ACTIVE AND RECENTLY ACTIVE VOLCANIC GEOLOGY ON THE ISLAND OF HAWAI'I

FACULTY
Bruce Loeffler, Colorado College
Richard Hazlett, Pomona College
Adjunct: James Kauahikaua, U.S.Geological Survey, Hawaiian Volcano Observatory
Logistical Assistant: Lynn Davis

STUDENTS
Soyini Baten, Amherst College
Dawn James, Franklin and Marshall College
Rusty Kahl, Franklin and Marshall College
Alex Kostera, Washington and Lee University
Brian Lehnerz, Pomona College
Christopher Oze, Whitman College
Christa Placzek, Colorado College
Stacey Robertson, Trinity College
Caroline Seaman, Colorado College
Adam Soule, Carleton College

VISITORS
Ed Beutner, Franklin and Marshall College
John Cheney, Amherst College
Eric Grosfils, Pomona College
Linda Reinen, Pomona College
John Winter, Whitman College

Active and Recently Active Volcanic Geology on The Island of Hawai'i

Bruce Loeffler, Project Director
Department of Geology, Colorado College, Colorado Springs, CO, 80903

Richard Hazlett
Department of Geology, Pomona College, Claremont, CA, 91711

James Kauahikaua
U.S. Geological Survey, Hawaiian Volcano Observatory, Hawaii Nat'l Park, 96718

GEOLOGIC SETTING

The Big Island of Hawaii is world famous for its on-going volcanic activity, centered at Kilauea and Mauna Loa volcanoes. Less well known is the volcanic geology of the older mountains making up the northern portion of this mid-Pacific island, including Hualalai, Mauna Kea, and Kohala. These represent volcanic centers once very much like Kilauea, but owing to northwestward plate motion at a rate of about 12-cm a year, now long dormant or extinct. The Big Island hence shows a range of volcanic landforms and rock types representing the primacy and decline of hot spot volcanism atop a rapidly shifting plate. In this particular Keck project, students explored different aspects of this geological setting, ranging from surveying of actively forming pahoehoe lava fields on the south flank of Kilauea, to the interpretation of an explosive trachtye cone deposits on the north slope of aged Hualalai.

STUDIES AT KILAUEA

On 3 January, 1983, an eruption broke out in the east rift zone of Kilauea, culminating in the growth of a new, 255-m high cinder-agglutinate cone, Pu'u O'o, which has since largely collapsed (Wolfe and others, 1987). Lava poured down the steep south flank of Kilauea to reach the ocean almost 10 km away. This flow field remained active during our summer study. In the coastal flatlands, where the lava spreads out, a great lava delta has grown across a hyaloclastite base extending many miles down the submarine flank of the Kilauea. One mechanism by which the field has grown so large is through the development of intricate lava tube systems. The major pattern of tube development is under study by the Hawaiian Volcano Observatory. Student **Christa Placzek** used a VLF (very low frequency) magnetometer and total field station to map and locate the major tubes active in a half-square km area at the base of a small pali (fault scarp) forming the inshore margin of the delta. Her work adds to an important database enabling us to understand how islands such as Hawai'i grow (e.g.--Greeley, 1987).

In the same vicinity, **Christopher Oze** examined a peculiar and beautiful type of pahoehoe lava, called "blue glassy" or "dense blue" pahoehoe, that was first observed forming during the on-going eruption. Blue glassy pahoehoe lacks many vesicles, and also shows quench mineral textures, glass refractivities and albedoes quite unlike that of the far more common varieties of pahoehoe. The ceramic nature of this peculiar glass is unknown. Chris mapped in detail a gridded area of blue glassy lava while in the field. Back on the Mainland, he undertook S.E.M. and petrologic thin section work to better characterize and shed light on the origin of the lava. Perhaps this unique glass may bear properties of great practical interest.

The southern flank of Kilauea is slowly sliding into the ocean. Among many resulting structures, one set may be the spectacular Koae Faults, which link the east and southwest rift zones of Kilauea (Duffield, 1975). These faults have certainly been active for the past 1,200 years, and possibly much longer. Not all faults in the set show signs of historical activity, but some do in sensational, road-destroying ways. **Brian Lehnerz** studied the unusually well-preserved scarp structures along one of the larger, older faults, Kalanaokuaiki Pali. Alternating rollover sinks and monoclines form a chain along the base of this 10-15-m high scarp. These structures tell us something about the mechanics of brittle failure in material like basalt. Brian has attempted to provide an explanation based on his detailed mapping and field measurements. Nearby, **Rusty Kahl** mapped the termination of Kalanaokuaiki Pali and of several other faults in the en echelon set. The faults progress into monoclines, *some of which are hollow*, at their terminuses. Rusty's work will raise questions, and we hope shed light on just how normal faulting began in the Koae system. This to bears on the evolution of Kilauea's southern flank structure.

Back at the Hawaiian Volcano Observatory, **Stacey Robertson** examined seismic data sets, and worked with seismologist Paul Okubo to study the seismicity beneath the Koae fault scarps. Her work, based on sophisticated and extremely challenging computer routines, may possibly enable a better geophysical model for what is taking place as the southern flank of Kilauea slips unsteadily toward the sea.

Nearby, on the floor of Kilauea Caldera, **Soyini Baten** re-examined, using modern analytical techniques, the deposits left by phreatic blasts taking place in Halema'uma'u Crater, the "Firepit" of Kilauea, in May, 1924. Her work will confirm more definitively, revise, or refute the interpretations of earlier workers (e.g., Chapman, 1947) who saw in this debris revealing samples of the volcano's interior petrography.

