THE CAVE OF REFUGE, HAKUMA HORST, KALAPANA, PUNA DISTRICT, HAWAIʻI

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The Cave of Refuge is part of a once-larger lava tube system formed on the southern flank of the Kilauea volcano 10,000 to 1500 B.P. It was truncated by two NE-SW striking high-angle faults along which a block less than 200 m wide, the Hakuma Horst, in Kalapana (Puna District, Island of Hawaiʻi) was lifted up. The cave system, 206 m long, consists of three tributary arms, the junction of which has largely collapsed. Into the breakdown a narrow entrance passage, 11 m long, has been built that allowed defense of the cave against intruders. Another, larger breakdown pit gives access to a small hall that probably has been used for dwelling. The system has six openings, one of which is in the fault face overlooking the Pacific. The system may soon be overrun by the ongoing Puʻu ʻOʻo-Kupaianaha eruption and should be studied archaeologically in detail before it is lost forever.

Introduction

The southern flank of the Kilauea volcano, Island of Hawaiʻi, is slipping seaward along roughly NE-SW striking lystric faults. This slipping is accompanied by frequent earthquakes (Klein et al. 1987). At the surface these faults are steep. At the base of the volcanic edifice, 5 to 10 km below the surface, these faults become subhorizontal. The individual wedge-shaped blocks slip at different rates, often pressing upward smaller blocks between them, forming small tectonic horsts. One of these, the Hakuma Horst, west of the site of Kalapana, District of Puna, rose up to 10 m above the adjacent landward block. The Kupahuʻa Cliff is the landward fault face of the horst; seaward it forms a steep coastal

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cliff. The horst is now threatened with inundation by the lava of the current eruption.

Kilauea volcano started erupting through its east rift on 3 January 1983 (Wolfe et al. 1987). In the initial phase of the eruption, forty-seven fountaining events built up a cinder and spatter cone, Puʻu ʻOʻo, 250 m high. In July 1986 the eruption center shifted 3 km to the east when a new fissure opened. This new eruption center (Kupaianaha) built up a low shield and produced large amounts of lava. Much of the lava flow occurred through tubes. By November 1986 the lava reached the ocean for the first time, 11 km south of the erupting rift. In the following years the lava created new land seaward and destroyed houses, roads, and vegetation in a large area. Periods of quiet tube flow were interrupted by periods of more pronounced surface flow. In March 1990 the lava made an excursion eastward and was deflected toward Kalapana by the Hakuma Horst. The new layer of pahoehoe lava reduced the height of Kupahuʻa Cliff to 1 to 6 m. In August 1990 Kalapana's famous black sand beach was covered by lava and its palms were burnt. Until late summer 1991 tube flow dominated again. Then the deeply buried tube system failed and a new phase of surface flow started.

This sequence of events shows that sooner or later the surface of the Hakuma Horst will be covered. In many places the new lava has already reached the brink of its landward fault. To document caves on the horst, in summer 1991 members of the Hawaiʻi Speleological Survey mapped the only generally known cave there, the Cave of Refuge (Hakuma Cave).

Two earlier descriptions of the main section of the cave have been published. In 1952 Kekahuna and Kelsey gave an account of the cave visited by them on 6 July 1951. Kekahuna (1951) also produced a sketch map of the cave below the fortified entrance that also records some interesting surface features. The map gives measured distances (not drawn to scale) but is wrong concerning directions, which apparently were only estimated and not measured. A second brief description was written by Hudson (cited in Barrera and Barrère 1971, their site 50-HA-A22-1) who listed the cave as site 182. Hudson and Barrera and Barrère concluded that the cave lacked archaeological interest. On the basis of additional spelean findings, however, we disagree.

Description of Cave

The cave is marked on many standard maps of Hawaiʻi. Because of dense bushes, its entrance is nevertheless difficult to find, and we in fact needed two trips to locate it. About 400 m from the eastern end of the

horst, the cliff is still relatively high. One can ascend the cliff over a talus cone (which actually marks the collapsed end of the cave). The main entrance to the system is the well-known fortified entrance to the Cave of Refuge (figures 1, 2). We found the pole of a fallen civil defense marker here. As reported by Barrera and Barrère (1971), the sign originally marked the cave as a shelter for 250 persons against nuclear fallout. It was erected after 1951, and the map of Kekahuna describes a hole, lined with small rocks "where an idol was placed," which may have been used to set the pole.

