

GEOLOGY OF THE BIG ISLAND OF HAWAII
Field Trip of the Geologists of Jackson Hole, Wyoming,
4-12 November, 2016

Trip leaders:

Richard W. Hazlett (Professor Emeritus, Pomona College; Affiliate Faculty Member,
University of Hawaii at Hilo)

Robert I. Tilling, U.S. Geological Survey (*ret.), Menlo Park, California



(Map: Bing Images)

The Island of Hawaii (Big Island) is the youngest and largest of the eight major landmasses of the Hawaiian group, the most isolated archipelago in the world. The Big Island also features the greatest variety of landforms, climates, and ecosystems in the

island chain. Indeed, it shows some of the greatest diversity in natural features of any area of comparable size in the world.

This expedition will introduce participants to many remarkable aspects of this landscape, including insights into its geological development that are both current and profound. The trip leaders both have decades of experience working with Hawaiian geology. Robert Tilling, a leading volcanologist of international standing, is former Chief Scientist of the Hawaiian Volcano Observatory. Richard Hazlett is former Chair of the Department of Geology at Pomona College, founder of the Environmental Analysis Program there, and a present researcher in the southwest rift zone of Kilauea.

A close look at the trip itinerary follows. Please note that some aspects of this schedule will depend both upon the state of volcanic activity and weather conditions, though even rainy days provide fine opportunities for exploration.

Except where indicated otherwise, all breakfasts and dinners are the personal responsibility of participants; the Welcome, Volcano House, and Farewell Dinners are included in the cost of the field trip. The trip leaders shall provide suggestions or recommendations for convenient venues for private dining. They shall also provide all lunches, most of which will be served while “in the field.”

Friday NOV 4 (Day 1)

Field trip participants will arrive at the Hilo International Airport with shuttle provided to the Hilo Hawaiian Hotel, where check in is available at convenience. Participants will have dinner on their own nickel, with the most convenient local restaurant located in the hotel’s Queen’s Court. Dinner service there includes an excellent buffet. Participants can unwind from travel, perhaps visiting Coconut Island or stroll through nearby Liliuokalani Gardens or around Banyan Drive, and prepare for the busy activities that will begin in the morning.

(Remember that the time zone difference between Hawaii and the Mainland (California) at this time of year is two hours, with Hawaii earlier than the rest of the coterminous United States. First-day arrivals tend to fall asleep and wake up especially early given this difference).



Coconut Island, a popular attraction adjoining the Hilo Hawaiian Hotel in Hilo. During World War Two this was a USO facility closed to the public. (Bing Images).

Saturday NOV 5 (Day 2)

We convene in the lobby of the Hilo Hawaiian Hotel at 9 am sharp. Here you will meet our two trip leaders, Dr. Tilling and Professor Hazlett, then board our bus for the day's exploration. Wear good walking shoes (tennis shoes or even boots recommended), prepare for strong sun or rain (both can prevail at different times during the day!), bring mosquito repellent and a good strong flashlight in the event that you wish to explore Kaumana Cave as described further below.

We'll start by driving west along the Hilo waterfront, a beautiful, wide-open expanse of lawn shaded by large banyan and palm trees. This parkland represents the forward-thinking response of the City to two disastrous tsunamis that struck Hilo Bay, in 1946 and 1960. The waves originated from earthquakes in Alaska and Chile, respectively, and drowned over 150 people mostly in what is now this cleared area and the neighboring port.

Driving past "Tsunami Park," we'll enter the Old Downtown of Hilo, where we'll stop for a half hour to allow participants a visit the famous Hilo Farmers Market, perhaps picking up some fresh fruit for the road, or a pastry at locally well-loved Papa's Bakery nearby. A pharmacy, natural food store, excellent island-themed book store, and various other shops of potential interest line the drive next to Farmers Market as well.

Then, we turn upslope to visit Rainbow Falls in Wailuku State Park—a geologically significant feature related to alternating down-cutting of the Wailuku River, and infilling by lava coming from Mauna Loa Volcano. Three flows have entered the river channel within the past 15,000 years, displacing its channel which has eroded a new gulch as deep

as 30 meters—some of the fastest erosion rates reported anywhere along rivers flowing across hard rock. Much of this erosion could be attributed to massive debris flows originating from volcanic activity beneath and around the Pleistocene ice cap of Mauna Kea, the summit of which we can easily see from Hilo on a cloud-free day.

Our morning exploration culminates in a visit to Kaumana Cave, a principal pyroclastic (lava tube) of the 1881-82 lava flow from Mauna Loa, which nearly entered the town of Hilo. (Much modern housing now stands atop this flow in Hilo's western suburbs).

