ART. XLI.—*Some Characteristics of Kau;** by J. S. EMERSON.

OF the Hawaiian group of islands, Hawaii is the largest, the most lofty and the most recent. The fires of its volcanoes are still burning, and from time to time new material is poured out over the surface of a land which is still in process of formation. Here is the place to study Nature in her workshop and see a world in making. But it is not of Hawaii as a whole that we propose to speak. It is made up of districts with characteristics marked and distinct from one another.

The Hilo-Hamakua-E. Kohala district, occupying the northeast side of the island, from Hilo Bay to Upolu Point, is the land of gulches and streams of water, of disintegrated rock and deep heavy soil.

The W. Kohala-Kona-W. Kau district, occupying the west side of the island from Upolu Point to South Cape, is the land of slowly disintegrating rock, almost without gulches and running streams. The extreme richness of its coffee lands is due to the fact that new soil is ever being formed, as wanted, from the loose mass of *aa* rocks, which contains every element needed for plant growth.

Puna is the district where frequent showers fall upon loose stone and sink out of sight, without forming gullies and streams, and where vegetation thrives without soil. Here the cocoanut tree grows in immense forests as nowhere else in this group.

Kau is unique, a district by itself; "*Kau ka maka lepo*"; Kau the dusty. That portion extending from South Cape to and including Kapapala Ranch, a distance of some thirty miles, contains all the land of any value for grazing or agriculture. Briefly described, it is a wide expanse of comparatively modern lava, forming a floor of rock upon which is spread a superficial covering of fine, light, reddish or yellowish dust of varying depth. In places the ephemeral mountain torrents have washed away this unstable soil and revealed the bed rock beneath, which has scarcely yet begun to disintegrate and ally itself with earth. This superficial coating of dust is distinct from the rocky stratum on which it rests, as the dust which the cleanly housewife removes is from the floor which she has swept. And such dust as that of Kau is found in quantity in no other district of these islands. In the olden days the natives of this section, when engaging in the popular pastime of *lehe kawa*, jumping from a high bank, often substituted a bath of this dust for the usual pool of water. An

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ordinary dirt road, unless properly covered with stone, is quickly worn down by constant travel. The wheels of loaded teams sink into the soil, which in time is blown away by the winds, or washed out by the heavy rains which occasionally fall.

From Waiohinu to Hilea the cane fields are mostly on the hills, where the soil is of great depth and remarkably free from rocks or stones, so that almost anywhere a crow bar or walking stick can readily be thrust down to its full length. On the low lands, however, the soil is usually shallow, with the bed rock frequently cropping out, or may be wanting altogether. The Hawaiian Agricultural Co. are more fortunate in the lay of their plantation, and have an extensive tract of about four thousand acres of rich cane land, not perched on isolated hills, but occupying two large valleys with the gentle slopes between them. These fields are somewhat scattered about, with unproductive areas between them, but as a whole they are far more compact and accessible than the fields from Waiohinu to Hilea.

Kau is not a well-watered district. It often suffers from prolonged drought, when the dry winds parch and destroy whole fields of young cane and raise clouds of dust from the newly plowed lands. When at length the long wished for rain comes, it sometimes pours down in such torrents as to cause great destruction of property. The light soil soon dries up again, so that the irregularity of the rains is the more keenly felt, while the cane stalks register the fact in the varying and irregular length and diameter of their joints. During these periods of drought great care has to be exercised to prevent any one from smoking in the fields or making a fire in the grass, for when a fire is once started, it is sometimes extremely difficult to prevent it from spreading under ground. The roots and other vegetable matter in the soil are consumed, while the mineral basis of the soil itself is so light and spongy as to allow enough air to enter to support combustion many inches below the surface. At times, when such a fire was supposed to be extinguished, it has burrowed its way unobserved, to show its presence at some other point where the surface would cave in and the ground itself seemed on fire. Mr. W. E. Rowell states that "one peculiarity of the soil on the Pahala plantation is the entire absence of any clay or anything adhesive in its composition, so that it does not stick to the shoes, however wet it may be."

At various points through the district it is possible to examine the record of the rocks and to see the character of the successive strata resting one upon another. It would appear from such observations that most of the strata represent ordinary lava flows, with but thin separating sheets of ash or earth. But Providence has most considerately anticipated the industrial wants of man at the present time, and above all these

successive layers of rock has added this crowning layer of dust, which makes it possible to plow and plant a district whose formation is so recent. How different it might have been if this superficial layer had been *aa* or *pahoehoe* rock, as in Kona, requiring another ten thousand years to distintegate it sufficiently for farming purposes.

