Lesson 2 Hawaiian Beach Sands "Crime Scene Bio"

Lesson at a Glance

This lesson allows students to study samples of Hawaiian beach sand and trace them to their volcanic or biological origins. Students begin to think about how the slow processes of weathering and erosion that breakdown and transport material as well as how fast processes like hot molten lava pouring into the ocean shatters to form certain types of sand.

Lesson Duration

Two 45-minute periods

Essential Question(s)

How is sand created?
What is a testable hypothesis and an experimental procedure?

Key Concepts

- Most sand is the result of slow (weathering, erosion) and fast (rapid cooling of volcanic material) Earth processes.
- Engaging in experimental procedures enable us to understand these processes.

Instructional Objectives

- I can describe how slow and fast processes form most of the sands of Hawai'i.
- I can describe a testable hypothesis and an experimental procedure.

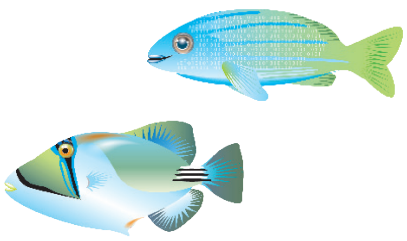
Related HCPS III Benchmark(s):

Science: SC 4.1.1
Describe a testable hypothesis and an experimental procedure.

Science: SC 4.1.2
Differentiate between and observation and an inference.

Science: SC 4.8.1
Describe how slow processes sometime shape and reshape the surface of the Earth.

Science: SC 4.8.2
Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth.



Assessment Tools

Benchmark Rubric:

Topic		Scientific Inquiry	
Benchmark SC.4.1.1		Describe a testable hypothesis and an experimental procedure	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Create a testable hypothesis and an experimental procedure to test it	Describe a testable hypothesis and an experimental procedure	Identify, with assistance, a testable hypothesis and an experimental procedure	Recognize, with assistance, a testable hypothesis or an experimental procedure
Topic		Scientific Knowledge	
Benchmark SC.4.1.2		Differentiate between an observation and an inference	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Explain the difference between an observation and an inference and give examples	Differentiate between an observation and an inference	Provide examples of observations and inferences	Define an observation and an inference
Topic		Forces that Shape the Earth	
Benchmark SC.4.8.1		Describe how slow processes sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how slow processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to slow processes	Provide examples of the shaping and reshaping of the Earth's land surface due to slow processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to slow processes

Topic		Forces that Shape the Earth	
Benchmark SC.4.8.2		Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how fast processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to fast processes	Provide examples of the shaping and reshaping of the Earth's land surface due to fast processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to fast processes

Assessment/Evidence Pieces

Lesson

- Results of The Sand Inquiry Record Sheet
- Observation of students participation in lab experiments
- Experimental procedure report or summary
- Short paragraph on sand, weathering, erosion and volcanic activity (fast processes).

Materials Needed

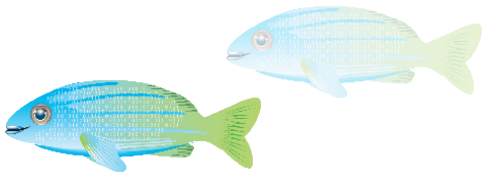
Teacher	Class	Group	Student
• Chart paper	• None	• Sand samples from three different beaches (or three different locations on the same beach) • Magnifying glass • Clear-drying liquid glue (craft glue) • Toothpicks • 3 small glass or plastic dishes • white distilled vinegar • 3 disposable pipettes or 3 plastic spoons for the vinegar	• Student Worksheet *Sand Inquiry Record Sheet*

Instructional Resources

Student Reading: *The Sand*
Student Worksheet: *Sand Inquiry Record Sheet*
Supplemental Resource: *Beach Detective Interactive Game*

Student Vocabulary Words

erosion: the transport of broken down material
sand: broken down rock or organic material that lines beaches
weathering: the breaking down of rock and organic material



