

# VOLCANOES ON STAGE

Grade 4



*‘Ōhi‘a Project / Exploring the Islands*

## Essential Question

How does a Hawaiian volcano change as it ages?

## Hawai‘i Content Standards and Performance Indicators

Science: Forces That Shape the Earth

- Describe the effects of waves, wind and water on the surface of the Earth.

Social Studies: Physical Systems

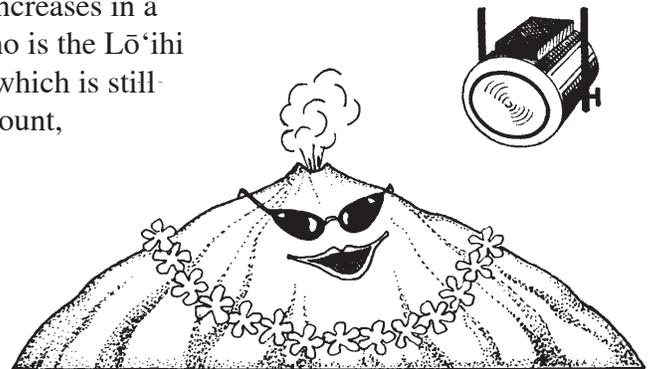
- Explain the formation of volcanic islands and atolls.

## Key Concepts

- Most Hawaiian volcanoes go through 10 stages beginning with the deep submarine stage and ending with a guyot.
- Stream/water, wind and wave action plus subsidence on high islands will eventually erode all volcanic rock and the islands will become atolls.
- The geological age of the Hawaiian Islands increases in a northwesterly direction. The youngest volcano is the Lō‘ihi Seamount and part of the island of Hawai‘i, which is still forming, and the oldest is the Emperor Seamount, which is 75 million years old.

## Activity at a Glance

Groups of students produce storyboards and scripts that creatively depict the stages of Hawaiian volcanoes.



## Assessment

Students will glue 10 volcanic stage cards in sequence from youngest to oldest and provide labels and captions that describe how volcanoes form and change in each stage.

## Exploring the Islands Telecast: “Volcanoes on Stage”

Students from Liholiho Elementary School visit the southeast shoreline of O‘ahu where they meet an “old volcano” who shares stories about his life with them. Students model the stages of a Hawaiian shield volcano in sand and put on a volcano skit about the “life” of a shield volcano.

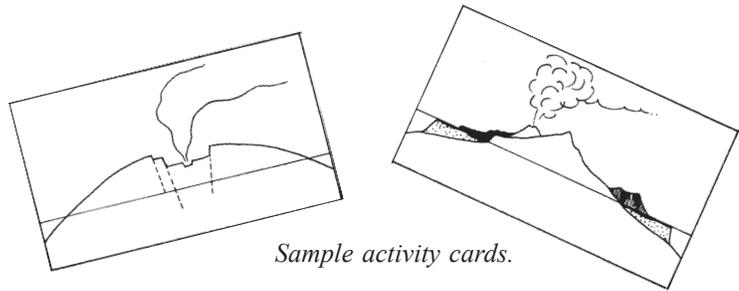
Dr. Alex Malahoff dives in a submersible craft over Lō‘ihi, the youngest volcano of Hawai‘i, and looks through the eye of a camera to see strange geologic formations, steaming vents, and living things new to science. In class, students sequence volcanic stages cards as the show progresses.

## Time

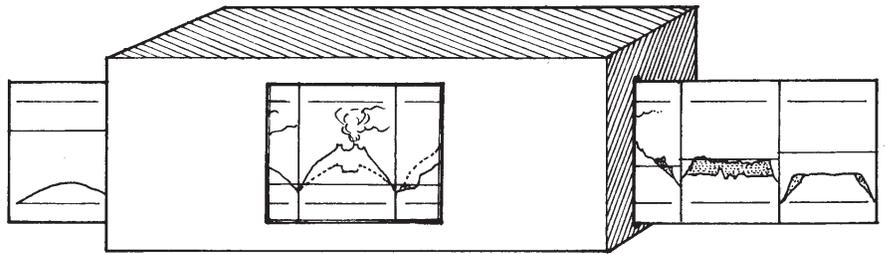
three–four class periods

## Materials/Resources

student activity cards (provided)  
student data sheet (provided)  
maps of the Hawaiian Islands  
scissors  
color markers  
staplers  
shoe box  
two large sheets of oak tag  
glue or rubber cement  
transparent tape



