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**Abstracts of Publications and Research
Department of Agronomy and Soil Science
College of Tropical Agriculture
1960-1974**

V. Soil Science

Peter P. Rotar, Editor

PREFACE

This series of six volumes of *Abstracts of Publications and Research, Department of Agronomy and Soil Science, College of Tropical Agriculture, 1960-74* details all the published research by members of the Department of Agronomy and Soil Science, University of Hawaii, and graduate student M.S. theses and Ph.D. dissertations prepared for degrees granted by the Department.

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Within each numbered section, the publications are listed in alphabetical order by senior author and date of publication, then by alphabetical order of second author, and finally by alphabetical order of title. Abstracts of theses and dissertations are longer than abstracts of published papers. The table of contents in each volume lists the complete citation—author, date, title, and publication data—for each publication.

Each abstract may be cut out and individually mounted on a 5 x 8 notecard for easier filing.

The choice of category for certain abstracts may appear somewhat arbitrary, especially since some abstracts fit well into any one of several sections. Choice of section was made by the compiler. Not all of the department's research efforts are presented in these reports: some were inadvertently missed; others fell by the wayside as deadlines were set and changed. These will all be published in an addendum at a later date.

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P.P.R.

The Editor

Peter P. Rotar is Professor of Agronomy, Department of Agronomy and Soil Science, University of Hawaii, and Agronomist, Hawaii Agricultural Experiment Station.

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V. Soil Science

Peter P. Rotar, Editor

(7) Soil Genesis, Morphology and Classification

Allen, V. T., and G. D. Sherman. 1965. Genesis of Hawaiian bauxite. Econ. Geol. 60:89-99.

ABSTRACT

Clinker zones composed of glass and slag at the top of basaltic lavas in the Hawaiian Islands provided permeable zones along which ground water circulated and removed silica from the original glass and minerals of basaltic lavas and formed bauxite.

Rain that fell in vast quantities along the central ridges of Kauai, Maui, and Hawaii descended along cracks to the permeable clinker zones and flowed laterally eastward to the present known areas of bauxite. Here, leaching along the permeable clinker zones augmented weathering processes that progressed vertically downward from the surface. This mechanism of lateral circulation and leaching by artesian waters under hydrostatic head provides an explanation of: the occurrence of nodules of gibbsite at various depths; the irregular distribution of high-alumina low-silica intervals with those of low-alumina high-silica in the same vertical section; the presence of gibbsite in regions of present low annual rainfall; the more rapid rate of bauxite formation in the Hawaiian Islands as compared with that in Oregon.

additional index words: bauxite, weathering, soil formation, rainfall

Atkinson, I. A. E. 1969. Rates of ecosystem development on some Hawaiian lava flows. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The objective of this study was to measure rates of plant succession and rock weathering during the first 400 years of ecosystem development on Hawaiian basalt lava flows. The flows chosen for study were on the wettest slopes of Mauna Loa and Kilauea in a rainfall of 90 to 250 inches and between elevations of 40 to 4000 feet. These flows are largely free from ash.

The oldest dated flow on Hawaii which occurred little more than 200 years ago (1750 A.D.), gives insufficient time for much development. To measure rates over a longer period, e.g. 400 years, it was necessary to date older flows. Since obtaining carbon for C-14 dating of the older flows was unlikely, a major part of the study was concerned with searching for a method of aging late prehistoric flows.

The vegetation of nine aa and two pahoehoe flows was examined and samples obtained of unweathered and weathered rocks. Of the methods investigated, compositional changes between unweathered and weathered rocks showed most promise as age indices; in particular, pH change, sodium loss, calcium loss, titanium gain, and a 110-350°C. weight loss measuring adsorbed and hydrated water. Measurements from 5 dated aa flows were used as dependent variables in a regression analysis. Included as independent variables were age, climate, effective plants (biotic factor), rock composition, rock texture and porosity. Two of the regression equations obtained were solved inversely to give an

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estimation of age with confidence limits of ± 87 and ± 108 years. These equations, when used to age two prehistoric aa flows, gave ages that agreed within 25 years (c. 360 years B.P.). The two equations used different compositional parameters, viz. pH, sodium and calcium loss in one case, and the 110-350°C. weight loss in the other. Thus, although no other dates are available for comparison with these ages the agreement in the result indicates that these methods are worthy of further study.

Four trends in plant succession all beginning on bare aa lava were recognized from the observations of vegetation in this high-rainfall region. A coastal succession appears to culminate in Pandanus forest. At altitudes below 1000 feet, successional trends are towards Metrosideros or Metrosideros/Diospyros forest. The latter trend appears to be associated with areas where rainfall is less than 100 inches and where there is a tendency towards summer-dry periods. At higher altitudes (3000 to 4000 feet), a relatively stable stage commonly reached is that of Metrosideros/Cibotium forest.

Concerning rates of plant succession, it was concluded that in the humid region with annual temperature of about 70°F., forest (> 80% cover of trees) can develop on aa flows within 200 years of flow formation. At higher altitudes (3000-4000 feet with annual temperatures of c. 60°F.), forest is developed within 300 years. These rates are slower than those reported elsewhere in the tropics but may be typical of succession rates on aa lava that has little ash.

Considering rates of rock weathering, the following mean rates of change over the 400 year period studied were found: pH changes of 0.76-1.50 pH units per century; sodium loss of <0.1-0.3% per century; calcium loss of <0.1-0.4% per

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century; relative titanium gain of 0.05-0.18% per century; and gain in water of 0.6-0.9% per century. There was a clear indication that rates of weathering were decreasing with time.

In this high-rainfall region, the rate of succession was highest at altitudes below 1000 feet. However, the rate of weathering on these flows was greater between 3000 and 4000 feet. It was concluded that temperature, with its effects on plant growth, evaporation and accumulation of organic matter, was the differentiating factor.

additional index words: plant succession, rock weathering, aa lava, pahoehoe lava, vegetational change, plant growth, seral development

Beinroth, F. H., G. Uehara, and H. Ikawa. 1974. Geomorphic relationships of oxisols and ultisols on Kauai, Hawaii. Soil Sci. Soc. Amer. Proc. 38(1):128-131.

ABSTRACT

A succession of Eutrustox-Eutrorthox-Gibbsiorthox-Gibbsihumox occurring in northeastern Kauai, Hawaii, is shown to be a climosequence. These soils developed synchronously on basic lavas forming one geomorphic surface of Pleistocene age. Ultisols found along the knickpoint of this surface to recent erosion surfaces are the result of soil creep. The mechanisms of clay mobilization by soil shear caused by creep are discussed.

additional index words: soil-geomorphology, oxisols, ultisols, soil creep

Bruce, R. C. 1971. A study of the relationship between soil and quantitative terrain factors. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The objective of the study was to determine whether or not different soil areas in Hawaii could be separated by means of quantitative terrain factors. Eight great soil group areas on Oahu and six soil association areas on Kauai were selected. A sufficient number of 0.5-mile square test cells was established at random in each of the soil areas. Ten terrain factors were quantified in each of the test cells from data measured on either the topographic maps or the aerial photographs or both.

The results showed that certain great soil groups on Oahu and certain soil associations on Kauai can be differentiated by their quantitative terrain factors. Average elevation, local relief, average slope, slope length, land texture ratio and drainage density were found effective in differentiating between these different groups and associations. Four terrain factors has been found effective in separating the Haplustox, Eutrorthox and Gibbsihumox areas on Oahu. These factors, in the order of decreasing effectiveness, were average slope, drainage density, slope length and local relief. The discriminant function equation developed for Tropohumult and Gibbsihumox areas, based on average elevation, average slope, slope length and drainage density, has satisfactorily segregated the two soil areas on Oahu.

The result of the numerical grouping analysis of 108 test cells established in 0.5-mile grids in eastern Kauai indicated that numerical methods on the basis of several terrain factors has much to offer in reconnaissance soil surveys of large, relatively undeveloped regions where information about the soil is not available.

additional index words: slope, drainage density, slope length, soil mapping, soil associations, land classification, great soil groups

Chotimon, A. 1969. The properties and genesis of four soils in southwestern Kauai, Hawaii. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

A sequence of four soils in southwestern Kauai was investigated to observe the effect of climate (low to moderate rainfall) on the formation of soils on highly weathered basic or ultrabasic basaltic material. There was a decrease in the clay content and a corresponding increase in the coarser fractions with an increase in rainfall. Oxides and/or hydrous oxides of aluminum and iron were present but kaolinite constituted the main clay mineral. Organic carbon and total nitrogen correlated with rainfall, and the c.e.c. was influenced by the mineralogy and organic matter content. These soils showed high free iron content ranging from 15 to 29 percent which was negatively correlated with 15-bar water.

additional index words: soil genesis, soil classification, soil characterization, Hawaiian soils

Fernandez, N. C., and G. D. Sherman. 1963. Certain morphological and chemical properties of four soils of the Molokai family. Philippine Agriculturist 47:168-182.

ABSTRACT

Certain morphological, mineralogical, and chemical properties of the Molokai, Pamoia, Waipahu and Mamala series, 4 of the 6 members of the Molokai family, were investigated.

Morphological studies showed marked individuality of the 4 series. A distinct color deviation was noted in the Waipahu; the Molokai, Pamoia and Mamala were reddish brown to red; the Waipahu was dark brown to brown.

As determined by DTA substantiated by X-ray diffraction analysis, the mineralogy of the lower horizons of the Waipahu was different from that of the corresponding horizons of the Molokai, Pamoia, and Mamala. The Waipahu contained montmorillonite as well as kaolinite; the Molokai, Pamoia and Mamala throughout the profile contained dominantly kaolinite.