Lesson Plan

Lesson Preparation

- Read the Science Background provided in the Unit's Overview.
- Gather sand samples for students to look at. Ideally, a sample that is from a white sand beach, a black sand beach, and something in between, will be useful.
- If you are pressed for time, do not have places for the students to apply glue on their worksheets, or cannot allow enough time for the glue to dry, substitute clear tape (e.g., scotch tape) instead of liquid glue. (Better results, however, are achieved when using liquid craft glue.) Note what beach the sand came from.
- Prior to the start of the lesson you may want to put the steps of the experimental process on a piece of chart paper. (See section I part C.)
- Preview the interactive piece Beach Detective to be completed at the end of Step III.

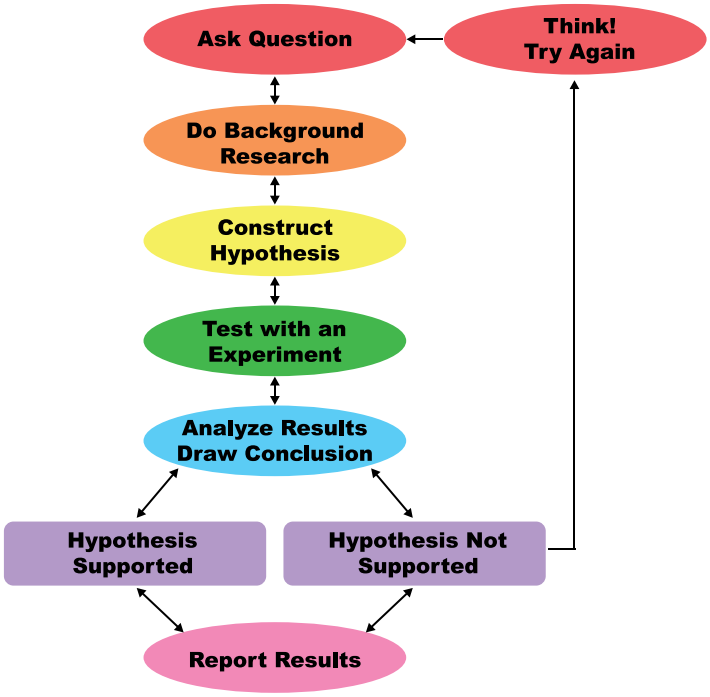
I. *What is an experimental procedure?*

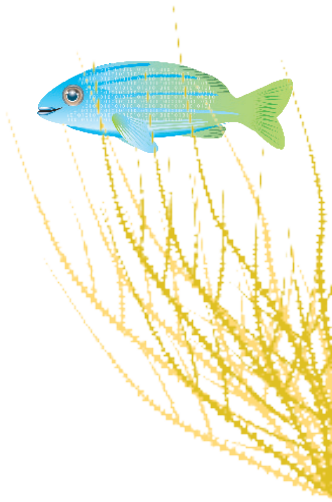
A. Review what was learned about observations, inferences, and hypothesis from Lesson1.

B. Explain that making observations, inferences, and hypothesizes are steps in a larger process that enables us to investigate the world around us.

C. Define what an experimental procedure is and describe the steps involved in the process. Experimental procedure is a way to ask and answer scientific questions by making observations and conducting experimentation. Below is an example of the steps involved in conducting an experimental procedure. Be sure that when you get to the step "Test hypothesis with an experiment" that it is clarified for the students what makes a hypothesis a *testable* hypothesis. A testable hypothesis should be one that can be measured through multiple experiments or tests. The results from those experiments should show whether your hypothesis is supported or refuted.

(**Teacher Note:** May want to put the steps below on a piece of chart paper and post at the front of the room. Use a clothes pin arrow to move down the steps of the experimental procedure as you explain them to the class so that they can follow along.)