*Sample activity cards.*



*Story board viewing box.*

## Preparation

Make a story board viewing box. Duplicate and cut out a set of student activity cards. Cut a narrow slit on each side of a shoe box. The slits should be slightly taller than the cards. Cut window in the front of the box large enough for one activity card to show through and at the same level as the slits on the sides of the box. Create a story board by gluing the volcanic stages cards (in correct sequence beginning with the submarine stage) onto a strip of oak tag. Allow a 15-cm (6-in.) space at the beginning of the story board as a leader. (See illustration of story board viewing box above.)

## Vocabulary

deep submarine stage, shallow submarine stage, shield-building stage, giant landslide stage, capping stage, erosion stage, reef growth stage, secondary activity stage, atoll stage, guyot stage, subsidence

## Teacher Background Information

### Island Ages

Compared to the 4.5-billion-year-old Earth, the Hawaiian Islands are very young. Kaua‘i emerged above the ocean surface only about 5 million years ago. The oldest island, Kure, in the Northwest Hawaiian Islands, is approximately 30 million years old. Beyond Kure, is a chain of seamounts beneath the ocean surface. The oldest Emperor Seamount may have been a high volcanic island approximately 75 million years ago.

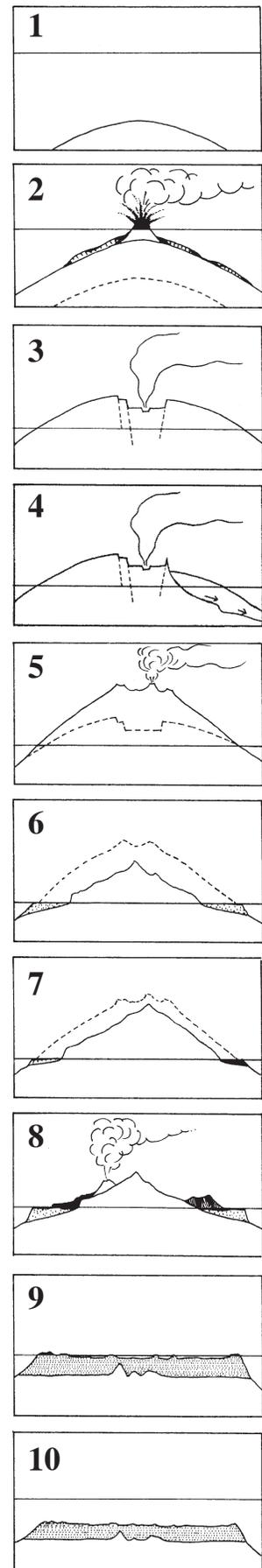
The approximate ages of volcanoes on the main Hawaiian Islands are listed on the student data sheet that accompanies this activity. The youngest of the volcanoes, Lō‘ihi, is still approximately 950 m (3,000 ft) below sea level. It will most likely be thousands of years before Lō‘ihi emerges to form the next Hawaiian island.

### Volcanic Stages

Most Hawaiian volcanoes progress through a series of stages, including shield-building, cap formation, erosion and rejuvenation. Hawaiian volcanoes typically pass through 10 stages, although the erosion, reef growth and rejuvenation or secondary activity phases can occur simultaneously. In stages 3 to 10, subsidence occurs. Present landforms provide examples of these stages:

Stages	Examples in present landforms
1. Deep submarine	Lō‘ihi
2. Shallow submarine	Lō‘ihi in thousands of years
3. Shield-building	Kīlauea and Mauna Loa
4. Landslide	Kīlauea?
5. Capping	Mauna Kea
6. Erosion	Kohala, W. Maui, E. Moloka‘i, Ko‘olau, Wai‘anae, Kaua‘i, Lāna‘i
7. Reef growth	W. Maui, E. Moloka‘i, Ko‘olau, Wai‘anae, Kaua‘i, Lāna‘i
8. Rejuvenation (secondary activity)	W. Maui, E. Maui (often referred to as Haleakalā), Ko‘olau, E. Moloka‘i, Kaua‘i
9. Atoll	Kure Atoll, Midway (Northwest Hawaiian Islands)
10. Guyot	many of the Emperor Seamounts

