CAVE EXPLORATION WITHIN THE GREAT CRACK OF KILAUEA VOLCANO

by
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The Big Island of Hawai`i is currently formed by the mass of five large volcanoes. The Kohala Range to the north is the oldest and has not erupted in recent geologic times. Mauna Kea is the tallest at 13,796 feet in elevation. It last erupted shortly after the most recent ice age, but has not erupted in historic times. Mauna Loa (Long Mountain) is the largest, stretching from Hilo on the east to Kona on the west and south to Ka Lae, the southernmost point of the island. The high point on the caldera rim to this massive structure reaches 13,677 above sea level. The base of the island formation plunges to more than 16,000 feet below sea level. Hualalai rises to 8,271 feet above the Kona coast. Kilauea perches on the southern flank of Mauna Loa at an elevation of just over 4,000 feet. It is the smallest of the volcanoes, but also the most active in historic times, erupting nearly continuously for the past forty years. The last three volcanoes in this list have all erupted in historic times and are expected to do so again. A sixth active volcano, Loihi, is actively growing beneath the ocean just to the south of Ka Lae.

The staff at Hawai`i Volcanoes Observatory (HVO) are actively monitoring all of these mountains in an effort to better understand their formation and hopefully better predict when and where the next eruptions will occur. One of their most promising techniques has been to closely follow the expansion and contraction of each mountain mass as lava plumes rise up from the deep mantle of the planet. These upward rising flows of magma originate tens of kilometers beneath the surface and exert enough pressure to actually enlarge the overall volume of an entire mountain core. Once the plume erupts to the surface, pressure is released and the mountain responds with a deflation episode. It shrinks in volume.

In order to accommodate these massive changes in volume, each mountain develops a set of three linear cracks that radiate outward from the summit caldera. They are normally arranged equidistance from one another, so that 120 degrees of arc separate one from the next. This highly regular pattern is believed to be related to the original crystal structure of the basalt. The same "three way split" can be seen on a smaller scale in tumulus formations that pop up on the surface of current day pahoe`hoe flows. In most cases two of these fault zones are dominant, while the third is often very subtle or sometimes buried beneath an adjacent mountain. The last stage eruption events of the more ancient mountains usually blanket the entire surface with deep ash deposits. On these mountains, the original fault zone areas are buried and no longer visible.

On current day maps and air photos, these active Rift Zones are clearly recognizable on the most active volcanoes. Mauna Loa has dominant features extending to the southwest and northeast. Kilauea has prominent rift zones to the southwest and east. The summit craters of Hualalai are developed along rift zones that extend to both the northwest and southeast. Most of the larger flows on the Big Island for the past 200 years have erupted along these zones. The Northeast Rift Zone of Mauna Loa has been actively depositing many of the longest lava flows on the island throughout historic times. Most erupt high on the mountain, flow down toward the saddle to Mauna Kea and then turn east toward Hilo. Some have even reached the city limits. Major events have been observed in 1842, 1855, 1881, 1935 and 1984. These eruptions are generally characterized by long duration events that often flow for months with a preference to deposit Pahoehoe lava rather than A`a. The Southwest Rift Zone has been equally active with major eruptions in 1887, 1907, 1919, 1926 and 1950. Eruptions along this active fault line generally spring out at elevations from 6,000 to 8,000 feet. Most reach the coastline below in record times ranging from three hours to eight days. Flowing at this volume and speed, they normally form open channels with fast moving material that deposits predominantly A`a lava. The single longest and largest flow on the island broke out at an elevation just above 11,000 feet on Mauna Loa in 1859. This flow is believed to be associated with a rather poorly defined Northwest Rift Zone. It reached the ocean approximately 47 miles from the eruption site in less than one week, depositing primarily A`a along the way. The event then shifted to a slower flowing regime and laid down a ribbon of Pahoehoe just adjacent to the original tongue. This more sedate episode eventually reached the ocean, as well and continued to flow for nearly four months.

Hualalai Volcano has erupted only once in historic times with flow events that originated off the Northwest Rift Zone and flowed to the sea in 1801.