The entrance (Figure 2) is a narrow passage completely walled and roofed artificially, leading downslope toward the ocean *(makai).* Only one person can pass crouched at a time. The passage has two bends preventing penetration of light. An intruder therefore would crawl down into a gloomy darkness, not being able to see ahead but knowing that the defender could easily see him or her against the dim light of the passage. To enter the first stretch of the passage, which is 4.3 m long, 0.6 m wide, and 1.25 high, one has to lower oneself into the rectangular entrance pit, which is 0.6 m wide and 1.2 m long. Beyond, the roof is formed by elongated blocks covering the passage like beams. After the first bend the passage opens up a little until, after 3.1 m, a massive pillar forms the right-hand wall. At the pillar the cross section measures 0.7 x 1.6 m. A huge stone plate, 1.1 m wide, forms the roof above the pillar. Possibly the pillar and the roof plate are pieces of natural breakdown artfully incorporated into the entrance construction. Behind the pillar the passage opens up just enough to give a defender room to attack an intruder. The constructed passage continues for another 3.8 m, now under the original lava tube roof. Near the ceiling the wall has been destroyed. Two holes have been opened to give access to a void behind the well-stacked walls. At the end of the passage, one steps down and out of a kind of doorway into the Hall of Refuge. Its floor is 3.1 m below the lip of the entrance pit.

Here the lava tube becomes fully visible for the first time. It is sealed from side to side by an artificial wall. Near the central doorway this wall is well preserved. Facing the construction one notices that the right-hand side is stabilized near the floor by two large buttress rocks standing on their edges perpendicular to the wall. On the left-hand side, in the lower part of the wall, large blocks of the original breakdown have been incorporated. On both sides of the tube the wall is partly destroyed, and two holes have been opened connecting with the holes at the ceiling in the last stretch of the passage. The western hole leads into a cavity that receives light through the blocks of the entrance passage. Its right-hand wall is also made from stacked lava plates.

