) in diameter; very strongly acid (pH 4.8); gradual wavy boundary.
B24 LSL No. 18758	110 to 150 cm (44-60 inches), dark reddish brown (2.5YR 3/4) silty clay, reddish brown (5YR 4/4) when rubbed and dry; strong fine and very fine subangular blocky structure; very hard, firm, sticky, and plastic; few micro and very fine roots; many micro, very fine, common fine tubular pores, many very fine interstitial pores; continuous pressure cutans; higher chroma sugar-like granules; saprolite is impregnated with white and

SOIL FAMILY Tropeutic Umbriorthox, clayey, oxidic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Puhi silty clay loam (taxadjunct) SOIL Nos. S63Ha-2-2 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 18741 - 18746

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-23	Ap			10	20	20		25			10	5						
23-53	B21			5	25	15		30			5	5						
53-75	B22			5	25	20		30			5	5						
75-98	B23			2	30	15		30			10	5						
98-120	B24			2	30	20		30			10	5						
120-150	B3			1	35	10		30			10	5						

Depth (cm)	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
	Percent of Whole Soil																
0-23	17.4	4.5	33.1	29.8	0.18	2.04	tr.	0.11	0.75	0.64	13.1	101.6	16.5	23.6		14.14	5.03
23-53	17.8	4.8	32.7	32.8	0.08	1.56	tr.	0.08	0.51	0.50	8.3	99.1	19.6	28.0		13.86	5.82
53-75	22.1	5.7	22.3	34.5	0.10	1.40	-	0.11	0.33	0.57	12.1	99.2	20.6	29.5		15.64	8.85
75-98	22.0	5.4	21.1	33.8	0.11	0.49	-	0.11	0.15	0.48	15.8	99.4	18.4	26.3		16.02	9.07
98-120	16.1	5.1	29.0	32.1	0.10	0.59	-	0.13	0.11	0.51	16.7	100.4	18.3	26.2		17.05	8.85
120-150	18.5	4.8	27.1	32.8	0.14	0.50	-	0.09	0.09	0.62	15.6	100.2	17.4	24.9		16.99	11.44

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-23	4.39	0.37	12	2.2	2.0	0.20	0.80	5.2		19.8		0.8	0.2	26.0		5.9	4.9
23-53	1.72	0.14	12	1.0	0.6	0.20	0.20	2.0		9.4		2.8	0.1	21.0		5.4	5.4
53-75	1.27	0.08	16	1.1	0.6	0.60	0.10	2.4		10.8		1.6		22.0		5.8	5.8
75-98	0.62			0.9	0.8	0.90	0.10	2.7		7.2		3.4		38.0		6.0	5.9
98-120	0.52			0.9	0.9	1.00	0.10	2.9		5.9		5.6		49.0		5.8	5.7
120-150	0.41			1.0	0.8	1.30	0.10	3.2		6.8		7.6		47.0		5.6	5.3

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: Field moist	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-23				-						0.91	2.87	71.0	46.3	34.2		
23-53				-						0.92	3.06	57.2	50.5	40.3		
53-75				-						0.98	3.05	55.1	49.2	42.3		
75-98				-						1.10	3.04	48.4	44.1	38.8		
98-120				-						1.14	3.08	47.1	41.1	34.5		
120-150				-						1.15	3.13	51.1	44.1	33.2		

a/ 18.4 kg of organic carbon per square meter to a depth of 1 meter.

PUHI SILTY CLAY LOAM (taxadjunct) 1/
S63Ha-2-2

Location: Island of Kauai, Kauai County, Hawaii; 3.7 km (2.3 miles) west of the Coco Palms Hotel. About 133 m (445 feet) north of the junction of Highways 580 and 581. About 9 m (30 feet) east of fence along Highway 581. Date of sampling: May 6, 1963.
Description by: D. E. Foote. Collectors: D. E. Foote, J. M. Williams, and J. A. DeMent.
Classification: **Tropeptic Umbriorthox, clayey, oxidic, isohyperthermic.**
Vegetation: Unirrigated pasture, kikuyugrass. Climate: Average annual precipitation is 175 cm (70 inches) with about 50 percent falling from November through March. Mean annual temperature is 22.2° C (72° F). Parent material: Formed in residuum from nephaline basalt, melatite nephaline basalt, olivine basalt and picrite basalt. Topography: Smooth upland. 1 percent slope. Elevation: 90 m (300 feet). Drainage: Well drained. Permeability of the B2, C and the underlying weathered rock is moderate. Runoff is slow to moderate. Soil moisture: Profile at field capacity when sampled.
Remarks: A few channels in B22 filled with A material. Colors are for moist soil. Textures are apparent field textures. Paired sample number S63Ha-2-1.

HORIZON	DESCRIPTION
Ap LSL No. 18741	0 to 23 cm (0-9 inches), brown (10YR 4/3) silty clay loam; moderate fine and very fine subangular blocky structure; friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine and fine tubular and many very fine interstitial pores; delayed reaction with hydrogen peroxide; clear smooth boundary.
B21 LSL No. 18742	23 to 53 cm (9-21 inches), reddish brown (5YR 4/3) silty clay loam, 5YR 4/4 color when rubbed; weak very fine subangular blocky structure to massive; friable, slightly sticky and slightly plastic; common fine and very fine roots; few medium, many fine and very fine tubular pores; gradual smooth boundary.
B22 LSL No. 18743	53 to 75 cm (21-30 inches), dark reddish brown (5YR 3/4) silty clay loam; weak fine and very fine subangular blocky structure; friable, slightly sticky and slightly plastic; common fine and very fine roots; few medium, many fine and very fine tubular pores; thin patchy glaze with higher chroma than matrix; gradual smooth boundary.
B23 LSL No. 18744	75 to 98 cm (30-39 inches), dark reddish brown (5YR 3/4) silty clay loam, 5YR 4/4 when rubbed; moderate fine and very fine subangular blocky structure; firm, sticky and plastic; few fine and very fine roots; many very fine interstitial, few fine and very fine tubular pores; stringy sugar-like threads of higher chroma; small pieces of saprolite; gradual smooth boundary.
B24 LSL No. 18745	98 to 120 cm (39-48 inches), dark reddish brown (5YR 3/4) silty clay loam; moderate fine and very fine subangular blocky structure; firm, sticky and plastic; few fine and very fine roots; many very fine interstitial, few fine and very fine tubular pores; stringy sugar-like threads with higher chroma; few more pieces of saprolite than B23; gradual smooth boundary.
B3 LSL No. 18746	120 to 150 cm (48-60 inches), reddish brown (5YR 4/4) silty clay loam; moderate fine and very fine subangular blocky structure; friable, sticky and plastic; few fine and very fine roots; many very fine interstitial, few fine and very fine tubular pores; sugar-like threads of higher chroma; about 50 percent purplish saprolite.

1/ The Puhi series is classified in Tropeptic Eutrorthox. In this pedon pineapple culture has caused the base saturation of the B21 and B22 horizons to be too low for Eutrorthox.

SOIL FAMILY Typic Torrox, clayey, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Molokai silty clay SOIL Nos. 861Ha-7-5 LOCATION Honolulu County, Hawaii

Beltsville Lab Nos. 61479 - 61483

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	K68 7A3 Kaolinites	Gibbs 7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	Ap1				40	12												
15-38	Ap2				40	10												
38-65	B21				52	10												
65-100	B22				54	2												
100-150	C																	

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-15	Ap1													9.9	14.1			
15-38	Ap2													9.7	13.8			
38-65	B21													9.1	13.0			
65-100	B22													7.8	11.2			
100-150	C													7.6	10.9			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2d Ca	602b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-15	1.92	0.200	10	6.0	3.0	0.26	0.43	9.7	13.8		23.5		tr.		41	5.7	5.0
15-38	1.97	0.187	10	5.3	3.1	0.25	0.13	8.8	12.1		20.9		tr.		42	6.0	5.3
38-65	0.50	0.066	8	3.0	2.2	0.63	0.03	5.9	5.7		11.6				51	6.4	5.8
65-100	0.50	0.050	10	3.2	2.5	1.37	0.04	7.1	7.3		14.4				49	6.6	5.9
100-150	0.24			2.0	1.8	0.90	0.08	4.8	5.4		10.2				47	6.9	6.1

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	4B2 15 bar A.D.	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	
0-15													22.3		
15-38													22.5		
38-65													22.1		
65-100													23.1		
100-150													21.2		

MOLOKAI SILTY CLAY
S61Ha-7-5

Location: Island of Oahu, Honolulu County, Hawaii. Block 2, Field 4115-16, Dole Pineapple. Date of sampling: 1961
Description by: D. Womack. Collectors: D. Womack and J. M. Williams.
Classification: **Typic Torrox, clayey, kaolinitic, isohyperthermic.**
Vegetation: Pineapple. Climate: Average annual precipitation is 75 cm (30 inches). **The mean annual temperature is 22° C (72° F).** Parent material: **Basic igneous rock or alluvium.** **Elevation: 96 m (335 feet).** Soil moisture: **Dry.**
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted.

HORIZON	DESCRIPTION
Ap1 BSL No. 61479	0 to 15 cm (0-6 inches), dark reddish brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) dry; moderate coarse medium and fine granular structure; very hard, friable, sticky, plastic; many roots; many fine and very fine interstitial pores; strong effervescence with hydrogen peroxide; few fine black shot presumed to be manganese dioxide; strongly magnetic; clear wavy boundary.
Ap2 BSL No. 61480	15 to 38 cm (6-15 inches), dark red (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) dry; weak medium and fine subangular blocky structure; very hard, friable, sticky, plastic; many roots; many medium fine and very fine tubular pores; common very fine black shot that effervesce with hydrogen peroxide presumed to be manganese dioxide; strongly magnetic; strong effervescence with hydrogen peroxide; abrupt wavy boundary.
B21 BSL No. 61481	38 to 65 cm (15-26 inches), dark reddish brown (2.5YR 2/4) silty clay; moderate fine and very fine subangular blocky structure; friable, sticky, plastic; very few fine roots; many fine and very fine tubular pores; somewhat brittle; many small patches of pressure coatings; common very fine black shot that effervesce with hydrogen peroxide, presumed to be manganese dioxide; strongly magnetic; clear wavy boundary.
B22 BSL No. 61482	65 to 100 cm (26-40 inches), dark reddish brown (5YR 3/3) light silty clay; weak and moderate fine and very fine subangular blocky structure; friable, sticky, plastic; few roots; many very fine and fine tubular pores; few medium pores; many small patches of pressure coatings; gradual wavy boundary.
C BSL No. 61483	100 to 150 cm (40-60 inches), dark reddish brown (5YR 3/4) silty clay loam; weak medium and fine subangular blocky structure; friable, sticky, plastic; common coarse medium and fine dark red and strong brown mottles due to weathered rock fragments; few small patches that retain rock structure, presumed to be relics of weathered gravel; many medium fine and very fine tubular pores; many patches of pressure coatings.

