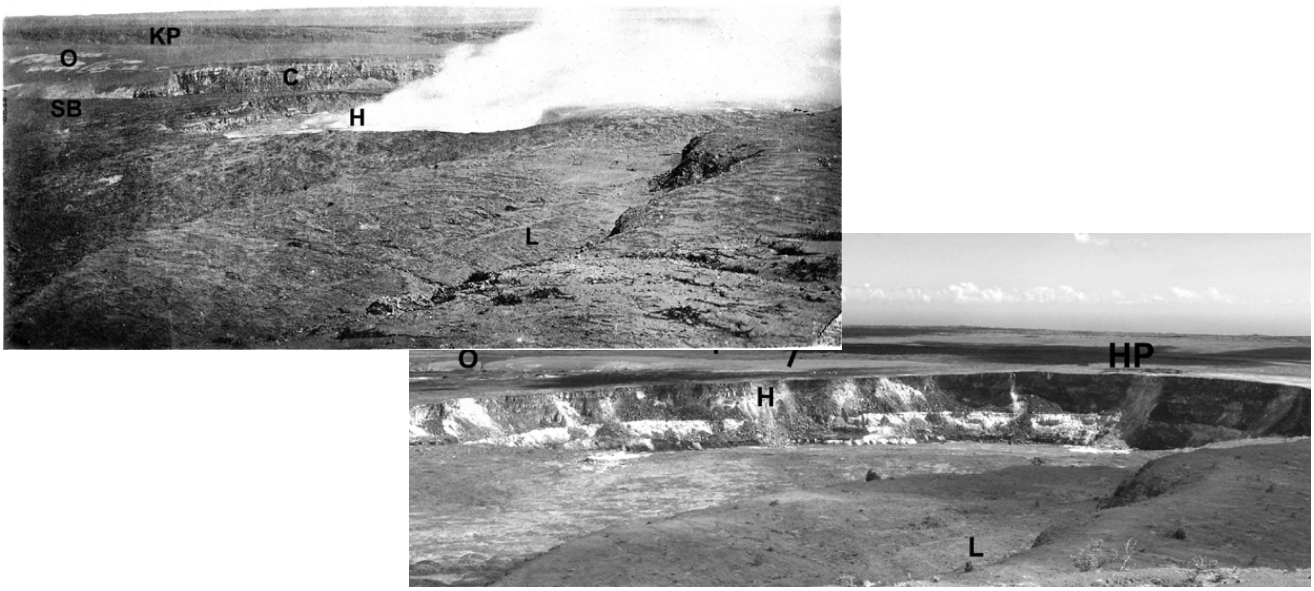
Explosive Eruptions at Kīlauea Volcano

Grade 6



Although known for quiet eruptions of lava that rarely endanger lives, Kīlauea Volcano on the Island of Hawai'i has also produced devastating and deadly explosive eruptions in the past. Because such eruptions are sure to occur again, U.S. Geological Survey (USGS) scientists are studying deposits from Kīlauea's past explosive eruptions to better understand what caused them and to identify communities at risk from such eruptions in the future. What conditions cause explosive eruptions to occur?