For more information on experimental procedure and the scientific method visit:
http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml or
http://writing.colostate.edu/guides/research/experiment/pop2c.cfm

II. *What is sand?*

A. Write the word *sand* on the board. Ask students to try to define *sand*. Write their definitions on the board as a brainstorm. You will want to informally introduce the ideas of slow Earth processes like weathering and erosion here by asking questions, such as: *How did the sand break down into small particles? How did the particles get to the beach? Does the beach ever change shape?*

B. Handout the Student Reading *The Sand*. Read out loud to students and discuss fast and slow Earth processes that shape different types of Hawai'i's sand.

C. Distribute Student Worksheets and sand, and divide students into groups of four. Briefly review the worksheet directions. Have students complete the observation and inference portion of the lab then stop when they get to the vinegar test. Remind students to follow the steps of experimental procedure as listed up on the board as they go through the lab experiments.

D. After all groups have completed the first portion of the lab observation/inference section lead a class discussion that reviews what students found in each sample addressing the following questions: (At this point make sure to point out to students what step the class is on the experimental procedure chart.)

1. *The first step in an experimental procedure is to "ask a question" about something that you observe.* In this case the class did an observation of sand. Ask students, "How can you describe what you see and feel?" Beach sand in Hawaii comes from non-biological and biological sources. The non-biological type are the particles that come from volcanic materials that weathered and eroded and make up the black, grey, green, and red sand beaches; and the biological type are the white sands that are made up of hard particle remains of living organisms. If possible, have samples of coral, shells, and larger white sand components ready to show students, including *puka shells*, *paper shells*, *cat's eyes,* and other readily recognizable biological sources of sand. If you are searching for samples of biological sand particles, keep in mind that wind and wave action sometime sort the particles, forming smaller pockets on the beach of different kinds of beach particles. However, many of Hawai'i's beaches contain mixtures of both biological and non-biological sands.
2. *"Complete background research" is the second step in an experimental procedure.* Explain to the class that in this case the teacher completed the background research on the types of sand that the class will test today. May want to refer students to the chart on the second page of the student reading for a refresher on types of sand and where they come from. Discuss places the class could go if they did need to complete research on this topic.
3. *The third step in an experimental procedure is to form or "create a hypothesis".* This step can be done in two smaller steps. First have students make inferences about their observations of the different sand samples. Ask students prompting questions. *Where do you think the volcanic sands (black, grey, or red) came from?* Based on your observations, make an inference. These sands originated from a source that was weathered (broken down) and then eroded (moved). Write the word *weathering* on the board and explain that weathering is the breaking down of material. *How do you think the sand got to the beach?* Make an inference. After the source of the sand has weathered (broken down), then through erosion the sand is transported (moved). The erosion of sand can be caused by ocean currents and waves, or streams, and/or wind. Write the word *erosion* on the board and explain that it is the actual transport of material. It is very common for students to misunderstand or confuse weathering and erosion as they are related processes. These are processes that occur all the time on Earth and are slowly reshaping the surface by breaking down and moving material. Help students to understand that the processes of weathering and erosion also work to form and reshape white sand beaches. Fast processes also change the shape of the Earth and play a role in the formation of shiny black sand beaches like *Punaluu* on the Big Island. In this case molten lava pours into the ocean and the quick cooling of the lava causes it to shatter, which forms these shiny black sand beaches.
    a. After making observations and inferences of the sand samples, students will now form a hypothesis. Hypothesis is defined as "an idea that can be tested by an experiment or observation" (ScienceSaurus, 2005). You may use either of the following formats: "if…then…" or "if…then… because…" Remind students that the hypothesis must be a testable hypothesis, which means it can easily be measured. If developing hypotheses for the first time, you may want to consider creating hypotheses as a class.