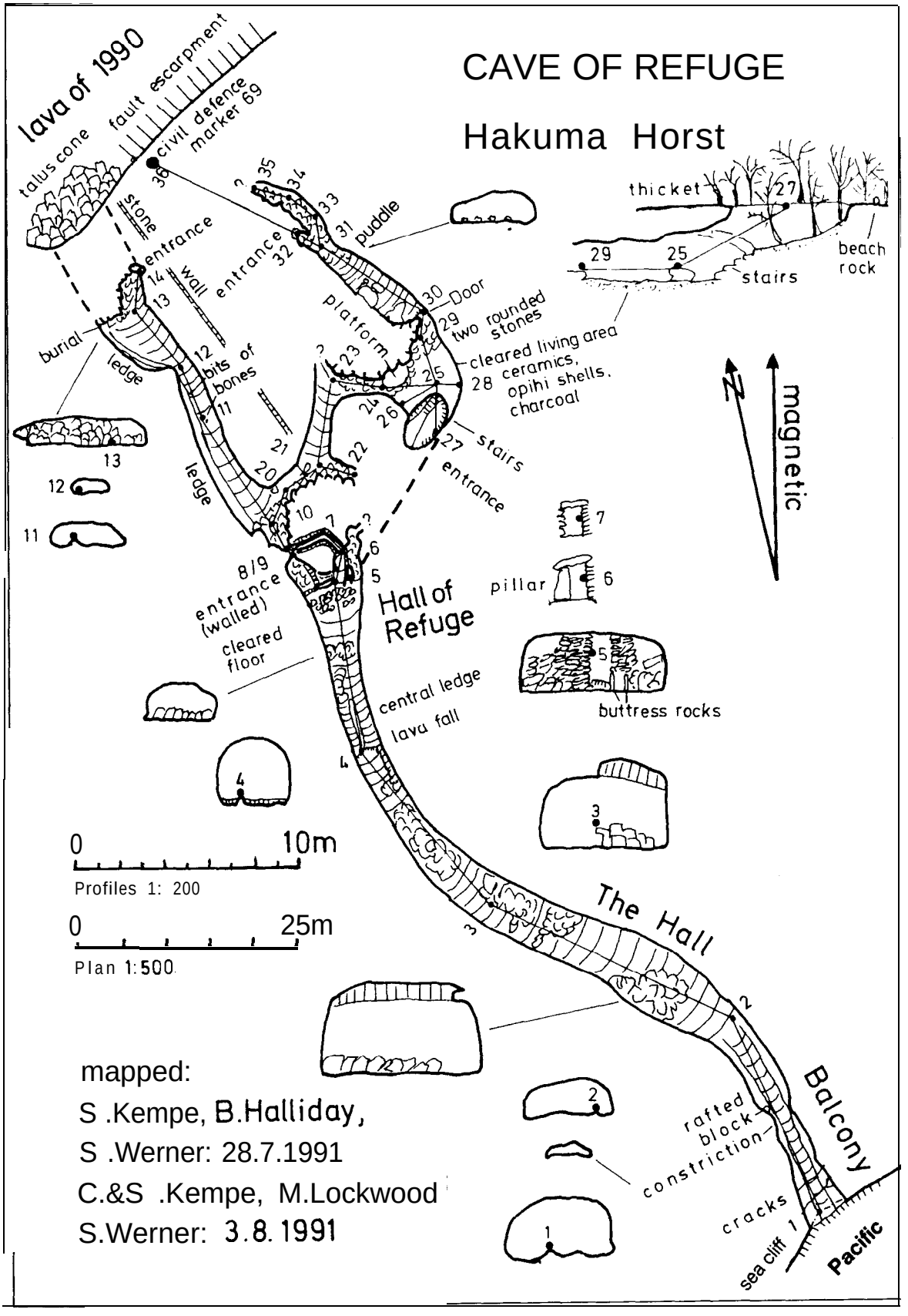

FIGURE 1. **Map of the Cave of Refuge, Kalapana, Puna District, Island of Hawai'i.**

FIGURE 2. **C. Ketz-Kempe at the fortified entrance to the Cave of Refuge. Note the nicely stacked walls and the roofing with larger slabs of lava.**

Thus, this hole and the entrance corridor appear to be parted only artificially by a large, elongated pillar with sides of carefully stacked rocks and probably backfilled with loose rubble. The eastern hole in the wall leads over loose stones down into natural breakdown that contains discarded *ʻopihi* (limpet) shells.

The Hall of Refuge had been cleared of rocks by the builders of the fortification. Now components of the partly destroyed wall litter the floor. The tube itself is quite large, 6.4 m wide at the artificial wall and 2.35 m high. The tube continues *makai* but soon narrows to 3.1 m, and the ceiling drops to 1.65 m. The builders of the fortification made no attempt to move rocks found here, making visits to the lower tube awkward. Given the effort required to construct the entrance, this obstruction comes somewhat as a surprise and may indicate that the population to be protected was not more than ten or twenty people at a time. For that number of persons the Hall of Refuge might have been sufficient as a hideout. However, the hall does not show signs of any extended use. Apart from a few *ʻopihi* shells, not much litter is noticeable. No fireplaces were set, and the floor was not filled with sand to make walking or sleeping more comfortable.

Makai of the constriction the tube opens up again. One notices a lava

"island" on the floor. The pahoehoe flows on either side soon encounter a 0.4 m-high lava fall. The tunnel gently bends eastward, and one enters a large hall up to 7.2 m wide and roughly 4 m high. No signs of human occupancy are noticeable apart from a few bits of charcoal. On the walls mineral deposits occur, and at places breakdown blocks litter the floor. The pahoehoe of the floor is granular. At the end of the hall, daylight is reflected off the wet lava. Through a constriction, 2 m wide and 0.5 m high (a tube-in-tube structure), one crawls out into the Balcony Passage (12 m long) high above crashing waves. Two cracks parallel to the seaward cliff cut across the tube. The Kekahuna map gives a length of 13 m for the Balcony Passage. Because we cannot reconstruct exactly where Kekahuna's stations were placed, the recession of the sea cliff cannot be precisely evaluated, but certainly it did not measure more than a meter within the last forty years. A few ferns grow inside the tube. It is a perfect spot for a caving picnic: the arch of the tube frames a semicircular piece of the Pacific and its eternal motion of waves (Figure 3). No land is encountered south of here until the Antarctic continent.