Hawaiian volcanoes do not necessarily go through all of these stages. The capping stage was skipped on the W. Moloka‘i, Lāna‘i, and Kaho‘olawe volcanoes, and W. Moloka‘i and Lāna‘i have not experienced rejuvenation even though younger volcanoes have passed into this stage. Volcanic stages can be compared to young, middle-aged or old people. A volcano has reached old age when the shield stops building and continues to erode. At this point, the volcano’s smooth shield shape begins to “wrinkle” as streams cut into the shield’s surface. It will continue to erode as the volcano matures.



Volcanic stages

From the study of Lō‘ihi, scientists have discovered that a caldera may form when the volcano is still in the deep submarine stage and may be present throughout the shield-building stage as magma repeatedly withdraws and returns. A caldera is a crater more than 1.6 km (1 mi) in diameter that forms when the summit of a shield volcano collapses. During the main active shield-building stage, a caldera repeatedly collapses as magma withdraws, and refills as eruptions occur within it. However, some of our shield volcanoes have no visible caldera. Any evidence of a caldera on the W. Moloka‘i volcano or Hualālai on Hawai‘i has been obscured by erosion or burial.



*A shield volcano “wrinkles” as it ages.*

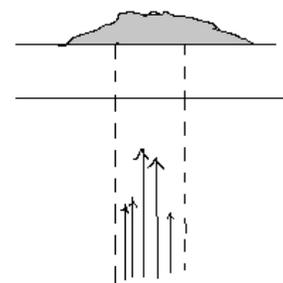
### Landslide Stage

Until a few years ago it was believed that erosion from rain and wave action was the primary destructive force in the aging of our Hawaiian volcanoes. Recent discoveries from sonar views of the sea floor around our islands have shed some fascinating new light on our volcanic past.

Recent sonar “pictures” have revealed vast talus (broken rock) deposits off shore of most of the high sea cliffs in the Hawaiian Island chain. These deposits, frequently at depths of 5,488 m (18,000 ft) in the trenches that parallel the island chain, are the result of great **landslides** that carried away up to a third of the above-sea-level mass of some of our shield volcanoes. Most of these slides probably occurred early in the final stages of the shield’s building and, in some cases, capping phase. (For more information about these giant landslides, visit the Moanalua Gardens Foundation web site at [mgf-hawaii.com](http://mgf-hawaii.com).)

### Capping Stage

The **capping** stage may occur when a volcano begins to move off the hot spot. At this time, less frequent and more explosive eruptions produce ash or cinder cones and viscous, slow-moving lava that builds up a steep-sided bumpy cap on top of the volcano. The viscous, alkalic capping lava is due to the nature of the hot spot. If you consider the hot spot as a cylindrical body of hot mantle material, rising due to buoyancy, the central part rises faster and the outside material rises more slowly. The faster the mantle material rises, the more it experiences rapid decompression and the greater the amount of melting that occurs. This produces the tholeiitic composition of the main shield-building stage lavas. On the edges of the hot spot, the material rises more slowly, melts to a lesser degree, and produces small volumes of alkalic lavas. These are the lavas that produce the bumpy surface of Mauna Kea on the island of Hawai‘i, which exemplifies this stage of a shield volcano.



*The hot spot may be considered a cylindrical body of hot mantle material. The central part rises faster than the outside material.*

As a volcano is moved away from the hot spot, it progresses through a series of stages including erosion and reef growth and, sometimes, rejuvenation.

## Rejuvenation (Secondary Activity) Stage

**Rejuvenation** (renewed volcanic activity) sometimes occurs after the bulk of the island is formed and the volcano has experienced considerable erosion. Cones produced during this secondary activity are similar to the cones built along rift zones during shield building. Well-known examples of rejuvenation include Lē‘ahi (Diamond Head) Crater and Hanauma Bay on O‘ahu, and Kilohana Shield on Kaua‘i.