For those who wish, we shall explore 200 m of gently sloping underground passage at Kaumana Cave, entering through one skylight and turning around at another upslope. Spectacular features associated with lava tube development, including re-melted wall rock, recessional ledges, and transitions between a'ā (rough) lava and pahoehoe (smooth or coiled lava) may be seen here. We shall provide high-beam caving lights for the group, but ask that participants bring their own flashlights or headlamps as well.



Winter scene, Mauna Kea. Telescope domes stud the summit. (Bing Images)

We next head to Imiloa Astronomy Center for lunch at the Sky Garden Restaurant. (This will not be a pack-out lunch, but will be covered by trip expenses). Following this, participants may explore the Astronomy Center museum next door for a nominal entry fee. This excellent museum includes exhibits on the role of astronomy in the native culture of Hawaii, recent satellite and observatory discoveries about the cosmos, Space Station research, and compelling artwork and photography inspired by the Big Island's night skies.

From 2:30-3:30 pm, we shall meet with Dr. Don Thomas at the Geology Department at the University of Hawaii, practically next door. Dr. Thomas is Director of the Hawaii

Scientific Drilling Project, which has revealed some fascinating and unexpected aspects of Hawaii's internal structure in recent investigations.

From 4 to 6 pm, participants may enjoy some "down-time" back at the hotel. From 6-7:30 pm we reconvene at the Queen's Court Restaurant for a Field Trip Welcome Dinner. Following this, from 8 -9 pm, Dr. Tilling and Professor Hazlett will deliver an orientation presentation, putting in context the outstanding geology we'll explore in the days to follow.

Sunday NOV 6 (Day 3)

Participants should have had breakfast and be ready to depart promptly at 9 am for a day that will include more walking than the previous one (weather dependent). Mosquitoes will not be a problem, and a flashlight won't be needed today—or any day to follow.

We'll drive to the 1500 m high summit dome of Kilauea Volcano, about a forty minute drive from Hilo to the southwest. After a brief orientation at the Kilauea Visitor Center we shall take an approximately 3 km easy walk along the Sandalwood-Hakalamanu trails for an overview of Kilauea Caldera and its formation. Participants need not follow this entire loop, but may turn around at personal discretion. (Next to the Visitor Center is a well-known art center, natural history book store, and a coffee bar at the Volcano House Hotel with a panorama of the caldera and its steaming pit, Halemaumau. Non-walkers are free to explore these options as the rest of the group hikes).

We shall have box lunches on the lawn and picnic shelter at Kilauea Military Camp not far from the Visitor Center.

After lunch, we'll travel to the U.S. Geological Survey Hawaiian Volcano Observatory (HVO) to meet with Dr. Tina Neal, the Scientist-in-Charge, for a description of HVO operations, followed by a visit to the Jaggar Museum of Volcanology next door. The overlook at the Jaggar Museum offers the closest view available to the public (as of this writing) of Halemaumau, the main vent of Kilauea and the site historically of many long-lasting molten lava lakes.

Then we shall drive along the rim of Kilauea Caldera to the east, through the beautiful ohia-tree fern forest at the summit of ancient Ai-laau lava shield, source of Kilauea's largest known subaerial outpouring of lava. We'll stop at Kilauea Iki Overlook, Nahuku Lava Tube, and Pauahi Crater. We shall walk through the cave at Nahuku, but this is an easy 15 minute stroll on paved trail, which is well illuminated in the cave interior with artificial lighting.

The drive will continue down Hilina Pali Road to Kalanaokuaiki Pali, one of the finest examples of normal fault scarp development in the world with many ancillary structures worth considering. HVO staff scientist Donald Swanson will speak to us about his work along this fault system, and what the system means in the larger context of Kilauea's dynamic behavior.

Dinner will be on trip tab at the Volcano House Hotel, if lucky by the light of lava active within Halemaumau a few kilometers away. Return to the Hilo Hawaiian Hotel mid-evening.



Lava lake in a vent that opened in 2008, within Halemaumau Crater.

Monday NOV 7 (Day 4)

Prepare today as the day before, but mosquito repellent is an especially good idea for some parts of the planned itinerary. We shall leave, as previously, at 9 am from the front of the hotel. (The bus will be waiting for boarding). Today we'll explore the Puna District, the easternmost part of Hawaii, where Kilauea's volcanically active east rift zone slopes into the sea. Our first stop will be the Pahoa waste transfer facility where we shall meet Dr. Ken Hon (University of Hawaii at Hilo) to learn about how his team helped protect Puna's main electrical transmission line from destruction by lava during the spring, 2014 flow from nearby Puu Oo vent. He will also describe what we learned from flow structure preserved at the waste transfer site.

