Alpine/Aeolian Unit 1

Learning From the Mountain

Overview

The geological features of the summit area of Haleakalā strongly influence the conditions under which plants, animals, and insects live in the alpine/aeolian zone. The history and influence of these features is not always easy to decipher. This unit helps students explore the geology of the summit area, focusing on what we can find out about the alpine/aeolian ecosystem and the geologic processes that shape it by observing and studying Haleakalā.

Length of Entire Unit

Three class periods

Unit Focus Questions

1) What can we learn about Haleakalā by studying its geological features?

2) What can we learn about the conditions for life in the alpine/aeolian ecosystem from studying the geological formations of Haleakalā?

3) How do geologists use science skills such as observation, hypothesizing, collecting data, and analysis to answer questions about Haleakalā?

Unit at a Glance

Activity #1

Haleakalā Past and Present

Students study the origin of Hawaiian volcanoes, including Haleakalā, and relate the history of these volcanoes to present conditions in the alpine/aeolian ecosystem.

Length
One class period, followed by a homework assignment

Prerequisite Activity
None

Objectives
- Make connections between environmental conditions in the alpine/aeolian ecosystem and the formation of Haleakalā.
- Describe basic characteristics and the process of formation of Hawaiian volcanoes, including plate tectonics.
- Compare a modern scientific explanation of the origin of the Hawaiian Islands with a traditional Hawaiian explanation.

DOE Grades 9-12 Science Standards and Benchmarks
FORCES THAT SHAPE THE EARTH: Students analyze the scientific view of how the Earth's surface is formed.
- Analyze how any of the Earth's Systems shapes the Earth.
- Relate the Theory of Plate Tectonics to our island formation, volcanic activity, and/or earthquakes.

Activity #2

Haleakalā Detective Work

Students learn how geologists apply the scientific method to posing and answering questions about the past and future of Haleakalā and describe examples of hypothesis creation and testing.

Length
One class period, preceded and followed by a homework assignment
[Note: More time may be required for this activity if students have not met the Grades 4-5 Science Standard and Benchmark:
FORCES THAT SHAPE THE EARTH: Students analyze the scientific view of how the Earth's surface is formed.
- Explain the causes and effects of earthquakes and volcanoes.]

Prerequisite Activity
None

Objectives
- Describe how the ability to determine the age of lava flows using different methods is used to answer specific questions about Haleakalā.
- Explain the difference between a dating method that yields an absolute age and a comparative method.
- Explain and illustrate the process of radioactive decay and how it is used in determining the age of rocks.
- Hypothesize about the potential effects of a future eruption on the alpine/aeolian ecosystem of Haleakalā.

DOE Grades 9-12 Science Standards and Benchmarks
USING UNIFYING CONCEPTS AND THEMES: Students use concepts and themes such as system, change, scale, and model to help them understand and explain the natural world.
- CHANGE: Explain the effect of large and small disturbances on systems in the natural world.

NATURE OF MATTER: Students examine the nature of matter.

- Analyze the interactions of molecules and their relationship to the physical properties of compounds in the context of biological, chemical, and/or physical systems.

FORCES THAT SHAPE THE EARTH: Students analyze the scientific view of how the Earth's surface is formed.

- Analyze how any of the Earth's Systems shapes the Earth.

Activity #3

The Dating Game

Students play a game in which they demonstrate their knowledge of the geology of Haleakalā and proper visitor behavior in the alpine/aeolian ecosystem.

Length
One class period

Prerequisite Activity
Activity #2 "Haleakalā Detective Work"

Objectives

- Demonstrate an understanding of:
  - Different techniques for determining the age of lava flows,
  - Basic geological facts about Haleakalā,
  - Characteristics of different volcanic products,
  - Cultural connections with the alpine/ aeolian zone, and
  - Proper visitor behavior in the summit basin.

DOE Grades 9-12 Science Standards and Benchmarks
See Activity #2 standards and benchmarks.

Enrichment Ideas

- Simulate the process of predicting volcanic eruptions by placing Alka Seltzer in water in a film canister and closing the lid. Before you do this, ask for predictions about what will happen after you cap the canister. Have students predict how much time it will take for the canister to "blow its top," then compare predictions to the actual elapsed time.