MAUNA LOA AND HUALALAI

Though also in its youthful shield stage of development, Mauna Loa is no longer as active as Kilauea is today (Lockwood, 1995). Buttressed to the northwest by the older bulk of Hualalai, it has no organized rift zone in this direction extending from its summit. Rather, vents radiate out across all points of the compass. One such vent area strikes along the southern contact of Mauna Loa with Hualalai. In this area, near the coast, a promininent and traditionally sacred cinder and agglutinate cone named Pu'u O'hau rises, marking the boundary between the North and South Kona coasts. **Adam Soule** from Carleton college studied deposits and geologic sections of sea cliffs cutting the flank of Pu'u O'hau to resolve a controversy at the Volcano Observatory concerning whether Pu'u O'hau is a littoral cone formed by steam explosions where lava entered the sea, or a primary vent that happened to open near the coastline. His work has yielded some strong evidence that will help clear up the controversy.

In 1800-1801, Hualalai produced its lastest eruption, two massive outpourings of lava, one of which forms the peninsula of land on which the Kona airport is built. The flows contain numerous xenoliths of dunite, gabbro, and peridotite. Some petrologists in past claimed that these were mantle derived, others more recently have claimed that they are from the fractionation of magmas within the volcano. **Alex Kostera** collected a suite of these xenoliths from a heretofore lightly sampled portion of the flow complex for analysis, and possible reinterpretation.

Near the Kona airport itself, the 1800-1801 flow inundated one of the great artificial fish ponds constructed by the Polynesians who settled this coast. **Dawn James**, using a VLF magnetometer and total field station, surveyed a large section of the flow surface to try to detect a sign of the ancient buried wall, one of the largest structures of its kind, which formed the seaward perimeter of the fish pond. Her work took her as well to the library of the University of Hawai'i for archaeological research. Location of the fish pond will give geologists a better grasp of just how much new land Hualalai added to the island during its last burst of life.

Hualalai no longer produces the tholeiite basalt frequently erupted by its neighbors to the south, Mauna Loa and Kilauea. Instead, it infrequently erupts large amounts of alkali-olivine basalt, and extrudes domes of trachyte. The most prominent such dome forms Pu'u Wa'awa'a, a forested pumice cone low on the northern flank of the volcano which is also one of the last haunts of the nearly extinct Hawaiian crow, the alala. Though **Caroline Seaman** saw no alala, she did examine the deposits of the cone, as well as the two big flows emanating from its base, and now partly covered by younger lavas. She discovered some remarkable mixed-magma fabrics, which will shed light on the origin of erupted trachytes at Hualalai. Are these lavas the result of fractional crystallization of alkali basalt melts, and if so, what do the mixed-magmatic textures imply? Trachyte is not a common Hawaiian lava, but it is characteristically erupted by many of the volcanoes as they pass into their old stage of growth (Macdonald et al., 1983).

LOGISTICS AND OVERVIEW

The student teams took lodging in two localities; the Kilauea group at a bed-and-breakfast accomodation in the village of Volcano, and the Hualalai-Mauna Loa group at a condominum in Kailua. The groups prepared their own meals, with the assistance of **Lynn Davis**, a very welcome assistant from Anchorage drafted in advance to help with provisioning. Professors Hazlett and Loeffler supervised the separate teams, trading places mid-stream several times. In general, this went well, though the workload and expenses were arguably greater than they might have been had the teams not been separated. Hazlett and Loeffler believe, given the unique quality of the research projects, that this division was nonetheless merited.

Keck Hawai'i stands out in another way as well; it did not have the focus of tackling a thematically single geological question, unlike most other Keck programs. Nevertheless, the student projects proved both very manageable and pertinent to the interests of the broader geological community studying Hawai'i. In no small part, this was due to the work of **James Kauahikaua** and the Hawaiian Volcano Observatory, who provided guidance in setting up a program of self-contained student studies. We also wish to acknowledge the hospitality of Bobbie Camara (Resource Management, U.S. National Park Service), whose special support for the program at Kilauea will long be remembered and appreciated. Aloha nui loa!

REFERENCES

Chapman, P.W., 1947, Crystallization phenomena in volcanic ejecta from Kilauea, Hawaii, American Mineralogist, vol. 32, p. 105-110.

Duffield, W.A., 1975, Structure and origin of the Koae Fault system, Kilauea Volcano, Hawaii, U.S. Geological Survey Prof. Paper 856, 12 p.

Greeley, 1987, The role of lava tubes in Hawaiian volcanoes, vol. 2, chap. 59, in Decker, R.W., Wright, T.L, and Stauffer, P.H., Volcanism in Hawaii, U.S. Geological Survey Prof. Paper 1350, p. 1589-1602

Lockwood, J.P., Mauna Loa eruptive history--The preliminary radiocarbon record, in Rhodes, J.M., and Lockwood, J.P., Mauna Loa Revealed: Structure, Composition, History, and Hazards, Amer. Geophys. Union Monograph 92, p. 81-94

Macdonald, G.A., Abbott, A.T., and Peterson, F.L., 1983, Volcanoes In The Sea: The Geology of Hawaii (2nd ed.), Honolulu, HI, The University of Hawai'i Press, 517 p.

Wolfe, E.W., Garcia, M.O., Jackson, D.B., Koyanagi, R.Y., Neal, C.A., and Okamura, A.T., 1987, The Puu Oo eruption of Kilauea Volcano, episodes 1-20, January 3, 1983, to June 8, 1984, vol. 1, chap. 17 in Decker, R.W., Wright, T.L., and Stauffer, P.H., Volcanism in Hawaii, U.S. Geological Survey Prof. Paper 1350, p. 471-508.