# THE DISTRIBUTION OF CHROMIUM IN THE LATOSOLS OF THE HAWAIIAN ISLANDS

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# INTRODUCTION

The Hawaiian Islands were formed from basic igneous rocks, the major constituents of which are the femic minerals such as pyroxene, amphibole, and biotite. The foregoing minerals contain the bulk of the chromium to be found in the lithosphere. Thus it is reasonable to assume that chromium is present in the soils of Hawaii. Hough et al. (8) in his work in 1941 on rock weathering has affirmed this assumption. The present study was designed to determine the presence and the distribution of the element in the various great soil groups formed through the process of laterization. Another objective was to determine the correlation, if any, between chromium concentration and the intensity of weathering in the soils. During the course of research it became apparent that weathering by itself could not be responsible for the accumulation of the element in question. Another factor, namely the parent material of the soils, was then given consideration. This study will attempt to show that both these factors play important roles in the concentration of chromium in the Hawaiian soils which were analyzed.

## REVIEW OF LITERATURE

The work carried out thus far on the problem of the chromium content of soils is limited. Very little is known of the role of chromium in soil, although there is a general agreement as to its toxic effect upon plants. Therefore much of the investigation has been limited to studies of infertile soils containing large quantities of chromium. The literature, as may be expected, in view of this fact is not extensive and what is available to the student in the English language in addition to the above mentioned studies of infertile soils are general studies in trace element distribution. Data on chromium content of soils may also be obtained from chemical analysis tables in soil survey reports and soil analysis tables. According to Swaine (20) there are several studies available in foreign languages, the most significant ones appearing to be those published by Vinogradof in 1945 and 1949.

The available literature can be divided into two general categories for the purposes of this investigation. In one group of publications the parent material and the resultant chromium concentrations are noted. In the other category, the investigations are of Pacific Island soils where parent material differences are omitted and correlation between weathering and accumulation of the element were found.

## Parent Material Studies

Among the earlier soil survey reports where chromium contents are reported is that of Bennett and Allison (1), which covered Cuban soils. The Nipe clay described in the survey has since become the modal profile for comparative purposes for writers dealing with the problem of infertile soils high in chromium.

Robinson et al. (11) conducted their investigation of infertile soils of Maryland, Pennsylvania, Virginia, Oregon, California, Cuba and Puerto Rico. These soils were derived from serpentine or chlorite, and they all showed in common a comparatively high chromium and nickel content. Chromium was found to range from 510-38,360 ppm, with the average being 8350 ppm. Birrell et al. (2) studied lateritic soils of Western Samoa and Niue Island. These soils were derived from limestone and serpentine. The chromium content was high throughout, but the soils of serpentine origin contained much higher amounts of chromium. The work of Birrell and Wright (3) was done on a New Caledonia soil of serpentine origin, where chromium was found to be from 20,900-33,800 ppm. The soils of South African Transvaal were discovered to be toxic to citrus plants by van der Merwe and Anderssen (21). This infertile soil was high in chromium and was derived from chromiferous rocks.

Both Robinson (10) and Slater et al. (17) have investigated trace elements in agriculturally important American soils. These soils were derived from loess, granite, gneiss, schist, shales, and limestone; and chromium was found to be present in the soil profiles in small amounts, usually from a trace to 170 ppm. Swaine (20) studied trace element distribution in some Scottish soils. He investigated soils formed from different parent materials and found chromium to range from 15-500 ppm in soils with parent materials ranging from acidic to basic rocks. In soils derived from serpentine till, concentrations of 3000-3500 ppm were found.

The literature tends to indicate that the concentration of chromium is partially dependent upon the parent material from which the soil is derived. The literature further indicates that soils developed from ultra basic rocks such as serpentine and chlorite contain chromium in amounts likely to be toxic to plants. Soils developed from basic rocks do not contain chromium in amounts as high as the above mentioned soils. When the soils have been developed from acidic rocks and their derivatives, the chromium content has been uniformly low.

## Weathering Studies

Seelye's survey of the soils of Western Samoa (14) and the survey by Grange et al. (6) of the soils of the Lower Cook Group give the chromium content of the soil profiles in their tables of chemical analyses. No discussion is found

on chromium in either of these soil surveys. An observation of the chemical analysis tables indicated that there was an appreciable amount of chromium in the soils and that the content increased with the weathering of the soil.

