ERTH402

The geology of the Hawaiian Islands

Today: Moloka‘i FT redux
Friday: accelerated intro to island hydrogeology
Saturday: Waihe’e tunnel tour with BWS

This is the agenda (above), but it's not what we actually did.

1. Trace the itinerary we actually took, day by day

a. Where did we go? Locate the stops on a map
b. What did we see there?
c. What did we learn?

Day 1: East Moloka‘i

Zeth, Hope, Aliya

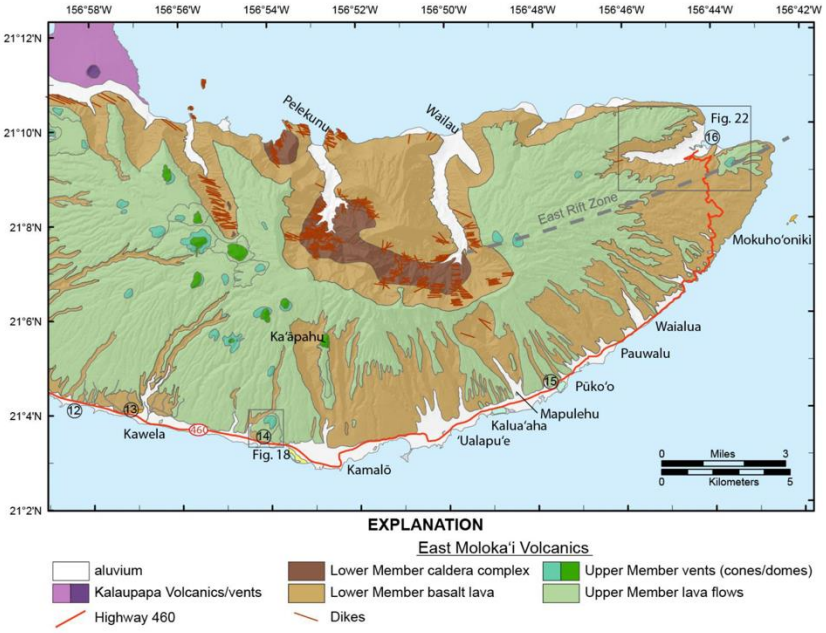
Day 1

Stop #
- 12: Post-Shield Hawaiiite w/ carbonate
- 13: No carbonate layer, massive, post-shield Hawaiiite w/ Kawela mound cultural site
- H: Unusually high Phosphorus/Sr conc. in flows
- 15: Lunch spot, good look @ Lanai + west Maui, layered lower member, mugerite, and benmorite
- 16: Halawa valley, offshore tuff cone, ranches, beautiful beach and river output @ bottom, exposed lava flows on walls of valley, extreme play-Pleric cobbles

What we saw
- Beautful scenery, post-shield lavas/structures, fishponds
- Adze quarry

main things we learned.
- East molokai Volcanics is interesting in post shield composition varies greatly between others + the upper + lower member, Dont go to paddlers and get the corn dogs!

Stops 12-16

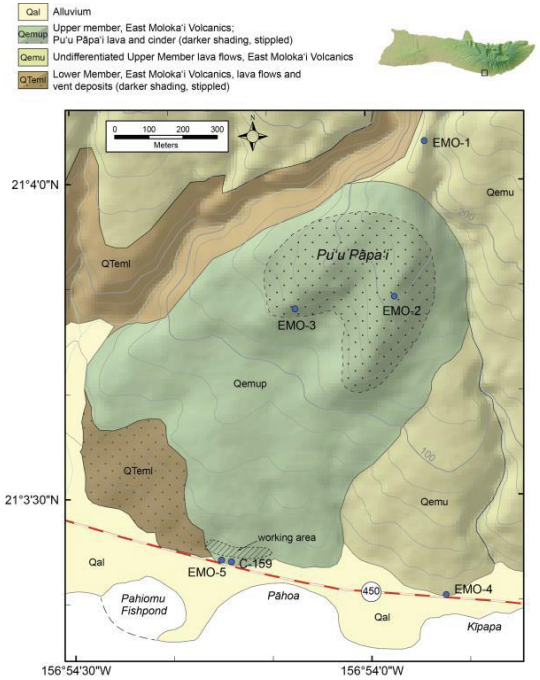


STOP 12. The thick slabby lava outcropping directly opposite the Moloka‘i Shores condominium complex is Upper Member hawaiite.

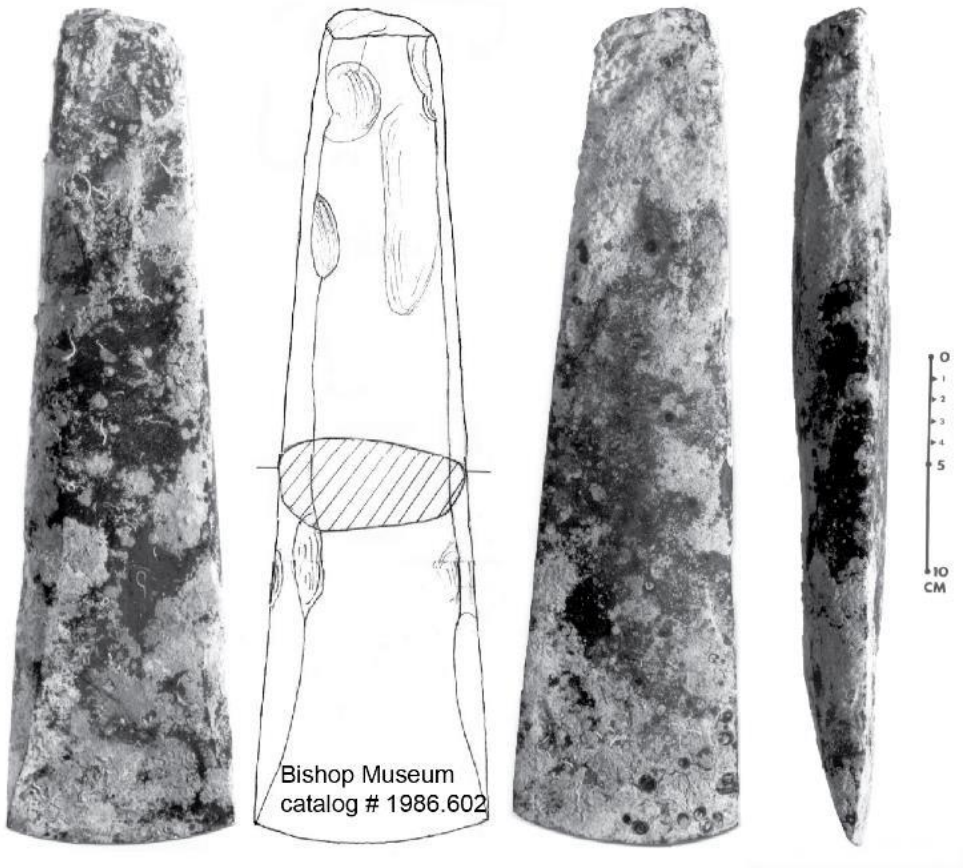
STOP 13. West Kawela. (the heat) Carbonate beach sand overlies Lower Member porphyritic olivine+plagioclase+clinopyroxene basalt along the access road. On the northwest side of the road intersection is the 1.5 m-high Kawela Mound site (State of Hawai'i site number 50-60-04-

This was an important early Hawaiian habitation site, located close to nearby fresh water and marine resources. The mean of 8 radiocarbon age determinations of organic material from the lowest excavated cultural layer is 1121-1262 C.E., the oldest habitation date for Moloka'i (Weisler and others, 2023).