  Link this activity to the general theme of the unit by explaining that geologists studying Haleakalā and other Hawaiian volcanoes are interested in when the volcanoes will erupt again. They gather clues from the layers of rock produced by past eruptions and use that evidence to help them predict when and where future volcanic activity is likely to occur. In making their predictions, scientists rely on basic science skills such as observation, discerning patterns, and sorting out likely effects of different variables.

  Expand on this demonstration:

  - Repeat the process several times using the same proportion of Alka Seltzer and water. Calculate the mean eruption time, and the range. Make the point that scientists can predict future eruptions based on past patterns, but there is still variation.
  - Have students calculate the average error in their predictions using all of the data they collected. Then have them recalculate the average error, throwing out the data from the first round. Teaching point: The first round helped them "calibrate" their predictions, probably leading to more accurate predictions in the second and subsequent rounds.
  - Mark film canisters with different colored labels and vary the amount of Alka Seltzer in each. Ask students to predict how long each will take to erupt. Then time and record each "eruption." Then do one final "eruption" without telling students how much Alka Seltzer you used. Have them estimate the quantity of Alka

Seltzer based on past observations. Teaching points: Different types of volcanoes and individual volcanoes at different stages of development have different eruptive patterns. Scientists compare current eruptions with past eruptions to learn about the volcano's stage of development.

- Brainstorm other variables that could affect the timing of the film canister "eruptions." These could include the fit of the lid, small variations in the amount of water or Alka Seltzer used, outside air pressure and temperature, and so forth. Then brainstorm a list of factors that might influence the timing and/or character of a volcanic eruption. Students may not know a lot about volcanoes, so this list may be quite general. You may need to give students clues. Use this brainstorm to set up the rest of the unit.

- Following the Activity #1 comparison of cinders to soil, have students design an experiment to compare the two as growing media for plants under different climatic conditions.

- Enlarge and photocopy the stages in the life of a Hawaiian volcano (p. 18), whiting out the numbers that indicate their sequence. Cut them apart and have students assemble these stages into the correct order as a thought experiment leading into the student reading "Haleakalā Detective Work."

- Have students select a topic about Hawaiian volcanoes and research it using Internet and print resources.

- Have students make an educational display and presentation about the formation of Hawaiian volcanoes and the geological history of Haleakalā for a younger class.

- While students are playing Activity #3 "The Dating Game," have them keep track of questions they miss. As homework, have students explain the correct answer to each question.

Resources for Further Reading and Research

Hazlett, Richard W. and Donald W. Hyndman, *Roadside Geology of Hawai'i*, Mountain Press Publishing Company, Missoula, Montana, 1996.

Macdonald, Gordon A., Agatin T. Abbott, and Frank L. Peterson, *Volcanoes in the Sea: The Geology of Hawaii*, 2nd edition. University of Hawai'i Press, Honolulu, 1983.

Hawai'i: Born of Fire, NOVA video production, 1995. One hour in length. Order from 1-800-949-8670.

Information About Hawaiian Volcanoes Available on the Following Websites:

Hawaiian Center for Volcanology at <www.soest.hawaii.edu/GG/hcv.html>.

U.S. Geological Survey Hawai'i Volcanoes Observatory at <hvo.wr.usgs.gov>.

Activity #1

Haleakalā Past and Present

● ● ● Class Period One *The Influence of the Past on the Present*

Materials & Setup

- *'O Wākea iā Papa Hānau Moku* acetate (master, p. 9)
- Overhead projector and screen
- *Inside Hawaiian Volcanoes* video, Smithsonian Institution (provided with this curriculum)
- VCR

For each group of four to six students
- Small plastic bag of cinder (from a garden supply store)
- Small plastic bag of soil

For each student (optional)
- Student Page "*Inside Hawaiian Volcanoes* Quiz" (pp.10-11)

Instructions

1) Divide students into groups of four to six students. Give each group a bag of cinders and a bag of soil. Have them observe the contents of the two bags, write down a description of each, then write a comparison of the two.

2) Ask groups to share some of their responses.

3) Ask groups to write down an hypothesis about which would be easier for a plant to grow in and why. Again have groups share some of their responses. Help students consider the effects of the cinders' porosity (inability to store water) and sharpness (danger of cutting fragile roots) on the ability of plants to grow.

4) Ask students whether an earthworm would do best in the soil or cinders. What about a spider? Have students explain their reasoning.