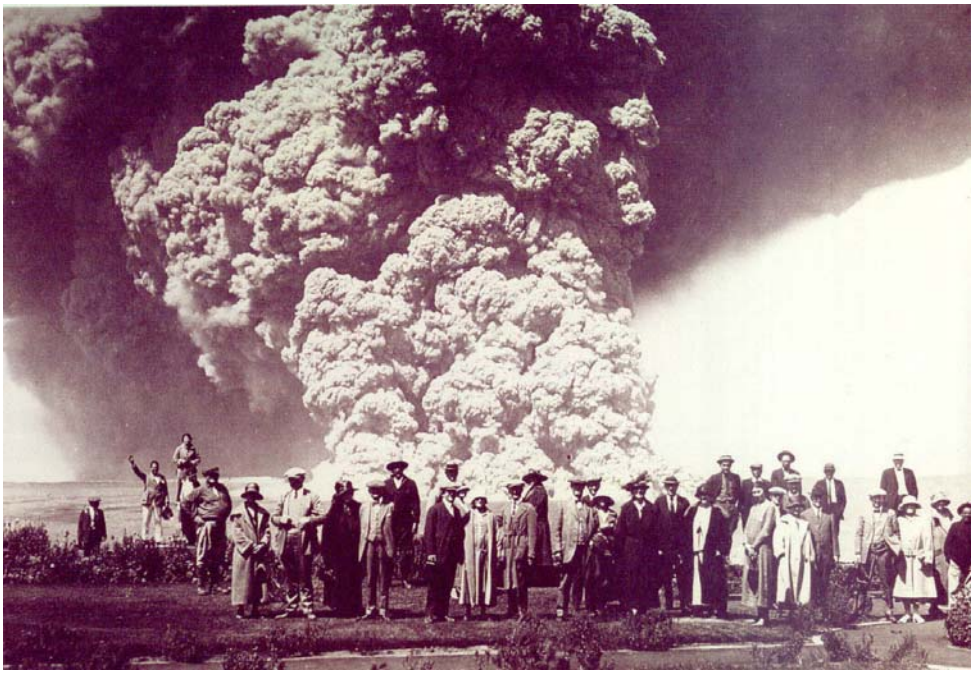


Photo Analysis

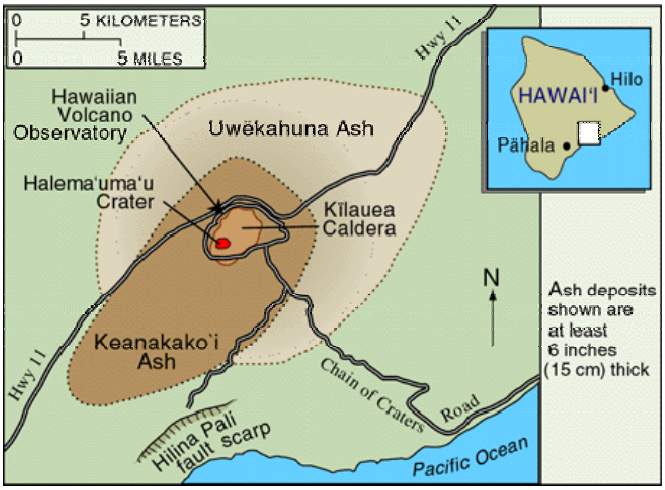
1) What do you think is happening in this photo at Kīlauea Volcano?
2) What information can you gather from the photo?

Setting the stage

Explosive eruptions do not generally come to mind when people think of Hawai'i's volcanoes. Their eruptions are typically characterized by the relatively quiet outflow of very fluid lava and by sometimes spectacular lava fountains. Hawai'i's volcanoes have therefore become the textbook example of non-explosive volcanism, and the term "Hawaiian type" is used to refer to such eruptions. Eruptions at Kīlauea can often be observed safely at close range. For this reason, in 1912, volcanologist Thomas Jaggar established the Hawaiian Volcano Observatory (HVO), now operated by the U.S. Geological Survey (USGS) at the top of Uwekahuna Bluff near Kīlauea's summit. Jaggar even called Kīlauea "the safest volcano on Earth" because of its typically gentle activity.

Scientists now know that Kīlauea in the past has produced numerous explosive eruptions, many dwarfing even the one that occurred about 1790. Although explosive eruptions at Kīlauea are infrequent, deposits of ash discovered by USGS and other scientists document that they actually occur about as often as explosive eruptions from volcanoes in the Cascade Range of the Pacific Northwest, which includes Mount St. Helens, Washington.

Locating the Site: Map



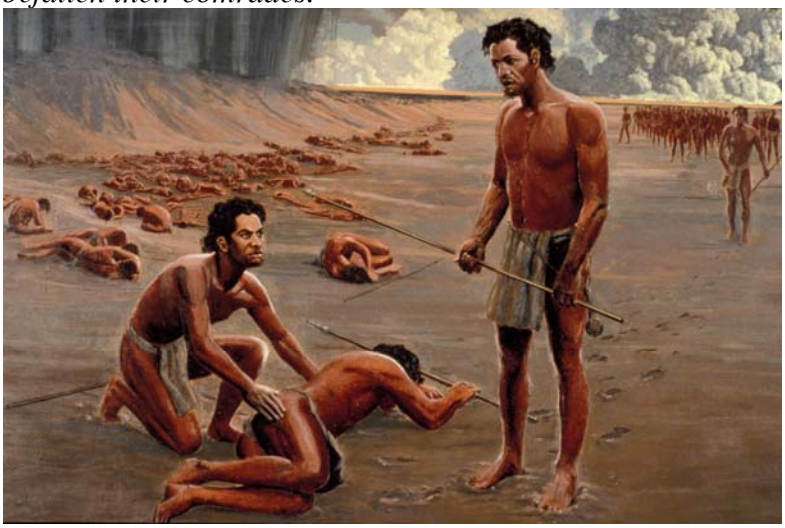
Determining the Facts

The eruption of Kīlauea in 1790 is of great interest to geologists and Hawaiian historians. Hawaiians provided a narrative of the eruption to early missionaries (Ellis, 1827; Dibble, 1843). Recent advances in volcanology have also provided new interpretations of the dynamics of the eruption. Lastly, and most obviously, the deposits of this eruption blanket the rim of the caldera, offering physical clues to the nature of the eruption.