STOP 14. Pāhoa. Lavas from Puʻu Pāpaʻi (crab hill) are exposed in roadcuts here. This lava was first described by Macdonald (1968, his C-159). It has the highest known P_2O_5 (2.5 wt %) of any Hawaiian volcanic rock (compared to >3500 analyses compiled by Sherrod and others, 2007), along with exceptionally high Sr (~2500 ppm, Sinton and Sinton, 2015). The rock contains magnetite, apatite, and rare olivine microphenocrysts. At 46 wt % SiO_2 the rock has >6 wt % normative nepheline and is andesine normative; it classifies as tephrite or nepheline-hawaiite.
An age of 1.31 ± 0.01 Ma for the Pāpaʻi lava (Sinton and others, 2017) is the youngest age yet obtained for East Molokaʻi.



JH and WN collected a sample here



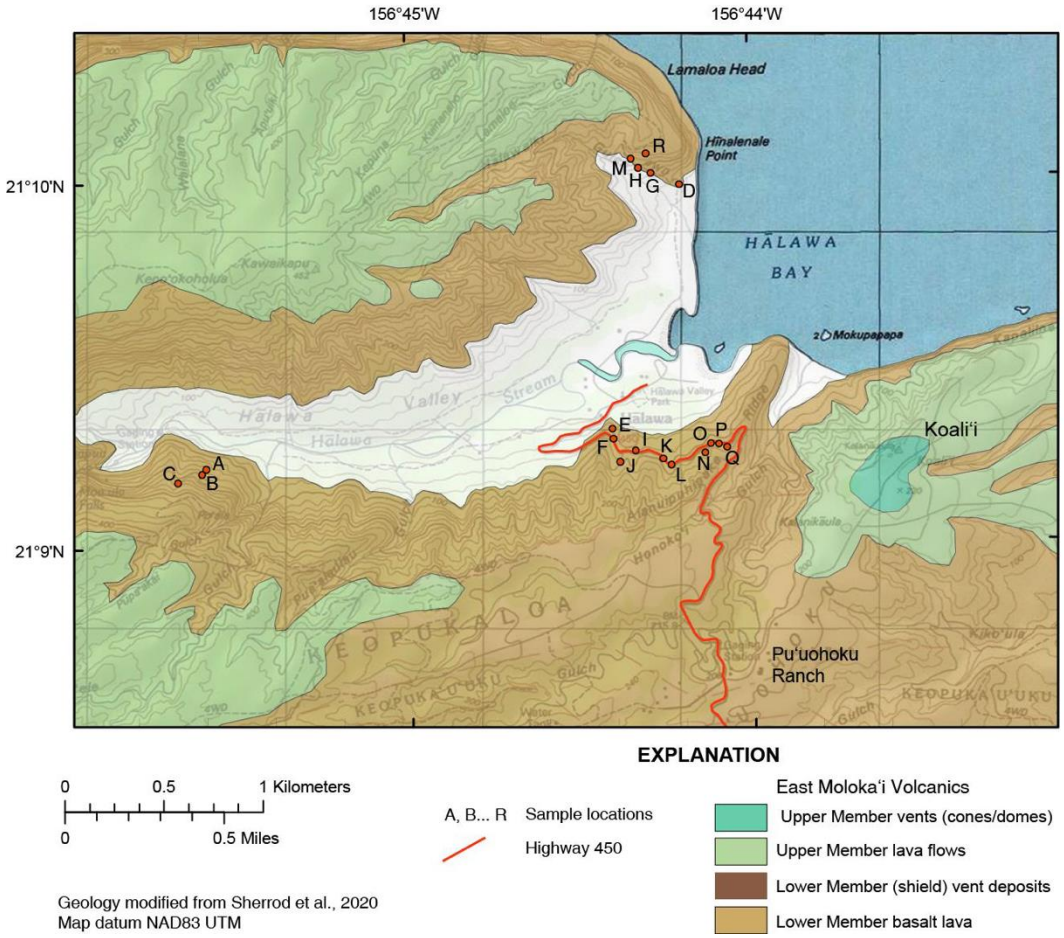
In 1986 an unusually large adze was found in the ocean at 100 ft depth off Sand Island, Oʻahu and brought to the B.P. Bishop Museum in Honolulu. The artifact (B.P. 1986.602) is exceptional for a Hawaiian adze, not only for its large size (37 cm long) but also for its flat cross-section and lack of a tang. According to Dr. Yosihiko H. Sinoto, then senior archeologist at the Bishop Museum, it resembled adzes from the oldest assemblages in the Marquesas Islands. **Adze 1986.602 is mineralogically, texturally, and compositionally identical to lava from Puʻu Pāpaʻi,** an observation that led to additional field work in the Pāpaʻi area, which revealed evidence for prehistoric tool making (Sinton and Sinoto, 2015). The collection and curation of samples from this area by Macdonald (1968) was critical to the discovery of the previously unrecognized adze quarry in this area. Adze fragments from the Pāpaʻi source have been found in three different habitation sites on Molokaʻi with calibrated radiocarbon ages from the 12th to 17th centuries (Weisler and others, 2024), **making Pāpaʻi the oldest dated, and one of the longest lived, adze quarries in the Hawaiian Islands**. Figure from Sinton and Sinoto, 2015.