4. *The fourth step of the experimental procedure is to "test your hypothesis with an experiment"*. Have the class conduct the vinegar test on the samples at this point. The vinegar test is used to trace the origin of the sand, whether it is of volcanic or biological origin. White is made up of remnants of coral skeletons, skeletons of animals that incorporate calcium carbonate into their shells or protective structures, and calcareous and coralline algae. When vinegar is added, bubbles form giving off carbon dioxide gas, evidence of its biological origin. No bubbles mean that the sample is volcanic.
5. *After the experiment it is time for the fifth step in the experimental procedure, which is to "analyze the results and draw a conclusion"*. Once your experiment is complete, you collect your measurements and analyze them to see if your hypothesis is supported or not supported. When scientists do this step if they find that their hypothesis was not supported then they begin the entire process again beginning with the asking questions phase. Ask the students to analyze the results of their vinegar test with their hypothesis. Was it supported?
6. *Final step in the experimental procedure is to communicate your results*. This is normally done by creating a report or summary of the experiment and its results. Have students write a short report or summary of the experiment detailing out their hypothesis, the results of the vinegar test and their conclusions (was their hypothesis supported or not supported. Why or Why not?)

E. Bring small groups back into the class setting. Collect sand, magnifying glasses, and toothpicks.
F. The *Sand Inquiry Report Sheet* may be used as a summative assessment.

III. *Check for Understanding*

A. If time permits have students go to the computer in small groups and play with the interactive game on the formation of different types of sand called Beach Detective.
B. Return to the original definition for sand. Ask students whether they think the original definition agrees with their definition. If they think their definition is incorrect, ask them how they could modify the definition to make it correct.
C. Ask students to write in their journal how Claude's habitat might change over time. Claude is a ghost crab and his habitat is the sand. Remind students that the beach is a dynamic place. The beach landscape is always changing, for example, long shore currents move sand away from beaches. In their journals be sure that the students include "debris" and "sand formation".
D. Check for understanding of the terms by asking the students to write a summary paragraph that connects sand, weathering, erosion, and volcanic activity (fast processes).

Extended Activities

1. Make a class collection of sand particles from all around the island. Glue (or tape) a small sample of each beach sand onto a map of the island. Following the procedures in this lesson, identify the kinds of particles found in each sample.

2. Have students look at samples under microscopes at 10X and 20X, if they are available. Make sketches of what the students see.

3. Have students create their own poster, customized to the beach study site that analyzes the sand content. Use the *Beach Sand.PDF* poster as a reference.
4. Have students sort sand by particle size using a kitchen strainer.

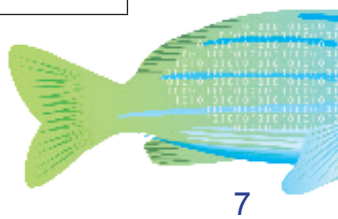
Lesson 2 The Sand

Hawaiian beach sand may look uniform at first glance, but it usually contains a combination of particles. Black and green sands are the result of weathering and erosion of volcanic rocks, and red sands are the result of breaking down of volcanic cinders, which are slow Earth processes. Shiny black sand beaches, such as *Punaluu* on the Big Island of Hawai‘i, formed when hot molten lava poured into the ocean and shattered, which is s fast Earth process; duller black or gray sands, such as the beaches in Hilo, were formed by the slower weathering and erosion of already cooled lava flows. Green sand beaches, such as the one found at South Point on the Big Island, or near *Mokapu Crater* on *O‘ahu*, or at *Ha’ena Point* on *Kaua‘i*, are formed from olivine, a hard crystalline substance that may appear yellow green or even brown. Sands that originated from volcanic material become hot in the sun.