Differences in relative maturity and in the condition under which these soils formed seemed to account for variations in morphological, mineralogical, and chemical properties.

additional index words: latosols, oxisols, soil classification, soil analysis, clay mineralogy, montmorillonite, kaolinite

Hammond, L. L. 1969. The characterization and classification of the soils of Christmas Island. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The soils of Christmas Island are extremely youthful in development. They are composed of fragments of coral, algae, mollusks, Foraminifera, echinoids, and other calcareous organisms. Calcium carbonate is present both as calcite and aragonite. No silicate clay minerals were identified in these soils. All soils exhibited a coarse texture, with the sand fraction accounting for 96 to 99% of the soil material in all except two of the profiles. Organic matter is extremely low in all profiles, reaching a high of 2.3 percent and rapidly decreasing with depth. Carbon and nitrogen are closely related, with an average C/N ratio of 12. The pH ranges from 7.7 to 8.0, being lowest in the surface horizon and increasing with depth. The properties of all profiles are within the ranges described for the Shioya series, one of the series commonly described on other atolls. The Shioya series is classified as a member of the isohyperthermic family of the Typic Ustipsamments in the U. S. Comprehensive Soil Classification System. It is felt that this series and the Jaucas series found in Puerto Rico and Hawaii show enough similarity to be combined into a single series.

additional index words: Christmas Island, soil characterization, soil classification, coral, soil formation, calcareous organisms

Hassan, T. S. 1969. The properties and genesis of soils derived from Pahala ash in Kau District, Hawaii. M. S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Whereas the sequence of volcanic ash soils on the windward slope of Kohala Mountains is derived from andesitic parent material, there exists a sequence of volcanic ash soils derived from Pahala Ash in Kau, Hawaii, which is believed to be basaltic in composition. Although the latter sequence occurs in a lower rainfall belt which ranges from 50 to 80 inches per year, definite trends in weathering were again observed. The 15-bar water, clay content, organic carbon, free iron, and x-ray amorphous material correlated with rainfall. Data have now been collected so that predictive equations may be derived not only to relate many of these properties to climate but also to determine the parent materials of these volcanic ash soils.

additional index words: soil genesis, soil classification, soil characterization, Hawaiian soils

Hussain, Md. S. 1967. A genetic study of the gray hydromorphic soils of the Hawaiian Islands. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The morphological, physical, chemical, and mineralogical properties of six soil profiles representing typical gray hydromorphic soils of the Hawaiian Islands were studied. The unique morphological feature common in all but one of these soils was the presence of mottled horizons in the subsoil. Presence of mottles was considered to bear testimony to a fluctuating water table in the profile throughout the year. Clay-sized materials in these soils ranged from 60-90%.

Cation exchange capacities ranged from 21-85 m eq. per 100 grams of soil. Ca^{++} and Mg^{++} were the two dominant cations present. Percent base saturation in all but one soil profile was very high.

Moisture retention at 0.33 bar was higher than the moisture equivalent value. Moisture retention at moisture equivalent showed a significant correlation with moisture content at 0.33 bar.

The pH values in most of these soils were high. Despite high base saturation the ΔpH (pH in N KCl solution - pH in H_2O) were unusually high and ranged from 0.30 to 1.25 pH units.

Free iron oxides were low in gley horizons and increased near the surface of the soils. In less hydromorphic soils free iron oxide remained constant throughout the profile. Free manganese oxides followed a similar distribution pattern to that of free iron oxides.

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Montmorillonite was the dominant mineral in the clays of strongly hydromorphic soils, whereas metahalloysite was dominant in the clays of the less hydromorphic ones. In the clay fractions of all soils there was a trend of an increase of montmorillonite and a decrease of metahalloysite with depth. The montmorillonite type mineral was identified as an iron-rich montmorillonite or nontronite.

Gleization was considered as the major soil-forming process operating in these soils; its intensity increased with increasing drainage impedence. The presence of high amounts of metahalloysite in the least hydromorphic soils was explained on the basis of the principle of "pedogenic hysteresis".

The decrease in metahalloysite content with depth was considered to be authigenetic. High concentrations of bases and silica in soil solutions derived from weathering basalts of nearby uplands, is suggested as the cause of synthesis and stability of montmorillonite clays.

Gley horizons were found in very poorly drained soils. Both reversible and irreversible types of gleying were observed among the soils by examining the color change after exposure to the atmosphere. The soils were classified according to the Comprehensive Soil Classification System of U.S.D.A.

additional index words: vertisols, gley horizons, soil formation, soil classification, montmorillonite, metahalloysite

Hussain, M. S., and L. D. Swindale. 1970. A morphological and mineralogical study of the gray hydromorphic soils of the Hawaiian Islands. *Pac. Sci.* 24(4):543-553.

ABSTRACT

Gray hydromorphic soils are imperfectly to poorly drained soils that occur on the coastal fringes of the Hawaiian Islands on surfaces of Pleistocene to Recent age. Mottling is characteristic of the soils, and gley horizons occur in the more hydromorphic soils in the group. As the soils become hydromorphic, soil color values increase and structures deteriorate.

Halloysite is the dominant clay mineral in the less hydromorphic soils and montmorillonite is dominant in the more hydromorphic soils of the group. The montmorillonite is iron-rich and in one soil has the formula $(X_{0.74}K_{0.11})(Si_{7.52}Al_{0.48})^{IV}(Al_{1.85}Fe_{1.66}^{3+}Mg_{0.35}Ti_{0.10})^{VI}O_{20}(OH)_4$. Hydrated halloysite occurs in all the soils studied, but it is most abundant in the more hydromorphic soils. Although the soils are derived from different alluvial materials, the trend of increasing montmorillonite and increasing hydrated halloysite with increasing hydromorphism is clearly related to the pedogenic processes operating in the soils. Similar mineralogical trends are found with increasing depth in each soil.

additional index words: soil formation, soil classification, vertisols, mollisols, inceptisols, clay mineralogy, halloysite, montmorillonite

Jackson, M. L., T. W. M. Levelt, J. K. Syers, R. W. Rex, R. N. Clayton, G. D. Sherman, and G. Uehara. 1971. Geomorphological relationships of tropospherically derived quartz in the soils of the Hawaiian Islands. *Soil Sci. Soc. Amer. Proc.* 35:515-518.

ABSTRACT

The percentage of quartz in surface soils over quartz-free mafic (basic) rocks of the Hawaiian Islands varies with the amount and source of annual rainfall and with landscape elevation and age. On the Island of Oahu, the quartz content of the soil A horizon varies in the range 0.2 to 0.7% in Molokai soil at 40 m elevation (and 750 mm of rainfall), 1.1 to 1.6% in Wahiawa soil at 300 m elevation (and 1,250 mm of rainfall), 13 to 22% in Paaloa soil at 380 m elevation (and 2,000 mm of mainly Trade Wind rainfall), and 1 to 45% in Olokui soil at 450-1,250 m elevation (and 1,750 to 5,000 mm of rainfall). The pronounced increase in quartz percentage from Wahiawa to Paaloa soil reflects the somewhat greater rainfall, but particularly the greater proportion of Trade Wind rainfall and the greater landscape age of the Paaloa sites on old interfluvies. With higher rainfall and site age of Olokui soil on mountain tops, the quartz contents are higher; where erosion and denudation have kept the landscape younger on ridges and saddle crests, the contents are lower. Quartz contents, varying from 0.1 to 17% with rainfall and landscape age, were also determined in soils of the Islands of Kauai, Molokai, Maui and Hawaii.

The close similarity of three parameters of the quartz (particle size distribution - 70% in the 10-2 m fraction; particle morphology-angular rather than euhedral; and oxygen isotope abundance - $\delta^{18}O$ = averaging 17.6 0/00)

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in soils of several islands are remarkably similar to those of pelagic sediments of the north central Pacific Ocean and aerosolic dusts of the Northern Hemisphere. This similarity is attributed to their common eolian origin from arid continental areas of the Northern Hemisphere. Dust carried by the circumpolar Westerly Winds is scrubbed by clouds formed by orographic-convective rise of air from the Trade Winds in the Hawaiian Islands and then is deposited on soils by rainfall. The percentage of quartz in surface soils on the oldest landscapes approaches that in the north central Pacific pelagic sediments. The percentage of quartz in most Hawaiian soils, however, is much lower as a consequence of dilution by mixing with indigenous quartz-free soil, weathering products, occasional volcanic ash showers, and soil organic matter. Mass wasting appears to have removed the primary landscapes from the basalt dome. The thickness of quartz-rich surface horizons since accumulated is therefore only a fraction of a meter rather than the several meters thickness of pelagic sediments laid down during periods corresponding to the known island ages. The quartz-enriched (and micaceous vermiculite-enriched) surface soil horizons constitute an example of an ombitrophic ecologic environment in which soil-borne nutrients are provided abundantly from the atmosphere. This environment is especially likely to receive pollution from radioactive elements and toxic chemicals such as DDT, lead from gasoline, and related man-derived materials.

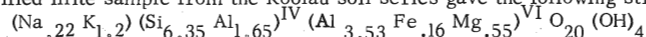
additional index words: quartz oxygen isotope abundance, scanning electron microscopy, particle size distribution, dust in rain, landscape age

Juang, Tzo-chuan. 1965. Genesis of secondary micas from basalts and related rocks in the Hawaiian Islands. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Seven soil profiles representing six soil series, six soil families and four Great Soil Groups were studied for their illite content. Illite content decreased with soil depth and increased with increasing wetness of the soil. Illite content ranged from 1.5 to 42.5 percent.

Chemical analysis of a purified illite sample from the Koolau soil series gave the following structural formula:



It was concluded that illite in Hawaiian soils is synthesized in soils during soil formation. Low mica contents of Hawaiian rocks and the dissimilarity of soil illite to biotite were used as the major evidence for this conclusion.

Concentration of potash by vegetative recycling was suggested as the probable mechanism for creating an environment favorable to illite formation.

additional index words: rock weathering, clay minerals, soil development, soil taxonomy

Juang, T. C., and G. Uehara. 1968. Mica genesis in Hawaiian soils. Soil Sci. Soc. Amer. Proc. 32:31-34.

ABSTRACT

A soil mica having a formula $\text{Na}_{0.11} \text{NH}_4_{0.06} \text{K}_{1-24} (\text{Al}, \text{Si}) (\text{Al}, \text{Fe}, \text{Mg}) \text{O}_{20} (\text{OH})_4$ has been identified in soils of the wet uplands in the Hawaiian Islands. It contains 7.2% potash and is predominantly a mixer-layered mica with vermiculite-montmorillonite and chlorite. The mica is concentrated in the surface horizons, and its concentration increases with soils formed under increasing rainfall and elevation. Biological recycling of potash is proposed as a mechanism for its formation.

additional index words: moire patterns, electron microscope

Kimura, H. S. 1966. A study of Lahaina silty clay soils forming from different parent materials. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Statistical tests of the chemical and mineralogical properties indicate that the Lahaina silty clay soils have attained pedogenic convergence with the exception of the K_2O and the related pedogenic mica content. The divergence of K_2O and mica is probably dependent on the parent material instead of the parent rock. The extractable zinc and phosphorus appear to have converged and are deficient in the Lahaina subsoils. The high zinc and phosphorus contents of surface horizons is probably the result of fertilization or recycling by organic matter. The total zirconium and nickel of the Lahaina soils did not attain pedogenic convergence. Because of the divergence of zirconium and nickel, a discriminant function of the form $Zr - 1.44 Ni$ has been developed to distinguish between parent rocks of strongly weathered Hawaiian soils. The function was primarily developed for use with Lahaina silty clay soils but was extended successfully for use with unweathered rocks and with a wide range of Hawaiian soils. Total zirconium in the solum increased with increasing weathering: total nickel in the solum increased up to the upper limit of the Haploxerox and then decreased progressively. With increasing pedogenetic development, zirconium tended to be eluviated from the upper horizons, and accumulation of zirconium was found in the spodic horizon of a Tropaquod. With increasing pedogenetic development, nickel tended to be eluviated from the profile, with the greatest eluviation in the upper horizons. A relative accumulation of nickel occurred in the spodic horizon of the Tropaquod. Although zirconium and nickel have different distribution patterns throughout the soils, the discriminant function successfully differentiated andesite-derived from basalt-derived materials for every horizon in every soil analyzed.