At 58 wt% SiO_2, the Ka‘āpahu benmoreite is the most differentiated lava analyzed from East Moloka‘i

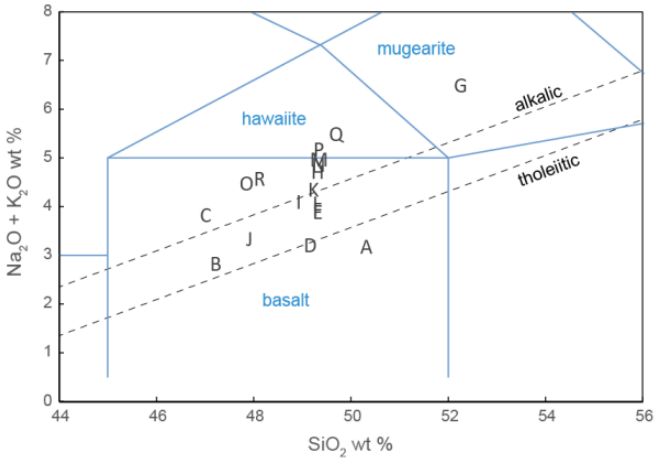
Kamalō (probably originally Kamalo‘o — the dry place). Site of a not-so-old wharf. Mauka of Kamalō is Ka‘āpahu (the truncation) benmoreite dome and flow, referred to by all in these parts as the mo‘o, possibly because it resembles a lizard or dragon, but mostly because it represents the guardian spirit for this district. There are at least two separate Upper Member lavas comprising the mo‘o (Figure 19). The upper lava and dome are white-weathering benmoreite, which overlies a red-weathering mugearite.

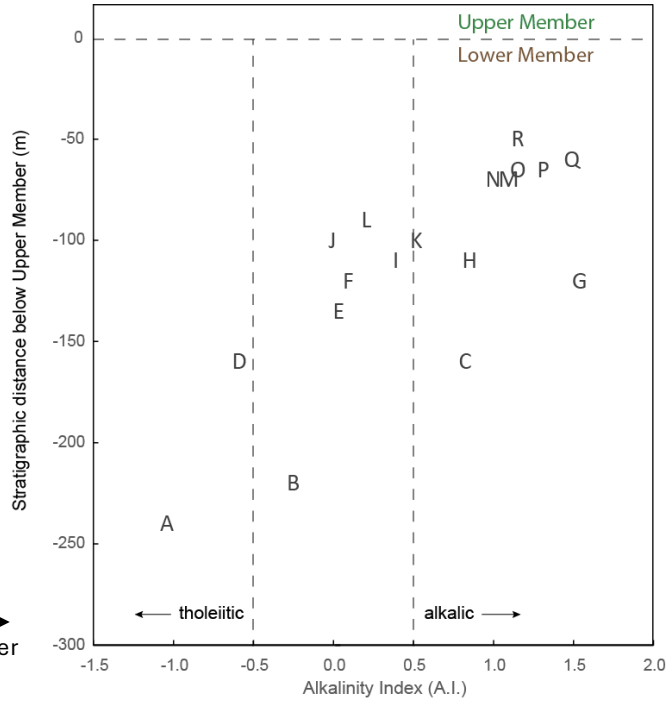
STOP 16. Hālawa (curve). At Alanuipuhipake (smoke tobacco) ridge are alkalic basalts with >1.3 wt % K_2O. Hālawa is a fairly wide U-shaped valley with classic amphitheater-headed morphology. At the back are two towering waterfalls (Hipuapua and Mo‘ula).

Chemical variation in the Hālawa Valley section.
Only Lower Member units have been analyzed in this area, which range from tholeiitic basalt to mugearite.



Geology modified from Sherrod et al., 2020
Map datum NAD83 UTM



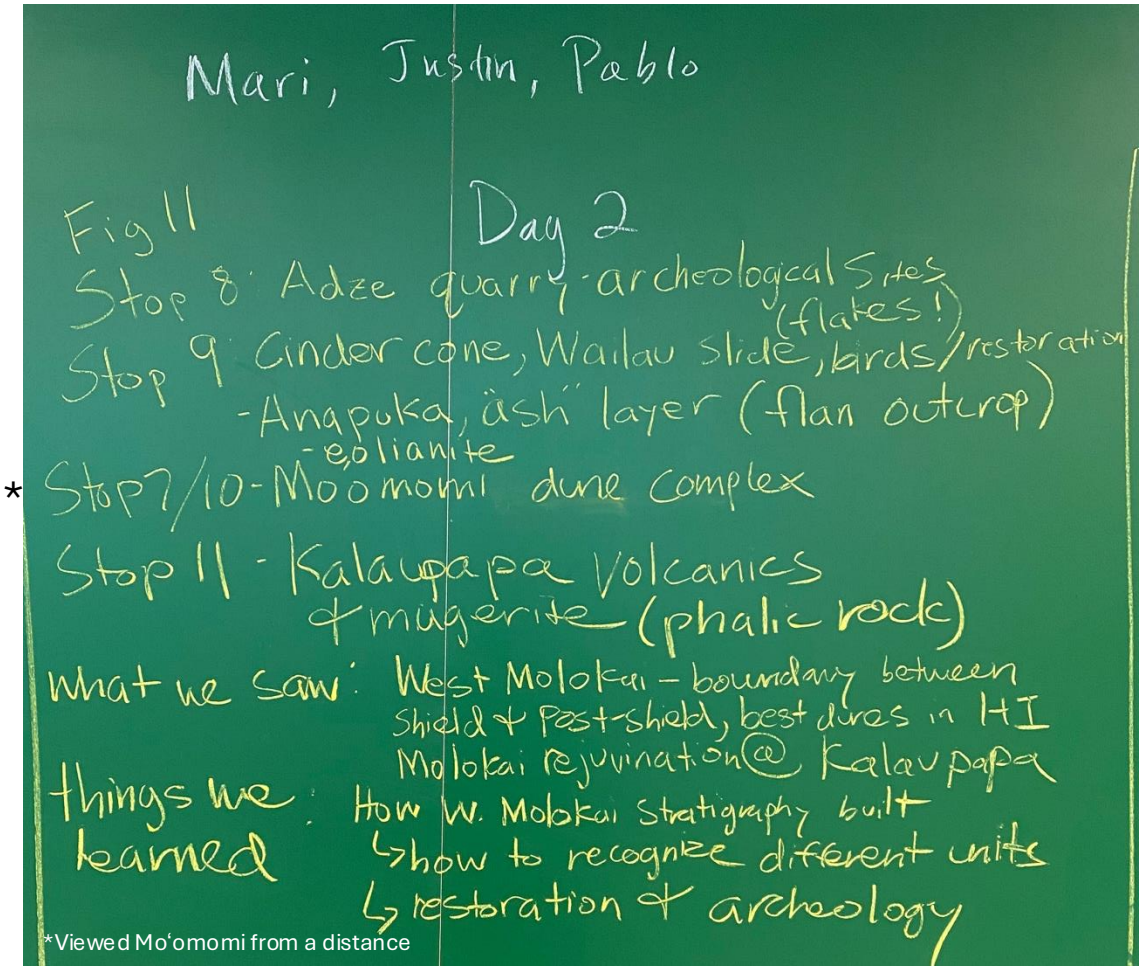


Samples are plotted at their stratigraphic depth below the Upper Member boundary.