SOIL FAMILY Typic Torrox, clayey, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Molokai silty clay loam SOIL Nos. S61Ha-7-10 LOCATION Honolulu County, Hawaii

Beltsville Lab Nos. 61515 - 61519

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	7A3 Kaolinites	7A3 Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-28	Ap				24	13												
28-75	B21				47	10												
75-103	B22				52	2												
103-133	B23				40	-												
133-173	B24				50	-												

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-28	Ap													12.9	18.4			
28-75	B21													14.4	20.6			
75-103	B22													13.7	19.6			
103-133	B23													11.7	16.8			
133-173	B24													10.7	15.3			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a 6N2d Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation 5C1 NH_4OAc	5C3 Sum	pH 8C1a H_2O 1:1	8C1c KCl 1:1	
				Meq./100 g.										Percent				
0-28	0.98	0.144	7	4.6	3.4	0.40	0.33	8.7	8.8		17.5				50	6.5	5.9	
28-75	0.49	0.083	6	2.5	1.9	0.50	0.07	5.0	8.0		13.0				38	6.2	5.9	
75-103	0.25			3.0	2.2	0.72	0.05	6.0	8.1		14.1				43	6.6	6.2	
103-133	0.29			3.1	2.4	1.09	0.05	6.6	7.1		13.7				48	6.7	6.4	
133-173	0.17			2.9	2.7	1.08	0.05	6.7	6.3		13.1				52	7.0	6.7	

Depth (cm)	Size class and particle diameter (mm) 3A1 Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits Plastic limit	Liquid limit	Plastic index	Bulk density 1/3 bar	Oven dry	Field moist	Particle density	Water content	1/3 bar	15 bar	Extensibility 4D1 COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	

MOLOKAI SILTY CLAY LOAM
S61Ha-7-10

Location: Island of Oahu, Honolulu County, Hawaii. Sample located 15 m (50 feet) south of Macadam Road at a point .64 km (.42 mile) from Highway 83 on road to Waikele Naval Ordnance Depot. Date of sampling: 1961.
Description by: D. Womack. Collectors: D. Womack and J. M. Williams.
Classification: **Typic Torrox, clayey, kaolinitic, isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: Average annual precipitation is 55 cm (22 **inches). The mean annual temperature is 22° C (72° F).** Parent material: **Weathered olivine basalt. Topography: Undulating lower slopes of West Koolau Range, 7 percent to west. Elevation: 78 m (275 feet).** Soil moisture: **Dry.**
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted.

HORIZON	DESCRIPTION
Ap BSL No. 61515	0 to 28 cm (0-11 inches), dark reddish brown (2.5YR 3/3) silty clay loam, slightly stronger chroma (2.5YR 3/4) dry; weak very fine, fine and medium granular structure; slightly hard, friable, slightly sticky, plastic; many interstitial pores; many very fine black concretions; strong effervescence with hydrogen peroxide; decomposing cane trash throughout horizon; strongly magnetic; clear wavy boundary.
B21 BSL No. 61516	28 to 75 cm (11-30 inches), dark reddish brown (2.5YR 3/4) silty clay loam; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky, plastic; many roots; many very fine, fine and medium pores; many very fine black concretions; strong effervescence with hydrogen peroxide; few thin patchy shiny coatings that follow prism fractures; moderately magnetic; appears to be compacted by tillage; clear wavy boundary.
B22 BSL No. 61517	75 to 103 cm (30-41 inches), dark reddish brown (2.5YR 3/4) silty clay loam; weak moderate subangular structure; friable, slightly sticky, plastic; few roots; many very fine, fine and common tubular pores; few very fine black concretions; moderate effervescence with hydrogen peroxide; **pseudosand** appearance under magnification; clear wavy boundary.
B23 BSL No. 61518	103 to 133 cm (41-53 inches), dark reddish brown (2.5YR 3/4) silty clay loam; strong very fine subangular blocky structure; friable, slightly sticky, plastic; many very fine and fine pores; few very fine black concretions; nearly continuous coatings on ped surfaces; moderately compact in place; clear smooth boundary.
B24 BSL No. 61519	133 to 173 cm (53-69 inches), dark reddish brown (2.5YR 3/4) clay loam that crushes to a higher chroma (5YR 3/3); strong very fine subangular blocky structure; friable, slightly sticky, slightly plastic; many very fine and fine pores; continuous glaze coating on ped surfaces that appears like pressure coatings; many very firm earthy lumps that resist breaking down.

SOIL FAMILY Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Lihue silty clay SOIL Nos. S62Ha-2-7 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 17318 - 17323

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	Ap1			15	40	15		20			5	5						
15-30	Ap2			15	40	15		20			3	5						
30-53	B21			15	40	10		20			3	5						
53-68	B22			15	40	10		25			3	5						
68-120	B23			10	45	5		25			3	5						
120-150	B24			10	45	5		25			5	5						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-15	Ap1	22.0	4.4	29.7	21.7	1.21	0.99	0.08	0.19	1.16	0.58	17.7		13.0	18.6		6.61	14.24
15-30	Ap2	21.8	4.2	31.2	20.9	1.42	1.09	tr.	0.17	1.16	0.63	17.1		12.9	18.4		6.08	14.14
30-53	B21	24.7	4.6	31.9	22.7	0.52	0.58	tr.	0.22	1.13	0.33	14.0		14.4	20.6		7.28	13.48
53-68	B22	23.7	5.0	30.2	23.8	0.24	0.64	tr.	0.20	1.12	0.38	13.7		14.8	21.2		8.60	14.88
68-120	B23	25.2	5.6	29.1	24.9	0.16	0.47	tr.	0.19	0.81	0.38	13.0		15.8	22.6		10.37	12.56
120-150	B24	24.2	6.1	28.5	26.8	0.13	0.07	tr.	0.16	0.54	0.42	13.0		16.2	23.2		11.33	12.19

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-15	2.66	0.27	10	6.8	4.4	0.2	0.8	12.2		19.1		0.3	tr.	64		5.5	5.0
15-30	2.00	0.21	10	5.3	3.3	0.1	0.3	9.0		17.3		0.1		52		5.5	4.9
30-53	0.45	0.09	5	3.0	1.9	0.2	0.2	5.3		7.9		1.0		67		6.3	6.0
53-68	0.37			2.7	1.5	0.1	0.1	4.4		7.3		0.9		60		6.6	6.2
68-120	0.42			3.0	1.2	0.2	0.1	4.5		7.4		0.9		61		6.6	6.2
120-150	0.44			3.6	1.7	0.4	0.1	5.8		8.3		0.8		70		6.6	6.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-15				tr.						0.97	2.88		46.1	33.8		
15-30				-						1.05	2.89		46.0	33.6		
30-53				-						1.14	2.99		39.7	32.3		
53-68				-						1.22	2.99		38.4	33.0		
68-120				-						1.21	3.02		39.6	34.2		
120-150				-						1.19	3.04		40.3	35.0		

a/ 10.5 kg of organic carbon per square meter to a depth of 1 meter.

LIHUE SILTY CLAY
S62Ha-2-7

Location: Island of Kauai, Kauai County, Hawaii. Approximately .81 km (.5 mile) northwest of town of Lihue at a point 170 m (568 feet) north and 630 m (2,100 feet) west of the junction of Highway 56 and Highway 57 in Lihue. The pit located 79 m (265 feet) north of the highway which leads to the airport. Date of sampling: 1962.
Description by: J. M. Williams and D. E. Foote. Collectors: J. M. Williams and D. E. Foote.
Classification: **Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: Average annual precipitation is 125 cm (50 inches) with several dry months during the summer. The mean annual temperature is 22.8° C (73° F), the mean January temperature 22.2° C (72° F), and the mean July temperature 25.6° C (78° F). Parent material: Formed in residuum from basic igneous rock. Topography: Gently sloping to steep uplands. Elevation: Ranges from near sea level to 240 m (800 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Paired sample number S62Ha-2-8.

HORIZON	DESCRIPTION
Ap1 LSL No. 17318	0 to 15 cm (0-6 inches), dusky red (2.5YR 3/2) silty clay, yellowish red (5YR 4/8) dry; cloddy, breaking to weak fine and medium subangular blocky structure; very hard, firm, sticky and plastic; abundant roots; common very fine and fine pores; many black concretions; strong effervescence with hydrogen peroxide; strongly acid (pH 5.5); abrupt smooth boundary.
Ap2 LSL No. 17319	15 to 30 cm (6-12 inches), dusky red (2.5YR 3/2) silty clay, yellowish red (5YR 4/6) dry; massive; very hard, friable, sticky and plastic; many roots; many very fine and fine pores; many very fine black concretions; strong effervescence with hydrogen peroxide; strongly acid (pH 5.5); abrupt smooth boundary.
B21 LSL No. 17320	30 to 53 cm (12-21 inches), dark reddish brown (2.5YR 3/4) silty clay, red (2.5YR 4/6) dry; moderate medium, fine, and very fine subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many very fine and fine pores; many fine black concretions; moderate effervescence with hydrogen peroxide; nearly continuous glaze on ped surfaces; faces of peds have glaze that look like clay films; slightly acid (pH 6.3); clear broken boundary.
B22 LSL No. 17321	53 to 68 cm (21-27 inches), dark reddish brown (2.5YR 3/4) silty clay, red (2.5YR 4/6) dry; strong very fine subangular blocky structure; very hard, friable, sticky, plastic; many roots; many very fine and fine pores; nearly continuous glaze on ped faces; common black concretions; weak effervescence with hydrogen peroxide; few fine black manganese dioxide stainings on ped faces; neutral (pH 6.6); clear smooth boundary.
B23 LSL No. 17322	68 to 120 cm (27-48 inches), dark reddish brown (2.5YR 3/4) silty clay, red (2.5YR 4/6) dry; strong very fine subangular and angular blocky structure; hard, firm, sticky, plastic; few roots; many very fine and fine pores; continuous glaze on ped faces that looks very much like thick clay films; glaze has superimposed on it 10R 3/6 material which appears like pseudosand under magnification; large black coatings on primary structural units; neutral (pH 6.6); gradual smooth boundary.
B24 LSL No. 17323	120 to 150 cm (48-60 inches), dark red (2.5YR 3/6) silty clay, red (2.5YR 4/6) dry; strong very fine subangular and angular blocky structure; hard, firm, slightly sticky, plastic; no roots; many very fine and fine pores; thin patchy coatings that look like clay films; many distinct pressure cutans; ped surfaces have superimposed on them stringy 10R 3/6 pseudosand or frost-like coatings; this is more prevalent than in horizon above; neutral (pH 6.6).