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The behavior of the discriminant function and pedogenetic mica differentiated Lahaina soils from residuum and alluvium. The discriminant function for the soils plotted against mica content of the clay fraction show two distinct patterns: one a linear and the other an irregular. The Maui and Oahu soil profiles which show a linear pattern of points are probably formed from residuum, whereas the two Molokai soil profiles which show an irregular pattern are believed to be formed from alluvium. The andesitic Lahaina soil from Molokai appears to have developed from residuum and alluvium.

additional index words: discriminant functions, weathering, soil genesis, clay minerals

Loganathan, P. 1967. The properties and genesis of four middle altitude Dystrandepts from Mauna Kea, Hawaii. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Four soils classified as dystrandepts taken from the middle elevations of Mauna Kea, Hawaii, showed variations in properties that were closely correlated with variations in rainfall. The soils contained plagioclase feldspars in the silt and sand fractions of some horizons, together with magnetite, plant opal, and small amounts of olivine and pyroxenes. The clay fraction of all the soils contained allophane. Umikoa and Maile, the two wetter members, contained gibbsite and a little kaolin, mica, and vermiculite. The amount of allophane in the clay fraction was found to decrease in the order: Apakuie > Hanaipoe > Umikoa > Maile. The amount of allophane in the whole soil was found to increase in the order: Apakuie < Maile < Hanaipoe < Umikoa.

Soil pH was neutral to slightly acid. The decrease of pH in the sequence was highly correlated with increase of rainfall. The pH was always found to be lower in the surface horizon than the horizons below. Percentage carbon and nitrogen were found to be very high and highly correlated with each other. The variation in carbon and nitrogen content in the sequence indicated that they are dependent on both temperature and rainfall. Free iron oxides in the mineral soils ranged from 6.7 to 37.5 percent, with the greatest amounts in the surface horizon of the Maile soil. In the sequence, it increased with increasing temperature and rainfall. The high cation exchange capacities and 15-bar water contents of these soils correlated well with the high amounts of allophane. Base saturation varied logarithmically with the rainfall as expected from fundamental principles of thermodynamics. The relative abundance of the exchangeable bases decreased in the order: $Ca > Mg > K > Na$.

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The textures of these soils were clayey except for the Apakuie soil which was slightly coarser than the rest. This indicated that the soils are moderate to highly weathered with the degree of weathering increasing in the order: Apakuie < Hanaipoe < Umikoa < Maile. Laboratory analyses show more clayey texture than field observations.

The allophane in these soils is mainly allophane A, in which the silica and alumina are randomly combined. Quartz was found to increase with increasing rainfall in the sequence, with high amounts in the silt fraction of surface horizons.

Numerical values for the factor $\frac{\partial S}{\partial r}$ of Jenny's soil formation equation were obtained. The soil properties (S) studied were base saturation, pH, and ΔpH . The soils were also classified according to the new U.S. System of Classification. The Apakuie soil, the driest and least weathered, is classified as an Entic Dystrandept; Hanaipoe and Umikoa soils as Typic Dystrandepts; and the Maile soil, the wettest and most weathered, as a Hydric Dystrandept.

additional index words: allophane, clay minerals, soil classification, soil formation

Loganathan, P., and L. D. Swindale. 1969. The properties and genesis of four middle altitude Dystrandept volcanic ash soils from Mauna Kea, Hawaii. Pac. Sci. 23(2):161-171.

ABSTRACT

The four soils collected from the middle altitudes of the northern slopes of Mauna Kea, Hawaii, contained volcanic glass and plagioclase feldspars in the silt and sand fractions of some horizons, together with magnetite, plant opal, and small amounts of olivine and pyroxenes. The clay fractions of all the soils contained allophane. The Umikoa and Maile soils, the two wetter members, contained gibbsite and small amounts of kaolin, mica, and vermiculite. The four soils, arranged in order of decreasing amounts of allophane in the clay fraction, are: Apakuie > Hanaipoe > Umikoa > Maile.

Profile differentiation was confined only to the formation of the dark granular epipedons, except in the Maile soils where additional differences occurred in the surface horizon.

The Apakuie soil is moderately weathered, neutral to slightly acid, moderate in amounts of base saturation, and medium in cation exchange capacity. The Hanaipoe soil is moderately to strongly weathered, slightly acid in reaction, and has low base saturation, high cation exchange capacity, and very high organic matter. The Umikoa soil is strongly weathered, is slightly acid in reaction, and has very low base saturation, high cation exchange capacity, and high organic matter. The Maile soil is very strongly weathered, is acid in reaction, and has very low base saturation, high cation exchange capacity, and high organic matter.

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The Apakuie soil, the driest and least weathered, is classified as an Entic Dystrandept; Hanaipoe and Umikoa soils are Typic Dystrandepts; and the Maile soil, the wettest and most weathered, is a Hydric Dystrandept.

additional index words: allophane, volcanic glass, clay minerals, tropical soil classification and formation

Nakamura, M. T., and G. D. Sherman. 1965. The genesis of halloysite and gibbsite from mugearite on the island of Maui. Hawaii Agr. Exp. Sta. Tech. Bull. 62. 36 p.

ABSTRACT

Mineral transformation in a mugearite (oligoclase andesite) in Hawaii is discussed. The results of differential thermal and X-ray diffraction analyses, thin section studies, electron microscopy, and chemical analysis indicate that the vesicular rock weathers uniformly into pure halloysite whereas within a dense rock where there is a diversity of micro-environments, the feldspar weathers to gibbsite or halloysite depending on the concentration gradient of alumina and silica. The analysis of the purest halloysite obtained from drainage channels was 40.35% SiO_2 , 37.00% Al_2O_3 , and 22.62% H_2O . The electron-micrographs of the different halloysites revealed a morphology ranging from almost spheroid particles to imperfect to typical tubular materials.

additional index words: halloysite, mugearite, gibbsite, weathering

Oshiro, K. 1969. The properties and genesis of a sequence of soils on Kohala Mountain, Hawaii. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

A sequence of volcanic ash soils on the windward and wet slope of Kohala Mountains showed the occurrence of Aquepts at the higher elevation where the temperature is cool. The 15-bar water, organic matter, cation exchange capacity, quartz content, and x-ray amorphous material correlated with rainfall. Free iron increases as the mean rainfall increased from 80 to 125 inches. However, there was a sharp decrease in the free iron at a rainfall of 150 inches, especially in the A2 horizon. The downward movement of organic carbon and the formation of an "organic carbon bulge" in the same profile and the presence of a weak albic horizon suggested the initial stage of the formation of a Spodosol in a high rainfall area.

additional index words: soil genesis, soil classification, soil characterization, Hawaiian soils

Pandey, S. 1969. Prediction and comparison of properties of Hawaiian and Indian red earths using automatic data processing techniques. Ph. D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Tropical Red Earth is a term in common use throughout the tropical world to describe a group of soils which are in general red in color, deeply weathered, with weak profile differentiation, and have kaolin clays. Terminology is not precise but it is probable that 7.6 million mi^2 of soils representing 38 percent of tropical land area have at some time been included under the title.

These soils are extensive and of great agricultural importance in Hawaii, U. S. A. and India. This project has attempted to predict salient properties and determine the similarities and differences among the Red Earths of these two countries.

An extensive survey of the published literature was completed to define the term Red Earth, note their global distribution, describe the properties and of Red Earths of Hawaii, and discuss the properties, factors of formation and genesis of those of India.

Computer science techniques were used, methodology developed for coding measured and descriptive data, and the advantages and disadvantages of many statistical computer techniques determined in developing the predictions and comparison.

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Twenty-one profiles from Hawaii and 55 profiles from India were included in the study.

The Red Earths of Hawaii showed striking uniformity of properties as shown by low coefficients of variability and narrow ranges of frequency distribution of their variables. Kaolin is their predominant clay mineral with fairly high amounts of iron oxides and smaller amounts of gibbsite and titanium oxides. Several variables were highly correlated with depth or log depth, some with median annual rainfall, and others with C. E. C. Attempts to predict C. E. C., organic carbon, total nitrogen and bulk density were successful, the last furnishing clear proof of the usefulness of descriptive variables in prediction. The Indian Red Earths, a more heterogeneous group than those of Hawaii were subdivided into three subgroups: (1) Argillaceous, (2) Kaoargillaceous, and (3) Oxides greater than Kaolin. The properties common to all three to a greater or less degree were: high sand fraction content which often exceeds 50 percent of particle size distribution, clay illuviation being a common phenomenon, much less aggregation than in Hawaiian group, and uniformly poor content of organic matter, nitrogen, phosphorus and potassium. The important clay mineral constituents are kaolin, amorphous substances and micaceous and inter-gradient species. It is suggested that erosion and polycyclic pedogenesis have significantly contributed to their development. There was a progressive reduction in the contents of exchangeable Ca^{++} and exchangeable Mg^{++} , C. E. C., silt, $\text{SiO}_2/\text{Al}_2\text{O}_3$ ratios in the three groups according to the progress of weathering from Argillaceous to Oxides greater than Kaolin groups.

Classification and comparison of soils were done by two separate methods. Firstly, by checking a priori subjective classifications by discriminant function analysis and, secondly by using hierarchial classification procedure to achieve optimum number of classes so that the variance within the groups was minimized in relation to the variance

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between the groups. For discriminant function analysis soils were classified and compared using soil horizons and weighted soil profiles as units in distinct steps. The separation of Indian Red Earths into three subgroups was possible both by horizons and profiles. The comparisons of Hawaiian and Indian Red Earth subgroups were attempted using horizons and weighted profile values. The separations were clear and significant overlap of Hawaiian and Oxides greater than Kaolin group was evident in each case. Hierarchial classification studies did not reveal clear cut separations, though several interesting results were obtained.

additional index words: soil taxonomy, oxisols, soil characterization, clay minerals, soil weathering

Raymondo, M. E. 1965. The properties of the black earths of Hawaii. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Morphological, physical, chemical, and mineralogical studies were carried out on six profiles representing the black earths on the island of Oahu, Hawaii. The ranges of these properties were compared with those of the black earths in other tropical and subtropical areas. Only a few of these properties were needed as bases for classifying the soils into soil series and at higher categories.

Morphology of the soil profiles which have been classified and mapped as "Dark Magnesium Clays" were typical of the black earths except for the Papaa soil. The intense dark color, the depth and width of the cracks produced by shrinkage and swelling, the presence of carbonate and gypsic horizons, and the hardness or stickiness of the heavy textured soils observed in the field were similar to those for other black earths. Some variations in depth of the solum, in the depth and approximate quantities of gypsum and carbonates, in parent material, relief and drainage conditions, and the relative compaction were observed. These variations, however, were within the range of properties observed in other black earths.