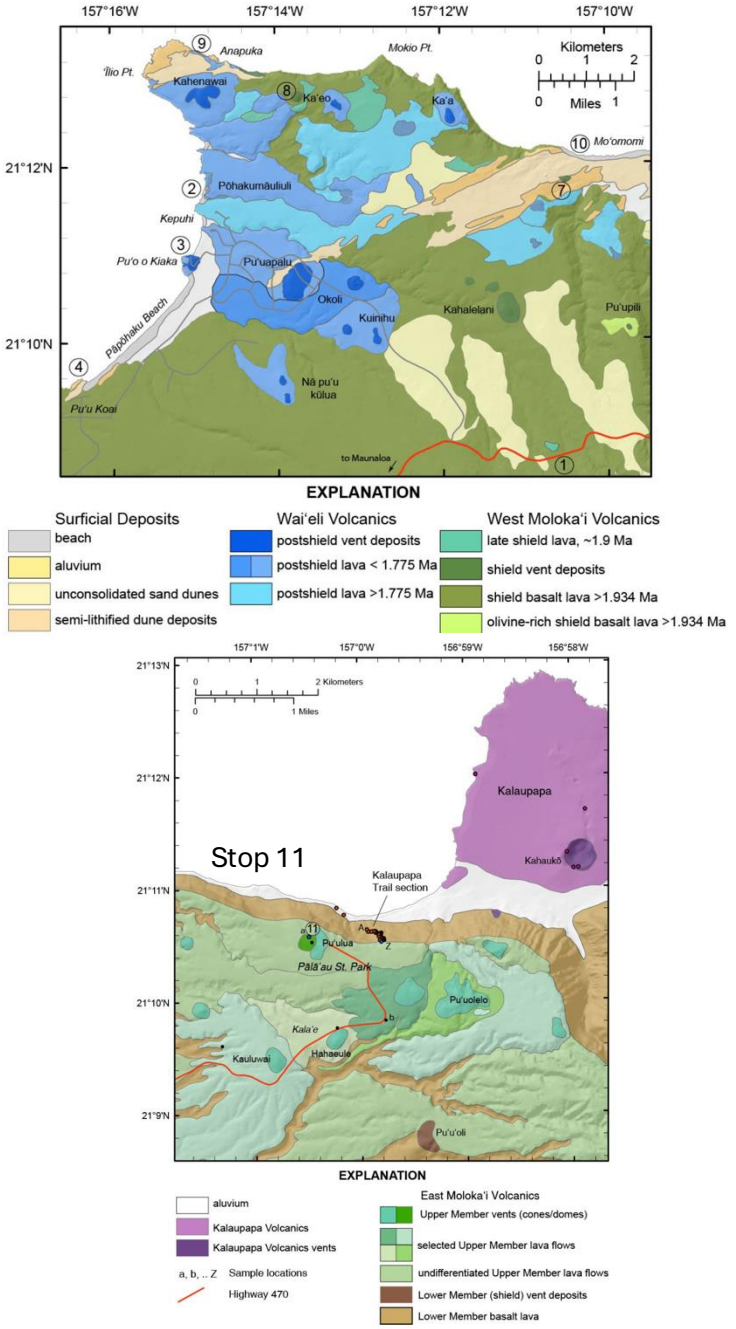

West Maui trachyte domes

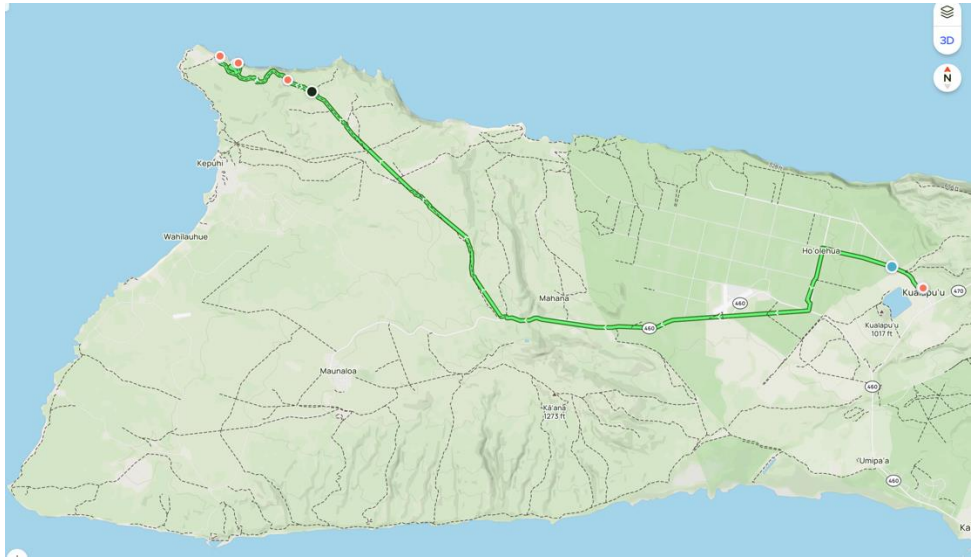

East Molokaʻi tuff cone, Mokupapapa

Day 2: West Molokaʻi and East Molokaʻi



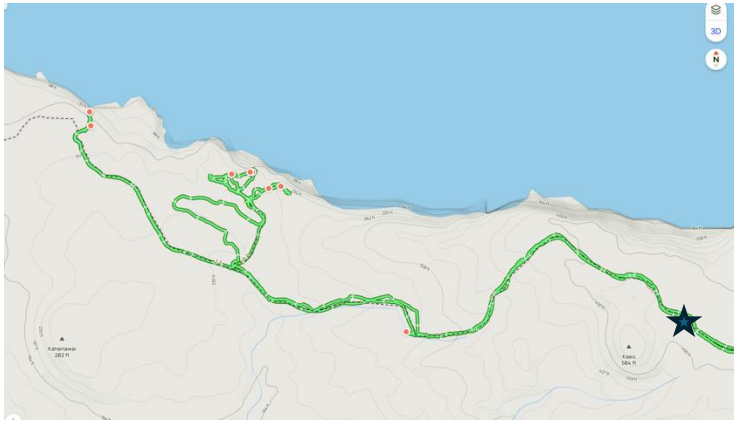
Stops 8 and 9

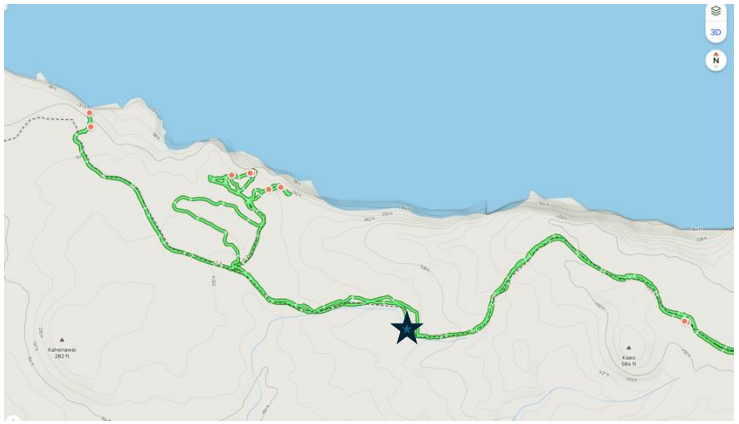




Molokaʻi Land Trust Headquarters

STOP 8. Ka‘eo. This West Moloka‘i Volcanics tholeiitic olivine basalt hosts one of the better known adze quarry and habitation sites in the Kaluako‘i ahupua‘a.