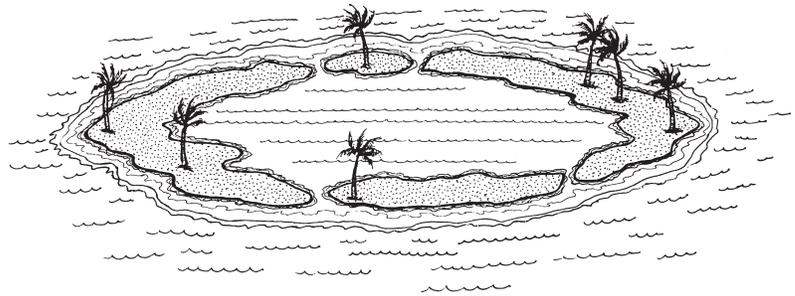
Scientists are unsure why older, eroding volcanoes become active again. The rejuvenation typically occurs after the plate has carried a volcano approximately 150 km (90 mi) away from the hot spot.

## Weathering and Erosion

Shield building ceases as a volcano moves off the hot spot, and weathering and erosion continue the slow process of wearing the island down. **Erosion** is the gradual wearing away of earth by water, wind and ice. Hawaiian shield volcanoes are composed primarily of basalt, which is easily broken down by roots, wind and rain. Streams are the primary source of erosion in Hawai‘i. Over millions of years, streams carve valleys out of the slopes of shield volcanoes and gradually carry bits of rock to the sea. Stream action, combined with the forces of waves, wind, and the **subsidence** (gradual sinking) of the islands, eventually reduces shield volcanoes to small lava remnants, like Necker Island, in the northwestern part of the island chain.

## The Final Stages

Gradually all traces of basalt are submerged beneath the sea and an island becomes an **atoll**—a lagoon with a fringing reef. But the island’s story is not complete until the land is submerged beneath the sea. The movement of the plate eventually carries the atoll into colder water where the coral cannot survive. The coral’s growth cannot keep up with the islands’ sinking. When the coral dies, only a **guyot** (a flat-topped submerged seamount) remains of the former high volcanic island.



*A typical atoll.*

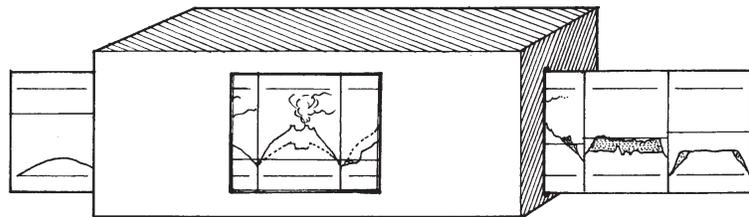
## Teaching Suggestions

1. Ask students to think like a detective and make a list of questions they would ask or observations they would make to discover the life history of a landform such as Diamond Head. For example: What is it made of? If it is layered, which layers came first, i.e., which layers are older? What happened to it since it was formed?

2. Have students look for evidence of different landforms in their neighborhood. Discuss possible ways these features were formed.
3. Ask students to guess the age of their home island. Write their guesses on the board. To help them put the age of the island into perspective, compare the age of the Earth (4.5 billion years) to a nine-month school year. With this scale, each one million years would be equal to 1 hour and 24 minutes. Refer to the student data sheet and ask students to compute an average age for the island and use the “school-year” scale to figure how old their island would be. (O‘ahu would be 4–5 hours old.)
4. Conduct a discussion about the island stages using the following questions:

#### Discussion Questions

- Do you think islands have a life cycle like living things do? (*Discuss.*)
  - Where is the youngest of the Hawaiian volcanoes forming? (*On the ocean floor south of the Big Island.*)
  - If the youngest volcano is south of the Big Island, what and where is the oldest volcano that is still above sea level? (*Kure Atoll northwest of Kaua‘i.*)
5. Watch the *Exploring the Islands* telecast. During the program, students will be asked to arrange the volcanic stages activity cards in proper sequence from youngest to oldest as the program progresses. (See Materials/Resources above.)