5) Ask whether anyone has been to the summit area of Haleakalā. Did they see cinders up there? How about soil? The substrate of the summit area largely consists of cinders and other volcanic products such as lava bombs. These rocks can tell us a lot about the past, present, and future of Haleakalā. They tell a story about the challenges of life in the summit area. They tell us something about the age of Haleakalā. As Hawaiian volcanoes reach a certain stage, their eruptions tend to become more explosive and they tend to eject more cinders than lava flows. And they may help scientists predict the general location and timing of future eruptions. Deciphering the secrets of Haleakalā and learning from the mountain are the themes of this unit. In order to learn about the present, we need to understand the past.

6) Show the *'O Wākea iā Papa Hānau Moku* acetate. Read the chant aloud with students. Take the "one" role yourself or ask a student who is proficient in Hawaiian pronunciation to take that role. This chant illustrates one view of the origin of the Hawaiian Islands. Ask students to share ideas about how this chant compares with their understanding of the origin of the islands.

7) For another perspective, show the *Inside Hawaiian Volcanoes* video (25 minutes).

8) As homework, assign students the task of writing and/or illustrating how plate tectonics theory explains the formation of the Hawaiian Islands.

Teaching Option

- Instead of, or in addition to, the homework assignment, have students complete the Student Page "*Inside Hawaiian Volcanoes* Quiz."

Journal Ideas

- How is the formation of the Hawaiian Islands explained in Hawaiian tradition? Write and/or illustrate your response, and keep in mind that there is more than one traditional explanation of the Islands' origin. You may wish to find another version than the one presented in the chant you read during class.
- Compare the plate tectonics explanation of the formation of the Hawaiian Islands with a traditional Hawaiian explanation.

Assessment Tools

- Student writing and illustrations of the plate tectonics theory explanation of Hawaiian Islands formation
- Optional: Student Page "*Inside Hawaiian Volcanoes* Quiz" (teacher version, pp. 7-8)
- Journal entries

Teacher Version

Inside Hawaiian Volcanoes Quiz

1) What is the name of the rock that Hawaiian volcanoes are made of?

   Hawaiian volcanoes consist almost entirely of a rock called basalt.

2) If the active volcano Loʻihi, now 914.6 meters (3000 feet) beneath sea level southwest of Kīlauea Volcano, has .3 meters (1 foot) of lava added to its summit each year, when will the volcano become an island?

   A little over 3000 years from now

3) Geologists know that the increasing weight of a growing volcano progressively depresses or pushes down the underlying sea floor. How will this process affect the time needed for Loʻihi to become an island?

   Loʻihi will require more time to become an island because of that process.

4) What is the geographic relationship between most active volcanoes and the boundaries of tectonic plates? Do the Hawaiian volcanoes conform to this general relationship? Why or why not?

   Most active volcanoes are located along the boundaries between the crustal plates. These are locations where the processes of global plate tectonics favor the emergence of magma at the boundaries.

   The Hawaiian volcanoes do not conform to this general situation and instead are near the center of the largest of all the crustal plates, the Pacific Plate. The Hawaiian volcanoes receive magma from a “melting spot” or “hot spot” in the mantle, 25 miles or more beneath the ocean floor. The reason for the existence of the hot spot is not known.

5) Hawaiian volcanoes swell or inflate before eruptions. How can the resulting change in shape of the ground surface be measured?

Inflation-caused change in shape (ground deformation) of Hawaiian volcanoes can be measured a) by leveling surveying stations to determine their change in elevation, b) by using an electronic distance-measuring instrument to determine changes in horizontal distance and, c) by leveling the corners of a triangle to determine changes in the slope or tilt of the ground surface.

6) Most Hawaiian volcanoes are called shield volcanoes because of their broad, gentle profiles. Why do you suppose this shape is so common for Hawaiian volcanoes, in contrast to shapes of such steep-sided cones as Mount St. Helens and other high volcanic peaks in the Cascade mountain range of the Pacific Northwest?