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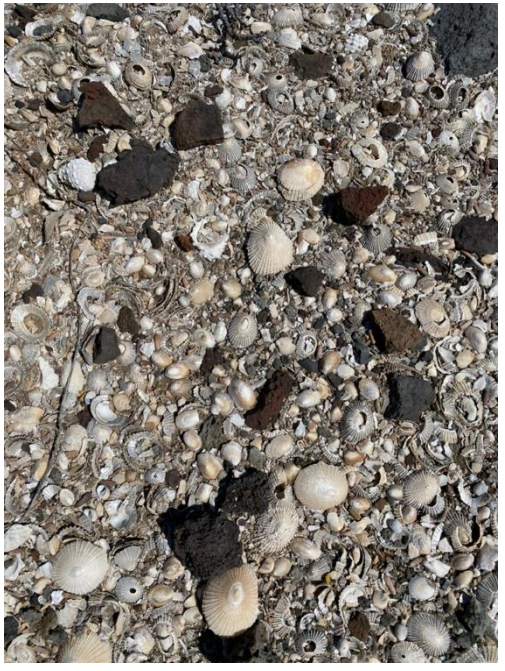
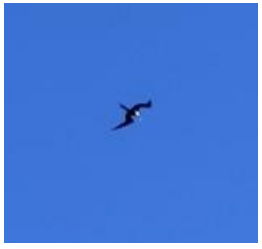
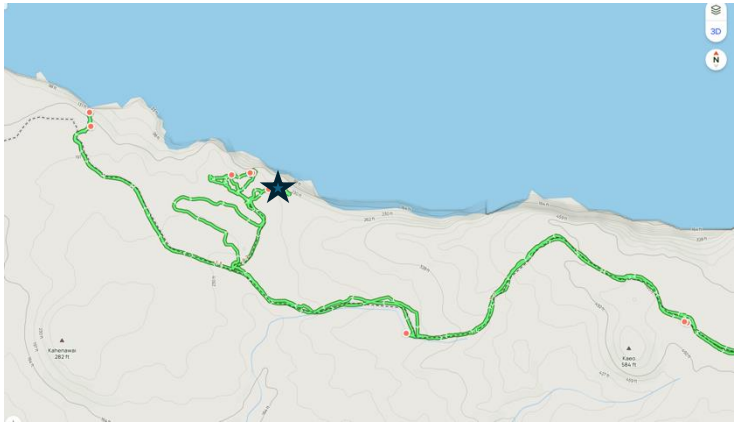
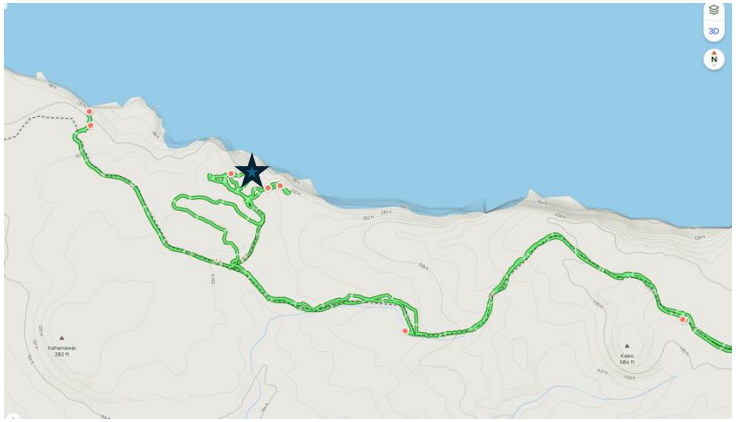




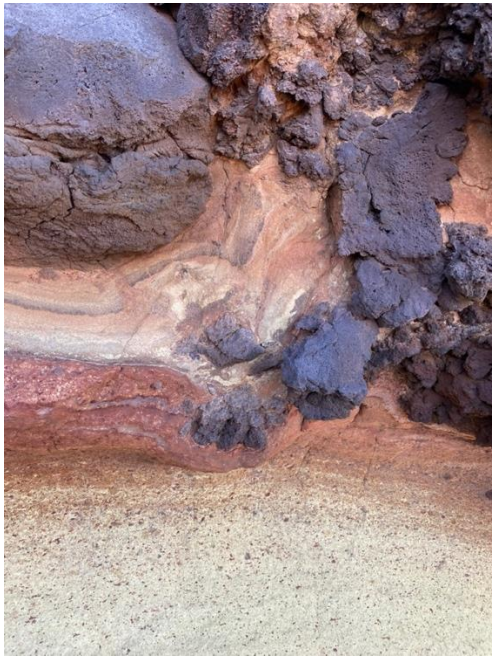
STOP 9. Anapuka (cave with holes). In this region dunes and eolianite partially cover reversely magnetized hawaiite lava from Kahenawai, the prominent cone to the south. The Anapuka eolianite is the site of a remarkable effort by Moloka‘i Land Trust to restore the coastal habitat and ecosystem.