Bulk densities of the soils ranged from 1.41 to 1.84 g per cc. These values were high compared to values found for most soils in Hawaii. Clay contents ranged from 30 to 80%.

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Silt fractions were generally below 15% of the whole soil, whereas most of the other black earths contained 20 to 50% silt. Only one soil in Kenya showed similarly low quantities of silt fraction. Water retentive capacities of the soils were high because of clay contents. Ranges were 75 to 101% at saturation, 38 to 76% at moisture equivalent, and 25 to 40% at 15 atmosphere pressure. Thus, the black earths of Oahu have about the same water retention capacities as found in coastal prairie grumusols of Texas.

The pH values for the sola of the black earths of Hawaii were 6.50 to 8.10, except for one profile. The pH values of these soils which were in the order of 0.25 to 2.3 pH units were very high compared to the pH value of similar soils elsewhere. Organic matter content of the black earths of Hawaii ranged from 0.42% to 2.20% among the horizons of all the profiles. These values are comparable to the other black earths. It is doubtful that these levels of organic matter per se will impart the dark color to these soils.

The calcium determinations included total CaO, exchangeable Ca++, and water-soluble calcium. Total CaO, ranging from 1.36 to 13.19%, was higher than in most soils. Except for one profile, the soils from Hawaii contained more than 20 m.e. exchangeable calcium per 100 g soil. Four of the Oahu profiles showed high amounts of water-soluble calcium, especially in the gypsic horizons which could be attributed to the presence of soluble forms of sulfates and probably carbonates in these horizons.

The magnesium levels in these soils, both total MgO and exchangeable Mg++, were high compared to other black earths. The Oahu soils exchangeable Mg++ range was from 16 to 40 m.e. per 100 grams. The ratio of exchangeable Mg/Ca was between 1:0.6 and 1:2.4 in the profile of Hawaii. The ratio of 1:3 is common for most black earths.

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A range of 0.1 m.e. to 14 m.e. exchangeable sodium per 100 g soil was measured and is similar to the range for other black earths. More exchangeable sodium was observed in soils which are closer to the sea. The soils contained between 0.2 and 1.13% total potassium. About 1.5 m.e./100 gm of exchangeable K were found in surface horizons.

The total silica contents of profile I indicated that the profile is a possible intergrade from the black earths to the red earths. The $\text{SiO}_2/\text{R}_2\text{O}_3$ ratio of four profiles were similar to those of other black earths. The amounts of total iron varied from 13.28 to 19.74% as Fe_2O_3 . Titanium oxide contents of the soil varied from 2.27% to 6.45% and appeared more dependent on the original parent material than an indication of soil development.

The clay fractions were found to be dominantly montmorillonitic and may be nontronitic. Two profiles from Lualualei Valley showed almost pure montmorillonite clay while the others indicated kaolin and halloysites. The coarse clay fraction was found to contain some amounts of non-crystalline materials.

The profiles studied were classified according to the U.S.D.A. Comprehensive System of Classification. Some of the profiles could not be satisfactorily classified under the present categories. Hence, a modified scheme based on the same principles was suggested for the Vertisols.

additional index words: vertisols, black magnesium clays, soil formation, soil classification, soil mineralogy, soil properties, soil chemistry, soil physics

Sangtian, C. 1969. The nature of argillic horizon in Hawaiian ultisols. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The argillic horizons of four Hawaiian Ultisols have a high clay accumulation and higher fine to coarse clay ratio than the surface horizons but not necessarily the highest in both cases. The argillic horizons also have low base saturation and low $\text{SiO}_2/\text{R}_2\text{O}_3$ ratio but not necessarily the lowest ones in the profile. Cutans formed from kaolin and cutans formed from mixed-layer mica cannot be distinguished from each other. Cutans may be transformed, but the mechanism is not understood. The mineralogy of the cutans and the clay in the soils are similar. However, the amounts of clay may differ. Soil pH in the argillic horizons is strongly acidic.

additional index words: soil genesis, soil classification, soil characterization, ultisols, argillic horizon

Sato, H. H. 1971. Interpretation of index properties of the unified classification system for Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

In Hawaii, the engineering classification systems in many cases underestimate the value of soils as engineering material. High clay content of Hawaiian soils and the resultant high specific surface make it possible for soil material to adsorb large amounts of water. In many soils with kaolinitic or oxidic mineralogy, however, the fine clay particles are cemented into aggregates which often behave as sands or gravels and do not expand when moistened. Thus, these aggregates do not disintegrate and serve as good engineering material. Modifications to the classification systems are proposed for better application of the systems in Hawaii.

additional index words: engineering classification, unified classification, mineralogy

Schroth, C. 1970. Analysis and prediction of the properties of Western Samoa soils. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The object of this study was to develop statistical procedures to reduce the time and cost of reconnaissance soil surveys. A detailed study of the nature, genesis, and classification of Western Samoa soils provided a basis for interpretation of statistical results.

Age of parent material and the amount and distribution of rainfall had the greatest influence on soil formation. Soils derived on the youngest volcanic material were higher in organic matter, cation exchange capacity, and base saturation and lower in free iron oxides than those derived from older volcanics. As the age of the soil increased, the mineralogy changed from mixed-layer and amorphous materials to predominately hydrated iron and aluminum oxides. Soils occurring on the steep eroded slopes of the oldest volcanics were halloysitic.

Soils with pronounced dry periods in the lowest rainfall areas showed weak mixed-layer mineral development. With increasing rainfall, amorphous materials, hydrated iron and aluminum oxides and depth of solum increased; base saturation and boulderiness decreased.

The soils, except for an Oxisol and a possible Ultisol, were Inceptisols. Dystrorpepts and Humitropepts were the predominant Great Groups.

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Summary statistics indicated that a majority of the variables had positively skewed distributions. A normal density function represented pH; lognormal density functions represented percent organic C, percent total N, and exchangeable K; gamma density functions represented cation exchange capacity, total bases, C/N ratio, and exchangeable Ca and Mg. The use of the density functions provided estimates of central tendency and defined a modal profile.

Correlation and regression analyses separated the variables into two groups: Those affected by rainfall - base saturation, total bases, exchangeable Ca and Mg; and those affected by age - percent organic carbon, percent total N, cation exchange capacity, and exchangeable K. Prediction of selected variables of a control group of soils indicated that the regression equations were accurate over a wide range of conditions.

Regional trends of soil variables were examined by trend surface analysis. Linear, quadratic, and cubic polynomial surfaces were fitted by least squares to an array of data points. The resulting "best" surface was contoured and plotted by means of a computer. Surfaces for base saturation, total bases, exchangeable Ca and Mg were identical to rainfall (MAR) maps. Percent organic carbon, percent total N, cation exchange capacity, and exchangeable K had lower R^2 values than the above surfaces. Examination of the residual surfaces indicated that the deviations were associated with local effect of parent material. Surfaces for climatic and topographic variables were fitted. All the various surfaces were screened by means of a computer to produce predicted special purpose soil maps.

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Soil variability between and within the different levels of classification was estimated by nested analysis of variance design with use of the U. S. Comprehensive Soil Classification system as a frame of reference. The results indicated that variability of some properties could be estimated. Variability of other properties, however, could be estimated only with difficulty due to the vertical anisotropy of soils and the criteria used in the classification system.

additional index words: soil taxonomy, soil classification, soil genesis, cation exchange capacity, volcanic soils, Oxisols, Ultisols, Inceptisols, soil variables

Sherman, G. D., and H. Ikawa. 1968. Soil sequences in the Hawaiian Islands. Pac. Sci. 22:458-464.

ABSTRACT

The soils of the Hawaiian Islands offer excellent opportunities for the study of the effects on soil formation of the differential intensity of the factors involved in soil development.

There are sequences of soils which reflect the effect of rainfall: soils rich in montmorillonite type minerals develop in areas of low rainfall, kaolin develops where rainfall is moderate, and free oxides where the amount of rainfall favors complete leaching and rapid desilication of the weathering matrix.

The islands offer an excellent site also for the study of the effect of age on soil development. Examples of the transition of one type of soil group to a soil group of greater stability are described.

The interaction between the influence of parent material and of weather and rainfall is being studied. The first phase of this preliminary study is to determine why the products of rock weathering can range from kaolin to ferruginous bauxite on a single lava flow, with rainfall being the chief variable. The second phase is a study of the effect of the nature of the first product of rock weathering on subsequent soil formation. Soils of three great soil groups are developed on this parent material, namely, Aluminous Ferruginous Latosol, Ferruginous Humic Latosol, and Low Humic Latosol.

additional index words: latosols, secondary minerals, weathering, clay minerals

Swindale, L. D., and G. Uehara. 1966. Ionic relationships in the pedogenesis of Hawaiian soils. Soil Sci. Soc. Amer. Proc. 30:726-730.

ABSTRACT

A pedogenic mica is believed to be present in a sequence of Hawaiian soils, the lower, drier members of which are Oxisols and the upper, wetter members Ultisols. The mica decreases with depth within each soil and increases generally with increasing rainfall and elevation. Direct relationships exist between the amount of mica in the soils and the amount of exchangeable potassium per unit of base saturation, and between the amount of mica and the concentration of potassium in the soil solution. The parameters $\log (K^+)/ (H^+)$ and $\log (H_4SiO_4)$, of the mass action equations between mica, kaolin, and gibbsite, when measured for the soil solutions, are useful indicators of the probable stabilities of the minerals in the soils. Tests of physical models of the chemical system involved, indicate that the exchangeable potassium and the potassium in the soil solutions as measured are not in equilibrium with the minerals in the soils.

additional index words: mica, soil mineralogy, phase equilibria, mineral stability, chemical weathering, Oxisols, Ultisols, kaolin, gibbsite

Uehara, G., K. W. Flachs, and G. D. Sherman. 1962. Genesis and micromorphology of certain soil structural types in Hawaiian latosol and their significance to agricultural practice. *Int. Soc. Soil Sci. Trans. New Zea.* p. 264-269.

ABSTRACT

This paper describes the factors which are thought necessary for structural development and aggregate formation in Hawaiian Latosols. Two factors are considered important in stable aggregate formation in these soils: first, the nature of the soil minerals; and second, the arrangement of these minerals within the soil pedological units and the process by which these arrangements come about.

Mineral composition of Hawaiian Latosol is relatively simple. The soils under study can be treated as a two-component system of kaolin and free iron oxide.

additional index words: aggregate formation, pedological units, latosols

Uehara, G., H. Ikawa, and H. H. Sato. 1971. Guide to Hawaii soils. *Hawaii Agr. Exp. Sta. Misc. Pub. 83.* 32 p.

ABSTRACT

This brochure describes a few of the 190 soils of Hawaii as well as some interesting geological points. The Vertisols and Inceptisols generally occur on recent lowland terraces and coastal plains. Soils developed directly on basaltic flows are primarily Oxisols and Ultisols. Andepts are found on land covered with pyroclastic material. On the relative young lava flows that are covered with dense native vegetation, accumulation of organic debris leads to formation of Histosols.