Next, we'll drive through the small town of Pahoa to the Hawaii PGV geothermal plant to hear a field presentation by UH-Hilo Professor James Anderson, who will discuss his work with students in monitoring ground deformation in the immediate vicinity of the geothermal facility, and its geological significance.

This will be followed by a box lunch at Lava Tree State Park, where we shall view instructive features related to the 1790 east rift zone eruption well preserved at this site.

After lunch we'll continue to Cape Kumukahi, the easternmost point of land in the State, where lava erupted in 1960 nearly destroyed a lighthouse and built a significant amount of new land upon entering the sea.

From Cape Kumukahi, we continue to Isaac Hale Beach Park to examine the converse of land construction—subsidence associated with tectonic response to the great mass of the growing island. The rate of subsidence is so great (coupled with rising eustatic sea level) that the coastal road here periodically floods at high tide these days.



This power plant provides about 25% of the electricity used on the Big Island of Hawaii. It is a hybrid binary and flash plant.

Geothermal development in the Puna District, south of Hilo (Bing Images)

We continue then to Kalapana (Road's End) to walk out across recent lava flows to examine the infilling of Kaimu Bay and the destruction of the Hawaiian community of Kalapana, which has only partly recovered. We'll examine coastal horst and graben structure, examine the south flank pali system (normal faults in this area), and consider the great 1868 and 1975 earthquakes which heavily impacted this shore.

On our return to the Hilo Hawaiian Hotel from here, we will cross wide stretches of lava erupted from Ai-laau, Kilauea's late prehistoric summit shield, while the trip leaders discuss future volcanic risks in Hilo's suburbs and introduce participants to the Kazamura lava tube system formation of which accompanied development of this field. (There will be no time to visit this important pyroduct directly, entry of which requires landowner permissions and some technical equipment).

Tuesday NOV 8 (Day 5)

We'll leave earlier than usual today—8 am. And participants should bring clothing in preparation for potentially cold, blustery conditions. (Intense sunshine and rain remain possibilities too!). Mosquitoes won't be an issue, however; we are “going to altitude.”

Our first destination is Puu Huluhulu, an ancient Mauna Loa cinder cone in Humuula Saddle, the broad pass between Mauna Loa and Mauna Kea volcanoes. From there we shall head up the northern flank of Mauna Loa to the 3400 m elevation, where we shall visit one of the world's premier climate research facilities, the Mauna Loa Observatory (MLO), where Scripps oceanographer Roger Revelle and his student Charles Keeling first began measuring the buildup of CO₂ in Earth's atmosphere in March, 1958. Dr. John P. Lockwood (USGS ret.) will discuss his protection of this key facility by construction of a lava diversion barrier that he designed. From this location too, we can well consider the growth and aging of neighboring Mauna Kea Volcano, visible most mornings in virtually complete profile across the Saddle.



Mauna Kea from Humuula Saddle, the center of the Big Island (Bing Images).

Following our visit to MLO, we shall return to Puu Huluhulu. Here we shall also rendezvous with vans for a trip to Mauna Kea's summit, with a look at periglacial features, the summit cinder cone field, and the astronomical facilities there. On the way up, we shall stop at Hale Pohaku Visitor Center for restroom facilities and a meeting with Dr. John Dvorak (USGS ret.) to learn about operations of the key telescope facility with which he is associated. If time permits, we shall take a 3 km roundtrip walk (at 4000 m elevation) to Lake Waiau, the highest (and only natural freshwater) lake in Hawaii. Here, patterned ground and fine examples of subglacial lava structure exposed by ice cap melting may be seen.

Wednesday, NOV 9 (Day 6)

Back to lower elevation and warmer weather today. We shall be visiting the drier southern region of the island, so prepare for considerable sunshine (though intense rain remains a possibility practically anywhere on the Island). Mosquitoes are not likely to be an issue.

Meet at 9 to begin an hour and a half drive to the Kahuku Section of Hawaii Volcanoes National Park, near Ka Lae (South Point), where we shall take a gentle, 5 km long loop walk along the Palms Trail. Here we shall investigate the 1868 Mauna Loa Southwest Rift Zone eruptive fissure, and learn about the interaction between volcanic eruptions, ecosystem patterns, and evolution in the long history of the island. We shall also examine grazing impacts and ecosystem recovery in the beautiful Palms landscape. Box lunches in the field here, with a return stop at the Footprints Trailhead next to the prominent Kaoiki Fault scarp on the southwest flank of Kilauea. Here too we shall take a walk, 2 km roundtrip, to see one of Kilauea's most important stratigraphic horizons, the Footprints Ash, an accretionary lapilli deposit related to the catastrophic 1790 eruption. We shall consider recent discoveries about the Kilauea southwest rift zone too, and learn in what ways it fundamentally differs from its counterpart—the east rift zone.