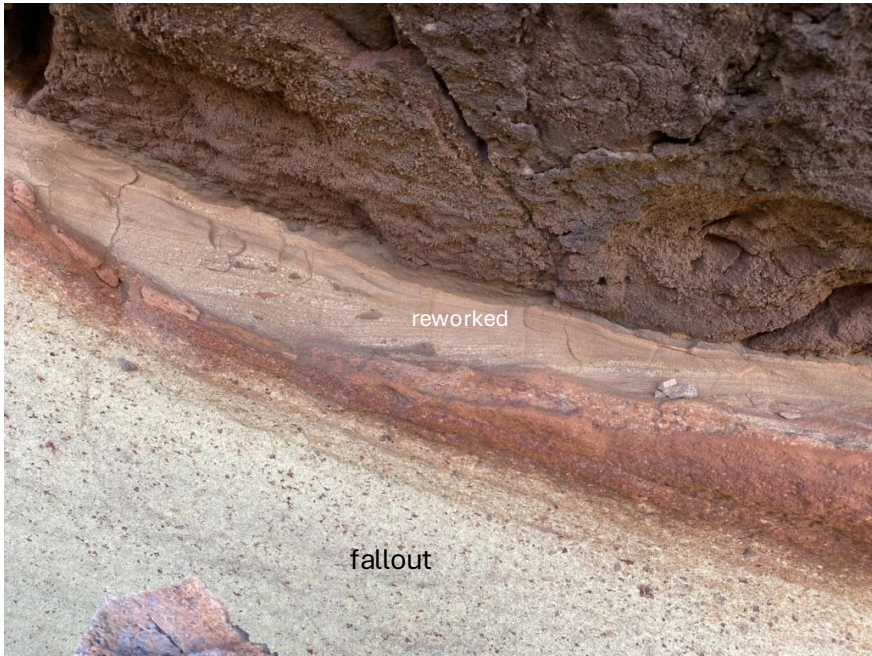


“Flan” outcrop

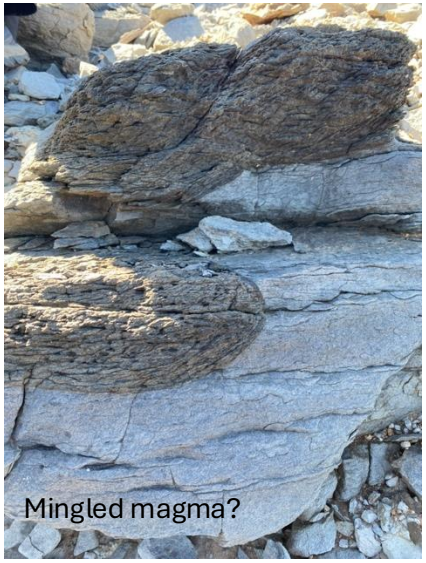


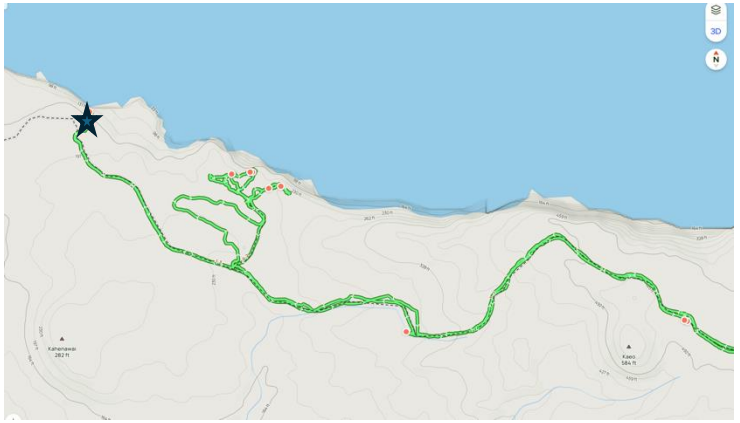
Baked ash emplaced synchronously with a‘a lava flow



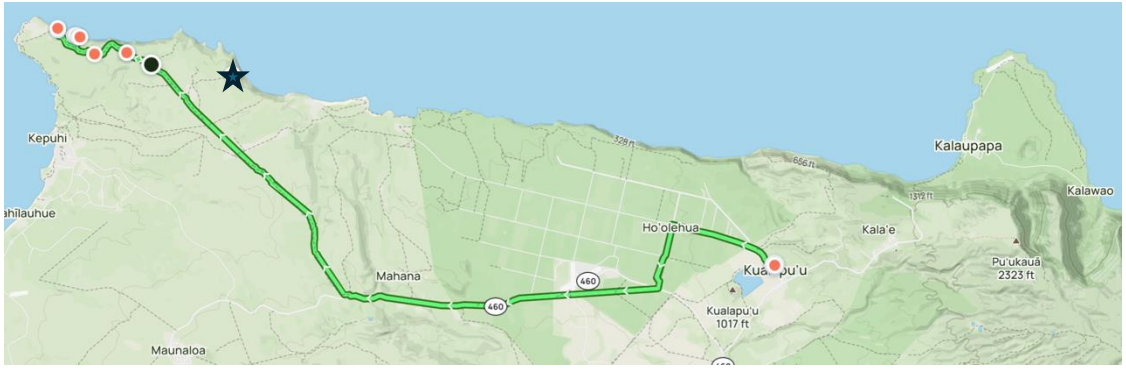



Eolianite overlying
hawaiite lava from
Kahenawai

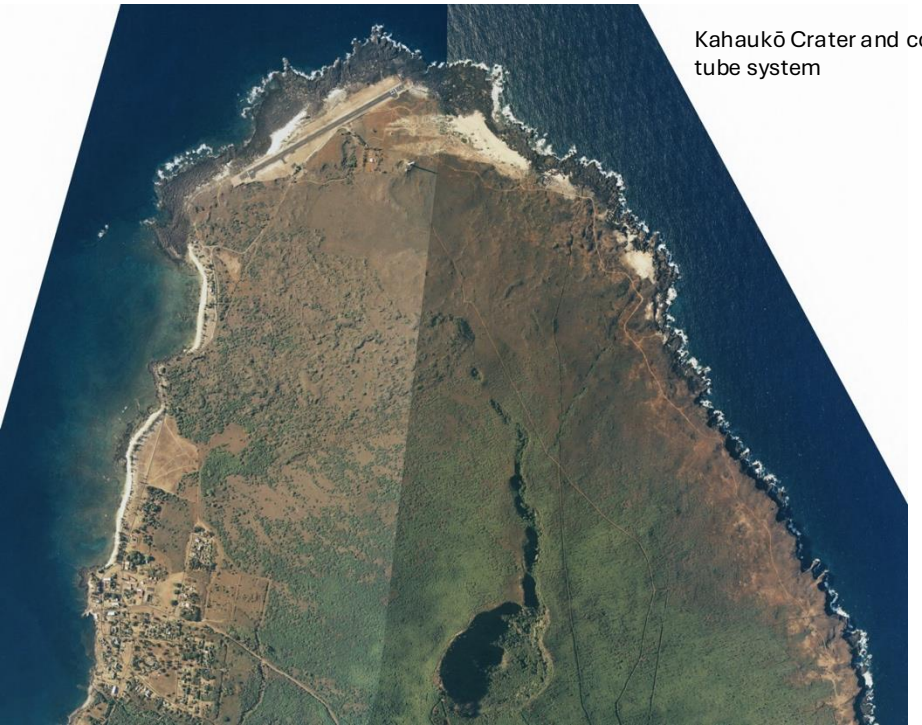

Mingled magma?