The pertinent observations of Dibble (1843, p. 51-53) are contained in Wright and Takahashi (1989), a source more readily available than the original work. Note that the timing of the eruption coincided with Kamehameha's fight to unite the Hawaiian Islands. Keōuakū'ahu'ula, a rival king, was returning to defend his native Ka'ū when he camped with his army near the summit of Kīlauea. That night, the eruption began. Keōuakū'ahu'ula remained near the summit for two more days, with violent eruptions occurring each night. On the third day, the army divided into three groups and began their march toward Ka'ū. Dibble recounts:

Moʻoʻōlelo – Oral History

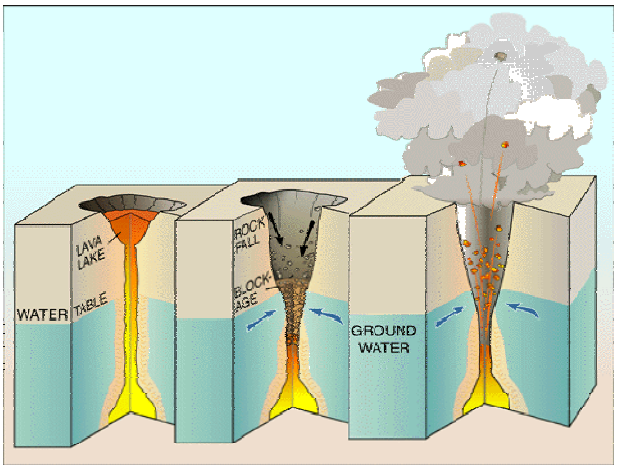
The army of Keōuakūʻahuʻula set out on their way in three different companies. The company in advance had not proceeded far before the ground began to shake and rock beneath their feet and it became quite impossible to stand. Soon a dense cloud of darkness was seen to rise out of the crater, and almost at the same instant the electrical effect upon the air was so great that the thunder began to roar in the heavens and the lightning to flash. It continued to ascend and spread abroad until the whole region was enveloped and the light of day entirely excluded. The darkness was the more terrific, being made visible by an awful glare from streams of red and blue lights variously combined that issued from the pit below, and being lit up at intervals by the intense flashes of lightning from above. Soon followed an immense volume of sand and cinders which were thrown in high heaven and came down in a destructive shower for many miles around. Some few persons of the forward company were burned to death by the sand and cinders and others were seriously injured. All experienced a suffocating sensation upon the lungs and hastened on with all possible speed… The rear body, which was the nearest to the volcano at the time of the eruption, seemed to suffer the least injury, and after the earthquake and shower of sand passed over, hastened forward... but… on coming up to their comrades of the center party, they discovered them all to have become corpses. Some were lying down, and others sitting upright clasping with their dying grasp their wives and children and joining noses … as in the act of taking final leave. So much like life they looked that they first supposed them merely at rest, and it was not until they had come up to them and handled them that they could detect their mistake. The whole party, including women and children, not one of them survived to relate the catastrophe that had befallen their comrades.



The army of Keōuakūʻahuʻula in the Kaʻū Desert

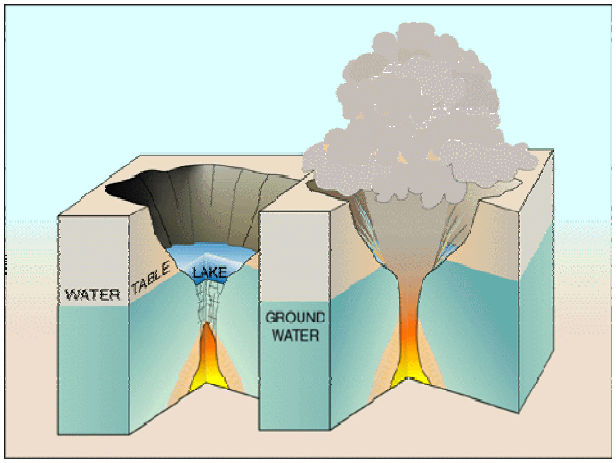
Footprint in the Kaʻū Desert

Scientific Evidence



Explosive eruptions at Kīlauea are thought to be caused when water comes into contact with hot or molten rock (magma) and flashes into steam. In 1924, this happened after the level of the lava lake in Halema'uma'u Crater dropped below the water table. The walls of the crater then collapsed and blocked the opening down which the lava had drained, allowing steam pressure to build up and cause violent explosions.