Return to Hilo Hawaiian Hotel.



The park-like landscape of the Kahuku area, southwest rift zone of Kilauea, site of a volcanic eruption and epicentral region of the Big Island's largest historical earthquake in 1868. (Bing Images)

Thursday, NOV 10 (Day 7)

We check out from the Hilo Hawaiian Hotel with the aim of departing for Kailua-Kona on the west coast of the Island in the 9-9:30 time slot by way of the Hamakua coast, northwest of Hilo. Plan as usual for variable though generally warm weather. Mosquito repellent recommended for the day's activities!

Our first stop will be the Hawaii Tropical Botanical Garden to explore this beautiful site and consider the process of stream development on the windward flank of Mauna Kea. We shall examine the unusual Onomea Bay breccia deposit here too, and consider its origin.

Our next stop will be Akaka Falls State Park, where the themes developed at the Botanical Garden are expressed further in the landscape. This will be a self-guided loop walk, approximately 1.5 km long, on a well paved trail past a series of spectacular waterfalls.

From Akaka Falls we head to the Waipio Valley Overlook in north Hamakua. Here your trip leaders will discuss the evidence in this landscape for a titanic submarine landslide from the northeastern flank of Kohala Volcano stretching almost 100 km east of the island across the seafloor. We shall also consider the Pleistocene and Holocene histories of Waipio Valley as shown in its overall geomorphology. Nearby outcrop study will reveal late-stage aspects of the aging of Kohala Volcano too. This will be the site of our box lunch picnic today.



The floor of Waipio Valley cultivated in taro. We shall look into the valley from the eastern rim of its mouth (Bing Images).

After lunch, we shall continue through the beautiful little town of Kamuela-Waimea to Puu Kohola Heaiu near Kawaihae harbor, and important religious site for ancient Hawaiians. From here, you'll learn about volcanic risk along the Kona Coast, plus resource sharing and ecological impacts of prehistoric Hawaiian land use.

From here we drive south to Kailua-Kona. Along the way we shall visit the 1801-1802 lava xenolith locality on the flank of Hualalai Volcano, overlooking Kailua-Kona. Sample collection is not permissible at this spectacular protected site, but photography is certainly welcome!

When we reach Kailua-Kona, we shall check into the King Kamehameha Hotel. The trip leaders will confer with trip participants about possible special arrangements for eruption viewing the next day, depending upon weather forecasts and the state of volcanic activity. Maps will also be distributed to participants showing various possible local dining and shopping venues for the late afternoon and evening. They also will point out the location of tomorrow evening's Farewell Dinner.

Friday, Nov 11 (Day 8)

If there is viewable active lava, but **NO** allowed or safe ground access, for those who are keen on personal adventure, we can facilitate air or boat tours of active eruption sites (at individual expense), contingent upon availability, weather and eruptive behavior of the volcano. Participants interested in taking such commercial tours may require early morning (i.e. -6 am) departures to assure timely return for the evening Farewell Dinner, and they also will be responsible for their own lunches.

For the balance of the group, we shall plan a departure at 9 am from the King Kam Hotel to explore geology in the Puuhonua o Honaunau—Kealakekua Bay area (site of the Captain Cook Monument, technically a piece of Great Britain lying within the State of Hawaii), and of the enormous 105 ka Alike landslide. We'll return early afternoon to the hotel to allow time for packing and/or personal exploration of the Kailua-Kona area. (Adventurous spirits may take a short taxi ride to Kahaluu Bay, a favorite local snorkling area well-known for its population of sea turtles).

This is likely to be the day with most intensive sunshine and potential for dehydration—so prepare well in these regards. Mosquito repellent is also a good idea for coastal areas when the wind is down.



Kealakekua Bay, head scarp of the great Alike landslide, youngest of the catastrophic submarine slides in the Hawaiian Islands. Captain Cook lost his life here in 1778. (Bing Image).

We shall host our Farewell Dinner beginning at 6:30 pm at the King Kamehameha Hotel.

Friday, NOV 12 (Day 9)

Check-out from the Hotel and departure for participants from Keahole-Kona Airport (except at personal option). Notify trip leaders of any special departure needs for assistance.