SOIL FAMILY **Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Lihue silty clay SOIL Nos. S62Ha-2-8 LOCATION Kauai County, Hawaii

Lincoln Lab Nos. 17324 - 17328

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-30	Ap1																	
30-53	B21																	
53-95	B22																	
95-145	B23																	
145-175	B24																	

Depth (cm)		Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-30	Ap1													13.4	19.2			
30-53	B21													14.4	20.6			
53-95	B22													16.6	23.7			
95-145	B23													18.1	25.9			
145-175	B24													18.3	26.2			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a				Sum of bases	Extr. acidity	Cation exch. capacity		NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation		pH	
				6N2a Ca	6O2a Mg	6P2a Na	6Q2a K		6H2a	5A1a NH_4OAc	Sum			5C1 NH_4OAc	5C3	8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-30	2.05	0.219	9	6.8	3.0	0.2	0.1	10.1		16.7		0.6		60		5.7	5.2
30-53	0.69	0.099	7	4.1	0.9	0.2	0.1	5.3		7.9		1.4		67		6.5	6.1
53-95	0.51	0.071	7	2.9	1.2	0.2	0.1	4.4		6.4		1.8		69		6.6	6.3
95-145	0.61	0.057	11	2.1	1.1	0.3	0.1	3.6		5.5		1.1		65		6.4	6.2
145-175	0.45			2.4	1.4	0.7	0.1	4.6		7.2		1.1		64		6.6	6.3

Depth (cm)	Size class and particle diameter (mm) 3A1			Coarse fragments >2mm pct. of whole soil	Atterberg limits			Bulk density			Particle density	Water content			Extensibility 4D1	
	Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)		Plastic limit	Liquid limit	Plastic index	1/3 bar	Oven dry	Field moist			1/3 bar	15 bar	COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-30				-						1.05	2.90		42.5	32.4		
30-53				-						1.18	2.98		41.3	33.7		
53-95				-						1.22	3.05		41.4	35.7		
95-145				-						1.20	3.11		39.2	33.8		
145-175				-							3.14		44.3	37.1		

a/ 11.3 kg of organic carbon per square meter to a depth of 1 meter.

LIHUE SILTY CLAY
S62Ha-2-8

south of Highway 501 at a point .97 km (.6 mile) east at junction of Highway 501 with Haleko and Weke Roads. Date of sampling: 1962.

Description by: J. M. Williams and D. E. Foote. Collectors: J. M. Williams and D. E. Foote.

Classification: **Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic.**

Vegetation: Irrigated sugarcane. Climate: Average annual precipitation is 100 to 125 cm (40-50 inches) with several dry months during the summer. The mean annual temperature is 22.8° C (73° F), the mean January temperature 22.2° C (72° F), and the mean July temperature 25.6° C (78° F). Parent material: Basic igneous rock. Topography: Low windward slopes slightly convex to east, slope 3 percent. Elevation: Ranges from near sea level to 240 m (800 feet). Drainage: Well drained; moderately rapid permeability; medium runoff. Soil moisture: Moist.

Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S62Ha-2-7.

HORIZON	DESCRIPTION
Ap1 LSL No. 17324	0 to 30 cm (0-12 inches), dusky red (2.5YR 3/2) silty clay mixed with material from below by cultivation; cloddy breaking to weak fine and medium subangular blocky structure; sticky, plastic, friable; many roots; common very fine and fine pores; many very fine black concretions; effervescence with hydrogen peroxide is strong; numerous chunks of charcoal and burnt cane; abrupt smooth boundary.
B21 LSL No. 17325	30 to 53 cm (12-21 inches), dark reddish brown (2.5YR 3/4) silty clay; weak coarse prismatic breaking to moderate very fine and fine subangular blocky structure; sticky, plastic, friable; many roots; many very fine and fine pores; many black concretions; effervescence with hydrogen peroxide is moderate; patchy glaze on ped surfaces; along primary structure lines continuous cutans appear like clay flows; clear smooth boundary.
B22 LSL No. 17326	53 to 95 cm (21-38 inches), dark reddish brown (2.5YR 3/4) silty clay; weak coarse prismatic breaking to strong very fine subangular and angular blocky structure; sticky, plastic, firm; few fine roots; many very fine and fine pores; continuous cutans on ped surfaces that appear like very thin clay flows; along prism faces the clay films are thicker; common black concretions; slight to moderate effervescence with hydrogen peroxide; some pores lined with black staining; gradual smooth boundary.
B23 LSL No. 17327	95 to 145 cm (38-58 inches), dark reddish brown (2.5YR 3/4) silty clay with persistent rubbing; weak coarse prismatic breaking to strong very fine angular and subangular blocky structure; sticky, plastic, firm; few fine roots; many very fine and fine pores; nearly continuous cutans on ped surfaces that appear like thin clay flows; along prism faces cutans are thicker; few black coatings of manganese on ped surfaces; gradual smooth boundary.

SOIL FAMILY Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Wahiawa silty clay SOIL Nos. 861Ha-7-7 LOCATION Honolulu County, Hawaii

Beltsville Lab Nos. 61492 - 61497

Depth (cm)	Horizon	Mineralogical Analysis															
		Allophane	Montmorillonites	Micas	Kaolinites 7A3	Gibbsite 7A3	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	Ap1				40	-												
15-30	Ap2				43	-												
30-40	B21				53	-												
40-83	B22				55	-												
83-113	B23				53	-												
113-150	B24				50	-												

Depth (cm)		Total Chemical Analysis												Extractable iron 6C2a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-15	Ap1													8.8	12.6			
15-30	Ap2													9.0	12.8			
30-40	B21													8.5	12.2			
40-83	B22													10.0	14.3			
83-113	B23													9.7	13.9			
113-150	B24													9.8	14.0			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2d Ca	602b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-15	1.65	0.204	8	5.4	2.9	0.27	0.75	9.3	16.4		25.7		0.2		36	5.3	4.5
15-30	1.10	0.183	6	6.4	3.7	0.22	0.13	10.5	13.8		24.2		<0.1		43	5.9	5.0
30-40	0.78	0.130	6	4.9	3.6	0.21	0.08	8.8	7.7		16.5				53	6.4	5.4
40-83	0.22			4.1	3.3	0.18	0.05	7.6	5.5		13.1		<0.1		58	6.4	5.6
83-113	0.19			4.3	3.2	0.32	0.05	7.9	5.6		13.5		<0.1		58	6.3	5.9
113-150	0.23			4.4	2.6	0.52	0.07	7.6	5.2		12.8				59	6.3	6.0

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	15 bar 4B2 A.D.	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	
0-15													24.4		
15-30													25.1		
30-40													25.1		
40-83													24.3		
83-113													24.6		
113-150													24.7		

WAHIAWA SILTY CLAY
S61Ha-7-7

Location: Island of Oahu, Honolulu County, Hawaii. Dole Corporation field No. 4101-02, plot No. B-30, about 300 m (1,000 feet) east of the main road. Date of sampling: 1961
Description by: D. Womack. Collectors: D. Womack and J. M. Williams.
Classification: **Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic.**
Vegetation: Pineapple. Climate: Average annual precipitation is 100 cm (40 inches). The mean annual temperature is 21.7° C (71° F), the mean January temperature 20.6° C (69° F), and the mean July temperature 22.8° C (73° F). Parent material: Olivine basalt. Topography: Low nearly level upland. Relief about 2 percent convex to west. Elevation: 150 m (500 feet). Drainage: Well drained; moderate to moderately rapid permeability; slow runoff. Soil moisture: Dry.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted. Upper solum dry when described. Paired sample number S61Ha-7-8.

HORIZON	DESCRIPTION
Ap1 BSL No. 61492	0 to 15 cm (0-6 inches), very dusky red (2.5YR 2/2) silty clay, dusky red (2.5YR 3/2) dry; moderate medium, fine and very fine granular structure; very hard, friable, sticky, plastic; many roots; many medium, fine and very fine pores; many 3 to 5 mm (1/8-1/4 inch) black concretions; violent effervescence with hydrogen peroxide; medium acid (pH 5.6); abrupt smooth boundary.
Ap2 BSL No. 61493	15 to 30 cm (6-12 inches), dusky red (2.5YR 3/2) moist and dry silty clay; common dark reddish brown (2.5YR 3/4) material from the B horizon mixed by cultivation; moderate coarse subangular blocky structure; hard, firm, sticky, plastic; compact in place; many roots; few fine and very fine tubular pores; many black concretions; violent effervescence with hydrogen peroxide; medium acid (pH 5.8); abrupt wavy boundary.
B21 BSL No. 61494	30 to 40 cm (12-16 inches), dark reddish brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) dry; moderate fine and very fine subangular blocky structure; hard, firm, sticky, plastic; common roots; common fine and very fine pores, few coarse tubular pores; many black concretions; strong effervescence with hydrogen peroxide; medium acid (pH 5.6); gradual wavy boundary.
B22 BSL No. 61495	40 to 83 cm (16-33 inches), dark reddish brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) dry; moderate and strong fine and very fine subangular blocky structure; hard, friable, sticky, plastic; few roots; common fine and very fine tubular pores; nearly continuous pressure faces; many fine distinct black stains; few black concretions; strong effervescence with hydrogen peroxide; slightly acid (pH 6.5); diffuse wavy boundary.
B23 BSL No. 61496	83 to 113 cm (33-45 inches), dark reddish brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) dry; moderate and strong very fine subangular blocky structure; hard, friable, sticky, plastic; common fine and very fine tubular pores; nearly continuous pressure faces; many fine distinct black stains; few black concretions; moderate effervescence with hydrogen peroxide; neutral (pH 7.1); diffuse wavy boundary.
B24 BSL No. 61497	113 to 150 cm (45-60 inches), dark reddish brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) dry; moderate and strong very fine subangular blocky structure; hard, friable, sticky, plastic; common fine and very fine tubular pores; few fine black stains; thin patchy clay films; continuous pressure faces; many distinct slickensides up to 5 cm (2 inches) long; very few black concretions; slight effervescence with hydrogen peroxide; neutral (pH 6.9).