Lunch spot with a stunning view toward East Moloka'I sea cliffs and Kalaupapa



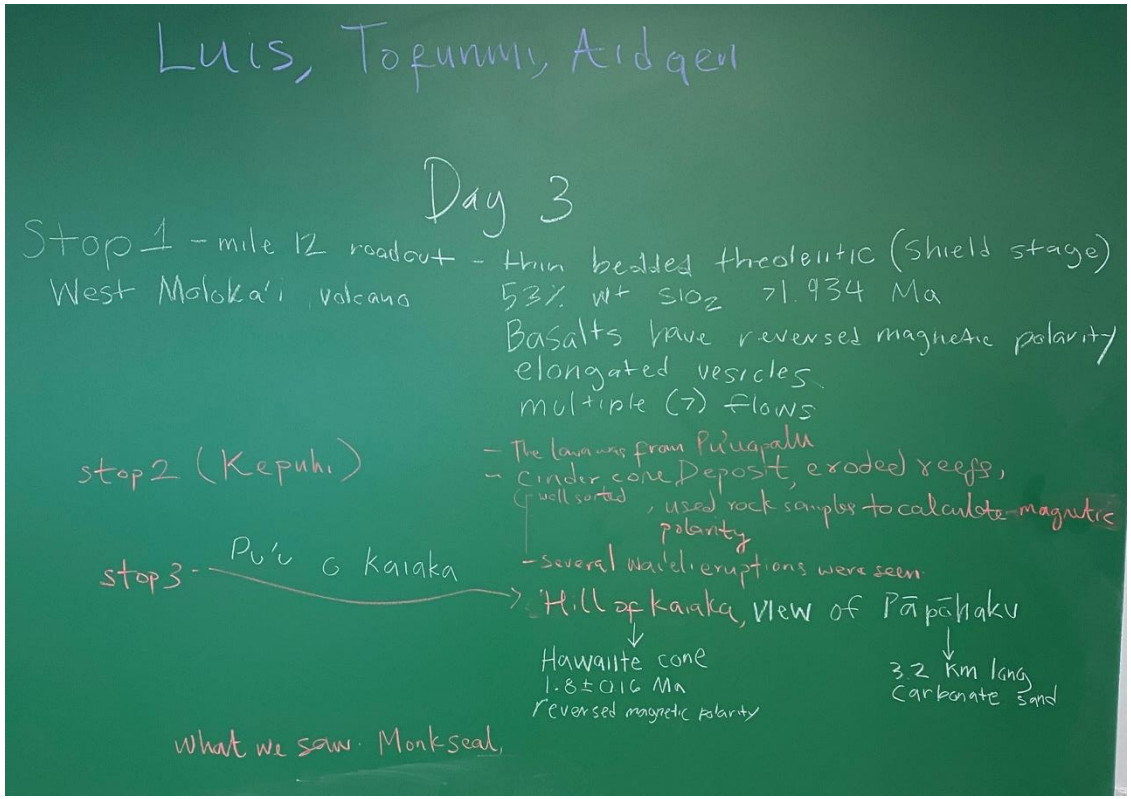
STOP 11. Pālā‘au State Park.
Hwy 470 ends in a parking area. A short trail to the east leads to the Kalaupapa Overlook, with iconic views down to Kalaupapa Peninsula. Weather permitting you can make out the summit crater (Kahaukō) and collapsed tube heading off to the north from it.



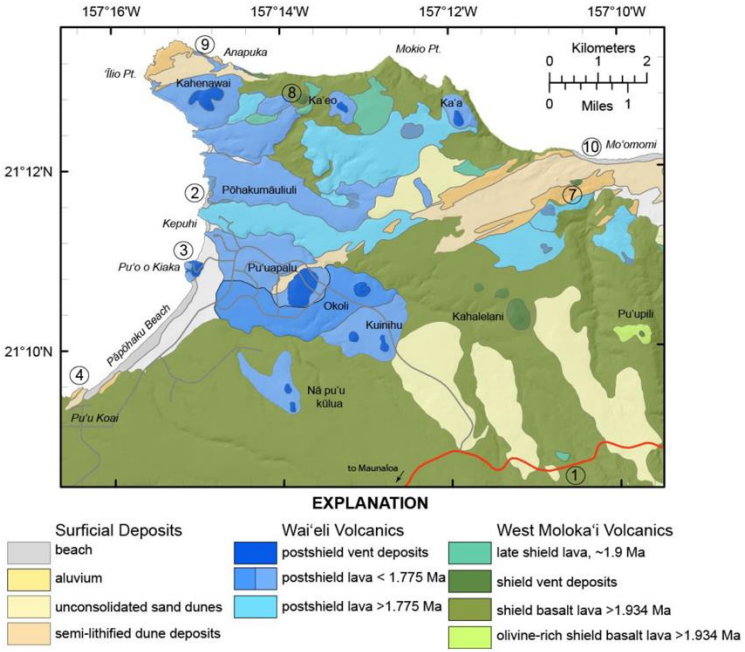
Kahaukō Crater and collapsed tube system

Ka‘ule is a mugearite outcrop that has been enhanced by humans. In addition to Ka ule, there are other stone images of fertility in this region. It is said that women could bring offerings to these images and spend the night. In the morning they would go home pregnant.

