Caves of Southern Kauai

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Caves in southern Kauai are worthy of protection for the following reasons: (1) remaining sources of human habitation records, (2) unique biological resources, (3) geological resources, (4) burials, and (5) aesthetics. Human interference has already resulted in the loss of many surface archaeological sites in the area. Growth in human population will lead to pressures to convert arable land into more profitable enterprises. As the human population shifts and grows, a depletion in the quality of natural features on the landscape may occur. Mining of volcanic cinder has led to the flattening of volcanic cones that previously had shown a time sequence in island geology. Mining of unconsolidated and lithified sand dunes disturbed may Hawaiian burials and a record of geology at work today.

There are few caves on Kauai Island. Sea caves are present and reflect the record of the ocean's change in sea level. Lave tubes are present and are subject to urban encroachment. Limestone caves are present at the unconformity between beach rock and underlying alluvium. The unsoiled caves worthy of protection are in the southeast region of the island.

Waimea Canyon Volcanic Series

Kauai Island is a single shield volcano that rises 17,000 feet above the sea floor and a little more than 5,000 feet above sea level. The activity of the shield building Waimea Canyon Volcanic Series has a potassium-argon estimate of beginning 5.7 and ending 3.8 million years ago (McDougall, 1964). These lavas have normal remnant magnetism (Macdonald and Abbott, 1979) The aa and pahoehoe lava flows of the Waimea Canyon Volcanic Series are tholeiitic basalt, alkalic olivine basalt, and hawaiite. Early lavas generally have larger phenocrysts of olivine than those found in the post-erosional flows.

On the southeast part of the island, near the cave area, is the Haupu range of mountains. This basalt ponded caldera is on the flank of the Kauai shield volcano. Its eruptive episode probably coincided with that of the collapse and development of the summit caldera. The lavas surrounding the Haupu caldera slope away from the center of the island. Hoary Head, the highest point of the Haupu caldera, marks the top of the caldera filling lavas that remain in relief with the erosion of the less dense surrounding lavas.

Post-erosional Koloa Volcanic Series

Large amounts of sediments, deposited as erosional unconformities, mark the passage of time between volcanic series on Kauai. Nearly two million years of quiescence passed before the Koloa Volcanic Series marked the beginning of renewed post-erosional activity about 1.5 million years ago. These lavas, which covered about the eastern half of the eroded island, include nepheline basalt, alkalic olivine basalt, basanite, and melilite nephelinite. These lavas generally had a darker matrix than the rocks of the Waimea Canyon Volcanic Series. Fe^{+2} is blue black, Fe^{+3} is red (rust). The difference in color may be due only to the amount of oxidation (i.e. age). Some later post-erosional Koloa Volcanic Series lavas have reversed remnant magnetism. This series marked the end of post-erosional volcanic activity on Kauai over 100,000 years ago.

The episodes of volcanic activity within the Koloa Volcanic Series are believed to be sporadic due to the large numbers of erosional unconformities found between successive volcanic layering. Forty vents are identified from the Koloa Volcanic Series. The orientation of the vents is north-northeast to south-southwest across the island. Most of the eruptive fissures are small cinder-and-spatter cones and Strombolian-type cinder cones.

Lava Tubes in Southeastern Kauai

Because of the high value of land, many remaining lava tubes in southern Kauai are facing urban effects. Some lava tube entrances have been

plugged (Kikuchi, 1963) in the following ways: (1) filling with sugar cane residue, rocks, and debris during field operations, (2) intentional filling by cowboys to protect the herd, and (3) use for sewage disposal by local residents.

A steady flow of applications for re-zoning from agricultural to resort usage has led to other implications. Increased housing construction coinciding with resort development probably will result in deterioration of cave entrances. Presently, many cave entrances are located with difficulty in dense brush and are protected by their remoteness.

Caves were used for human burials. Skeletal remains are found near the end of an open traverse of a lava tube on the margin between pasture land and a planned residential community. Due to the high atmospheric water vapor content, much of the human bone has deteriorated. Five molars were present. Extensive disturbance by artifact hunters is evident. Holes dug in the soil in the entrance area of the cave appear to have destroyed a part of the archaeological record here and at other cave sites in the region (Kikuchi, 1963).

Two other lava tubes, on former pasture land, are natural hazards at the Kiahuna Golf Course. Evidence of recent tampering, probably during golf course development, is especially noticeable around the cave entrance areas. A sign at one entrance says, "This cave, in which the endangered no-eyed big-eyed hunting spider (*Adelocosa anops*) resides, is set aside for its protection." Populations of *Spelaeorchistia koloana* and an occasional *Adelocosa anops* are noted more than once by workers such as Howarth and Stone and more recently by Holsinger and Ferguson.

Southeastern Karst Topography

In the late Pleistocene, earthy deposits accumulated along the southeastern shoreline of Kauai during a higher stand of the sea. These small pieces of weathered rock deposited by gravity formed an alluvium sedimentary base. The sedimentary deposit is a mixture of stream-laid sand, gravel, and silt. These fragments of organic and inorganic weathered products got transported to the place of deposition during the long periods of inactivity of the Koloa Volcanic Series. Hydrochloric acid confirmed the presence of carbonates in these weathered products.

After that, sand deposits blew inland by entrainment during a lower stand of the sea. This resulted in the formation of eolian dunes. Evaporating rain water, passing through the permeable dune sand, deposited molecules of the crystalline compound $CaCo_3$ (Calcium Carbonate). Wind blown ocean spray probably resulted in deposits of NaCl (Sodium Chloride or common salt), $MgCl \cdot 6H_2O$ (Magnesium Chloride, white crystals that can absorb atmospheric water vapor until they are completely dissolved), $MgSO_4$ (Magnesium Sulphate, colorless crystals), CaS (Calcium Sulphate, a white crystalline salt, insoluble in water), and KCl (Potassium Chloride, colorless crystals that are soluble in water) (Godman, 1981). This dune sand eventually formed a well cemented, cross-bedded, eolianite. These lithified sand deposits lie atop the older alluvium.

The older alluvium, acting as a poorly permeable solute, may be transported. Unknown is how large a role rainwater, percolating through the overburden, has played in the alluvium transportation process. In the space between the older alluvium below and the lithified sand deposits above, small caves have formed. At the Grove Farm Quarry in Maha'ulepu, holes on the surface show evidence of caves broken into during mining activities.

Historical records of the Maha'ulepu area record the presence of a community of farming, fishing, and grazing activities. Due to the extensive alteration of the landscape by the sugar plantation, much of the surface archaeology is gone. Some remaining surface features are: (1) ditches and flumes of the awai irrigation system, (2) walls and C-shelters, (3) house platforms paved with ili ili, (4) petroglyph rock boulder and beach rock terraces, and (5) heiaus.

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