Between the South Point and the road from Kahuku Ranch to Waiohinu is a beautiful sketch of smooth grassy pasture. At various points near the Cape the writer has measured the depth of the soil to the bed rock, and recorded it as having an average thickness of about ten feet, separated into two layers of nearly equal thickness by a thin layer of whitish earth perhaps half an inch thick. One branch of the flow of 1868 traversed a portion of this plain from the vicinity of the Kahuku Ranch house half way to the Kaalualu landing. Flows of an earlier date have also covered other portions with a horrid mass of rock. But it is outside of the purpose of this paper to describe the various lava flows which cover much of the territory below the cane lands and the Kapapala Ranch.

The woods above the plantations are difficult, if not positively dangerous, to traverse on horseback, so much so that Mr. Julian Monsarrat, who knows the country well, pronounced the carrying of supplies through these woods to his workmen engaged in building a fence along their upper edge, as impracticable. The soft treacherous mud gives no foothold for man or beast. Consequently the supplies were carried a long distance around.

The Kau hills, Iholena, Puu Enuhe, Makanao and Kapuna, bear a most striking family resemblance to each other, so that the profile of one will serve pretty well for all. Captain Dutton in his Hawaiian Volcanoes speaks of them as "mere remnants of a large alluvial formation which was originally continuous," and the valleys which separate them as "valleys of erosion." In speaking of these hills he uses the following language: "The more we see of this country the more will the evidences accumulate that these buttes are silent witnesses of an extensive upheaval of this part of the island at an epoch not very remote." Again he says, "It is difficult to estimate with precision the amount of elevation attested by these terraces, but there are evidences still legible of several of them—one of them 1,200 to 1,400 feet high, another about 2,800, and perhaps, though more doubtful, a third at 3,400 feet." (See Dutton's Hawaiian Volcanoes, page 98.)

This theory, though advanced by a recognized authority on the geology of portions of the western United States, lacks the support of facts. It has not a single ledge of coral, a bed of shells, or a vestige of marine life of any sort on which to rest.

Until such proof of marine origin is found, we cannot accept the theory of upheaval as proven or even as a working hypothesis. To speak of the Kau dust as an "alluvial formation" only removes the question of its origin one step further back. Whence came it? The process of disintegration has scarcely begun in much of the Kau bed rock. The most casual study of its soil shows that it is not decomposed rock. It is totally unlike the soil of Hilo or Kona, and certainly was not washed down from the *aa* and *pahoehoe* of upper Mauna Loa.

Evidently it is a formation similar to that which covers a large portion of the slopes of Vesuvius and overwhelmed the ancient city of Pompeii. This volcanic ash is the evidence of a series of explosive eruptions in Kau on the grandest scale, probably far surpassing anything of a similar nature of which we have any evidence in this group. We must then look to the medium of the atmosphere rather than to the action of water to explain the remarkable distribution of this dust which has been sifted down on the ridges, as well as in the hollows, in a manner far more regular and uniform than could have been accomplished by the action of running water.

To locate the source or sources of this aërial eruption is a problem not yet fully solved, but some light may be thrown upon it. We need hardly look to Mokuaweoweo, the summit crater of Mauna Loa, as a source. For had such an explosion occurred there, the dust would also have been carried in the direction of Kona. But as a fact, neither in Kona nor on any side of the great dome of Mauna Loa is this dust found in quantity, until we reach the wood belt of Kau. Kilauea, the only remaining active volcano, may be looked to as a possible source with slightly greater probability. But between the district covered by the Kau dust and Kilauea lies the Kau Desert with an area of "many miles" of a totally different formation, while nothing is to be seen of the dust anywhere around the volcano. The writer has examined fissures in the Kau Desert to a depth of perhaps thirty feet and failed to see any of the *dust*. If then Kilauea were the real source of the dust eruption, the evidences of it have been covered most completely by these later eruptions.

The supposition is barely possible, but extremely improbable. Another possible source in this enumeration should not be overlooked. It is the vicinity of Puu o Keokeo, greatest of all the offsprings of Mauna Loa, with an elevation of 6870 feet; it appears to those who sail around South Point as another grand mountain, the rival of its mighty parent. It is located on the great fissure, or rift, in Mauna Loa, extending from Pohaku Hanalei to the vicinity of South Cape. This fissure, probably as old as the mountain itself, lies in the direction of the line

joining Mauna Kea and Mauna Loa, the same as the line of the axis of Mokuaweoweo produced. The flows of 1868 and of 1887 seem to have escaped from the central shaft through this lateral rift in the mountain, and to have come to the surface at points on this line of least resistance. It is an axis of great volcanic activity, which has built up for itself the immense ridge of Mauna Loa which divides the geological district of Kau from that of Kona. About Puu o Keokeo as a center there is a large area cevered with pumice and gravel, quite similar to the so called Kau Desert, southwest of Kilauea. Manifestly it has been produced by explosive eruptions on a large scale. But as in the case of the vicinity of Kilauea, so here the peculiar Kau dust is altogether wanting. Further there is no sign of any such dust deposit at any distance, on the Kona side, of this area covered with pumice, while the entire portion of Kau covered with dust is at a distance of many miles in the opposite direction.