On the Island of Hawaii, at the site of the Hilo soils, there is a highly weathered, acid soil that feels smeary and carries on a weight basis 2 to 4 times as much water as mineral content. In the dry regions, soils developed on identical parent material of the same geologic age are less weathered and neutral in reaction. On the Saddle Road there are relatively unweathered volcanic ash deposits and aa and pahaehoe lava flows.

On Oahu, there are soils developed from basaltic lavas. At the site of the Molokai soil there is a red, featureless soil. At higher elevation there are soils with stronger soil structure and higher manganese appear. Clay skins begin to appear in soils on the landscape above the Wahiawa soils. The Manana and Paaloa series are typical of soils with clay skins.

additional index words: vertisols, inceptisols, oxisols, ultisols, histosols, clay skin, soil classification, Hawaiian soils

Yaibuathes, N. 1969. Comparative studies of oxic horizons. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The physical, chemical, and mineralogical properties of oxic horizons in some soils from Hawaii, Brazil, and Thailand were investigated. Clay content as determined by the pipette method using Calgon as a dispersing agent or as obtained from the value of 2.5 x 15-bar water is influenced by the nature of the parent material and the age of the soil. In general, soils derived from basic igneous rock parent materials show incomplete dispersion. The amount of water-dispersible clay is low in the oxic horizon (Range: 3-8%). This variable is unrelated to per cent free iron oxide, permanent charge or to any of the other properties which were determined but it appears to be a good indicator of the oxic horizon. The chemical properties meet the requirements set forth by the Soil Survey Staff, USDA. Except for one highly weathered soil from Hawaii, the mineralogy of the oxic horizon is similar to the surface and subsurface horizons and is related to the nature and age of the parent material and the intensity of weathering. The oxic horizon may contain kaolin, gibbsity, iron oxides, and in some cases quartz.

additional index words: soil genesis, soil classification, soil characterization, oxisols, oxic horizon

Yaibuathes, N. 1971. An investigation of the tropical histosols in Hawaii. Ph.D. Dissertation, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Approximately 430,000 acres of Tropofolists exist in Hawaii. Much is in native vegetation with less than 15,000 acres in macadamia and papaya. These Histosols are unusually shallow with highly irregular boundaries at lithic contact. Once the land is prepared for use, the original landscape is drastically altered and almost all organic matter is lost. These soils are now being considered for more agriculture. Properties were, therefore, studied. High water retention is shown by having 1/3-1/2 of water content at saturation being released at 1/20 bar but much water still being retained at 15 bars (56-264 g/100 g). Total N was .3-3%; C/N, 10-45. In .01M CaCl₂, pH was 3.5-5.9; CEC was 71-354 meq/100 g. Characteristics such as positive correlation between humic acid and degree of decomposition was like other Histosols. Base saturation was generally high (12-80%) indicating high fertility. Characterization of the 9 of 14 series showed most of the properties to be similar. Fiber determination was not useful, and designation of such terms as euic and dysic may not be reliable. However, the classification scheme for Tropofolists is highly useful in suggesting land utilization in Hawaii.

additional index words: soil genesis, soil classification, soil characterization, histosols, tropofolists

(8) Soil Mineralogy

Alcordero, I. S. 1963. Physical and mineralogical properties of drained paddies and of their reclaimed counterparts. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

The physical properties and moisture constants of wet paddies change with reclamation, the greatest change being observed in the surface soils. Where the wet paddies are not tilled at any time during reclamation, the subsoils tend to retain the massive and compact conditions which are found in newly drained wet paddies. Excessive amounts of organic matter puddled into fine-textured paddy soils tends to make the workability of the paddies more difficult, regardless of whether or not the clay mineral is montmorillonite or kaolinite. The location of the wet paddies in Hawaii dictates the type of the clay mineral present. Where the paddies are located near the base of mountains, the clay mineral is primarily kaolinitic. However, on a wide flat plain, the clay mineral is primarily montmorillonitic. Plant roots play a dominant role in the establishment of macropore space in wet paddies.

additional index words: paddies, land reclamation, land management, soil properties, kaolinite, montmorillonite

ABSTRACT

This study, conducted on six clays representing 2:1, 1:1, and amorphous minerals, resulted in the following conclusions:

1. The order of increasing viscosities for similar concentrations of clay in water was generally as follows: Choyo clay, vermiculite, halloysite, Akaka clay, kaolinite, and montmorillonite.
2. The presence of magnesium on the exchange complex of clays decreased the viscosities of three clay-water systems, namely montmorillonite, kaolinite, and Choyo clay in water. This was attributed to reduction of the extent of the electrical double layer around the clay particles which favored a decrease in number of particles through face-face attraction. The other three, vermiculite, halloysite, and Akaka, became more viscous when the exchange surface was saturated with Mg^{2+} .
3. Addition of NaCl first caused a reduction in viscosity of sodium saturated montmorillonite, vermiculite, and Choyo clay suspensions. This was attributed to hydrolysis and subsequent formation of more flocculated H, Al-clays in the absence of electrolyte. Further increases in NaCl concentration resulted in increased viscosities. In contrast to these three clays, an inverse relationship existed between viscosity and NaCl concentration for Na-kaolinite and Na-Akaka clay systems. No definite effect of electrolyte concentration was noted on Na-halloysite.

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4. Addition of $MgCl_2$ to Mg-Choyo clays resulted in a viscosity increase that varied directly as the concentration of $MgCl_2$. Conversely, viscosities of the five other Mg-clays were inversely related to $MgCl_2$ concentrations.
5. Sodium saturated crystalline clays suspended in dilute NaCl generally showed viscosity highs at pH 4 and viscosity lows at pH 10. On the other hand, sodium saturated amorphous clays, had viscosity lows at pH 4. Na-Akaka clay had maximum viscosity at pH 7. The viscosity of Na-Choyo showed a continued rise to pH 10.
6. All the Mg-clays suspended in dilute $MgCl_2$ solutions had their highest viscosity values at pH 10. However, the Mg-kaolinite system had essentially equal viscosities at pH 4, 7, and 10.
7. Measurable tensions of 1-2 cm were detected in very dilute Na-montmorillonite and Na-vermiculite systems indicating that interparticle configurations may occur at clay concentrations far below those necessary to form observable rigidity or gel structure. Sodium clay systems that yielded the highest viscosities required the most clay for tension response.
8. Electron micrographs of freeze-dried clay suspensions failed to reveal edge-face or edge-edge interparticle configurations. Evidence was found for face-face positioning of sheets in Na-montmorillonite that had been freeze-dried in NaCl as well as in Na-kaolinite freeze-dried in HCl.

additional index words: vermiculite, halloysite, Akaka clay, kaolinite, montmorillonite, clay mineralogy

ABSTRACT

Four soils derived from volcanic ash deposited on the slopes of Mauna Kea were collected and examined physico-chemically and mineralogically. A Reddish Brown (Waikalua), two Reddish Prairie (Mahoelua and Waikii), and a Latosolic Brown Forest soil (Hanipoe) were included in this study. The degree of weathering of the soil material increased in the order,

Waikalua < Mahoelua < Waikii < Hanipoe

and decreased with depth for each profile.

Soil properties were found to vary with the degree of weathering. The following relations among these soils were found:

1. Organic carbon content increased in the order given above. It decreased with depth in the first three soils, but varied irregularly with depth in the Hanipoe soil. Nitrogen was highly correlated with carbon in the four soils.
2. Within a given soil profile, phosphorus was highly correlated with carbon. The soil phosphorus was found to be mainly in the inorganic form. The phosphorus content of the surface soil was related to the rate of organic matter production, while the carbon content was related to the ratio of the rate of production and decomposition of organic matter. Based on these assumptions, it was shown that the organic matter production was lowest in the Waikalua soil, highest in the Mahoelua, and decreased in the order, Mahoelua, Waikii, and Hanipoe. Decomposition rates decreased in the order, Waikalua, Mahoelua, Waikii, and Hanipoe soils.

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3. There was a significant correlation between moisture equivalent and 15 atmosphere percentage of the Waikalua, Mahoelua, and Waikii soils. No such correlation was found in the Hanipoe soil.
4. Cation exchange capacities of these soils were shown to be highly dependent on the concentration ratio of base and hydrogen ions of the leaching solution. Comparison of exchange curves of some synthetic silica, aluminosilicate and alumina gels to those of soils and clays suggested that (a) the functional groups which gave inflection points near pH 8 were due to surface silanol groups; (b) functional groups which were effective in cation exchange in the acid range were probably due to internal charges which were attributable to tetrahedrally coordinated aluminum atoms; and (c) silanol groups of discrete silica units were present in these soils.
5. It was shown that halloysite content decreased with increasing degree of weathering. The non-crystalline components increased inversely with halloysite content.
6. A scheme for secondary aluminosilicate mineral formation from volcanic ash is given.

additional index words: soil weathering, aluminosilicates, silica, halloysite, cation exchange, soil organic matter, volcanic ash soils, soil pH

Houng, K. H., G. Uehara, and G. D. Sherman. 1966. On the exchange properties of allophanic clays. Pacific Sci. 20:509-514.

ABSTRACT

1. Cation exchange in soils is considered to be an equilibrium reaction between the clay acid and the clay salt, assuming that the hydrogen-saturated and metal ion-saturated clays behave as if they were weak acid and salt, respectively.
2. Comparisons of the exchange curves obtained on clay minerals, allophanic clays, soils, and on synthetic silica, aluminosilicate, and aluminum hydroxide gels indicated that the so-called pH-dependent charges of the clays were most likely due to the dissociation of surface hydroxyl groups associated with silicon atoms (silanol groups), and that the so-called permanent charges were due to isomorphous replacement. In synthetic gels and the allophanic clays, the permanent charges were most probably due to tetrahedrally coordinated aluminum atoms in the aluminosilica network.
3. The lower exchange capacity obtained with NH_4^+ ions at higher pH values is explained on the basis that competition of protons between the pH-dependent charges and the ammonia molecules resulted in dissociation of NH_4^+ ions to protons and ammonia molecules, which resulted in the loss of ammonia upon removal of the excess salt.
4. It is suggested that the amount of exchangeable bases should be expressed in terms of percentage of the permanent charges, since the pH-dependent charges were considered not to take part in the exchange reaction under normal soil conditions.

additional index words: allophanic clays, pH dependent charge, permanent charge, isomorphous replacement

Jones, R. C. and G. Uehara. 1973. Amorphous coatings on mineral surfaces. Soil Sci. Soc. Amer. Proc. 37: 792-798.

ABSTRACT

Amorphous coatings on mineral surfaces too thin to be resolved by most electron microscopes were detected bridging particles suspended over holes in the supporting substrates. The coatings are gel-like in appearance, may flow when wet, shrink and become porous when heated, cement primary particles into large masses, and exhibit a coat-of-paint effect with curved solid-air interfaces. Amorphous gel coatings were found in alumino-silicate systems, in high aluminum soils, and on quartz surfaces.

additional index words: gel-hulls, alumino-silicate system, aluminum system, silica system, electron microscopy, holey substrates

Kanehiro, Y., and L. D. Whittig. 1961. Amorphous mineral colloids of soils of the Pacific region and adjacent areas. *Pac. Sci.* 15:477-482.