Many of Kīlauea's pre-1924 explosive eruptions that produced significant ash deposits probably happened when the volcano's summit crater was so deep that its floor was below the water table, letting ground water seep in to form a lake. Whenever magma erupted into the lake water, violent explosions of steam and volcanic gases resulted, fragmenting the magma into tiny ash particles and driving fast-moving, extremely hot ash-laden steam clouds (pyroclastic surges) out of the crater.



Visual Evidence

Field Activity I. Kīlauea Volcano Southwest Rift – Observe and Identify Layer Deposits

Observe the 1790 ash deposits, identify and draw the layers, complete the student worksheet.

Name:_____ **Student Worksheet**

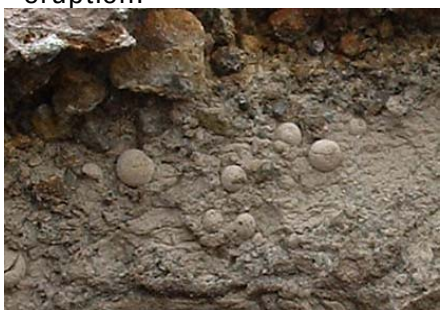
1790 Ash Deposit Layers Along Southwest Rift

In the box below, draw the layers you see at the southwest rift. Use the vocabulary words to label each layer.

Vocabulary

Ash – fine, volcanic dust produced by an explosive eruption.

Lapilli – tiny ash balls formed in flight during an explosive eruption.



Lithic Block – blocks of dense rock ejected from an explosive eruption.

Tephra – any rock or lava material formed when ejected into the air during an eruption.

1. How many layers can you see? Measure the layers and record them.

2. How did the lithic blocks become embedded in the ash layers? How big are they?

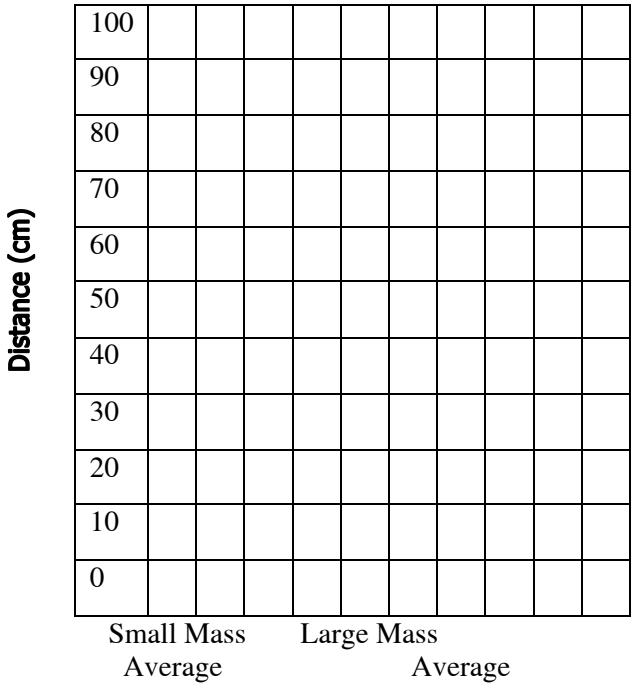
Name:_____ **Student Worksheet**

Tephra Catapult

1. Record the distances the object with small mass traveled 10 times in the left side of the table, and the distances the object with large mass traveled 10 times in the right side of the table.

Trial Number	Distance small mass traveled (cm)	Distance large mass traveled (cm)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Average (Total distance/10)		

2. Make a bar graph of the distance traveled for the small mass and large mass.



3. Did the large mass or the small mass travel the greatest distance from the catapult? Why?

4. In a volcanic explosion, what would you expect to fall closest to the eruption site?

   a) lightweight ash b) medium weight cinder c) heavy blocks

Field Activity II. Halemaʻumaʻu – Catapult Experiment

Make a catapult, launch volcanic rocks of different sizes, record data on a bar graph, complete student worksheet.

Conclusion

Scientists know that explosive eruptions have happened many times at Kīlauea. Why is this information important to us today?

The information is important to us today because future explosive eruptions of Kīlauea could endanger the lives of thousands of people who live, work, or spend time as visitors near the volcano.

Research and Information Sites:

Hawaiʻi Volcanoes National Park Website: http://nps.gov/havo, www.efieldtrips.org/havo
Hawaiian Volcano Observatory Website: http://hvo.wr.usgs.gov
United States Geological Survey Website: http://volcanoes.usgs.gov
Volcano World Website: http://volcano.und.nodak.edu/vw.html

Credits:

A Teacher's Guide to the Geology of Hawaiʻi Volcanoes National Park, Stephen R. Mattox, Ph.D.

U.S. Geological Survey, Data and Photos

Hawaiʻi Alive Enrichment Program, 2001 Geophysical Institute -UAF