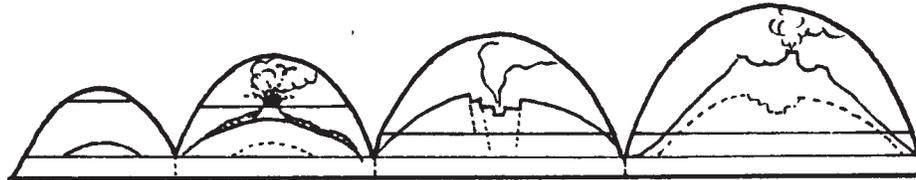


6. After the program, place the storyboard viewing box in front of the class. Demonstrate how the storyboard was made and pull it through the opening in the box.
7. Distribute the student data sheet. Working individually or in groups, have students pick one volcano to be the subject of their storyboard. Use a map of the Hawaiian Islands and have students locate their volcano on the map. For additional background information on each island include pages 1–12 from *The Hawaiians of Old* (Dunford, Betty, 1987, *The Hawaiians of Old*, Honolulu, Bess Press).
8. If working in groups, students can divide tasks of writing the script and illustrating one of the volcanoes. All storyboards should depict current stages of volcanoes accurately but creative art and writing skills should be encouraged! Help students see how a volcano could take on a personality as it matures from infancy through adolescence, maturity and old age.

9. Ask students to put their volcanoes on stage and present their storyboards to the class. Each presentation could omit the volcano's name and see if others can determine the identity.
10. Distribute the student activity sheet of 10 volcanic stages and a construction paper or oak tag sheet measuring 9 by 12 in. to each student. Have them cut out the volcanic stage cards and glue them in order from youngest to oldest on the large sheet. Ask them to label each stage and write a descriptive sentence under each picture. Their descriptions should include how the volcanoes formed and how waves, wind and water have changed the surface of the islands.