What is available on this topic as far as the Hawaiian Islands are concerned is limited to the publication of Hough and his associates in 1941 (8). The subject of the study was rock weathering and incidental thereto the investigators analyzed the chromium content of the soils. In the course of the general analysis, Hough and his associates found indications that chromium was present in Hawaiian soils, with certain soils containing appreciable amounts of the element.

# EXPERIMENTAL PROCEDURES

## Method of Analysis

The analytical method used was a composite of the methods outlined in Sandell (12, 13) and Hillebrand et al. (7).

A half gram of oven dried sample was fused with 5-6 grams of sodium peroxide in a nickel crucible. This melt was leached with water and eight drops of ethyl alcohol was added to reduce any manganate manganese present to the hydrated manganese oxide. The resulting solution was digested over a water bath for an hour, then filtered through filter paper and made to volume.

The aliquot to be taken from the above solution in order to be used in the subsequent analysis for sexivalent chromium should not contain more than 0.1 microgram of chromium in the final 25 ml. solution. The appropriate aliquot obtained from the solution above was neutralized with 0.4 N sulfuric acid. A half ml. of a one to three nitric acid solution was added to this neutralized solution which was then boiled to decompose the peroxide. One ml. of one per cent silver nitrate and two ml. of 10 per cent ammonium persulfate was then added to the boiling solution and boiled for about 10 minutes to expel the excess ammonium persulfate. This step was taken to reoxidize any chromium that might be in the trivalent state into sexivalent chromium. Sandell states that vanadium

will interfere with the determination of chromium by the diphenylcarbazide method, if vanadium is in excess of chromium in the solution. However, the vanadium content of Hawaiian soils does not exceed that of chromium, therefore this separation was not necessary.

The diphenylcarbazide color was developed according to Sandell's method (13). The intensity of the color of the solution was then read in the Klett-Summerson photoelectric colorimeter using a filter having a maximum transmission at the 540 millimicron wave length.

## Description of Samples

The appended tables contain the lists of soils, rock samples, and concretionary materials analyzed during the course of the experiment. Representative samples from the families of some of the dominant great soil groups of the Hawaiian Islands were analyzed for chromium. General descriptions of the typical modal profiles of the soils have been given by Cline et al. (4) in the soil survey of the Hawaiian Islands. There are a number of publications on the Humic Ferruginous Latosol soils with detailed profile descriptions and chemical analyses of the soils that were analyzed in this study (5, 15, 16).

Also analyzed for chromium were some rock samples representing the parent materials of the Hawaiian Islands. The olivine basalt collected on Kunia Road, Oahu, has been

treated as picrite basalt of the oceanite type, following Macdonald's classification system (9), since its olivine phenocrysts ranged from 30-50 per cent.

Samples of concretionary products of soil weathering were also analyzed. Although it would have been desirable for the purpose of this study to have these samples sifted from the analyzed soils, this was possible only in the case of a few samples. Where other concretionary materials were concerned, it was necessary to collect them from soils in the same family group, but not from the exact locations where the soil samples were dug.

The only concretionary products sifted from the soil samples studied were those from the Naiwa soil of Kokee, Kauai. Other ferruginous samples obtained were from Kilauea, Kauai and from the iron pan crust of the Haiku soil of Lihue, Kauai. The iron crust was separated into the following five layers:

A. layer above iron pan

B. iron pans 1 and 2

C. layer just below iron pans 1 and 2

D. soil layer between iron layers

E. soil below second iron pan

Bauxitic materials analyzed were all gathered during the study and as in the case of most of the ferruginous materials were obtained from related soil profiles rather than by sifting. The gibbsitic aggregates listed in Table III were obtained through the dehydration of a Hilo soil.

Both the gibbsitic fraction and the remaining dark soil material were analyzed. Other bauxitic aggregates were taken from Hanalei and Lihue, on the Island of Kauai, from Haiku soil profiles.

# EXPERIMENTAL RESULTS AND DISCUSSION

## Distribution of Chromium in the Great Soil Groups

Hough and his associates (8) in their study found chromium to be generally present in Hawaiian soils with appreciable amounts in certain soils. Their tables, however, omit reference to the element in several instances. This could probably indicate that the quantity present was not great enough to be detected by the analytical procedures followed. The method of analysis followed in this study, on the other hand, was a micro-analysis and probably more sensitive to chromium analysis than that followed by Hough et al. Every soil sample analyzed in this investigation contained chromium. These results are included in Table I.