ABSTRACT

The work on the amorphous mineral colloids of soils of the Pacific region and its nearby areas is described. The amorphous colloids, especially allophane, dominate the clay fraction of many soils derived from volcanic ash, as well as some rocks, in the Pacific area. Soils dominated by these amorphous colloids have many distinct and unique properties. The position of the amorphous colloids, especially of allophane, in the weathering sequence remains to be fully clarified. For many reasons, the identification of amorphous colloids is often difficult; however, recent improvements in instrumental techniques have greatly facilitated this identification.

additional index words: amorphous soil minerals, allophane, Pacific area soils, volcanic ash soils

Katsura, T., I. Kushiro, S. Akimoto, G. L. Walker, and G. D. Sherman. 1962. Titanomagnetite and titanomaghemite in a Hawaiian soil. *J. Sed. Petrol.* 32:299-308.

ABSTRACT

Large amounts of titanomaghemite containing as much as 33% TiO_2 by mol ratio as an essential component have been found in a Hawaiian soil. This titanomaghemite was probably formed by the direct oxidation of primary titanomagnetite occurring in basaltic rocks without any subtraction of iron from the system or addition of titanium into the system.

additional index words: titanium, titanomagnetite, titanomaghemite, weathering

Keng, J., and G. Uehara. 1974. Chemistry, mineralogy, and taxonomy of oxisols and ultisols. *Proc. of Florida Crop and Soil Sci. Soc.* (in press)

ABSTRACT

Unlike soils of the temperate regions which contain clay minerals of the constant surface charge type, soils of the tropics, particularly the Oxisols and Ultisols, contain minerals which are predominantly of the constant surface potential type. This latter group includes the kaolin minerals, allophane, the crystalline and non-crystalline oxides and hydrous oxides of silicon, iron, and aluminum, and organic matter. For these materials, hydrogen and hydroxyl ions are the potential determining ions. The sign and magnitude of the net surface charge on minerals of the constant surface potential group are controlled by soil solution pH. The sign of the charge can be positive, zero, or negative. When the net charge is zero, the soil or material is said to be at its zero point of charge. For most soils containing minerals of the constant surface potential type, the pH at the zero point of charge ranges from pH 3.5 to 5.0. The pH at the zero point of charge generally decreases with increasing organic matter content, and therefore, the zero points of charge generally increase with increasing soil depth.

Lime application increases net negative charge by deprotonation of surface hydroxyls. Oxides can develop very high surface charge densities, and this accounts for the large quantity of lime required to change soil pH in oxidic soils with virtually zero cation exchange capacity.

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Negative surface charge density can also be increased by shifting the zero points of charge to lower pH values. This can be accomplished in the field by addition of organic matter, phosphate fertilizers or silicate amendments.

additional index words: oxisols, ultisols, potential determining ions, zero point of charge, lime

Kimura, H., and L. D. Swindale. 1966. A discriminant function using zirconium and nickel for parent rocks of strongly weathered soils. *Soil Sci.* 104:69-76.

ABSTRACT

A discriminant function of the form $Zr - 1.44 Ni$ has been developed to distinguish between parent rocks of strongly weathered Hawaiian soils. The function was primarily developed for use with Lahaina silty clay soils but was extended successfully for use with unweathered rocks and with a wide range of Hawaiian soils. It was found that total zirconium in the solum increased with increased weathering; total nickel in the solum increased up to the upper limit of the oxisols and then decreased progressively in ultisols and a spodosol. With increasing pedogenic development, zirconium tended to be eluviated from the upper horizons, and accumulation of zirconium was found in the spodic horizon of the spodosol. With increasing pedogenic development, nickel tended to be eluviated from the profile, with the greatest eluviation in the upper horizons. A relative accumulation of nickel occurred in the spodic horizon of the spodosol. Although zirconium and nickel have different distribution patterns throughout the soils, the discriminant function successfully differentiated andesite--derived from basalt-derived materials for every horizon in every soil analyzed.

additional index words: soil genesis, chemical weathering, pedogenic development indices, discriminant functions, tropical soils

Lai, Sung-ho, 1967. Some physico-chemical properties of amorphous mineral colloids. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

This study was conducted on one volcanic ash soil from Japan and four from Hawaii. Results were as follows:

Fine clay is x-ray amorphous with various amounts of weakly formed 2:1 minerals except in the case of Waikalua. The coarse clay fraction consisted mainly of crystalline minerals, mica, kaolin, and gibbsite.

Differential thermal analysis of the fine clay fraction showed a strong endothermic peak between 100°C and 150°C and an exothermic peak between 850°C and 950°C. The area of the first endothermic peak was closely related to the degree of crystallinity as determined by x-ray diffraction methods.

Elemental analysis indicated that the SiO_2/Al_2O_3 molar ratios for fine and coarse clay fractions were 0.927 to 1.527 and 1.260 to 1.940 respectively. The loss on ignition was inversely proportional to the SiO_2/Al_2O_3 ratio.

The electron micrographs showed fibrous and sponge-like features in the fine clay fraction. Such observations suggest the transformation of allophane to crystalline aluminosilicates. As crystallinity increased, the morphology of the clay particles changed from irregularly shaped flakes to pseudo-hexagonal flakes. This change is accompanied by an increase in the size of the flakes as shown in the coarse fraction.

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The infrared absorption spectra of amorphous mineral colloids generally showed a similarity to those of aluminosilicates. The main absorption band at $10\ \mu$ shifted from $9.75\ \mu$ to $10.3\ \mu$ as the $\text{Al}_2\text{O}_3/(\text{Al}_2\text{O}_3+\text{SiO}_2)$ weight ratio increased from 50% to 65%. This reflects a change in the coordination state of alumina.

The results of the surface area determinations are inconsistent with the conclusions obtained from the observations of the electron micrographs.

The CEC generally increased as pH increased, especially on the alkaline side. The Δ CEC increased curvilinearly with the $\text{Al}_2\text{O}_3/(\text{Al}_2\text{O}_3+\text{SiO}_2)$ weight ratio from 45% to 65%. This may be attributed to the strong acidic behavior of Al^{IV} .

additional index words: soil clays, soil mineralogy, allophane, cation exchange capacity, soil pH

Lai, S., and L. D. Swindale. 1969. Chemical properties of allophane from Hawaiian and Japanese soils. *Soil Sci. Soc. Amer. Proc.* 33:804-808.

ABSTRACT

Four moderately to strongly weathered soils from Hawaii and one moderately weathered soil from Japan, all derived from volcanic ash, were treated to separate out the allophane. The separates are described. With one exception, the fine clay fractions ($< 0.1\ \mu$) were almost X-amorphous with only weak bands of 2:1 lattice clay minerals. The exception, the Waikaloa soil, contained much halloysite. Coarse-clay fractions ($2-0.1\ \mu$) were mostly crystalline mica, kaolin and gibbsite. Differential thermograms of the amorphous fine clays were characteristic of allophane. The area of the low temperature endotherm correlated with the degree of crystallinity estimated from X-ray data. Silica-alumina molar ratios for the fine clays, varying from 0.927 to 1.50, were larger than the ratios for whole soils. The ratios for the three fine clays fractions which appeared least crystalline were all close to 1.0. Loss on ignition was inversely correlated with the silica-alumina ratios. The allophane in these soils was fibrous and sponge-like. The main infrared absorption band shifted from 9.70 to $10.29\ \mu$ with increasing weight ratio of $\text{Al}_2\text{O}_3/(\text{Al}_2\text{O}_3 + \text{SiO}_2)$ and apparently reflected a change in state of coordination. Cation exchange capacities (CEC) of the separated fractions increased with increasing pH. There was a correlation between the apparent degree of crystallinity in X-ray patterns of fine clays and the total change in CEC from pH 4 to pH 8.5. The CEC and infrared data together suggested that some stabilized $\text{Al}^{\text{IV}}-\text{O}-\text{Al}^{\text{IV}}$ bonds occur in the allophane minerals.

additional index words: volcanic ash soils, soil mineralogy, soil formation, allophane

Liu, P., G. D. Sherman, and L. D. Swindale. 1966. Laboratory formation and characterization of taranakite in a Hydrol Humic Latosol soil from Hawaii. *Pacific Sci.* 20(4):496-500.

ABSTRACT

The mineral taranakite was obtained in reactions between samples of an Akaka soil and monopotassium phosphate solutions ranging from 0.2 to 0.6 molar, at pH values of the reacting system ranging from 2.3 to 2.9. Characteristics of the reaction products were compared with those of pure synthetic taranakite, using X-ray, chemical, optical, infrared, absorption, and differential thermal techniques.

The taranakite was essentially a potassium-aluminum-phosphate complex. There was no indication of isomorphous substitution of iron for aluminum. The molar ratios of K/PO_4 and Al/PO_4 of the reaction product were found to be 0.37 and 0.72 respectively. The taranakite was thought to be formed by precipitation of a soluble phospho-alumino complex anion together with potassium ions.

The possibility is suggested of the formation of taranakite when soluble potassium and phosphate react with Hydrol Humic and Humic Latosols in the field. During the early stages of reaction, the reaction product is believed to be cryptocrystalline, but the size of crystals increases with time.

additional index words: phosphorus fixation and precipitation, amorphous hydrous oxides, taranakite, latosols, soil mineralogy

Matsusaka, Y., and G. D. Sherman. 1961. Magnetism of iron oxide in Hawaiian soils. Soil Sci. 91:239-245.

ABSTRACT

Magnetism in some Hawaiian soils is attributed to the presence of the mineral maghemite which is identified by its low FeO content and X-ray diffraction characteristics. Differential thermal analysis curves of standard iron oxide minerals and of several soils are also presented. It is believed that the magnetism is produced by the dehydration of the iron oxide lepidocrocite to maghemite. Lepidocrocite in Hawaiian soils is characterized by poor crystallinity which can be identified adequately only by DTA.

additional index words: magnetism, iron oxides, lepidocrocite, maghemite, weathering

Matsusaka, Y., G. D. Sherman, and L. D. Swindale. 1965. Nature of magnetic minerals in Hawaiian soils. Soil Sci. 100:192-199.