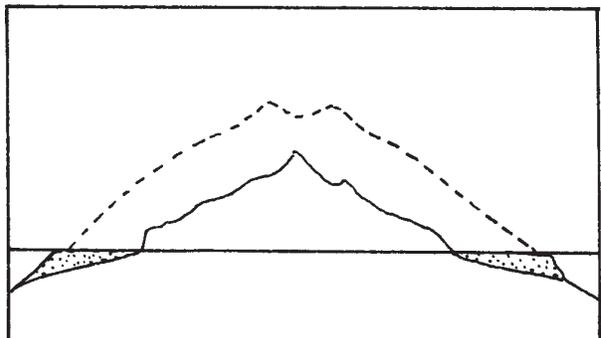
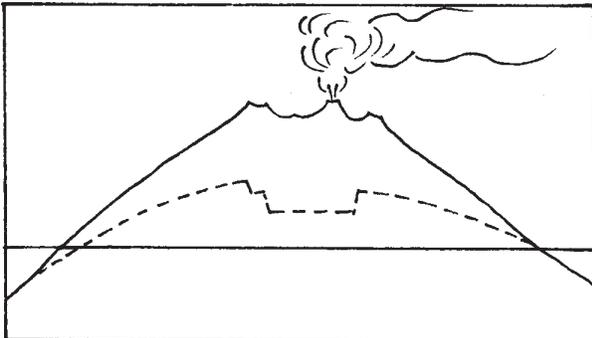
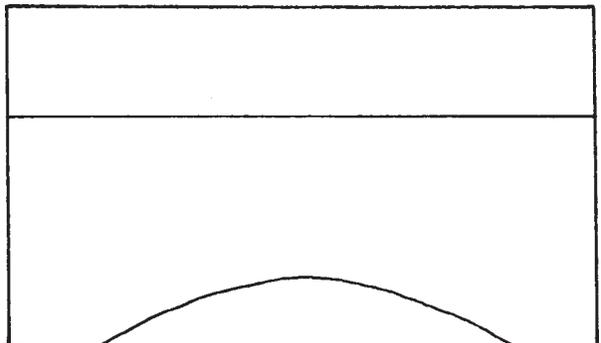
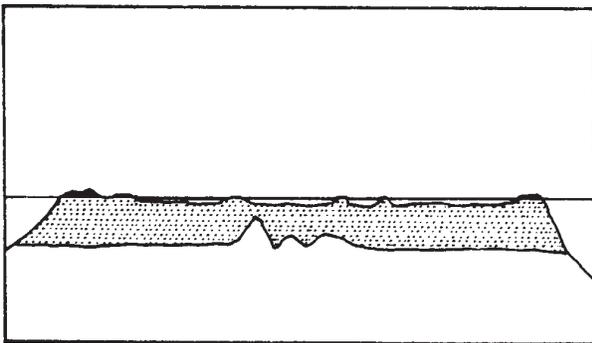
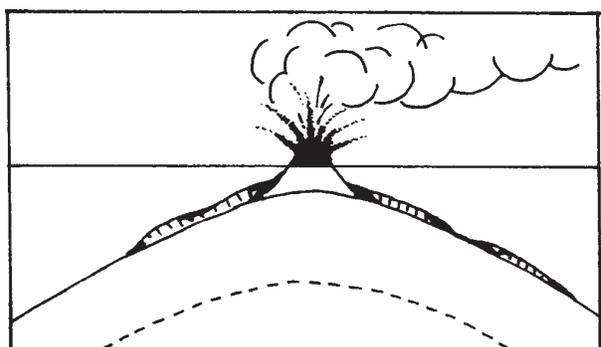
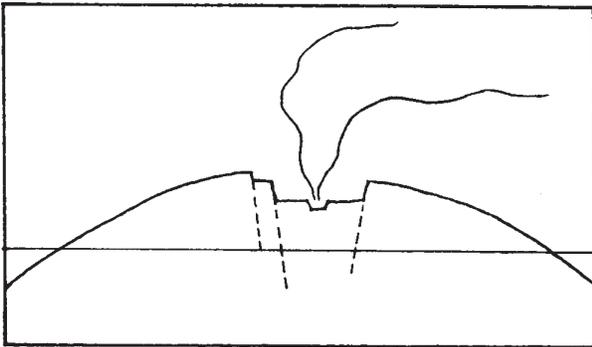
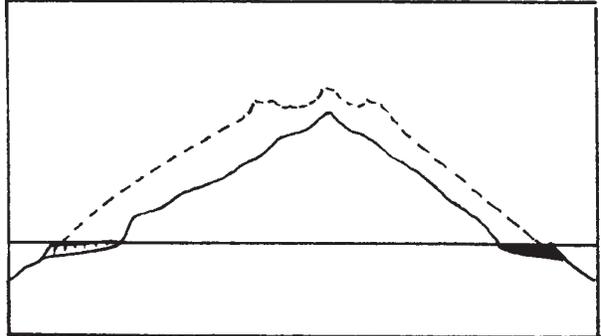
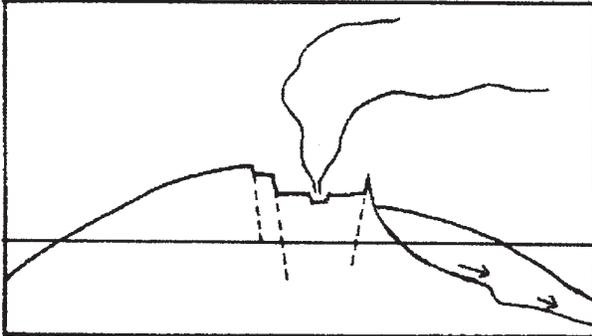
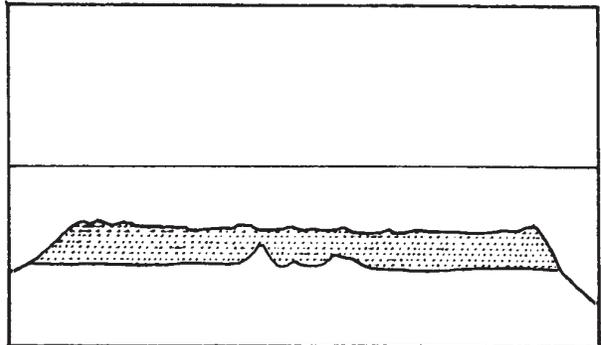
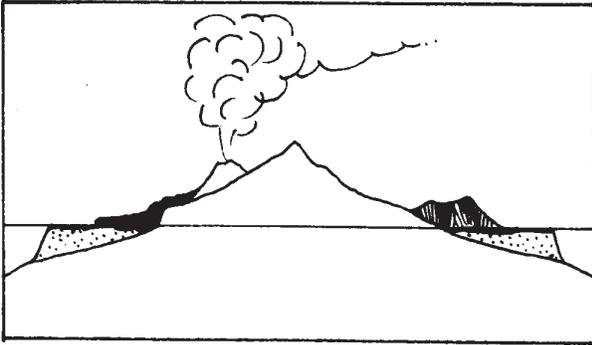
### Extended Activities