SOIL FAMILY **Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Wahiawa silty clay SOIL Nos. S61Ha-7-8 LOCATION Honolulu County, Hawaii

Beltsville Lab Nos. 61499 - 61506

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites (7A3)	Gibbsite (7A3)	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-10	Ap1				33	2												
10-30	Ap2				40	2												
30-48	B21p				42	2												
48-83	B22				47	<2												
83-103	B31				50	4												
103-123	B32				53	2												
123-150	C1				42	<2												
150-180	C2				32	<2												

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-10	Ap1													10.8	15.4			
10-30	Ap2													11.7	16.8			
30-48	B21p													11.7	16.7			
48-83	B22													12.0	17.1			
83-103	B31													11.9	17.0			
103-123	B32													10.4	14.9			
123-150	C1													11.4	16.3			
150-180	C2													11.5	16.5			

Depth (cm)	6A1a Organic carbon Pct.	6B2a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2b Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	5A3a Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3 Sum	pH: 8C1a H_2O 1:1	8C1c KCl 1:1
				Meq./100 g.										Percent			
0-10	1.72	0.206	8	2.5	0.2	0.14	0.24	3.1	20.3		23.4				13	4.6	4.2
10-30	0.82	0.150	5	0.1	0.4	0.08	0.19	0.8	17.7		18.5				4	4.0	3.9
30-48	0.34	0.117	3	0.3	0.3	0.08	0.18	0.9	15.6		16.5				5	4.1	4.0
48-83	0.29	0.092	3	3.4	1.2	0.12	0.39	5.1	7.8		12.9				40	5.8	5.5
83-103	0.45	0.075	6	3.5	1.6	0.15	0.27	5.5	8.1		13.6				40	6.2	5.7
103-123	0.24			3.3	1.5	0.18	0.26	5.2	7.3		12.5				42	6.4	6.0
123-150	0.23			3.2	1.4	0.19	0.34	5.9	6.3		11.4				45	6.6	6.3
150-180	0.23			2.9	1.2	0.25	0.54	4.9	7.2		12.1				40	6.6	6.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content: 1/3 bar	15 bar (4B2 A.D.)	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil		cm/cm	
0-10															
10-30															
30-48															
48-83															
83-103															
103-123															
123-150															
150-180															

WAHIAWA SILTY CLAY
S61Ha-7-8

Location: Island of Oahu, Honolulu County, Hawaii. Dole Pineapple field No. 4217-18, 90 m (100 yards) north and east of eucalyptus grove. Date of sampling: 1961.
Description by: D. Womack. Collectors: D. Womack and J. M. Williams.
Classification: **Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic.**
Vegetation: Pineapple. Climate: Average annual precipitation is 138 cm (55 inches). The mean annual temperature is 21.7° C (71.9 F), the mean January temperature 20.6° C (69° F), and the mean July temperature 22.8° C (73° F). Parent material: Weathered olivine basalt. Topography: Low nearly level uplands. Relief about 4 percent convex to southwest. Middle of long general sloping surface. Elevation: 246 m (820 feet). Drainage: Well drained; moderately rapid permeability; slow runoff. Soil moisture: Dry.
Remarks: Textures are apparent field textures. Colors are for moist soil unless otherwise noted. Paired sample number S61Ha-7-7.

HORIZON	DESCRIPTION
Ap1 BSL No. 61499	0 to 10 cm (0-4 inches), dusky red (2.5YR 3/2) silty clay, dark red (2.5YR 3/4) dry; moderate very fine and fine granular structure; hard, friable, sticky, very plastic; many roots; many medium fine and very fine interstitial pores; many medium and fine hard round black concretions; violent effervescence with
Ap2 BSL No. 61500	10 to 30 cm (4-12 inches), dusky red (2.5YR 3/2) silty clay with common medium and coarse dark reddish brown mottles resulting from mixing of the B horizons by tillage; weak very fine and fine granular structure; friable, sticky, very plastic; common very fine and fine tubular pores; many very fine, fine and medium round black concretions; abrupt smooth boundary.
B21p BSL No. 61501	30 to 48 cm (12-19 inches), dark reddish brown (2.5YR 2/4) silty clay, mottled with coarse and medium dark red particles caused by mixing of B horizon by tillage; moderate very fine subangular blocky structure; firm, sticky, very

SOIL FAMILY Typic Chromustert, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Honouliuli clay SOIL Nos. S62Ha-7-3 LOCATION Honolulu County, Hawaii

Lincoln Lab Nos. 17278 - 17282

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-60	Ap		9	1	55	5		10			15	7						
60-88	B21		10	1	55	5		10			15	6						
88-108	B22		15	1	55	4		10			15	7						
108-133	C1		15	1	55	3		10			15	6			2			
133-200	C2		15		55	3		10			10	3						

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-60	Ap	33.7	5.2	23.1	22.8	0.31	1.69	0.46	0.28	0.08	0.64	12.9	101.2	7.9	11.3		6.32	4.62
60-88	B21	33.1	5.7	22.9	23.7	0.39	1.57	0.39	0.38	0.07	0.71	11.6	100.5	7.6	10.9		7.31	5.77
88-108	B22	33.4	6.0	22.7	22.7	0.32	1.64	0.72	0.39	0.06	0.63	11.5	100.1	8.4	12.0		6.61	5.31
108-133	C1	32.4	6.1	24.0	23.5	0.27	1.43	0.83	0.36	0.07	0.59	11.4	101.0	8.7	12.4		6.84	5.03
133-200	C2	33.2	5.7	23.8	23.2	0.46	1.57	0.93	0.37	0.07	0.54	11.3	101.1	8.4	12.0		6.31	4.09

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	6O2a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-60	1.08	0.11	10	13.3	12.2	1.2	0.3	27.0		25.3		-		100+		7.0	6.0
60-88	0.53	0.08	7	10.8	9.9	1.6	0.1	22.4		21.3		-		100+		7.5	5.9
88-108	0.28	0.06	5	12.4	11.3	2.6	0.1	26.4		23.8		-		100+		7.6	6.3
108-133	0.20			11.0	9.5	2.6	0.1	23.2		20.4		-		100+		7.7	6.4
133-200	0.13			12.0	8.6	2.4	0.1	23.1		20.2		-		100+		7.9	6.6

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density 4A1c: 1/3 bar	4A1b Oven dry	Field moist	Particle density	Water content 4B1c: 1/3 bar clod	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-60	6.8	34.8	58.4	tr.						1.45	2.91		30.9	23.0		
60-88				tr.						1.54	3.00		28.0	22.0		
88-108	9.5	33.3	57.2	tr.				1.45	1.73	1.56	3.02	28.3	28.6	22.0		0.061
108-133				tr.						1.57	3.00		27.7	21.4		
133-200				-				1.45	1.70	1.61	3.04	28.1	26.5	20.9		0.054

a/ 12.2 kg of organic carbon per square meter to a depth of 1 meter.

HONOULIULI CLAY
S62Ha-7-3

Location: Island of Oahu, Honolulu County, Hawaii. Ewa Plantation Company, field number 41, 180 m (600 feet) south of reservoir number 6 and 30 m (100 feet) west of road. Date of sampling: 1962.
Description by: Elmer Hill. Collectors: Elmer Hill.
Classification: **Typic Chromustert, fine, kaolinitic, isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: Average annual precipitation is 38 to 75 cm (15-30 inches), occurring mainly between November and April. The mean annual temperature is 23.3° C (74° F), the mean January temperature 21.1° C (70° F), and

derived from basic igneous rocks. Topography: Nearly level coastal plain. Elevation: 23 m (78 feet). Drainage: Moderately well drained; moderately slow permeability; slow runoff. Soil moisture: Moist.
Remarks: This soil is irrigated periodically during the year and never allowed to dry out, which results in less churning. Textures are apparent field textures. Paired sample numbers are S62Ha-7-4 and S62Ha-7-5.

HORIZON	DESCRIPTION
Ap LSL No. 17278	0 to 60 cm (0-24 inches), dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 3/1) dry; moderate fine and medium granular structure; hard, firm, very sticky, very plastic; many fine and medium roots; common fine interstitial pores; also some mixing by deep cultivation of horizon below; dark reddish brown (5YR 3/4) clay; moderate fine and medium subangular blocky structure--may be nearly massive due to mechanical compaction when wet; hard, firm, very sticky, very plastic; few fine tubular pores; few black carbon specks; few light-colored sand grains; few shiny specks (magnetite); few manganese concretions; moderate reaction with hydrogen peroxide; clear smooth boundary.
B21 LSL No. 17279	60 to 88 cm (24-35 inches), dark reddish brown (5YR 3/3) clay, dark reddish brown (5YR 3/3) dry; moderate medium subangular blocky structure; hard, friable, sticky, very plastic; many fine and medium roots; few fine tubular pores; few light-colored sand grains; few shiny specks (magnetite); common manganese concretions; few black stains in root channels (manganese and organic) few rounded gravels 2 to 5 mm (1/8 to 1/4 inch) in diameter; moderate reaction with hydrogen peroxide; clear smooth boundary.
B22 LSL No. 17280	88 to 108 cm (35-43 inches), this horizon was separated for sampling; however, no significant physical difference could be determined in the field.
C1	108 to 133 cm (43-53 inches), dark reddish [illegible]

SOIL FAMILY Typic Chromustert, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Honouliuli clay SOIL Nos. S62Ha-7-4 LOCATION Honolulu County, Hawaii

Lincoln Lab Nos. 17283 - 17286

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-48	Ap																	
48-85	B2																	
85-130	C1																	
130-150	C2																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-48	Ap	34.17	4.46	24.36	21.03	0.28	1.26	0.43	0.15	0.06	0.70	13.76	100.7	7.6	10.9			
48-85	B2	33.56	5.18	23.97	22.20	0.33	1.13	0.35	0.15	0.04	0.61	12.90	100.4	8.0	12.9			
85-130	C1													8.3	11.9			
130-150	C2													7.8	11.2			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-48	1.27	0.124	10	11.8	10.9	1.1	0.5	24.3		22.2		-		109		7.1	6.1
48-85	0.43	0.072	6	8.4	8.8	1.0	0.2	18.4		18.0		-		102		7.0	5.8
85-130	0.20	0.061	3	8.0	8.6	1.3	0.1	18.0		17.4		-		103		6.9	5.9
130-150	0.16			8.4	9.1	1.4	0.1	19.0		17.3		-		110		7.0	5.9

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-48				-						1.32	2.88		29.6	23.7		
48-85				-						1.46	2.95		26.2	21.0		
85-130				-						1.43	2.94		24.2	20.8		
130-150				-						1.39	2.95		26.5	20.2		

a/ 10.8 kg of organic carbon per square meter to a depth of 1 meter.