The most significant fact uncovered during the analyses of the soils was the finding that the highest as well as the lowest concentrations occurred in the same family of the Humic Ferruginous Latosol group. The sample of the Naiwa soil taken from Kokee, Kauai, showed the highest amount of any of the samples with 9000 ppm of chromium present. The lowest occurred in the Naiwa soil from Meyer Lake, Molokai, where there was an average of 225 ppm of chromium.

The group which generally contained the lowest concentration of chromium was the Low Humic Latosol group. The soils of the Molokai, Lahaina and Wahiawa families were found to have an average content of 550 ppm. The two Kahana family

soils analyzed averaged a chromium content of 900 ppm. The Kohala family soil, the most weathered soil in this group, averaged 1200 ppm. The soils of the Humic Latosol group and the Hydrol Humic Latosol soils roughly averaged 1000 ppm of chromium.

The samples from the Humic Ferruginous Latosol group generally averaged the highest content of chromium among the great soil groups. However, as stated previously unexpected variations were discovered in the results of the analysis of certain families within this group, namely in the Naiwa soils and in the Haiku soils. The samples dug on the Island of Kauai all manifested the highest concentration, whereas the samples from Maui and Molokai, although from the same family, contained much lower amounts of the element.

## Relation of Parent Material to Chromium Distribution

The unexpected variations found within the same families led the writer to consider factors other than weathering in the investigation. The geological maps of all the islands were consulted and it was learned that the volcanic flows underlying the areas where the samples were taken differed even though the soil profiles indicated that the weathering processes that occurred were approximately the same. Representative rock samples were then obtained and analyzed for the element in question. The results are compiled in Table II.

The volcanic flow underlying the area where the sample of Meyer Lake soil was dug is listed as being from the East Molokai volcanic series (19). This is predominantly andesite and trachyte in rare instances. According to Wager and Mitchell (22) andesite contains less than 2 ppm of chromium. The parent material of the Naiwa sample from Wailuku, Maui, was a trachyte, which upon analysis was discovered to have 40 ppm of chromium. The flow underlying the Kokee area where the Naiwa sample was obtained is the Waimea Canyon volcanic series which is predominantly olivine basalt and picrite basalt of the oceanite type (9). The average amount of chromium in olivine basalts analyzed was 450 ppm, while picrite basalts averaged 1300 ppm of chromium.

Basaltic andesite was predominant in the flow underlying the Maui Haiku soil analyzed (18). A volcanic rock sample of basaltic andesite was found to have 56 ppm of chromium. The Haiku family soil from Lihue was taken from an area where the parent material is a melilite nepheline basalt with a chromium content of about 610 ppm. The area where the Haiku soil of Waipahi, Kauai, was obtained was covered by the flow from the Koloa volcanic series, which contains olivine basalt, picrite basalt of the ankaramite type, and nepheline basalt (9). The chromium content of these basalts range from 450 ppm to 1300 ppm.

A definite correlation between the parent material and the accumulation of chromium was seen when the parent materials were analyzed in the instances above.

## Relation of Weathering to Chromium Accumulation

Among the elements analyzed and listed by Grange et al. (6) in their tables accompanying their soil survey report of the Lower Cook Group was chromium. They list the element as being present in most of their soils. The chemical analysis of the soil profiles compiled by Grange et al. indicates that the concentrations of chromium are correlated to the degree of weathering the soils have undergone. Since the Islands of the Lower Cook Group were formed from basaltic flows in essentially the manner that the Hawaiian Islands were formed, an attempt was made by the student to discover a possible correlation between chromium accumulation and weathering in Hawaii and the Cook Islands. Since Grange et al. state that the soils of the Cook Islands were formed through laterization, particular attention was directed toward studying the latosols of Hawaii to note any correlation between chromium in the Cook soils and the Hawaiian latosols.