- Read the book, *How Much Is a Million?* (Schwartz, David M, 1985, *How Much Is a Million?* Lothrop, Lee and Shepard Books.) Compare the ages of the islands to the examples in the book.
- Have students use the activity cards to make volcano booklets. The first four cards could be cut out and glued on pages shaped like a growing volcano to show constructive stages (see illustration below). The book could then be flipped over to show destructive stages with the next four cards. The last stage could be glued onto the same page as the atoll stage.



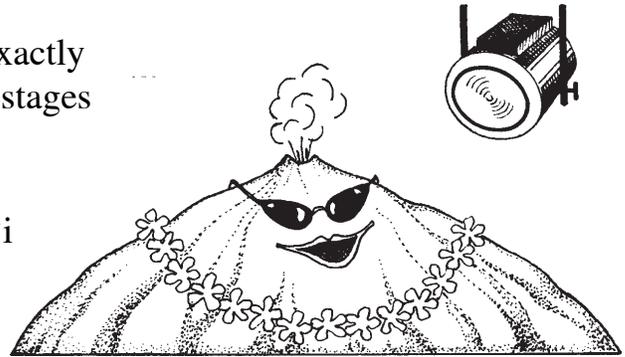
*Sample volcano booklet.*

- Each group of students could use creative dramatics to demonstrate the stages of a volcano on one of the islands. Using hand and arm motions, students could demonstrate magma rising and a shield shape being created. They could drop arms to depict the collapse of the caldera and then create a bumpy cap with their hands. They could sink to the floor as erosion occurs and another group of students could “swim” to the island and join hands to form a coral reef around it.
- Students could develop a time line depicting the ages of the main Hawaiian Islands. The time line could be created with string and a paper tag label for each island. Students will need to experiment with various scales until they can represent millions of years in a manageable space! If a scale of 1 m to 100,000 years were used, a time line including Kaua‘i would stretch 47 m (154 ft)! The time line could be laid out in the schoolyard or in the cafeteria and shared with other classes.



## Student Data Sheet

Some of the volcanoes in Hawai‘i have not exactly followed the stages as shown in the volcanic stages cards. The W. Moloka‘i volcano skipped the capping stage. Even though younger volcanoes have had secondary activity, Lāna‘i and W. Moloka‘i have not!



Volcano	Approximate Age (millions of years)	Current Stage
Lō‘ihi	still forming	submarine
Kīlauea	still forming	shield building
Mauna Loa	still forming	shield building
Hualālai	may still be forming	capping
Mauna Kea	0.4	capping
Kohala	0.5	capping
E. Maui (Haleakalā)	0.7	rejuvenation (secondary activity)
Kaho‘olawe	1.0	rejuvenation (secondary activity)
W. Maui	1.0	rejuvenation (secondary activity)
Lāna‘i	1.5	erosion
E. Moloka‘i	1.5	rejuvenation (secondary activity)
Ko‘olau	2.5	rejuvenation (secondary activity)
Wai‘anae	3.5	rejuvenation (secondary activity)
Kaua‘i	4.7	rejuvenation (secondary activity)
Ni‘ihau	4.9	rejuvenation (secondary activity)

1. Locate the island your group has selected on a map of the Hawaiian Islands. How many volcanoes are on your island? Find the volcanoes on the list above.
2. Use the information on this sheet and your knowledge about volcanoes to make a paper story board showing the stages of one of the volcanoes on your chosen island.
3. Be creative with your story! You could try comparing the volcano to a human. Is your volcano in infancy, childhood, adolescence (teenage), middle or old age? Give the volcano a personality and write a script that will give your classmates clues to the volcano’s identity.