Climbing out of the constructed entrance, we asked ourselves how far the tube continues upslope *(mauka)* and tested a tight vertical hole just past the entrance pit. After lowering ourselves down among some siz-

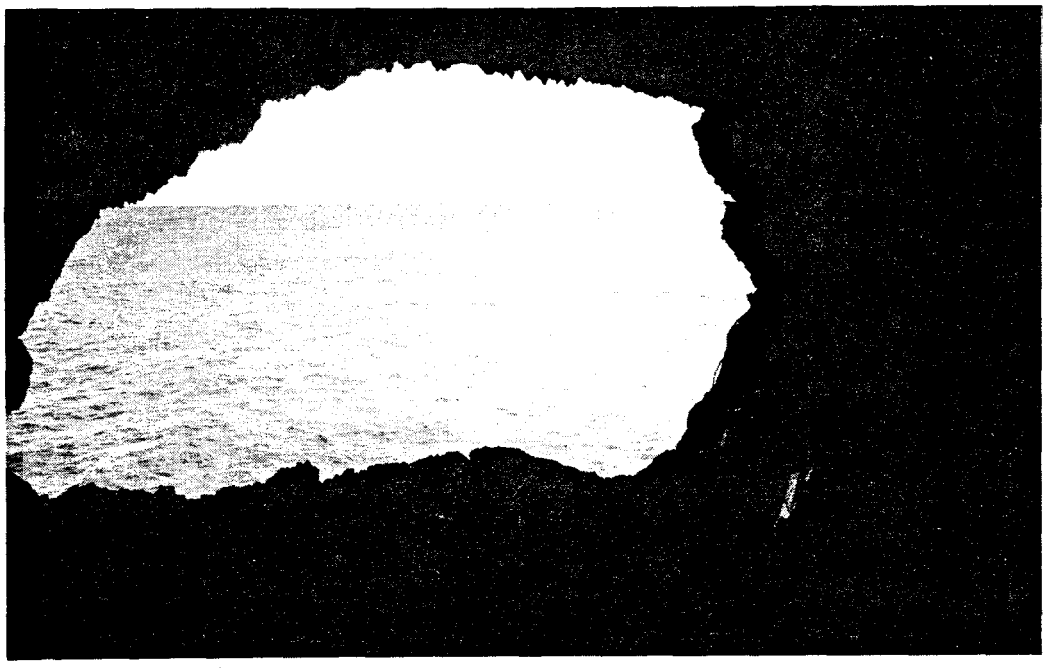

FIGURE 3. **The vista from the Balcony Passage, an opening in the sea cliff at the lower end of the cave.**

able breakdown blocks, we entered--as expected--the *mauka* continuation of the tube. Unexpectedly we discovered a crawl leading NE with breakdown on its right-hand side and a tube wall on its left-hand side. First we followed the *mauka* tube, which soon decreases from standing to crawling height. The floor is formed by relatively smooth pahoehoe. A few bits of bones were noticed on the otherwise rather clean floor. After a constriction the tube widens, and the ledge on the left-hand side becomes more prominent (Figure 4). After 30 m the tube ends in complete collapse. In the NW corner more bits of weathered or burnt bones were noted, partly underneath loose rocks, partly littered on the floor. Probably this was the site of a burial that has been looted. Dim daylight filters down among the blocks on the right-hand side of the breakdown, and the cave can be left through a narrow hole hidden in bushes and hard to find from the surface.