The soil samples in the Low Humic Latosol group were found to generally contain the lowest concentrations of chromium among the great soil groups. Cline et al. (4) in their analysis have considered that the clay minerals in this group are kaolinitic and therefore have not been subjected to as intensive weathering as the other latosol group soils. However, the lower three horizons of the Kahana soil samples from Anahola, Kauai, was discovered to average approximately

1900 ppm of chromium. This may partially be accounted for by the fact that the lower layers were buried soils. Chromium was present in a higher concentration in the Kohala family soil from Lawai, Kauai, than in the other Low Humic Latosol soils. Cline et al. describe the Kohala family as being subjected to certain conditions such as higher rainfall which tend to make it lapse into the Humic Latosol group in certain respects such as the accumulation of oxides.

The Humic Latosol group is described by Cline et al. as having been subjected to greater weathering than the Low Humic Latosols. The accumulation of chromium in this group of soils, when compared with the accumulation of the element in the Low Humic Latosols, fall into the general pattern suggested by the tables compiled by Grange et al. (6).

Although the Hydrol Humic Latosol soil is probably the most highly weathered soil in a continuously wet area, the chromium content approximated 1000 ppm, slightly higher than that of the soils in the Humic Latosol group. When the degrees of weathering in the two soil groups are considered, the Hydrol Humic soils showed a relatively lower total of chromium accumulation. Although it is possible that the intensive weathering process in the Hydrol Humic Latosols could have leached some of the element out of the soil profile, this possibility has not been established yet. Another explanation may lie in the fact that the parent material of the Hydrol Humic soils which were analyzed was andesitic ash,

whereas olivine basalt predominated as the parent material of the Humic Latosol soils analyzed.

Cline et al. (4) have described the Humic Ferruginous Latosol as being a highly weathered soil group concentrating oxides of iron and titanium. As noted previously, the highest concentrations were found in some of these soils. The chromium concentrations in the soil profiles of this group have also shown strong horizon differentiation coinciding with the stratification of the iron and titanium oxides.

The unexpected variations in the Naiwa family would appear to cast much doubt upon the consideration of weathering as an important factor in chromium accumulation. However, when the initial chromium content of the parent material is taken into account, there is no doubt that the weathering factor plays an important role. For example, in the Meyer Lake soil, the parent rock contained less than 2 ppm of chromium, but the highest horizon of concentration in the soil indicated 230 ppm of the element, an increase of 100 times the initial concentration. The Naiwa soil from Wailuku shows an increased concentration of 12 times the original, while the increase in the Kokee soil is 1 to 10.

## Distribution of Chromium in Concretionary Material

The concretionary materials analyzed were either bauxitic or ferruginous concretions. These samples were obtained in only two instances from the soil profiles that were analyzed, both of which were Kokee soil. In these instances it was

found that the concretionary samples which were ferruginous, contained 2140 and 1860 ppm of chromium respectively. The horizons where the concretions were found showed an accumulation of approximately 9000 ppm in both cases.

In the case where a ferruginous sample was obtained from the iron crust of a Haiku soil found at Lihue, Kauai, the chromium content was discovered to be lowest in the iron pan layer with only 465 ppm. The layers directly above and below the pan both contained approximately 900 ppm. The soil below the second iron pan registered the highest concentration, with 1110 ppm.

A bauxitic concretionary sample obtained by dehydrating a Hilo soil upon analysis showed 380 ppm of chromium, while the remaining fraction of dark soil material indicated double the chromium content of the gibbsitic aggregate, with a reading of 740 ppm.

In the other instances where the samples were obtained from related soils in locations other than where the soil samples themselves were dug, the relationship between the chromium found in the concretionary samples and in the soils approximated the ratio found in the Kokee soil. This held true whether the samples were ferruginous or bauxitic.

With a few exceptions, chromium distribution throughout the profiles of the soil samples was found to be fairly constant in the Low Humic Latosols, the Humic Latosols, and the Hydrol Humic Latosols. In these exceptional profiles the highest

concentrations occurred in the A horizons. In the Humic Ferruginous profiles, the horizons where the heavy minerals were accumulated showed the highest concentrations. The foregoing pattern of trace element distribution tends to indicate chromium to be a residual element where weathering is concerned. In the analysis of the concretionary materials, it was learned that the concretions themselves contained lower amounts of chromium than the surrounding soils, furnishing further proof of the resistant property found above. When the mobile aluminum or iron precipitates into concretionary materials, the relatively immobile chromium present in the soil probably is entrapped in the concretions. If chromium possessed the same mobile qualities of iron and aluminum, the concretions would in all probability contain higher concentrations of the element than the surrounding soil.