The geologists at Hawai`i Volcanoes Observatory have been monitoring lava flows on the Big Island for more than a century now. Their current facility, built in 1912 is perched on the rim of Kilauea Caldera. Monitoring the movement of subterranean magma upward beneath the caldera of Kilauea Volcano has long been their primary focus. Visitors to the Volcano in the 1800's often describe a "boiling inferno" or "Hades own hell" across the floor of Kilauea Caldera. Most of the activity during this century seems to have been centered beneath the mountain summit. Beginning in the twentieth century, things began to change. Flows broke out along the higher elevations of the Southwest Rift Zone as early as 1920 and persisted through the 1974. Large events also occurred along the lower Eastern Rift Zone in 1955 and 1960. During the early 1970's a major shift occurred toward the higher elevations of the East Rift Zone and eruptions have been more or less continuous in this area for the past 40 plus years. Major eruption sites include Mauna Ulu, Kupa`ianaha, and Pu`u O`o.

So finally we arrive at the primary focus of this paper, the lower extent of the Southwest Rift Zone on Kilauea Volcano. Beginning at roughly 2,300 feet in elevation, this section of the Rift is quite unlike any other on the island. Faulting activity here has consolidated into a feature named The Great Crack. It is just that, a single large crack that runs unbroken for more than 10 miles before finally reaching the coastline. Averaging 30 to 60 feet in diameter and roughly the same in depth, it is easily visible on Google Earth images and stands out as a prominent feature for any aircraft flying over the area. Most of the floor of this open crack is littered with breakdown, but there are occasional gaps where cave entrances and pit craters lead to greater depths within the Great Crack System. A master thesis by Chris Okubo has located more than twenty of these voids. Most require vertical climbing equipment to enter. A small group of dedicated cavers has been working to explore at least a few of these underground systems.

The Great Crack has been mentioned in many past publications by various geologists including Don Swanson from Hawai`i Volcanoes Observatory. Bill Haliday recognized the potential for caves to be developed within this fault system quite some time ago. They first introduced the author to the area in August of 2001. Our first trip was somewhat limited by the amount of gear that we packed along. Since no one had actually ever entered the cave entrances that were known to exist along the length of the crack, we didn't bring along much rope. One short hand line was about it. As we entered the cave opening that they had chosen for this original trip, it very quickly became obvious that these were caves of a very different sort. The horizontal cave entrance to this first Great Crack feature was substantial. A talus slope descended into an opening easily large enough to accommodate a two lane highway. The only problem was the house sized boulder that was lodged precariously between ceiling and floor. It was clearly out of sync with the angle of repose of the surrounding smaller sized breakdown matrix and looked as though it had no more than minimal contact where one tip end of the rock touched the ceiling. This theme of large boulders with little visible support was to hold true throughout our exploration of the Great Crack Caves.

With little rope and only small hand lights, we were not able to explore any distance into the cave, but did establish that there was a sizable horizontal passage that ended after only 150 feet. We did also establish that a small hole along the left hand wall was easily enterable into a deep vertical drop that blew a great deal of air. It was intriguing and certainly offered promise of more exciting exploration to come.

The next trip to the cave was on the 23rd of February, 2001 when Ric Elhard, Cindy Heazlit and the author returned with a full kit of vertical gear and more than 450 feet of rope. They managed to descend 85 feet to a second level of the cave that directly underlies the large upper passage explored on the initial trip. This pitch was followed immediately by a 20 feet up climb and then a 120 rapel into an even larger third level. This horizontal run lasted for a few hundred feet and then pinched down to yet another drop. Rigging their last small diameter line, they were elated to discover the largest passage yet at a depth of just over 400 feet below the surface. This horizontal run doubled back directly beneath the three upper level segments of the cave, four distinct levels stacked one on top of the other. This lowest level of the cave was also the largest averaging more than 30 feet in diameter with vertical walls that ascended straight up into darkness. The cave was definitely more of a crack than a tube, but thick wall coatings indicated that it has also carried large volumes of lava at various times in the past. A few collapsed sections revealed that at least four different flow events had passed through the crack system. Samples collected on this trip were turned over to Don Swanson at HVO. He was able to confirm that they were identical in composition to the 1823 flow which first rises to the surface several miles beyond this point along the crack system.

The entire cave is developed along vertical tectonic openings that were later occupied by large volumes of flowing magma. Floors throughout the cave are littered with highly unstable breakdown. The one point of solid bed rock seen in the entire cave occurred at the deepest point reached during the exploration. Ceilings exhibit clear flow features and filled dikes of basalt. They are believed to be formed as the surface of each subsequent flow event cooled on contact to the open air above. Pitches that allow egress to each level of exploration were most likely formed by collapse of thin shelled areas in this false floor. A similar process is often visible in lava tubes, forming characteristic “tube in tube” development.