HONOULIULI CLAY
S62Ha-7-4

Location: Island of Oahu, Honolulu County, Hawaii. Ewa Plantation Company, field 69, 690 m (2,300 feet) north of the intersection of Puuloa Road and Highway 764, 30 m (100 feet) west of irrigation canal. Date of sampling: 1962.
Description by: Elmer Hill. Collectors: Elmer Hill.
Classification: **Typic Chromustert, fine, kaolinitic, isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: Average annual precipitation is 38 to 75 cm (15-30 inches), occurring mainly between November and April. The mean annual temperature is 23.3° C (74° F), the mean January temperature 21.1° C (70° F), and the mean July temperature 25.6° C (78° F). Parent material: Fine-textured alluvium derived from basic igneous rocks. Topography: Nearly level coastal plain. Elevation: 11.4 m (38 feet). Drainage: Moderately well drained; moderately slow permeability; slow runoff. Soil moisture: Moist.
Remarks: This soil is irrigated periodically during the year and never allowed to dry out, which results in less churning. Textures are apparent field textures. Paired sample numbers are S62Ha-7-3 and S62Ha-7-5.

HORIZON	DESCRIPTION
Ap LSL No. 17283	0 to 48 cm (0-19 inches), dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) dry; moderate fine and medium granular structure; some mixing with lower horizon which has moderate fine and medium subangular blocky structure; hard, firm, very sticky, very plastic; common fine interstitial pores; many roots; few shiny specks (magnetite); some black carbon specks; few light-colored sand grains; strong reaction with hydrogen peroxide; clear smooth boundary.
B2 LSL No. 17284	48 to 85 cm (19-34 inches), dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) dry; moderate medium and fine subangular blocky structure; hard, friable, very sticky, very plastic; common fine and medium roots; common fine and medium tubular pores; few shiny specks (magnetite) few manganese concretions; few light-colored sand grains; few weak pressure faces; few wormcasts; strong reaction with hydrogen peroxide; abrupt smooth boundary.
C1 LSL No. 17285	85 to 130 cm (34-52 inches), dark reddish brown (5YR 3/2) clay; dark reddish brown (5YR 3/3) dry; weak medium and coarse subangular blocky structure; hard, friable, very sticky, very plastic; common fine roots; common fine and medium tubular pores; few manganese concretions; common weak slickensides oriented at 20 to 50 degrees with the surface; few light-colored sand grains; few shiny specks (magnetite) few weak vertical pressure faces; few dark stains in pores and between peds (manganese); strong reaction with hydrogen peroxide; gradual smooth boundary.
C2 LSL No. 17286	130 to 150 cm (52-60 inches), dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) dry; weak medium and coarse subangular blocky structure; hard, friable, very sticky, very plastic; few roots; common fine and medium tubular pores; few light-colored sand grains; few shiny specks (magnetite); many strong slickensides oriented at 20 to 35 degrees with the surface; weak vertical pressure faces; few manganese concretions; strong reaction with hydrogen peroxide.
IIR Not sampled	150 cm (60 inches), coral rock, **porous.**

SOIL FAMILY Typic Chromustert, fine, kaolinitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Honouliuli clay SOIL No. 862Ha-7-5 LOCATION Honolulu County, Hawaii

Lincoln Lab Nos. 17287 - 17291

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-38	Ap																	
38-65	B2																	
65-90	C1																	
90-120	C2																	
120-170	C3																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-38	Ap	35.43	5.04	23.00	25.10	0.84	0.22	0.11	0.23	0.04	0.31	12.36	102.7	7.5	10.7			
38-65	B2	33.98	3.38	21.70	27.23	0.75	0.14	0.11	0.22	0.03	0.25	12.17	100.0	7.7	11.0	-		
65-90	C1	35.36	4.72	20.92	24.42	0.37	0.19	0.07	0.23	0.04	0.33	12.29	98.9	7.9	11.3	-		
90-120	C2	32.63	5.74	23.79	22.44	0.27	1.50	0.97	0.31	0.04	0.63	11.51	99.8	7.6	10.9	tr.		
120-170	C3	32.77	5.39	24.02	22.57	0.23	1.42	1.41	0.35	0.04	0.62	11.35	100.2	7.7	11.0	tr.		

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-38	0.74	0.073	10	12.2	12.5	1.4	0.5	26.6		27.0		0.2		98		7.1	5.8
38-65	0.21	0.039	5	12.5	11.5	1.9	0.1	26.0		24.9		0.6		104		7.5	6.2
65-90	0.20	0.029	7	17.0	11.3	2.1	0.1	30.5		25.5		0.4		120		8.0	7.0
90-120	0.08			17.4	10.9	2.3	0.1	30.7		25.3		0.5		121		8.2	7.5
120-170	0.02			18.1	11.2	2.4	0.1	31.8		24.6		0.5		129		8.2	7.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-38				-						1.31	2.93		30.2	22.3		
38-65				-						1.49	2.98		28.1	20.9		
65-90				-						1.49	2.99		27.7	21.5		
90-120				-						1.48	3.00		27.6	21.6		
120-170				-							2.98		27.2	21.6		

a/ 5.4 kg of organic carbon per square meter to a depth of 1 meter.

HONOULIULI CLAY
S62Ha-7-5

Location: Island of Oahu, Honolulu County, Hawaii. Ewa Sugar Plantation, field number 53, 36 m (120 feet) north of Ewa School. Date of sampling: 1962.
Description by: Elmer Hill. Collectors: Elmer Hill.
Classification: **Typic Chromustert, fine, kaolinitic, isohyperthermic.**
Vegetation: Irrigated sugarcane. Climate: Average annual precipitation is 38 to 75 cm (15-30 inches). The mean annual temperature is 23.3° C (74° F), the mean January temperature 21.1° C (70° F), and the mean July temperature 25.6° C (78° F). Parent material: Fine-textured alluvium derived from basic igneous rocks. Topography: Nearly level coastal plain. Elevation: 13.5 m (45 feet). Drainage: Moderately well drained; moderately slow permeability; slow runoff. Soil moisture: Moist.
Remarks: This soil is irrigated periodically during the year and never allowed to dry out, which results in less churning. Textures are apparent field textures. Paired sample numbers S62Ha-7-3 and S62Ha-7-4.

HORIZON	DESCRIPTION
Ap LSL No. 17287	0 to 38 cm (0-15 inches), dark reddish brown (5YR 3/2) moist and dry clay; moderate medium and fine granular structure; hard, firm, very sticky, very plastic; common fine roots; common fine pores; few black specks; few shiny specks; few light colored sand grains; few black concretions that effervesce with hydrogen peroxide; moderate effervescence with hydrogen peroxide; neutral (pH 6.9); clear smooth boundary.
B2 LSL No. 17288	38 to 65 cm (15-26 inches), dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) dry; moderate coarse subangular blocky structure; common slickensides; hard, friable, very sticky, very plastic; common fine roots; many fine and medium tubular pores; few light colored sand grains; few shiny specks; common black concretions, few black stains that effervesce with hydrogen peroxide in pores and between peds; moderate effervescence with hydrogen peroxide; neutral (pH 6.9); clear smooth boundary.
C1 LSL No. 17289	65 to 90 cm (26-36 inches), dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) dry; weak medium and coarse subangular blocky structure; many moderate slickensides; hard, friable, very sticky, very plastic; common roots; common fine and medium tubular pores; few light colored sand grains; few shiny specks; common black concretions; few black stains that effervesce with hydrogen peroxide in pores and between peds; strong effervescence with hydrogen peroxide; neutral (pH 7.1); abrupt smooth boundary.
C2 LSL No. 17290	90 to 120 cm (36-48 inches), dark reddish brown (5YR 3/3) dry; moderate fine and medium subangular blocky structure; many strong slickensides; hard, friable, very sticky, very plastic; many fine roots; common fine and medium tubular pores; few light colored sand grains; few shiny specks; common black concretions that effervesce with hydrogen peroxide; neutral (pH 7.3); gradual smooth boundary.
C3 LSL No. 17291	120 to 170 cm (48-68 inches), dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) dry; moderate medium and fine subangular blocky structure; many strong deeply grooved slickensides; hard, friable, very sticky, very plastic; few fine roots between black concretions that effervesce with hydrogen peroxide; strong effervescence with hydrogen peroxide; mildly alkaline (pH 7.6).

SOIL FAMILY Typic Chromustert, very fine, kaolinitic, isothermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Waihuna clay SOIL Nos. S62Ha-3-1 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 17424 - 17429

Depth (cm)	Horizon	Mineralogical Analysis																
		Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-10	Ap1			1	45	2		15			15	5	1X					
10-43	Ap2			1	45	2		15			15	5	1X					
43-58	B21			1	45	3		15			15	5	1X					
58-93	B22			1	40	3		15			15	5						
93-135	B23			1	50	2		15			15	5						
135-163	B24			1	50	1		15			15	5						

Depth (cm)	Horizon	Total Chemical Analysis												Extractable iron 6C1a		Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble	
		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Fe	Fe_2O_3		SiO_2	Al_2O_3
		Percent of Whole Soil																
0-10	Ap1	30.8	4.1	26.5	22.9	0.83	0.86	0.88	0.14	0.05	0.20	14.2	101.5	9.1	13.0		12.46	11.69

WAIHUNA CLAY
S62Ha-3-1

Location: Island of Lanai, Maui County, Hawaii. Approximately 270 m (900 feet) west northwest of power plant which is on the southern edge of Lanai City. Field 5311-12. Date of sampling: 1962.
Description by: S. Nakamura and R. C. Malmgren. Collectors: S. Nakamura and R. C. Malmgren.
Classification: **Typic Chromustert, very fine, kaolinitic, isothermic.**
Vegetation: Pineapple. Climate: Average annual precipitation is 75 to 88 cm (30-35 inches), most of which occurs from November to April. The mean annual temperature is 20.6° C (69° F), the mean January temperature 19.4° C (67° F), and the mean July temperature 22.2° C (72° F). Parent material: Fine-textured alluvium. Topography: Nearly level alluvial land. Elevation: 450 m (1,500 feet). Drainage: Well to moderately well drained; moderately slow permeability; medium runoff. Soil moisture: Moist.
Remarks: Textures are apparent field textures. Colors are for moist soil. Paired sample number S62Ha-3-2.