A part of Hawai‘i’s white sand beaches comes from the breakdown of corals. Coral weathers during wave action, but is also broken down by animals in a process called bioerosion. The best known coral bioeroder is the Parrot fish, which literally eats the coral, and then excretes ground up coral as waste. However, much of the white sand particles found on beaches such as *Kailua* on *O‘ahu* come from coralline and calcareous algae (such as the oatmeal-like pieces of halimeda); or from foraminifera (the tiny disks found in the sand that have a hole in their center, and are used to make paper shell necklaces), or from the cat’s eyes, the hard trap-door like plate (operculum) used by many marine snails to seal themselves closed. Other organisms, such as sea urchin shells (tests) or spines, and tiny micro-mollusks also contribute to the white sands. Because all of these white particles are made from calcium carbonate, Hawai‘i’s white sand beaches do not become very hot in the sun. Add a few drops of vinegar to Hawaiian white sand particles, and bubbles of carbon dioxide will form.

Sand Chart	
Sand Type	**Origin**
Black	eroded volcanic rock with multiple types of minerals present
Red	Eroded cinder cone volcanic rock outcropping that is rich in iron, giving the sand its characteristic red color
White	Erosion of animal shells, coral reef skeleton, calcareous and coralline algae
Obsidian	Lava entering the ocean that is rapidly cooled to form black glass called obsidian. The lava explodes as a result of rapid cooling to spread fragments of obsidian onto the shoreline, the fragments erode into sand grains to form the beach
Olivine	Forms under the same process as above but the mineral olivine is produced during the cooling, giving the sands a green color

Source: http://hawaii.gov/dlnr/occl/Sand/BeachSand.pdf (site is being updated 8/22/8).



Lesson 2 Sand Inquiry Record Sheet

Name: _____ **Date:** _____

Directions:

1. Place a small sample of sand onto a piece of paper.
2. Using a toothpick, separate the particles.
3. Use a magnifying glass to observe the particles.
4. Glue (or tape) samples of the particles into the circle.
5. Answer the following questions in complete sentences.

Sample 1

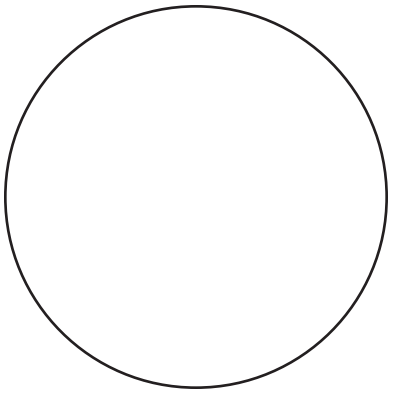
1. Observe the sand. How can you describe what you see and feel?

2. Where do you think the sand particles came from?
   Based on your observations, make an inference.

3. How do you think the sand got to the beach? Make an inference.

Sample 2

1. Observe the sand. How can you describe what you see and feel?

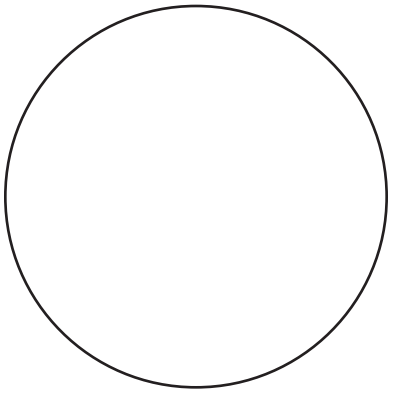


2. Where do you think the sand particles came from?
   Based on your observations, make an inference.

3. How do you think the sand got to the beach? Make an inference.

Sample 3

1. Observe the sand. How can you describe what you see and feel?



2. Where do you think the sand particles came from?
   Based on your observations, make an inference.

3. How do you think the sand got to the beach? Make an inference.

Vinegar Test:

The vinegar test is used to trace the origin of the sand, whether it is of volcanic or biological origin.

1. From your observations of the three sand samples, write down a testable hypothesis as to the origin of the sand. (Volcanic or biological using an "if, then, because" statement.)
2. Place 1 teaspoon of sand into the glass dish and add 1 to 2 tablespoons of vinegar. Observe what is happening?
3. Record your hypothesis and observations on the table below.

Sample Number	Hypothesis	Observations	Is the sand of volcanic or biological origin? What is your evidence? Explain
1			
2			
3