ABSTRACT

Magnetic separations were made on dispersed Hawaiian soils, and the magnetic fractions obtained were examined by X-ray diffraction, D.T.A., chemical and magnetic means. Both titanomagnetite and titanomaghemite were found in the soils, with the former occurring mainly in weakly weathered and continuously wet soils. Most of the titanomaghemite is formed by oxidation of primary titanomagnetite present in Hawaiian basaltic and andesitic rocks. The primary titanomagnetite seems to contain between 21 and 25 mole per cent of TiO_2 . Some of the titanomaghemite in the highly weathered soils may be formed by the dehydration of lepidocrocite in the presence of Ti^{4+} ions.

additional index words: iron oxides, titanium oxides, titanomagnetite, titanomaghemite, soil mineralogy, tropical soil genesis, magnetic minerals, weathering

Mikami, D. T. 1966. Native fixed ammonium and fixation of applied ammonium in Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

A wide range in native fixed ammonium content was found in some representative Hawaiian soils. Native fixed ammonium was found to range from 0.0 to 585.0 ppm., with an average of 93.4 ppm. Native fixed ammonium generally decreased with depth in most of the profiles studied. There was a highly significant correlation ($r = 0.910^{**}$, $df = 101$) between total K_2O , or percent illite and native fixed ammonium. This correlation indicates that illite is responsible for the native fixed ammonium content of the Hawaiian soils investigated. This relationship, however, does not apply to young, partially weathered soils containing some primary potassium-bearing minerals.

The ammonium fixing capacity of the Naalehu and Pahala soils, which were amorphous to X-ray diffraction, was investigated. A typical montmorillonitic soil (Lualualei), illite soil (Koolau), and a kaolinitic soil (Molokai), were also investigated. The amount fixed by the Naalehu and Pahala soils was equal to or exceeded that fixed by the montmorillonitic Lualualei soil. The sand and silt fractions of these soils fixed about the same amount of ammonium as did their corresponding clay fractions. Concentration study on selected horizons showed that ammonium fixation was virtually satisfied after addition of 50 to 100 me. ammonium per 100 grams soil. A decrease in ammonium fixation was observed at higher concentrations.

The mineralogical and chemical properties of the Naalehu and Pahala soils were examined by the techniques of petrographic microscopy, X-ray diffraction, thermal analyses, infrared absorption and chemical analyses to

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identify the mineral(s) fixing ammonium. It was concluded from results obtained from these methods of mineral identification, that amorphous mineraloids were responsible for the ammonium fixation. The results also showed that not all amorphous materials have the same capacity to fix ammonium. This was most evident in the Pahala soil where great changes in ammonium fixation were observed within the soil profile.

additional index words: ammonium fixation, illite, thermal release, kaolinite, montmorillonite

Nakamura, M. T., and G. D. Sherman. 1961. The vanadium content of Hawaiian Island soils. Hawaii Agr. Exp. Sta. Tech. Bull. 45. 20 p.

ABSTRACT

The vanadium content in the surface horizons of the Hawaiian soils range from 190 ppm. to a high of 1520 ppm., with an average of 450 ppm. The very high concentrations are confined to the Humic Ferruginous Latosol Group. Thus, the vanadium content of the Hawaiian soils are higher than those of other arable soils reported in the available literature.

The amount of vanadium in the soil is influenced by the amount found in the parent material but the concentration of the element is more clearly a reflection of the weathering processes. In the Hawaiian Islands, where the major soil-forming process is latosolization, vanadium accumulates in the soil profiles. This characteristic may be used to advantage to find lithologic discontinuities in soil profiles. The concentration ratios derived in this study reflected the weathering state of the soils. When these ratios were plotted against rainfall they fell into the natural soil grouping used by soil classificationists.

A correlation between the concentration of vanadium and titanium was observed in the Humic Ferruginous Latosol Group.

additional index words: soil vanadium, secondary oxides, latosols, weathering, titanium

Saing, Soe. 1964. Clarification of the nature of the kaolin minerals in Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

X-ray diffraction, differential thermal, and electron microscope studies were made on soils occurring under different rainfall and elevation on the island of Oahu, Hawaii. A special study was also made on the lattice expansion of Hawaiian kaolins.

Kaolinite was found to be the predominant kaolin mineral in the soils studied. A relationship between the concentration of kaolin minerals as a function of rainfall and elevation was noticed. The concentration of kaolin minerals decreased with increasing rainfall and elevation. The content of kaolinite remained uniformly high in all horizons of the Low Humic Latosols (Oxisols) but increased sharply with depth in soils which occur in the high rainfall belt.

Hawaiian soil kaolinites and halloysites do not undergo lattice expansion with potassium acetate.

additional index words: X-ray diffraction, clay minerals, soil weathering, soil genesis, soil extraction solutions

Sherman, G. D., H. Ikawa, G. Uehara, and E. Okazaki. 1962. Types of occurrence of nontronite and nontronite-like minerals in soils. *Pac. Sci.* 26:57-62.

ABSTRACT

This study describes the mode of occurrence of eight nontronite and nontronite-like minerals occurring in Australia, New Zealand, Fiji, and Hawaii. Each of the minerals has a relatively high content of Fe_2O_3 ranging from 8.8 to 31.5%. Six of these minerals contain sufficient Fe_2O_3 to be considered a nontronite.

The chemical composition suggests that the degree of iron substitution in the octahedral position is related to the concentration of the Fe. The iron oxide content of these 2:1 layered silicate minerals appears to increase as weathering of silicate minerals approach completion.

X-ray diffraction supports the identification of nontronite. The sample from a ferruginous bauxite boulder gave X-ray patterns almost identical to that of a standard nontronite sample from Manato, Washington.

The occurrence of nontronite in a bauxite suggests that the stability of the mineral must be due either to the concentration of Fe and Si in the percolating waters, or to possible protective mineral coatings or to greater resistance to weathering and leaching than has been previously considered.

additional index words: nontronite, mineralogy, weathering, silicate minerals, iron oxides, bauxite

Sherman, G. D., F. Schultz, and F. J. Alway. 1962. Dolomitization in soils of the Red River Valley, Minnesota. *Soil Sci.* 94:304-313.

ABSTRACT

The occurrence of dolomite in the subsoils of the Red River Valley, Minnesota was investigated by field and laboratory methods. The data showed that carbonates were converted to dolomite by the action of waters rich in Mg and that this process was limited to the zone of water fluctuations in the soil profile. Dolomitic soils, such as the Ulen and Bearden series, occurred most frequently in soils developed on the silt and very fine sand sediments of the glacial lake bed. The data also strongly supported the secondary origin of the dolomite. The process of conversion was probably the result of slow conversion of calcite by the action of Mg salts in the fluctuating water table. The occurrence of dolomite in locations on slopes, to micro-depressions, suggested a similarity in mode of occurrence to Mg solonetz on clay sediments.

additional index words: dolomitization, dolomite, soil formation

Sherman, G. D., Y. Matsusaka, H. Ikawa, and G. Uehara. 1964. The role of the amorphous fraction in the properties of tropical soils. *Agrochimica* 8:146-163.

ABSTRACT

The hydrated amorphous colloidal oxides occur in sufficient concentration to play a dominant role in the properties of the soils occurring in the humid, tropical regions. These hydrous oxides are commonly found in soils which have developed on rapidly weathering fine texture rocks or pyroclastic volcanic materials. These amorphous hydrated oxide systems include materials ranging from mixed mineral gels to crypto-crystalline hydrous oxides. On dehydration, the amorphous hydrated oxide system will develop crystalline oxides. This oxide system is sensitive to changing conditions of hydration and dehydration which produce marked changes in the physio-chemical properties of the soil. The amorphous hydrated oxide gels and hydrous crypto-crystalline oxides have a high water content with the former having as much as 300% water in field condition. The oxide gels have a very high cation exchange capacity which they lose, as much as 50%, on dehydration to the hydrous crypto-crystalline oxides. The cation exchange capacity becomes very low on further dehydration to the crystalline oxides. The bulk density of the oxide gel soils is extremely low, ranging from 0.25 to 0.50. On dehydration to hydrous oxides it will be lower than 1.0. When dehydration produces crystalline oxides the bulk density will approach 2.0. The hydrous oxide gels will form mineral complexes with phosphate and other anions while the more crystalline oxides will produce these complexes only under very special conditions. The oxide gels usually contain Al, Fe, and Si. The Al will differentially crystallize to gibbsite on dehydration of the gel.

additional index words: amorphous clays, hydrous oxides, gels, weathering

Sherman, G. D., and Y. Matsusaka. 1965. Occurrence of gibbsite nodules in the soils of the Koolau family of Kauai. J. Sed. Petrol. 35:504-507.

ABSTRACT

A number of forms of gibbsite nodules and mineral aggregates have been described as they exist in what is considered to have once been a weathering system rich in hydrated aluminum oxides under free drainage. With the development of poor drainage, the amorphous hydrated aluminum oxides resilicated to form kaolin type clay minerals. The crystalline aggregates persist because of their inertness to the resilicating processes.

additional index words: gibbsite, nodules, secondary minerals, weathering, clay minerals, kaolin, aluminum oxides

Sherman, G. D., and R. J. Kapteyn. 1966. Re-examination of the molybdenum content of Hawaiian soils. Agron. J. 58:358-359.

ABSTRACT

The results of determining molybdenum by alkaline digestion procedure in Hawaiian soils gave very substantially lower concentrations than those reported earlier when an acid digestion procedure was employed. The results ranged from approximately 3 to 50% of the earlier reported concentrations.

additional index words: molybdenum analysis, soil molybdenum

Sherman, G. D., J. L. Walker, and H. Ikawa. 1968. Some of the mineral resources of the Hawaiian Islands. Hawaii Agr. Exp. Sta. Bull. 138. 34 p.

ABSTRACT

This bulletin is a revision of an earlier report published in 1954 that dealt with information on the mineral resources in Hawaii. The mineral resources are largely composed of those materials which can be concentrated by the processes of chemical decomposition of rocks under a warm, humid, tropical climate and include, in particular, the oxides of Fe, Al, Ti, and Mn. Other products are elements such as Ni, Cr, V, and Co, and deposits of clay, coral sand, and volcanic rock materials. Salts recovered from ocean water are also cited. Bauxite, the oxide of Al, appears to have the best potential for ultimate development, but its development is limited by economic factors and the need for suitable mining laws.

additional index words: mineral resources, bauxite, weathering, iron oxides, aluminum oxides, titanium oxides, manganese oxides

Sherman, G. D., H. Ikawa, and Y. Matsusaka. 1969. Aluminous-ferruginous oxide mineral nodules in tropical soils. *Pac. Sci.* 23:115-122.

ABSTRACT

Secondary oxide mineral nodules occur in the ferruginous, ferruginous bauxitic, and bauxitic soils of the Hawaiian Islands. The concentration of these oxide nodule aggregates which are larger than 2 mm, ranges from 5% in some ferruginous soils, to as high as 85% in the ferruginous bauxitic soils of the Halii family. The nodules are formed by the process of induration in which the hydrated amorphous hydroxide and oxides are dehydrated to their crystalline oxide form. The resulting indurated oxide nodule becomes an independent unit in the soil system with corresponding loss of effective surface even though the nodule may contain friable clay material in its interior. The typical nodule produced in the ferruginous bauxitic soil has a dense iron oxide layer (hematite and maghemite) and, in the interior, soft to hard, lighter-colored material which contains gibbsite.

additional index words: iron oxides, bauxite, secondary oxides, nodules, weathering, gibbsite

Swindale, L. D., and P. F. Fan. 1967. Transformation of gibbsite to chlorite in ocean bottom sediments. *Sci.* 157:799-800.