The conclusion seems forced upon us that we must look for the origin of this great eruption within the limits of the district covered by it. With this idea guiding us, we naturally look first to the immediate vicinity of the hills already mentioned, where the peculiar Kau soil attains its maximum depth. One cannot but be struck with the suggestion that Puu Iki marks a point on the upper rim of a vast extinct crater extending south to Kaiholena, possibly even to the great whaleback ridge on which Kapuna Trig. Station is situated, while the eastern rim, now largely washed away, would be marked by the hills Makanao, Puu Enuhe and Kaumaikeohu with the steep side hill just to the east of it. Everything seems to point to this locality as the source of the stupendous explosion, or series of explosions, which has rescued Kau from being a waste of unproductive rock and transformed it to so large an extent into a land of pastures and plantations.

If we admit that this is indeed the source of these eruptions, the whole problem of the distribution of the dust is greatly simplified. As would naturally be expected, the ejected matter has been deposited on all sides, but the action of the trade wind has carried the finer particles to a much greater distance to the south and southwest than in the opposite direction. So that we find the country about South Cape covered to a depth of ten feet, as before stated, with the finest dust, without any admixture of coarse material. The whole district west of Kaaluala landing has been tilted up on its western edge, along the line of the great fissure already alluded to, forming an extensive fault from the sea to the Government road just above Col. Norris' residence. The visible deposit of dust breaks off abruptly at the edge of this precipice. But according to native

tradition the whole plane of Pakini at its base, on the Kona side, was formerly a rich field, cultivated with sugar cane and sweet potatoes. Since that time, however, various flows, among which are those of 1868 and 1887, have converted this garden into an uninhabited waste of *aa* and *pahoehoe.*

If, however, we examined the earth in the vicinity of the supposed center of eruption, we find a considerable admixture in places of stones, for example the so called Mud Flow of 1868 covered several hundred acres of good land to a depth of from ten to thirty feet with a heavy, red, clayey earth, abounding in stones, wholly unfit for cultivation, and producing a grass of such inferior character that even the cattle and horses shun it. This mud flow was simply a land slide. Kaapao pali was full of water and the great earthquake of April, 1868 loosened the superficial mass of earth and lubricated the rocky bed on which it rested. Gravity acting on a steeply inclined plane did the rest. Mr. Walton, the energetic and wide-awake manager of the Pahala plantation, has used his wits to good advantage in the search for water on the Kaapao pali and neighboring hillsides, and during the past few months has found enough, as I am informed, to irrigate five hundred acres of cane.

There are no traditions, so far as the writer can learn, relating to these great explosive eruptions. The only occurrence of the sort of which we have any historical information took place in 1790 at the volcano of Kilauea, which destroyed, as Dibble tells us, about 400 of the warriors of Keoua's army, one entire division. The sand, ashes, pumice and stones ejected at this time cover the country about the volcano for miles, and have been fully described by Dana and others.

The extensive area about Puu o Keokeo already alluded to is covered with material very similar to that of the Kau Desert. The "Alanui Umi," built early in the 16th century by King Umi, traverses this mountain desert from north to south. This road was made necessary by Umi's occupation with his court and warriors of the barren waste between Mauna Loa and Hualalai. When the political and military necessity for Umi's occupation of this strategic position ceased, he sought a more agreeable home, and spent the last years of his life at Kaawaloa, by the sea. The Umi road seems to have been little used since those days, save by the race of bird catchers and perhaps by the sandal-wood cutters of a later day.

Its very existence, however, is scarcely known to most of the dwellers on Hawaii. This ancient road is chiefly interesting to us at this moment as an evidence that no great explosive eruption has probably taken place in that portion of Hawaii for the past 350 years. It is pretty much in the condition in which Umi left it.