## SUMMARY

The soils of the latosol groups, rocks representing the parent material of the soils, and concretionary weathering products were analyzed for chromium. The presence of the element was indicated in all of the analyzed samples. The chromium content of the soils ranged from 230 ppm to 9000 ppm. The analyzed parent materials contained from 40 to 1400 ppm and the concretionary products ranged in content from 380 to 2140 ppm of chromium.

The chemical analysis table in Grange's soil survey of the Lower Cook Group (6) showed the chromium content to be higher in the more highly weathered soils. The soil samples analyzed in the course of this investigation generally followed the pattern of correlation between chromium concentration and intensity of weathering found by Grange. However, there were several samples with unexpectedly low amounts of chromium in view of the fact that the soils were considered to be intensely weathered. The unusually low concentrations, unaccountable through weathering alone, were in part explained by the extremely small amounts of the element that were present in the parent materials. A definite correlation between the parent material and the concentration of chromium in the soil was noted.

The correlation between weathering and the accumulation of chromium was definitely affirmed by the analyses of the latosols of the Hawaiian Islands. Weathering in itself,

however, cannot account for the amount of the element present in the soil since parent material and the physico-chemical properties of the element are responsible to a certain degree for accumulation. Chromium possesses properties which make it a residual weathering element and allow its accumulation in the soil.

# APPENDIX

## TABLE I. THE CHROMIUM CONTENT OF TYPICAL SOIL PROFILES OF SOME OF THE DOMINANT GREAT SOIL GROUPS OF THE HAWAIIAN ISLANDS

| Great Soil Group | Family | Location | Average Rainfall | Depth inches | ppm Cr. |
|---|---|---|---|---|---|
| Dark Magnesium Clay | Lualualei | Lualualei, Oahu | 20 | 0-6 | 315 |
| | | | | 6-12 | 335 |
| | | | | 12-18 | 350 |
| | | | | 18-24 | 335 |
| Low Humic Latosol | Molokai | Kunia, Oahu | 24 | 0-8 | 560 |
| | | | | 8-24 | 560 |
| | | | | 24-36 | 660 |
| | Lahaina | Waialua, Oahu | 35 | 0-6 | 620 |
| | | | | 6-11 | 550 |
| | | | | 11-18 | 600 |
| | | | | 18-22 | 620 |
| | Wahiawa | Poamoho, Oahu | 40 | 0-10 | 380 |
| | | | | 10-21 | 500 |
| | | | | 21-42 | 470 |
| | | | | 42+ | 500 |
| | Kahana | Waimea, Oahu | 40 | 0-1 | 800 |
| | | | | 1-6 | 955 |
| | | | | 6-10 | 410 |
| | | | | 10-24 | 480 |
| | | | | 24 + | 535 |
| | | Anahola, Kauai | 50 | 0-9 | 965 |
| | | | | 9-18 | 960 |
| | | | | 18-21 | 920 |
| | | | | 21-28 | 990 |
| | | | | 28-34 | 1515 |
| | | | | 34-52 | 2125 |
| | | | | 52 + | 1700 |
| | Kohala | Lawai, Kauai | 65 | 0-10 | 1490 |
| | | | | 10-15 | 1085 |
| | | | | 15-20 | 1175 |
| | | | | 20-26 | 1210 |
| | | | | 26-44 | 1180 |

TABLE I. (Continued) THE CHROMIUM CONTENT OF TYPICAL SOIL PROFILES OF SOME OF THE DOMINANT GREAT SOIL GROUPS OF THE HAWAIIAN ISLANDS