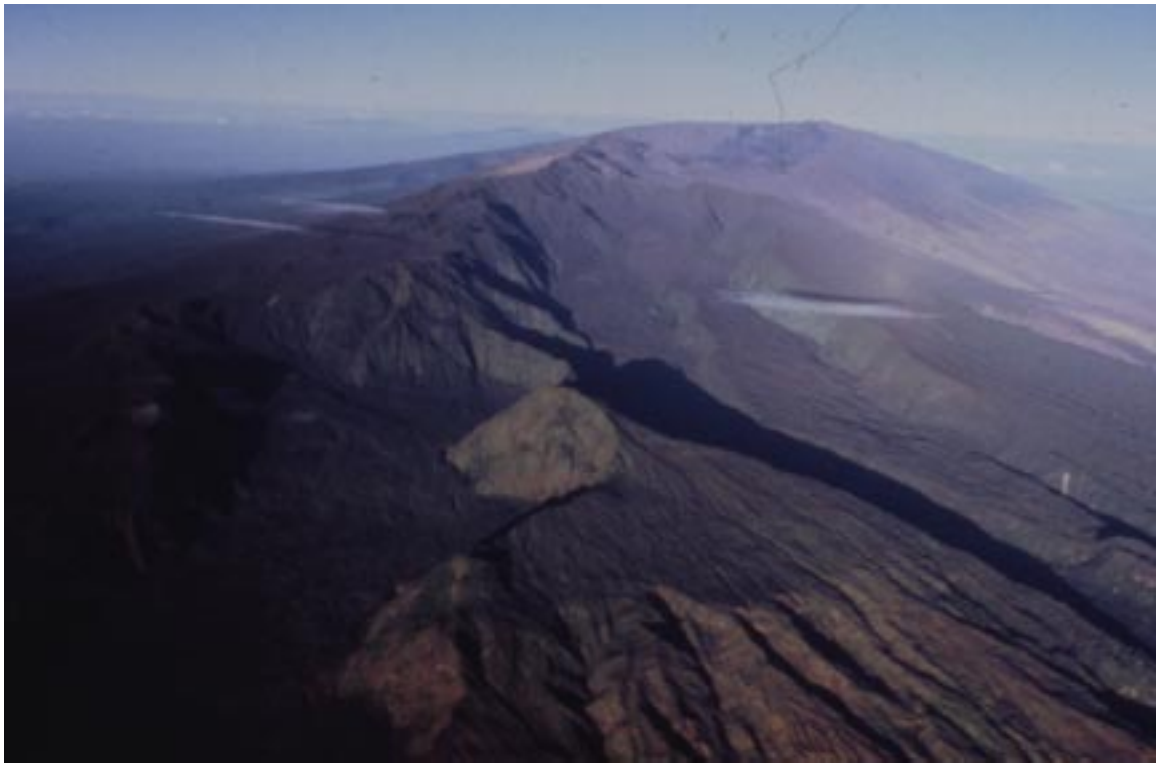
Hawaiian lavas (basalt) flow far more easily (lower viscosity) than the lavas (andesite and dacite) of a volcano like Mount St. Helens. Flows of high fluidity tend to spread farther and thinner than the stickier (higher viscosity) Mount St. Helens lavas. In addition, a Hawaiian volcano erupts lava flows at many vent areas on its flanks (rift zones) as well as at the summit. This wide vent distribution helps to build a similarly wide volcano with a broad, gentle profile.

7) Which is older, the West Maui volcano or Haleakalā? Explain your reasoning.

The West Maui volcano is older. Reasoning may include:

• West Maui is more weathered and eroded than Halekalalā.

• Haleakalā is located southeast of the West Maui volcano. The Hawaiian Islands are progressively older to the northwest.



Haleakalā from the air (Photo: The Nature Conservancy)

ʻO Wākea iā Papa Hānau Moku

(Malo/Traditional)

One: *ʻO Wākea noho iā Papa-hānau-moku*
All: *Hānau ʻo Hawaiʻi, he moku*
Hānau ʻo Maui, he moku
One: *Ho'i hou ʻo Wākea noho iā*
Ho'ohōkūkalani
All: *Hānau ʻo Molokaʻi, he moku*
Hānau ʻo Lānaʻi ka ula, he moku
One: *Lili-ōpū-punalua ʻo Papa iā*
Ho'ohōkūkalani
Ho'i hou ʻo Papa noho iā Wākea
All: *Hānau ʻo Oʻahu, he moku*
Hānau ʻo Kauaʻi , he moku
Hānau ʻo Niʻihau, he moku
He ʻula a o Kahoʻolawe

This chant talks about the birth of the Hawaiian Islands.

First is Hawai'i and Maui born of the union between Wākea (Sky Father) and Papa (Earth Mother).

Then Wākea is with Ho'ohōkūkalani (his daughter) and Moloka'i and Lāna'i are born.

Then Papa and Wakea have O'ahu, Kaua'i, Ni'ihau and Kaho'olawe.

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