HORIZON	DESCRIPTION
Ap1 LSL No. 17424	0 to 10 cm (0-4 inches), dark brown (7.5YR 3/3) clay; moderate very fine and fine granular structure; very hard, friable, very sticky, and very plastic; common plant remains that have been plowed under; many interstitial pores; violent effervescence with hydrogen peroxide; clear smooth boundary.
Ap2 LSL No. 17425	10 to 43 cm (4-17 inches), dark brown (7.5YR 3/3) clay; structureless (massive); very hard, slightly friable, very sticky, and very plastic; common plant remains that have been plowed under; common pores; violent effervescence with hydrogen peroxide; common variegated sand grains can be seen under hand lens; clear smooth boundary.
B21 LSL No. 17426	43 to 58 cm (17-23 inches), dark brown (7.5YR 3/3) clay; weak and moderate very fine subangular blocky structure; friable, very sticky, and very plastic; few roots; common pores; many variegated sand grains can be seen under hand lens; violent effervescence with hydrogen peroxide; clear wavy boundary.
B22 LSL No. 17427	58 to 93 cm (23-37 inches), dark brown (7.5YR 3/2) clay; moderate very fine and fine subangular blocky structure; friable, very sticky, and very plastic; no roots; many very fine and fine tubular pores; many manganese stains and concretions; common thin patchy glaze; crushed color has slightly higher chroma; many variegated sand grains; occasional highly weathered pebbles; strong effervescence with hydrogen peroxide; gradual wavy boundary.
B23 LSL No. 17428	93 to 135 cm (37-54 inches), dark brown (7.5YR 3/2) silty clay; weak medium prismatic breaking into strong fine and medium subangular blocky structure; friable, very sticky, and very plastic; no roots; many very fine tubular pores; many variegated sand grains can be seen under the hand lens; few highly weathered pebbles; many manganese stains and concretions; manganese stains are mainly on cleavage planes; common thin patchy glaze; few pressure cutans; slight effervescence with hydrogen peroxide except on manganese stains and concretions where it is violent; gradual wavy boundary.
B24 LSL No. 17429	135 to 163 cm (54-64 inches), dark brown (7.5YR 3/2) silty clay; strong medium and coarse subangular blocky structure breaking into weak very fine and fine subangular blocky structure; friable, very sticky, and very plastic; no roots; common very fine tubular pores; many variegated sand grains can be seen under a hand lens; many manganese stains and concretions; continuous thin glaze on ped surfaces; many **slickensides**, occasional highly weathered pebbles; slight effervescence with hydrogen peroxide except on manganese stains and concretions where it is violent.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL FAMILY Typic Chromustert, very fine, kaolinitic, isothermic

SOIL SERIES Waihuna clay SOIL Nos. 862Ha-3-2 LOCATION Maui County, Hawaii

Lincoln Lab Nos. 17430 - 17436

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-15	Ap1/Ap2																	
15-30	Ap3																	
30-45	Ap4																	
45-63	AC																	
63-103	C1																	
103-133	C2																	
133-163	C3																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-15	Ap1/Ap2													9.8	14.0			
15-30	Ap3													8.9	12.7			
30-45	Ap4													9.1	13.0			
45-63	AC													9.1	13.0			
63-103	C1													9.0	12.9			
103-133	C2													8.9	12.7			
133-163	C3													9.1	13.0			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-15	1.36	0.150	9	11.4	5.8	0.2	0.9	18.3		26.5		0.8	0.2	69		5.3	4.2
15-30	1.03	0.126	8	11.0	6.4	0.2	0.8	18.4		25.3		1.0	0.2	73		5.1	4.1
30-45	1.57	0.180	9	12.5	6.6	0.3	3.4	22.8		28.5		0.8	0.1	80		5.4	4.5
45-63	1.86	0.191	10	12.4	6.8	0.3	1.2	20.7		33.8		0.6	0.3	61		5.9	5.0
63-103	0.66	0.085	8	11.9	6.7	0.3	1.7	20.6		26.2		0.6		79		6.6	5.4
103-133	0.29			11.0	6.5	0.3	1.8	19.6		21.2		1.0		92		6.4	5.5
133-163	0.18			11.0	7.1	0.3	1.9	20.3		22.1		1.1		92		6.4	5.6

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 4A1f 1/3 bar	4A1h Oven dry	Field moist	Particle density	Water content: 4B1c 1/3 bar clod	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-15				tr.				1.14	1.35		2.93	33.3	34.4	26.6		0.058
15-30				tr.				1.19	1.43		2.95	35.5	38.5	29.5		0.063
30-45				tr.				1.27	1.57		2.95	34.0	35.3	29.1		0.073
45-63				tr.				1.27	1.55		2.94	33.2	35.6	28.2		0.069
63-103				tr.							2.94		37.0	30.8		
103-133				tr.				1.26	1.47		2.96	34.7	36.5	30.2		0.053
133-163				tr.				1.23	1.37		2.99	35.3	36.8	31.1		0.037

a/ 14.5 kg of organic carbon per square meter to a depth of 1 meter.

WAIHUNA CLAY
S62Ha-3-2

Location: Island of Lanai, Maui County, Hawaii. From Lanai City Post Office proceed northwest .64 km (0.4 mile), turn left at edge of city and proceed southwest .81 km (0.5 mile). The site is across (south) of the ditch about 15 m (50 feet) from the ditch in field 5311-12. Date of sampling: 1962.
Description by: S. Nakamura and R. C. Malmgren. Collectors: S. Nakamura and R. C. Malmgren.
Classification: Typic Chromustert, very fine, kaolinitic, isothermic.
Vegetation: Present vegetation is lantana (Lantana camara), natal redtop (Tricholaena repens), guineagrass (Panicum maximum), and cactus (Opuntia megacantha). Climate: Average annual precipitation is 75 to 88 cm (30-35 inches). The mean annual temperature is 20.6°C (69° F), the mean January temperature is 19.4°C (67° F), and the mean July temperature 22.2°C (72° F). Parent material: Fine-texture alluvium. Topography: Nearly level alluvial land. Elevation: 465 m (1,550 feet).
Drainage: Well to moderately well drained; moderately slow permeability; medium runoff except in basin positions where ponding is common after heavy rains. Soil moisture: Moist.
Remarks: Textures are apparent field textures. No sample taken of 0-3 cm (0-1 inch)--combined with 3-15 cm (1-6 inches). Paired sample number S62Ha-3-1.

HORIZON	DESCRIPTION
Ap1 No sample taken	0-3 cm (0-1 inch), very dark grayish brown (10YR 3/2) moist and dry clay; strong very fine and fine granular structure; hard, friable, very sticky and very plastic; violent effervescence with hydrogen peroxide; strongly acid (pH 5.3); clear smooth boundary.
Ap2 LSL No. 17430	3-15 cm (1-6 inches), dark brown (10YR 3/3) clay, dark yellowish brown (10YR 3/4) dry; moderate very fine granular structure; very hard, friable, very sticky and very plastic; many interstitial pores; cracks up to 2.5 cm (1 inch) wide develop on drying; many variegated sand grains can be seen under a hand lens; common plant remains that have been plowed under; violent effervescence with hydrogen peroxide; strongly acid (pH 5.3); clear smooth boundary.
Ap3 LSL No. 17431	15 to 30 cm (6-12 inches), dark brown (7.5YR 3/2) moist and dry clay; massive; hard, friable, very sticky and very plastic; few very fine tubular pores; cracks up to 2.5 cm (1 inch) wide develop on drying; many plant remains that have been plowed under; many variegated sand grains can be seen under a hand lens; violent effervescence with hydrogen peroxide; strongly acid (pH 5.1); clear smooth boundary.
Ap4 LSL No. 17432	30 to 45 cm (12-18 inches), dark brown (10YR 3/3) clay, dark yellowish brown (10YR 3/4) dry; weak very fine subangular blocky structure; very hard, friable, very sticky and very plastic; common pores; cracks up to 2.5 cm (1 inch) develop on drying; common plant remains that have been plowed under; many variegated sand grains can be seen under a hand lens; occasional highly weathered pebbles; violent effervescence with hydrogen peroxide; strongly acid (pH 5.4); clear smooth boundary.
AC LSL No. 17433	45 to 63 cm (18-25 inches), dark brown (10YR 3/3) moist and dry clay; weak coarse prismatic breaking to moderate very fine and fine subangular blocky structure; very hard, firm, very sticky and very plastic; no roots; common pores; common pressure cutans, some are weakly grooved; few highly weathered pebbles; many variegated sand grains can be seen under a hand lens; firm in place; violent effervescence with hydrogen peroxide; medium acid (pH 5.9); gradual wavy boundary.
C1 LSL No. 17434	63 to 103 cm (25-41 inches), dark brown (7.5YR 3/2) moist and dry clay; strong very fine subangular blocky structure; very hard, firm, very sticky and very plastic; no roots; common pores; many variegated sand grains can be seen under a hand lens; few highly weathered pebbles; common pressure cutans; few slickensides; strong effervescence with hydrogen peroxide; neutral (pH 6.6); clear smooth boundary.
C2 LSL No. 17435	103 to 133 cm (41-53 inches), dark brown (7.5YR 3/2) moist and dry clay; moderate very fine and fine subangular blocky structure; very hard, firm, very sticky and very plastic; no roots; many very fine tubular pores; many variegated sand grains can be seen under a hand lens; common highly weathered pebbles; common pressure cutans; strong effervescence with hydrogen peroxide; slightly acid (pH 6.4); gradual wavy boundary.
C3 LSL No. 17436	133 to 163 cm (53-65 inches), dark brown (7.5YR 3/2) moist and dry silty clay; moderate very fine and fine subangular blocky structure; hard, firm, very sticky and very plastic; no roots; many very fine and fine and few coarse tubular pores; common patchy pressure cutans; common manganese stains; many variegated sand grains, more than above horizons; common highly weathered pebbles; strong effervescence with hydrogen peroxide; slightly acid (pH 6.4).