| Great Soil Group | Family | Location | Average Rainfall | Depth inches | ppm Cr. |
|---|---|---|---|---|---|
| Humic Latosol | Kaneohe | Kaneohe, Oahu | 65 | 0-8 | 1015 |
| | | | | 8-24 | 985 |
| | | | | 24-34 | 1065 |
| | Honolua | Helemano, Oahu | 80 | 0-6 | 725 |
| | | | | 18+ | 760 |
| Hydrol Humic Latosol | Hilo | Hilo, Hawaii | 145 | 0-8 | 1135 |
| | | | | 8-40 | 1000 |
| | | | | 28-32* | 495 |
| | Akaka | Akaka falls, Hawaii | 225 | 0-12 | 980 |
| | | | | 12-24 | 880 |
| | | | | 24-32 | 1015 |
| | | | | 32-38* | 460 |
| | | | | 38-56 | 1175 |
| Humic Ferruginous Latosol | Mahana | Windward Lanai, Lanai | 34 | 0-6 | 1145 |
| | | | | 6-15 | 1470 |
| | | | | 15-21 | 1405 |
| | | | | 21-40 | 1425 |
| | | | | 40-48 | 1135 |
| | | | | 48+ | 935 |
| | Naiwa | Kokee, Kauai | 35 | 0-3 | 3180 |
| | | | | 3-5 | 8840 |
| | | | | 5-11 | 9290 |
| | | | | 11-13 | 5050 |
| | | | | 13-27 | 1906 |
| | | | | 27+ | 4260 |
| | | Wailuku, Maui | 50 | 0-8 | 340 |
| | | | | 8-14 | 500 |
| | | | | 14-20 | 400 |
| | | | | 20-40 | 400 |
| | | | | 40 | 175 |
| | | | | rock core | 100 |
| | | Meyer Lake, Molokai | 45 | 0-12 | 230 |
| | | | | 12-20 | 215 |
| | | | | 20-34 | 130 |
| | | | | 34+ | 155 |

* Dark organic layer

TABLE I. (Continued) THE CHROMIUM CONTENT OF TYPICAL SOIL PROFILES OF SOME OF THE DOMINANT GREAT SOIL GROUPS OF THE HAWAIIAN ISLANDS

| Great Soil Group | Family | Location | Average Rainfall | Depth inches | ppm Cr. |
|---|---|---|---|---|---|
| Humic Ferruginous Latosol | Haiku | Haiku, Maui | 70 | 0-8 | 690 |
| | | | | 8-14 | 745 |
| | | | | 14-17 | 560 |
| | | | | 17-26 | 495 |
| | | | | 26-42 | 490 |
| | | | | 42+ | 325 |
| | | Lihue, Kauai | 65 | 0-8 | 1880 |
| | | | | 8-14 | 1200 |
| | | | | 14-22 | 1170 |
| | | | | 22-34 | 1385 |
| | | | | 34+ | 1375 |
| | | Waipahi, Kauai | 150 | 0-4 | 2320 |
| | | | | 4-20 | 5040 |
| | | | | 20-30 | 1880 |
| | | | | 30+ | 1950 |

TABLE II. THE CHROMIUM CONTENT OF SOME ROCKS OF THE HAWAIIAN ISLANDS

| Rock | Location | ppm Cr. |
|---|---|---|
| Picrite basalt, ankaramite type | Waikolu Valley, Molokai | 815 |
| Picrite basalt, oceanite type | Kunia Road, Oahu | 1455 |
| | Kunia Road, Oahu | 1300 |
| Picrite basalt | Mauna Loa, Hawaii flow of 1852 | 1100 |
| Olivine basalt | Mauna Loa, Hawaii flow of 1950 | 400 |
| Basalt | Kapoho, Hawaii flow of 1955 | 125 |
| Andesitic basalt | Haleakala, Maui | 55 |
| Trachyte | West Maui | 40 |
| Latite | West Maui | 50 |
| Melilite nepheline basalt | Hanalei, Kauai | 610 |
| | Moilili quarry, Oahu | 360 |

TABLE III. CONCRETIONARY PRODUCTS OF SOME OF THE SOILS OF THE HAWAIIAN ISLANDS

| Description | Location | Soil Family | ppm Cr. |
|---|---|---|---|
| Magnetic iron oxide aggregates | Kokee, Kauai | Naiwa | 2140 |
| Iron oxide aggregates | Kokee, Kauai | Naiwa | 1860 |
| | Kilauea, Kauai | Haiku | 1400 |
| Iron crust | Lihue, Kauai | Haiku | |
| A. layer above Fe pan | | | 910 |
| B. Fe pans | | | 465 |
| C. layer just below Fe pans | | | 940 |
| D. soil between Fe pans | | | 800 |
| E. soil below 2nd Fe pan | | | 1110 |
| Gibbsitic aggregates | Hilo, Hawaii | Hilo | 380 |
| Dark soil material | | | 740 |
| Bauxitic aggregates | Hanalei, Kauai | Haiku | 1100 |
| | Lihue, Kauai | Haiku | 250 |

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