A third trip on January 12, 2002 was needed to complete the exploration and finish up survey work to complete the map that accompanies this article. The author and Ric Elhard lead this final trip and entered the cave along with Warren Hollinger, Penelope Pooler, Andrew and Eli Dubois. A final 85 feet ascend was climbed and rigged, surveys and photos were collected and the final terminus of the cave was reached. Total surveyed length was 2,320 feet. Maximum depth below the surface was established at 600 feet. The entire cave underlies roughly 1,000 linear feet along the Great Crack System with four distinct layers developed one on top of the other.

Thus ended our exploration into the first cave surveyed along The Great Crack. Things took a very interesting turn in December of 2005. Our next adventure into this fascinating new underworld started out as a very pleasant surprise. Don Swanson had been approached by a cinematography company named Pangolin Pictures. They were filming on the Big Island and were especially interested in documenting features along The Great Crack. The author and Ric Elhard accompanied them on a surface reconnaissance to the area, and they were very keen to do a segment on underground exploration into this unusual underground environment. The idea was to film an ongoing exploration into a new cave beneath the crack. They would also provide helicopter support to overfly the length of the rift zone and pick out the best potential site to film. The helicopter would also ferry all the gear and personnel to and from the location.

Filming this original exploration turned out to be one of the more frustrating elements of the entire project. The long day was spent taking one step forward and two back in order to make sure that the cameras caught every possible angle of the event. We did manage to finally bottom one pitch that day and confirm that the cave did continue down a much larger and deeper second drop. No survey or sampling occurred on this trip, but we did manage to take a number of nice photos of the Great Crack from the air and the filming was finally featured by the PBS broadcasting system as a segment of their feature *“Violent Hawai`i”*.

On December 28, 2005, we managed to return to the cave on foot without the helicopter or filming crew in tow. The author, Ric Elhard, Jack Vose, Kendall Whiting, Brian Killingbeck, Jeff Moore, Andy Porter, and Allen Cressler all invested what turned out to be a fine day of exploration, survey and photography. This cave turned out to be somewhat shorter than the first with 1,590 feet of survey accumulated. A maximum depth of 518 feet was recorded. This feature is developed along roughly 600 linear feet of the Great Crack fault.

This second cave system exhibited many strong parallels to the first. Both are composed of four distinct levels, each one formed directly above the next. The lowest level of each cave is also the largest and longest. Passage cross sections normally feature tall canyons rather than oval tubes. Flow features are prominent on the walls, especially in the lower levels of the cave. Floors are entirely composed of very friable breakdown, usually stacked at angle of repose and very treacherous to negotiate. Ceilings exhibit strong flow features and filled dikes. A clear pattern of formation is beginning to develop as we explore more of these underground features.

A third prominent feature of the Great Crack has long been known. This cave lies somewhat offset to the main fault feature, but is believed to be formed by the same processes. Wood Valley Pit Crater is a large open air feature that drops 150 feet directly into a large subterranean chamber. From here it descends through a second small breakdown filled chamber and seemingly ends there. A hardy few have managed to squirm on down through the breakdown floor and squeeze into a well developed lowermost level of the cave. From here the route doubles back directly under the entrance chamber along a well developed linear crack system that is quite a lot smaller than the lowermost levels of the Great Crack Caves, but does still exhibit clear flow features from the lava that coursed through at some time in the past.

Exploration of this cave was first begun by a British Expedition back in the 70's. HSS members have visited the cave many times since then, including a trip to host National Geographic photographers. A team of Swiss cavers lead by Geral Fauvre recently completed a very accurate and detailed map. The author is attempting to include at copy of this illustration with this article.

In summation: Rift Zone development within the volcanoes of the Big Island of Hawai`i have long been known to be primary routes for the movement of magma beneath these massive mountains. The famed "curtains of fire" that erupt along these dominant fault lines are normally the opening event of each new eruption. Monitoring of these events has been documented by the Hawai`i Volcano Observatory for many decades. For the first time, members of the caving community have also been able to physically enter into this fascinating and highly dynamic underground environment. Their documentation is beginning to form a much more detailed understanding of how these elements function.