SOIL FAMILY Typic Chromustert, very fine, montmorillonitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Lualualei clay SOIL Nos. S62Ha-7-1 LOCATION Honolulu County, Hawaii

Lincoln Lab Nos. 17292 - 17297

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-3	A11																	
3-25	A12																	
25-55	AC																	
55-75	C1																	
75-123	C2ca																	
123	C3ca																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-3	A11	30.54	7.71	19.29	26.26	0.30	1.50	1.57	0.26	0.07	0.50	11.63	99.6	7.3	10.4			
3-25	A12	31.74	7.59	20.34	25.81	0.33	1.07	1.72	0.28	0.08	0.48	10.81	100.3	7.0	10.0			
25-55	AC	33.91	7.52	19.04	26.28	0.45	1.57	0.62	0.29	0.05	0.51	10.87	101.1	7.5	10.7			
55-75	C1	33.54	7.59	19.57	25.82	0.43	1.72	0.34	0.37	0.06	0.36	10.54	100.3	7.3	10.4			
75-123	C2ca	32.25	6.18	20.02	24.24	0.33	1.58	2.56	0.44	0.04	0.38	11.39	99.4	6.6	9.4			
123	C3ca	31.52	6.57	20.39	22.37	0.38	1.50	4.39	0.49	0.07	0.29	11.56	99.5	6.0	8.6			

Depth (cm)	6A1a a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-3	0.66	0.082	8	17.1	15.2	0.8	1.4	34.5		34.1		0.9		100+		7.1	5.9
3-25	0.42	0.060	7	15.1	15.1	1.3	0.4	31.9		32.9		0.1		97		7.2	5.4
25-55	0.21	0.054	4	14.6	13.4	2.5	0.2	30.7		32.9		0.1		93		7.2	5.4
55-75	0.17	0.044	4	16.0	10.5	3.9	0.2	30.6		32.1		1.3		95		6.8	5.2
75-123	0.17			73.1	9.3	7.2	0.2			29.8		61.2				5.6	4.9
123	0.16			73.8	10.7	8.4	0.3			30.6		63.7				5.8	5.0

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 4A1f 1/3 bar	4A1h Oven dry	Field moist	Particle density	Water content: 4B1c 1/3 bar	1/3 bar	15 bar	Extensibility 4D1: COLE	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-3				tr.						1.29	3.08		31.8	22.0		
3-25				-						1.38	3.06		30.0	22.1		
25-55				-						1.52	3.07		28.4	22.7		
55-75				-				1.33	1.95	1.56	3.06	35.3	27.8	21.4		0.136
75-123				-						1.54	3.12		28.4	22.3		
123				-				1.28	1.86	1.42	3.11	37.7	34.5	25.3		0.133

a/ 3.7 kg of organic carbon per square meter to a depth of 1 meter.

LUALUALEI CLAY
S62Ha-7-1

Location: Island of Oahu, Honolulu County, Hawaii. Lualualei Naval Radio Station, .1 km (.08 mile) west of entrance gate and southwest along reservation fence, 30 m (100 feet) north toward steel radio towers. Date of sampling: 1962.
Description by: Elmer Hill. Collectors: Elmer Hill.
Classification: **Typic Chromustert, very fine, montmorillonitic, isohyperthermic.**
Vegetation: Kiawe (*Prosopis chilensis*), klu (*Acacia farnesiana*), lantana (*Lantana camara*), and fingergrass (*Chloris* spp.). Climate: Average annual precipitation is 38 to 75 cm (15-30 inches). The mean annual temperature is 23.9° C (75° F), the mean January temperature 21.7° C (71° F), and the mean July temperature 25.6° C (78° F). Parent material: Fine-textured alluvium from basic igneous rocks. Topography: Nearly level coastal plain. Elevation: 16 m (55 feet). Drainage: Imperfectly drained; slow permeability; slow runoff. Soil moisture: Moist
Remarks: This soil was utilized for the production of irrigated sugarcane prior to 1943. Since that time the government has used the area as a military installation with a minor part used for truck crops and pasture. Textures are apparent field textures. Paired sample number S62Ha-7-2.

HORIZON	DESCRIPTION
A11 LSL No. 17292	0 to 3 cm (0-1 inch), very dark gray (10YR 3/1) clay, very dark grayish brown (10YR 3/2) dry; strong fine and very fine granular structure; very hard, firm, very sticky, very plastic; many fine roots; few light-colored sand grains; vertical cracks up to 5 cm (2½ inches) wide; strong effervescence with hydrogen peroxide; neutral (pH 7.1); abrupt smooth boundary.
A12 LSL No. 17293	3 to 25 cm (1-10 inches), very dark gray (10YR 3/1) clay, very dark grayish brown (10YR 3/2) dry; moderate coarse prismatic structure breaking to moderate medium subangular blocky structure; very hard, firm, very sticky, very plastic; many fine roots; many fine tubular pores; some organic litter within the cracks; strong effervescence with hydrogen peroxide; neutral (pH 7.2); gradual smooth boundary.
AC LSL No. 17294	25 to 55 cm (10-22 inches), very dark grayish brown (10YR 3/2) clay, very dark grayish brown (10YR 3/2) dry; moderate coarse prismatic structure breaking to moderate medium subangular blocky structure; very hard, firm, very sticky, very plastic; many fine roots; many fine tubular pores; common slickensides; few black specks; few grains of coral sand; strong effervescence with hydrogen peroxide; neutral (pH 7.2); clear smooth boundary.
C1 LSL No. 17295	55 to 75 cm (22-30 inches), very dark grayish brown (10YR 3/2) clay, very dark grayish brown (10YR 3/2) dry; moderate medium and coarse subangular blocky structure; many weakly grooved slickensides; hard, firm, very sticky, very plastic; common fine and medium roots mainly matted between cleavage plains; few fine and very fine tubular pores; common black stains in pores and in dendritic pattern on ped faces; few light-colored sand grains; common shiny specks; strong effervescence with hydrogen peroxide; neutral (pH 6.8); gradual smooth boundary.
C2cs LSL No. 17296	75 to 123 cm (30-49 inches), very dark grayish brown (10YR 3/2) clay, very dark grayish brown (10YR 3/2) dry; strong medium and coarse subangular blocky structure; many deeply grooved slickensides; hard, firm, very sticky, very plastic; few fine roots matted between ped faces; few fine tubular pores; many fine and medium gypsum crystals; common black stains in pores and on peds; common shiny specks; few light-colored sand grains; strong effervescence with hydrogen peroxide; medium acid (pH 5.6); abrupt smooth boundary.
C3cs LSL No. 17297	123 cm (49 inches), very dark grayish brown (10YR 3/2) clay, very dark grayish brown (10YR 3/2) dry; strong coarse subangular blocky structure; many deeply grooved slickensides; extremely hard, very firm, very sticky, very plastic; few fine roots between peds; few fine tubular pores; common medium and coarse gypsum crystals; few shiny specks; strong effervescence with hydrogen peroxide; medium acid (pH 5.8).

SOIL FAMILY Typic Chromustert, very fine, montmorillonitic, isohyperthermic

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SERIES Lualualei clay SOIL Nos. S62Ha-7-2 LOCATION Honolulu County, Hawaii

Lincoln Lab Nos. 17298 - 17303

Depth (cm)	Horizon	Mineralogical Analysis: Allophane	Montmorillonites	Micas	Kaolinites	Gibbsite	Boehmite	Goethite	Amorphous SiO_2	Amorphous Al_2O_3	Magnetite etc.	Anatase	Quartz	Volcanic glass	Feldspar	Olivine	Pyroxene	Pyrite
		Percent of Whole Soil																
0-3	Ap1																	
3-38	Ap2																	
38-60	AC																	
60-80	C																	
80-95	C1cs																	
95-150	C2cs																	

Depth (cm)	Horizon	Total Chemical Analysis: SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO_2	MgO	CaO	Na_2O	K_2O	P_2O_5	L.O.I.	Total	Extractable iron 6C1a: Fe	Fe_2O_3	Carbonate as $CaCO_3$ 6E1b	0.5N NaOH Soluble: SiO_2	Al_2O_3
		Percent of Whole Soil																
0-3	Ap1	40.2	5.6	19.5	18.4	0.29	2.3	2.3	0.81	0.14	0.26	9.8	99.6	4.3	6.1	1		
3-38	Ap2	40.7	5.3	18.9	18.4	0.15	2.7	2.3	0.95	0.10	0.63	10.0	100.1	4.5	6.4	tr.		
38-60	AC													4.5	6.4	tr.		
60-80	C													4.2	6.0	1		
80-95	C1cs													3.1	4.4	2		
95-150	C2cs													3.0	4.3	2		

Depth (cm)	6A1g a/ Organic carbon Pct.	6B1a Nitrogen Pct.	C/N	Extractable bases 5B1a: 6N2a Ca	602a Mg	6P2a Na	6Q2a K	Sum of bases	Extr. acidity 6H2a	Cation exch. capacity: 5A1a NH_4OAc	Sum	NH_4OAc 6L2a extr. SO_4	KCl extr. Al^{+++} 6G1D	Base saturation: 5C1 NH_4OAc	5C3	pH: 8C1a H_2O 1:5	8C1c KCl 1:5
				Meq./100 g.										Percent			
0-3	0.59	0.079	7	41.5	19.8	9.8	1.3			56.5		2.4		100+		8.1	6.9
3-38	0.55	0.066	8	37.8	18.3	10.2	1.4			59.0		0.3		100+		8.8	6.9
38-60	0.35	0.045	8	38.9	17.1	13.5	0.8			62.0		1.2		100+		8.4	6.7
60-80	0.16			39.7	16.2	14.6	0.8			54.3		1.9		100+		8.6	7.0
80-95	0.08			103.8	10.2	10.7	0.4			36.8		73.7		100+		7.9	7.2
95-150	0.01			69.2	11.6	12.0	0.4			37.7		38.9		100+		8.0	7.2

Depth (cm)	Size class and particle diameter (mm) 3A1: Sand (2-0.05)	Silt (0.5-0.002)	Clay (<.002)	Coarse fragments >2mm pct. of whole soil	Atterberg limits: Plastic limit	Liquid limit	Plastic index	Bulk density: 1/3 bar	Oven dry	Field moist	Particle density	Water content:	1/3 bar	15 bar	Extensibility 4D1: COLEf	COLE
	Pct. of 2mm.							g/cc				Pct. of whole soil			cm/cm	
0-3				tr.						1.04	2.90		42.2	31.9		
3-38				tr.						1.22	2.92		40.5	32.3		
38-60				-						1.33	2.97		40.3	30.5		
60-80				-						1.31	2.94		39.9	29.8		
80-95				-						1.35	2.94		34.3	25.2		
95-150				-						1.35	2.94		35.4	24.2		

a/ 4.1 kg of organic carbon per square meter to a depth of 1 meter.

LUALUALEI CLAY
S62Ha-7-2

Location: Island of Oahu, Honolulu County, Hawaii. Pit on Brazil Dairy Farm on Mailiilii Road 396 m (1,320 feet) east of dairy barn and 30 m (100 feet) north of road. Date of sampling: 1962.
Description by: Elmer Hill. Collectors: Elmer Hill.
Classification: **Typic Chromustert, very fine, montmorillonitic, isohyperthermic.**
Vegetation: Fingergrass (*Chloris* spp.). Climate: Average annual precipitation is 38 to 75 cm (15-30 inches). The mean annual temperature is 23.9° C (75° F), the mean January temperature 21.7° C (71° F), and the mean July temperature 25.6° C (78° F). Parent material: Fine-textured alluvium from basic igneous rocks. Topography: Nearly level coastal plain. Elevation: 13.5 m (45 feet). Drainage: Imperfectly drained; slow permeability; slow runoff. Soil moisture: Moist.
Remarks: This soil was utilized for the production of [illegible] prior to 1943. Since that time the government has used the area as a military installation with minor parts used for truck crops and pasture. Textures are apparent field textures. Paired sample number S62Ha-7-1.