Next, we followed the crawl that leads around the entrance breakdown cone. *ʻOpihi* shells can be seen among the blocks. After 5 m an intact tube is encountered that can be followed for 10 m before it ends again in breakdown. To the right a crawl has been opened that leads upward on breakdown. From here a lighted hall at the northern end of

FIGURE 4. The westernmost of the three tributary branches in the *mauka* section of the cave. Note the large width but low ceiling of the passage. To the right is a lava ledge.

a breakdown pit is entered. It shows many signs of human occupation. Five to six steps have been set to facilitate access to the hall. Stones were removed from the floor. In the back a rough (sleeping?) platform has been erected. The floor *is* littered with charcoal, small *'opihi* shells, and a few pieces of broken ceramics. The cave apparently served as a dwelling well into the last century. The entrance itself is overgrown with bushes, and it was almost impossible to get out of it. This growth is the reason why we had not noticed the entrance previously. It also protected this part of the cave from the occasional visitor to the main section of the Cave of Refuge. The Kekahuna map shows this entrance ("B2 = women's working cave"), and Kekahuna and Kelsey wrote "an open cave mouth . . . was also used and connects with one of the lesser passages" (1952), but apparently they did not visit the northern passages themselves. Marlin Spike Werner crawled under the bushes toward the entrance pit and discovered a large, rounded beach rock in front of the pit. Two more beach rocks (20 to 40 cm in diameter) were found in the back of the cave. To the north of the hall, breakdown originally closed the tube, but a hole had been opened artificially (termed "Door" on the map). It may have served as an escape route or simply to provide access to the tube beyond where one could collect drinking water with calabashes. The tube starts out comfortably in size and narrows down after 15 m, when breakdown is encountered. To the left, another entrance to the system was found. To the right, the tube ends after 10 m in impassable breakdown. The entrance conveniently brings one back within 20 m of the landward fault scarp.

General Considerations

The total mapped length of the system is 206 m. The trunk section below the fortified entrance is 96 m long (Kekahuna's measurements add up to 104 m). The system undertunnels the width of the tectonic horst almost completely. No further faults are found within this part of the horst, but a few cracks cross the tube in places. The cave is older than the horst. According to Holcomb (1987), the lava of the Hakuma Horst belongs to flows of the age group 10,000 to 1500 years B.P. The tube is therefore one of the oldest caves presently known on Kilauea (Kempe and Ketz-Kempe 1993). Apparently the lava tube system started *mauka* with three smaller tubes (stations 35 to 27, stations 23 to 22, and stations 14 to 10 in Figure 1) that then joined to form the *makai* part of the Cave of Refuge, much larger in size than any of the upper arms. At the junction of the tributary arms the cave collapsed, forming

a complex and breakdown-dominated section. Including the Balcony at the cliff face, the cave has six entrances, five of which are caused by collapse of roof sections.

On the surface several stone walls and stone piles show that the area was intensively used in former times. Much of the area is thickly overgrown with bush, part of which was burnt when the approaching lava ignited the vegetation in 1990. The ashes of this fire sustained a thick undergrowth of plants in 1991, hiding any detailed surface structure in the vicinity of the cave system. When thrashing around in this vegetation, Werner found a surface (tumulus) cave, 7 m long, just 5 m from the Cave of Refuge entrance. It may have served also as a temporary shelter since *ʻopihi* shells litter its floor. This little cave ("B1 = women's working cave") was already noticed and sketched by Kekahuna (1951). Kekahuna also sketched some of the stone walls adjacent to the entrance area including a paved walkway, 1 m wide, leading to B1 from the east, now completely overgrown. Kekahuna also described some features of historic interest below Kupahuʻa Cliff that are now overrun by lava. These include four reclining coconut trees *(niu moe)* reportedly pulled down by Queen Emma (two), Ululane (wife of Governor John T. Baker), and Mrs. Kaʻimiʻola (wife of John Kanoelehua Kalehualoa, who owned one of the lots immediately adjacent to the cliff below the cave). He also mentioned a "bathing-spring, laboriously hewn from the hard pahoehoe lava that partially covers the land." It is conceivable that this spring was fed by groundwater conducted by the *mauka* extensions of the Hakuma cave system downfaulted at Kupahuʻa Cliff.

We think the Hakuma system is of major archaeological interest. The fortified entrance should be documented in detail, and the hall, conveniently accessible by steps in the breakdown pit, should be excavated before the Kupaianaha eruption covers this ancient Hawaiian site.

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