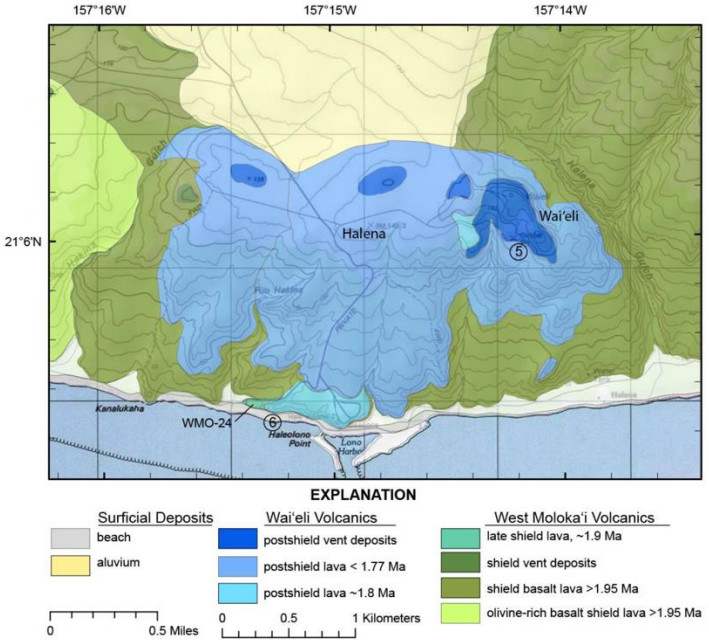
Day 3: West Molokaʻi



Stops 1-3



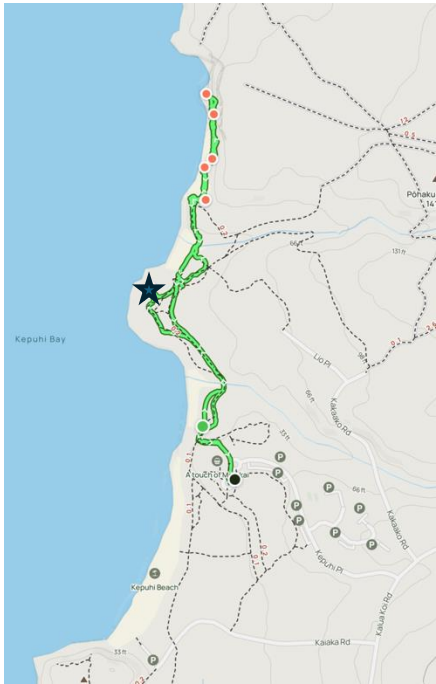
Stop6



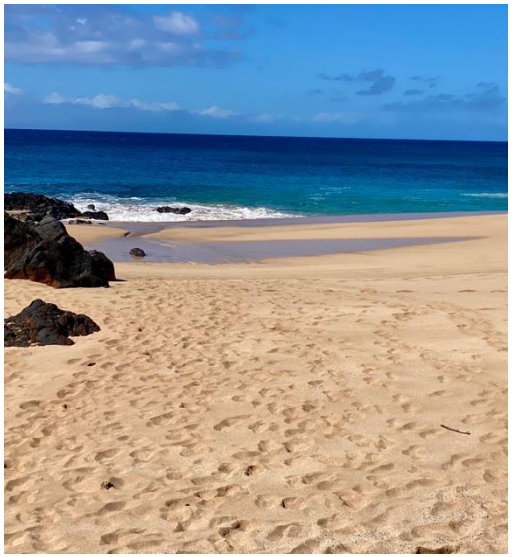
View to the South from stop 1 toward Kukui and East Moloka‘i (in the distance)

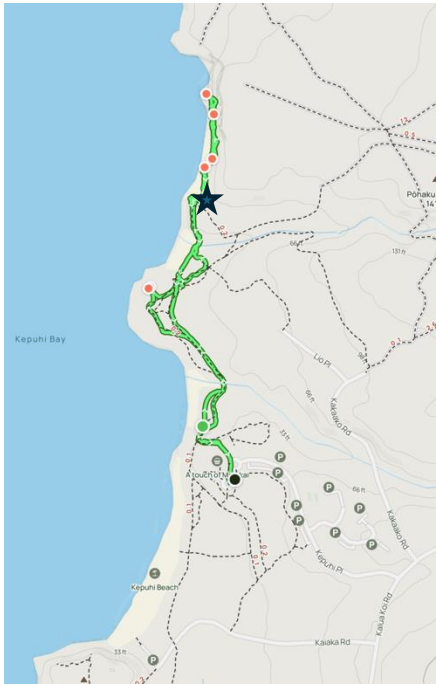
STOP 1. Around mile marker 12. Roadcuts here have been visited by many geologists, which established the reputation for West Moloka‘i Volcanics being unusually thin-bedded and mainly aphyric. That description certainly applies to these road cuts (Figure 10), even if it is hardly representative of much of the rest of the mountain. These outcrops are fairly high (late) in the shield section. Soil layers between the lava flows attest to declining eruption rate. Just north of the road is a small hill that is capped by massive tholeiite (52 wt % SiO_2) with normal magnetic polarity that overlies thinner bedded, reversely magnetized basalt. The upper lava is part of the late shield sequence of the West Moloka‘i Volcanics erupted during the Olduvai Normal-Polarity Subchron, younger than 1.934 Ma.

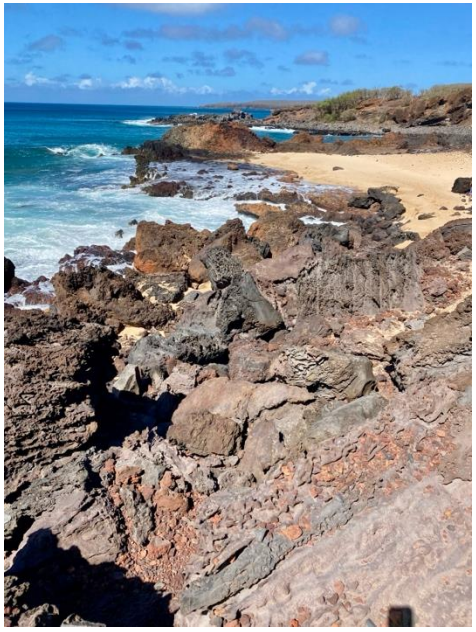
Stop 2. Kepuhi Bay. The products of several different Waiʻeli eruptions can be seen here. Kepuhi Pt. is lava from Puʻuapalu. Just across Kakaʻako Gulch to the north is hawaiite lava with normal magnetic polarity (slightly older than 1.775 Ma).

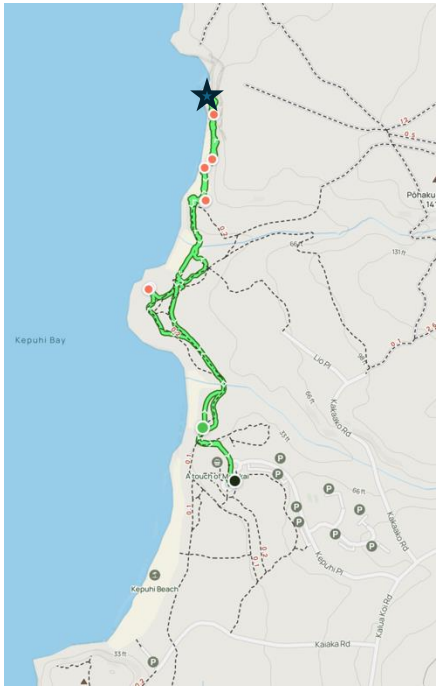


Continuing to the north, the Kaka‘ako hawaiite is overlain by scoria just along the beach. This scoria is a cone deposit (1.77±0.02 Ma, Cych and others, 2023) that was over-run by the Pōhakumāuliuli (dark stone) alkali basalt/hawaiite, which was erupted from vents on the NW rift zone, ~5km to the east








Kepuhi Bay
Kepuhi Beach
Kaiaka Rd
Kepuhi Pl
Kaluakoi Rd
Lio Pl

STOP 3. *view from* the Puʻu o Kaiaka (hill of Kaiaka). Hawaiite cone dated by Xu and others (2007) at 1.8±0.16 Ma. Pāpōhaku Beach. (stone fence). At ~3.2 km long this is one of the longer carbonate sand beaches in Hawaiʻi. And certainly one of the least crowded.

STOP 6. Hale o Lono Harbor. Built in the late 1950's. Canoe races to O'ahu begin here. Thick hawaiite lava overlies highly weathered, ashy (?) soil. Below is West Moloka'i Volcanics shield basalt.


MOKULELE
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