HORIZON	DESCRIPTION
Ap1 LSL No. 17298	0 to 3 cm (0-1 inch), very dark grayish brown (10YR 3/2) clay, very dark gray (10YR 3/1) dry; moderate fine and very fine granular structure; hard, firm, very sticky, very plastic; common fine roots; many fine interstitial pores; few light-colored sand grains; small amount of litter; prominent cracks 5 to 75 mm (¼-3 inches) wide; few black carbon specks; common shiny specks (magnetite); few manganese concretions; strong reaction with hydrogen peroxide; abrupt smooth boundary.
Ap2 LSL No. 17299	3 to 38 cm (1-15 inches), dark grayish brown (10YR 3/2) clay, very dark gray (10YR 3/1) dry; moderate coarse prismatic breaking to moderate fine and medium subangular blocky structure; weak thick platy structure was observed which has resulted from cultivation; hard, firm, very sticky, very plastic; common fine roots; common fine tubular pores; few light-colored sand grains; few small pieces of coral; some litter between cracks; few black carbon specks; few shiny specks (magnetite); prominent vertical cracks 5 to 50 mm (¼ to 2 inches) wide; common manganese concretions; strong reaction with hydrogen peroxide; clear smooth boundary.
AC LSL No. 17300	38 to 60 cm (15-24 inches), dark grayish brown (10YR 3/2) clay, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; hard, firm, very sticky, very plastic; common fine roots that occur between the slickensides and are matted--also few fine inped roots; few fine tubular pores; many strong slickensides oriented at 5 to 10 degrees with the surface and weak vertical pressure faces; few light-colored sand grains; few black carbon specks; common shiny specks (magnetite); few manganese concretions; strong reaction with hydrogen peroxide; clear smooth boundary.
C LSL No. 17301	60 to 80 cm (24-32 inches), very dark grayish brown (10YR 3/2) clay, very dark grayish brown (10YR 3/2) dry; moderate medium and coarse subangular blocky structure; hard, firm, very sticky, very plastic; common fine roots occur as a mat between the slickensides and few fine inped roots; common very fine and fine tubular pores; prominent slickensides oriented at about 10 degrees with the surface and weak vertical pressure faces; few light and dark-colored sand grains; few shiny specks (magnetite); few manganese concretions; strong reaction with hydrogen peroxide; clear smooth boundary.
C1cs LSL No. 17302	80 to 95 cm (32-38 inches), very dark grayish brown (10YR 3/2) silty clay, very dark grayish brown (10YR 3.2/2) dry; weak medium subangular blocky structure; hard, friable, sticky, very plastic; few fine roots; few fine tubular pores; many moderate slickensides oriented at about 10 degrees; weak vertical pressure faces; common gypsum crystals; manganese staining in pores and between ped faces; few shiny specks (magnetite); many light-colored sand grains; few manganese concretions; strong reaction with hydrogen peroxide; gradual smooth boundary.
C2cs LSL No. 17303	95 to 150 cm (38-60 inches), very dark grayish brown (10YR 3/2) clay, dark grayish brown (10YR 3.6/2) dry; moderate medium and fine subangular blocky structure; hard, firm, sticky, very plastic; few fine roots; common roots matted between slickensides; many strong deeply grooved slickensides oriented at about 10 to 15 degrees with the surface; thick vertical pressure faces; common black manganese stains on ped surfaces and within pores; common large gypsum crystals; common light-colored sand grains; common shiny specks (magnetite); few manganese concretions; strong reaction with hydrogen peroxide; gradual smooth boundary.

APPENDIX

Chemical Analyses

The samples collected before 1959 were analyzed by standard procedures for rock analyses (e.g., Hillebrand and Lundell 1929). A few samples that contained large amounts of iron and manganese oxides were digested in aqua regia prior to the carbonate fusion.

The samples were fused in sodium carbonate, and silica was determined gravimetrically by difference after removal as tetrafluoride. The residue was dissolved in hydrochloric acid. In one aliquot, sesquioxides were precipitated with ammonium chloride and ammonium hydroxide. In a second aliquot, iron plus titanium was determined in the precipitate. Titanium was determined by cupferron. Iron was determined by difference, and aluminum by difference between sesquioxides and iron plus titanium. Manganese was determined colorimetrically in a third aliquot.

Samples collected after 1959 were analyzed by Katsura's (1961) procedure. In this procedure the sample was fused in sodium carbonate as before and silica determined by difference. The sesquioxides were determined gravimetrically. Calcium and magnesium were determined in the leachate, calcium volumetrically with permanganate, and magnesium gravimetrically as pyrophosphate. Another subsample was digested in sulfuric and hydrofluoric acids. Titanium, iron, manganese, and phosphorus were determined colorimetrically using sulfuric acid and hydrogen peroxide for titanium, a-a bipirydyl for iron, and molybdovanadophosphoric acid for phosphorus (Kitson and Mellons 1944). Sodium and potassium were determined by flame photometry.

Physical Analyses

The Hawaiian Sugar Planters' Association made water content, particle density, bulk density, and water retention measurements on soil cores of most of the samples collected in 1962, 1963, and 1965. No methods codes are given for these samples. Methods codes in the appropriate columns indicate that the analyses were made instead by the SCS soil survey laboratories. Atterberg limits were determined by the SCS soil mechanics laboratory at Portland, Oregon.

a) Bulk density: The measurement was made from cores (45 mm diameter, 52 mm height). Duplicate cores were removed from the face of the pit in 5 cm increments. The average bulk density for each horizon was calculated from all cores removed from the horizon.

b) Water content: Samples were gently crushed and thoroughly mixed. Water retention of undisturbed samples was determined at 15 bar pressure and at 1/3 bar pressure in a pressure membrane apparatus. Equilibration time was extented as necessary, usually 10 to 14 days. All determinations were made in triplicate.

c) Particle density: The measurement was made with a pycnometer (Blake 1965).

d) Atterberg limits: The measurements were made by standard ASTM procedures (1970), methods D423 and D424. Samples that were expected to change properties on drying (see footnotes on data sheets) were not allowed to dry prior to analyses. These samples were not passed through a 420 micron sieve.

Mineralogical Analyses

Mineralogical analyses on all samples collected in 1958 and 1961 were made by the SCS soil survey laboratory at Beltsville, Maryland. The methods are identified by code and are described in detail in SSIR No. 1. Mineralogical analyses on all samples collected after 1961 were made by the Department of Agronomy and Soil Science of the University of Hawaii. In their data, qualitative and quantitative estimates are based on a combination of instrumental methods, X-ray, DTA, and chemical methods, total analyses, dithionite citrate extraction, and sodium hydroxide dissolution. These analyses were carried out on samples of whole soil. Silica and alumina were extracted by 0.5 normal sodium hydroxide from deferrated samples free of organic matter (Hashimoto and Jackson 1960). The sand and silt fractions were studied by X-ray diffraction and petrographic analyses, and the clay fraction was studied by X-ray diffraction analysis, and for some soils, by infrared analysis and electron microscopy. Except for amounts less than 3 percent, the figures have been rounded to the nearest 5 percent and are considered to be accurate at that level. Certain conventions have been adopted as follows:

a) Kaolinites: If hydrated halloysite was definitely identified by DTA, it is mentioned in a footnote.

b) Micas or clay mica: A potassium-containing 2:1 layer silicate is common in small amounts in many of the soils. It is clearly a dioctahedral, randomly interstratified mica made up of muscovite and vermiculite layers. In estimating its amount the following formula was used:

$$Na_{.22}K_{1.20}(Si_{6.35}Al_{1.65})(Al_{3.53}Fe_{.16}Mg_{.55})\ O_{20}(OH)_4 \qquad \text{(Juang 1965).}$$

c) Allophane or amorphous material: The soils were extracted with 0.5 normal sodium hydroxide. Analysis of standard samples and cross-checking by various analytical techniques showed that most of the silica and alumina came from kaolinite with some additional alumina from gibbsite. A conversion factor (0.21 X percent of kaolinites) for silica extracted from kaolinites was adopted. Alumina extracted from kaolinites was in the normal 2:1 molar ratio. If extracted silica and alumina remained after allocation to kaolinites, they were combined with water into amorphous materials ($Al_2O_3.SiO_2.2H_2O$). The remainder was calculated as amorphous silica or alumina. The actual values of extracted silica and alumina are shown in separate columns.

d) Goethite: All extractable iron oxide has been assigned to goethite although X-ray evidence shows traces of lepidocrocite in the most weathered soils.

e) Magnetite, etc.: The iron remaining after calculation of goethite was considered anhydrous and was assigned to magnetite, maghemite, hematite, and ilmenite (with an appropriate assignment of titanium oxide) without differentiation. If one or other of these minerals occured in noteworthy amounts, it is noted in a footnote.

f) Anatase: All remaining titanium oxide was assigned to anatase, which was also identified by X-ray diffraction. Traces of rutile occurred in strongly weathered soils.

g) Other: Allocation conventions for other minerals are essentially those of Jackson (1956).

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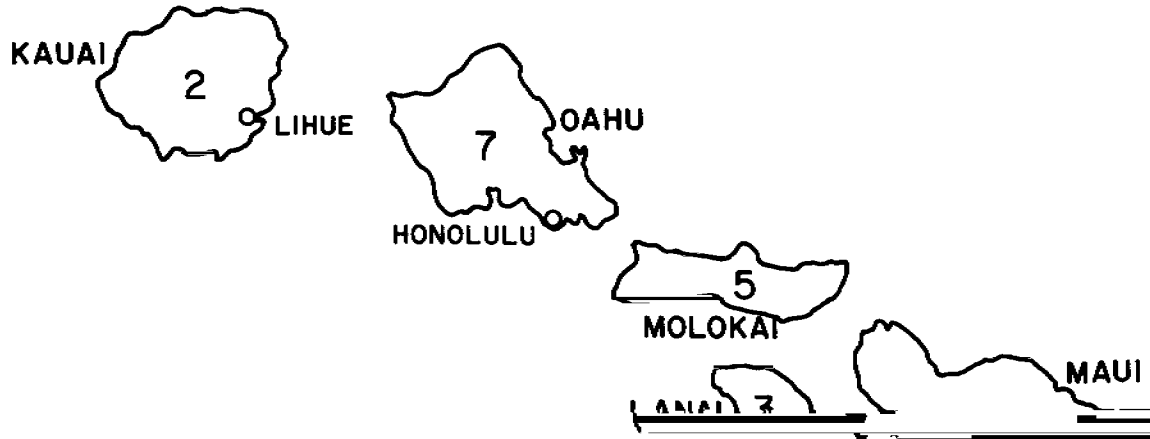
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