Some years since I had occasion to ride over a portion of this road, which was two or three feet wide and is still readily followed. So long as the mule kept to the old path he made good progress, but when he deviated but a few feet on either side, he sank down to his girth in the sand and pumice and floundered helplessly. It was most instructive to follow this path to the great natural amphitheatre on the southern slope of Puu o Keokeo, where the famous cock fights used to draw immense crowds to witness one of the great national games of Hawaii. The cock-pits or rather pens still stand, probably as Umi left them three and a half centuries ago. Had there been a shower of ashes or pumice from the vicinity of Puu o Keokeo during this interval, the old road and these cock-pits would have disappeared forever beneath the sands of the desert.

Since the above was written, Dr. A. B. Lyons of Oahu College has kindly furnished the following statement: "I have had occasion to examine the soil from some of the cane fields at Pahala. They were remarkable in several particulars. They contain a large proportion of organic matter, and yet could not be called peaty. They seemed rather sandy. They contain almost no clay. The mineral matter consists in fact of volcanic sand rich in olivine and very little decomposed—very similar in many respects to the sandy or gravelly soil of Punahou, which is made from recent volcanic sand. The abundance of lime in the soil confirmed also this view of its probable origin. Hawaiian soils composed of decomposed lava contain very little lime."

For the sake of clearness, a brief recapitulation and summing up of the argument with reference to the origin of the peculiar Kau soil may properly conclude this paper.

A district equal in extent to one-half the area of the Island of Oahu, 300 square miles, is covered with a soil quite unlike that of any adjoining district, and totally distinct from the very recent volcanic bed rock on which much of it rests. The entire absence of a single ledge of coral, bed of shells, or other positive evidence of marine formation, and the frequent occurrence of caves and caverns which remain unfilled with silt, together with the very porous character of the whole formation, discredits the theory "of an extensive upheaval of this part of the island at" any "epoch not very remote." On the contrary, this formation originated on dry land and has not been submerged. If this soil were alluvial it would show stratification. Instead of that it is blanketed like newly fallen snow upon the uneven contour of hill, plain and ridge.

If this formation were deposited at tide level, it would be interpenetrated by marine growths, animal and vegetable. But the evidence that such growth exists is conspicuously wanting.

But, finally, no better evidence as to the origin of this minute sand can be produced than its appearance under the microscope. Its mechanical features are sharp and broken as of volcanic sand, wholly unlike the rounded and worn features of beach sand. In short, the positive testimony of chemical analysis and microscopic examination shows that the mineral portion of this soil is volcanic sand, not the wash from any higher level of decomposed rock. This necessitates the theory of explosive eruptions on a scale of magnitude proportional to the extent of territory covered, which would have been greater but for the ocean which abruptly terminates it along the entire coast from Punaluu to South Cape, and a precipice on the southwest, beyond which all trace of this soil has been effectually covered up by flows of lava. Further, three great centers of volcanic activity, viz., Kilauea, Mokuaweoweo and the vicinity of Puu o Keokeo to the northeast, north and west respectively of the district in question, have covered extensive areas about them with other formations, so that it is impossible to locate the original limits of this unique formation in those directions. At the same time, the evidence is very strong, if not conclusive, that neither of these three volcanic centers was its source, while every consideration points to the great crater-like area below Puu Iki.

This locality is so little known and so difficult of exploration that we are unable to point out the exact location of the center of explosion. The unstable character of the material ejected would tend in a measure to cover up its source, which from the nature of the case could not be as sharply defined as that of a flow of *aa* or *pahoehoe*, whose birthplace is marked with solid rock.

As to the time when these remarkable explosions occurred, it may be observed that the only event of this character in these islands, of which we have any definite information, took place at Kilauea a little over one hundred years ago, as already stated. From the fact that the old cock-pits near Puu o Keokeo and the ancient road leading to them remain as they must have been left by King Umi 350 years ago, it seems quite evident that no explosive eruptions on a large scale have taken place during that interval either from the summit crater of Mauna Loa or from the great lateral rift which has been so active in building up the immense ridge which marks its southwest slope. The conclusion therefore is evident that the eruption which produced the Kau dust under discussion was earlier than the beginning of the sixteenth century. Though we may not locate the time of these eruptions as definitely as the place, yet the fact that they form the last of a long

series of distinct strata, each of which represents a considerable interval of time, shows that they must have occurred at a period very recent in the growth of the island. On the other hand, the entire absence of any tradition relating to them and the occurrence in several places of *aa* and possibly *pahoehoe* flows from Mauna Loa of limited extent and of uncertain age superimposed on this formation, make it probable that the stupendous convulsions of Nature which gave birth to this crowning feature of the district and prepared it for the support of man in an advanced stage of civilization, occurred many centuries ago, probably before the advent to these shores of its first Polynesian inhabitants.