ABSTRACT

Numerous grains of gibbsite surrounded by zones of chlorite were found in six samples of sediment taken from Waimea Bay off the coast of Kauai, Hawaii. The chlorite has formed from the gibbsite, and growth bands in the chlorite either are parallel to chlorite-gibbsite interfaces or are concentric around small remnants of gibbsite. Aggregates were found that appeared to be composed of two or more gibbsite grains surrounded by chlorite bands that have grown together. The index of refraction of the chlorite ranged from 1.58 to 1.60 and the chlorite displayed anomalous blue interference colors. The gibbsite was formed on land under conditions of strong weathering and strong leaching. When transported to the sea, the gibbsite was deposited in a solution containing silicic acid, magnesium, potassium, and hydrogen ions, in which it is unstable. Chlorite, a stable mineral in this solution, replaced the gibbsite.

additional index words: solution-mineral equilibria, clay mineralogy, weathering, submarine soils

Swindale, L. D., and I. R. Hughes. 1968. Hydrothermal association of pyrophyllite, kaolinite, diasporite, dickite, and quartz in the Coromandel area, New Zealand. *New Zealand J. Geol. Geophys.* 11:1163-1183.

ABSTRACT

Hydrothermal action has formed a clay deposit with a zone containing over 80% pyrophyllite and other zones containing kaolinite-dickite-quartz and kaolinite-diasporite from andesite in the Coromandel area New Zealand. The deposit was formed deep in the earth at pressures over 2,000 p.s.i. and temperatures above 335 C. The pyrophyllite in the deposits has the formula $(\text{Al}(\text{OH})_2)_{10.1} \text{Al}_2(\text{Si}_{3.90}\text{Al}_{0.10})\text{O}_{9.95}(\text{OH})_{2.10}$, and an X-ray diffraction pattern and differential thermogram similar to, but not identical with, those given in the literature. Dickite and lepidocrocite were identified in the deposits by X-ray diffraction techniques; diasporite by X-ray diffraction and optical techniques.

additional index words: clay mineralogy, ceramic deposits

Tamimi, Y. N., Y. Kanehiro, and G. D. Sherman. 1963. The effect of pH on the reactions of ammonium carriers in a humic latosol. *Agron. Abstr.* 25-26.

ABSTRACT

The reactions of ammonium phosphate in Paauhau soil, a humic latosol, were pH dependent. At an initial pH of 1.00 the only crystalline reaction product identified by X-ray diffraction method was $(\text{NH}_4)_2\text{O} \cdot 3\text{Fe}_2\text{O}_3 \cdot 6\text{P}_2\text{O}_5 \cdot 20\text{H}_2\text{O}$ described by Haseman et al. (*Soil Sci. Soc. Amer. Proc.* 1950, 15:76-84) as reaction product "K". At an initial pH of 1.45, reaction product "K" was dominant, but taranakite was also formed in considerable amounts. Taranakite became the only crystalline reaction product identified at pH levels of 2.05 to 3.90. Between pH 4.45 and 9.00, the reaction products in the soil were of an amorphous nature. Ammonium sulfate reacted with the Al of the soil at pH 2.00 to form $\text{NH}_4\text{Al}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ (Alum). Above this pH level, there was no crystalline reaction product identified. Ammonium chloride, at all pH levels investigated, did not give any crystalline reaction product.

additional index words: soil pH, ammonium phosphate, phosphate fixation, taranakite

Tenma, H. 1965. Some characteristics of non-crystalline constituents in Hawaiian soils. M.S. Thesis, Department of Agronomy and Soil Science, University of Hawaii.

ABSTRACT

Two groups of soil, one developed from volcanic ash and the other from basalt were analyzed for their amorphous mineraloid content. Allophane and non-crystalline hydrated oxides were identified as two important amorphous constituents of Hawaiian soils. Data is presented to show variations in these two constituents among soils as a function of present climate.

additional index words: soil classification, amorphous soils, clay minerals, volcanic ash, rock weathering

Uehara, G., H. Ikawa, and G. D. Sherman. 1966. Desilication of halloysite and its relation to gibbsite formation. *Pacific Sci.* 20:119-124.

ABSTRACT

The evidence presented points to the alteration of halloysite to gibbsite. Mineralogical data, as determined by X-ray and differential analysis, verify identification of halloysite and gibbsite. Chemical data confirm the expected lower silica and higher alumina content for samples which are predominantly gibbsitic. It is reasonable to assume from petrographic evidence that gibbsite develops by desilication of halloysite. Halloysite amygdules undergo desilication along the outer peripheries, where acid silica-deficient waters pass, attacking the halloysite by dissolving silica. Halloysite is stable only if it is protected from such solutions, or if the solution passing by is saturated with silica.

Whereas alteration of feldspar to halloysite involves a gain in volume, a loss in volume follows desilication of halloysite. This loss in volume is exemplified by the surface cracks clearly visible in the desilicated halloysite.

additional index words: feldspar, x-ray diffraction, differential thermal analysis

Uehara, G., and J. Keng. 1974. Management implications of soil mineralogy in Latin America. Symposium on "Management of Tropical Soils" in Cali, Colombia. (in press)

ABSTRACT

The properties of soils containing minerals whose surface chemistry is pH-dependent are briefly summarized. A few Zero Point of Charge (ZPC) values of soil materials have been measured, and they generally fall between pH 4-5. For most soils with pH-dependent charge minerals, the increase in Cation Exchange Capacity (CEC) per unit change in pH is greater when the pH is far away from ZPC. The slopes of σ_0 -pH curves give a good indication of the buffering capacity of a soil. When lime is added and mixed with the topsoil, most of the lime is consumed to create negative charge. The negative charge in turn are balanced by calcium ions at the site of lime applications, so that very little lime moves to the subsoil. Phosphorus increases net negative charge by lowering the pH corresponding to the ZPC. Each millimole of adsorbed phosphorus increases CEC by about 0.8 me. Application of lime to oxide soils can result in flocculation or dispersion depending on whether liming changes "effective" surface charge from positive to zero values (flocculation) or from zero to negative values (dispersion).

additional index words: zero point of charge, pH-dependent charge, cation exchange capacity, lime, phosphorus

Uehara, G., M. S. Nishina, and G. Y. Tsuji. 1974. The composition of Mekong river silt and its possible role as a source of plant nutrient in Delta soils. Report submitted to the Committee for Coordination of Investigations of the Lower Mekong Basin, United Nations. 109 p.

ABSTRACT

River sediment was collected at regular intervals from October 1972 to October 1973 at Long Xuyen, Cantho, and My Tho in South Viet Nam. Soils were collected along transects running perpendicular to the river at locations near the sediment sampling sites.

Small but significant differences in mineral, chemical, and acid extractable nutrient content were measured between sediment and soil. The sediment samples were higher in mica, hematite, kaolinite, feldspar, and chlorite-montmorillonite and lower in quartz contents. The sediment samples were also higher in magnesium, phosphorus, potassium, calcium, and manganese and lower in aluminum contents. The readily extractable phosphorus, potassium, and calcium content were also higher in the sediment than in soil samples.

Based on these data, the quantity of phosphorus, potassium, magnesium and calcium added to a soil each year by sediment was computed. A one millimeter thick deposit of one g/cm³ bulk density was assumed. The readily soluble nutrient added to a one Hectare area as measured by mild acid extraction amounted to 1.0 kilogram P, 3.2 kilogram K, 4 kilogram Mg, and 50 kilogram Ca per hectare. It was concluded that even if these computed values were doubled, the sediment deposit could not significantly increase the fertility of Delta soils.

additional index words: soil mineralogy, soil water, cation exchange capacity, water retention, sediment

Walker, J. L., G. D. Sherman, and T. Katsura. 1969. The iron and titanium minerals in the Titaniferous Ferruginous Latosols of Hawaii. Pac. Sci. 23:291-304.

ABSTRACT

Titaniferous Ferruginous Latosols are an important group of Hawaiian soils. They have developed by pedogenetic weathering of the volcanic materials of basic and ultrabasic lava flows and their associated pyroclastic materials, under climatic conditions having definite alternating dry and wet seasons. The annual rainfall range for these soils is 30 to 60 inches. Under the native and undisturbed vegetation, these soils have a profile of very friable silt material with very little horizon differentiation. When exposed to dehydration by removal of the protective canopy cover of the forest, as occurs after forest fires, a tremendous change occurs in the soil profile morphology. The change is greater than the morphological differences which normally occur between the profiles of the great soil groups. A surface indurated horizon develops in which the bulk density and particle density have an approximate two-fold increase. The mineralogical changes are substantial. The amorphous hydrated titanium and iron oxides are converted into good crystalline forms of anatase, rutile, pseudo-brookite, titanohematite and titanomagnetite. In some cases these minerals develop from the weathering of titanomagnetite-ilmenite mixed crystals. The unusual characteristic of these soils is the apparent movement of the colloidal material in a very short space of time, which results in an accumulation of titaniferous minerals in the indurated surface horizon and the accumulation of amorphous silica giving weak X-ray diffraction patterns of alpha quartz on the very surface of the soil. Rutile is also identified along with the silica at the surface. Aluminum oxides are removed to the lower horizons and in some cases accumulated as irregularly shaped gibbsite nodules in scattered pockets below the clay horizon.

additional index words: secondary oxides, iron oxides, titanium oxides, latosols, weathering, aluminum oxides

(9) Forest and Range Soils

Tamimi, Y. N., L. D. Swindale, and R. L. Voss. 1974. Mineral cycling in stands of four forest tree species in Hawaii. (in press)

ABSTRACT

Mineral cycling has been investigated in stands of four forest tree species that are common in Hawaii. These include ohia, koa, Australian red cedar and flooded gum. The study includes determinations on quantity and quality of rainfall, throughfall, stemflow and litter. This paper, a first part of a series to cover this subject, is related to rainfall. Chemical analysis included pH, $\text{NH}_4\text{-N}$, P, K, Ca, Mg and Si found in monthly collections during a period of two years. The pH of rain water was found to increase with increasing monthly rainfall. The pH levels reached a low 3.44 and a high 5.65. Concentrations of $\text{NH}_4\text{-N}$, Ca and Mg were negatively correlated with the amount of monthly rainfall. Average annual contributions of the elements followed the order: $\text{NH}_4\text{-N}$ greater than K greater than Ca greater than Mg greater than Si greater than P. Average amounts contributed in pounds/acre/year following the above order were: 10.72, 5.19, 4.12, 2.04, 1.38 and 0.19.

additional index words: forestry, forest nutrition, nutrient recycling



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College of Tropical Agriculture
University of Hawaii
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