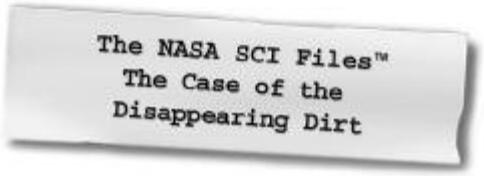



# Segment 4

The tree house detectives think that some kind of obstruction such as a jetty, bulkhead, or seawall has recently been built and is causing their beach erosion, so they set out to look for any new obstructions that might have been built along the shoreline. When they don't find any new structures, they once again go back to the Problem Board. After conducting a little more research, they read an article about beach erosion that just might be the answer. The detectives contact Dr. Jesse McNinch with the Virginia Institute of Marine Science (VIMS) and learn that their beach is a pretty "hot spot." With the problem solved, the detectives head to Dr. D's for a wrap-up of all that they have learned; then, it's off to the beach for volleyball practice, with the hope of having some fun and playing a good game!

# Objectives

The students will

- observe the erosion and deposition of sediment.
- observe wave action and understand terms related to waves.
- investigate the use of special research vehicles, like amphibious vehicles.

# Vocabulary

**amphibious vehicle** – a vehicle that can function both on land and in the water

**dynamic equilibrium** – balance between the forces of nature

**hot spot** – a region of the beach that erodes more during a storm than the surrounding beach

**jetties** – structures built out into the water to protect a harbor or influence the current

**recycle** – to process items such as glass, cans, and human body waste to regain materials for human use

**seawall** – a strong wall made to prevent the waves from wearing away the shore

# Video Component

## Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich the existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

## Before Viewing

1. Prior to viewing Segment 4 of The *Case of the Disappearing Dirt*, discuss the previous segment to review the problem and see what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site in the "Tree House" section and have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 3 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have occurred during Segment 3. Use tools located on the Web, as was previously mentioned in Segment 3.
4. Focus Questions—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program to answer the questions. An icon will appear when the answer is near.

## View Segment 4 of the Video

For optimal educational benefit, view *The Case of the Wacky Water Cycle* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

## After Viewing

1. At the end of Segment 4, lead students in a discussion of the focus questions for Segment 4.
2. Have students discuss and reflect upon the process that the tree house detectives used to solve the problem of the missing sand. The following instructional tools located in the "Educators" area of the web site may aid in the discussion: Experimental Inquiry Process Flowchart and/or Scientific Method Flowchart.

3. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
4. Wrap up the featured online problem-based learning (PBL) investigation. Evaluate the students' or teams' final product, generated to represent the online PBL investigation. Sample evaluation tools can be found in the "Educators" area of the web site under the main menu topic "Tools" by clicking on "Instructional Tools."
5. Have students write in their journals what they have learned about the rock cycle, rocks and minerals, weathering and erosion, and/or the problem-solving process and share their entry with a partner or the class.

### Careers

marine biologist
ocean engineer

# Resources

## Books

Blobaum, Cindy: *Geology Rocks*. Williamson Publishing, 1999, ISBN: 1885593295.

Bright, Michael: *Storms at Sea*. Millbrook Press, 2002, ISBN: 076132724X.

Fletcher, Ralph: *Have You Been to the Beach Lately?* Scholastic, Inc., 2001, ISBN: 0531303306.

Gallant, Roy: *Story of Dunes: Sand on the Move*. Scholastic Library, 1998, ISBN: 0531158896.

Green, Michael: *Amphibious Vehicles*. Capstone Press, 1997, ISBN: 1560654600.

Landalf, Helen: *Moving the Earth: Teaching Earth Science Through Movement*. Smith & Kraus, Inc., 1997, ISBN: 1575251086.

O'Brien-Palmer, Michelle: *How the Earth Works: 60 Fun Activities for Exploring Volcanoes, Fossils, Earthquakes, and More*. Chicago Review Press, 2002, ISBN: 1556524420.

Petty, Kate: *Amazing Pop-Up Geography Book*. Dutton Juvenile, 2000, ISBN: 0525464387.

Publishers Group Advanced: *Let's Start Sand Art*. Silver Dolphin Books, 1999, ISBN: 1571453814.

Stanley, George Edward: T*he Riddle of the Stolen Sand*. Aladdin Paperbacks, 2003, ISBN: 0689853769.

## Videos

Eyewitness: *Ocean*. Dorling Kindersley, 1997, ASIN: 078942147X

Eyewitness: *Seashore*. DK Publishing, 1996, ASIN 6304165293.

Eyewitness: *Plants.* Dorling Kindersley, 1997, ASIN: 0789421496.

Eyewitness: *Rock & Mineral.* DK Publishing, 1996, ASIN: 6304165285.

Eyewitness: *Volcano.* DK Publishing, 1996, ASIN: 6304165323.

# Resources (concluded)

## Web Sites

**Virginia Institute of Marine Science (VIMS)**
Visit this web site to read the top stories and to learn about the latest marine science research at VIMS.
*http://www.vims.edu/*

**Virginia Institute of Marine Science (VIMS): Coastal Shoreline Defense Structures**
Download this PDF file to learn about the various types of shoreline defense structures that are used to help prevent beach erosion. Great pictures and diagrams.
*http://www.vims.edu/ccrm/wetlands/techreps/coastal-shoreline-structures.pdf*

**Office of Naval Research: Research Vessels**
Look at the most up-to-date research vessels the Navy uses to learn more about the world under the sea.
*http://www.onr.navy.mil/focus/ocean/vessels/default.htm*

**Sea Grant: Marine Careers**
Visit this web site to explore various careers in marine science. You can even check out the salary ranges for each career and meet real people currently working in the field.
*http://marinecareers.net*

**Sea Grant: Coastal Erosion and Beach Loss in Hawaii**
Visit this web site to learn the difference between coastal erosion and beach erosion as you discover some of the most beautiful beaches in the world.
*http://www.soest.hawaii.edu/SEAGRANT/CEaBLiH.html*

**AskERIC Lesson Plans: Erosion**
Visit this site for a variety of mini lessons that help students understand erosion.
*http://www.reachoutmichigan.org/funexperiments/quick/eric/erosion.html*

**The Geological Society of America: Intermediate Rocks, Minerals, and Mining**
This web site is a great teacher resource for hands-on activities in Earth Science. Use everyday household items such as towels and candy bars to illustrate important earth science concepts.
*http://www.geosociety.org/educate/LessonPlans/i_rocks.htm*

**Mining Internet Services: Mining Lesson Plans**
Outstanding site for hands-on activities related to mining and minerals.
*http://www.coaleducation.org/lessons/middle.htm*

**The BBC: The Rock Cycle Experiments**
An interactive web site that allows students to learn about the forces that shape and create our Earth. The interactive map allows students to click on a process to learn more, and each item contains an activity that helps to illustrate that concept.
*http://www.bbc.co.uk/education/rocks/rockcycle.shtml*

**The Rock Cycle Song**
Listen to a song about the rock cycle.
*http://www.chariho.k12.ri.us/curriculum/MISmart/ocean/rocksong.htm*

**BrainPop**
Pick an animated movie that explains the rock cycle, plate tectonics, and much more. Play a game or participate in an experiment with Bob the Rat. This site also contains dozens of additional science and history topics. Users may register to score points and keep track of activities completed.
*http://brainpop.com/science*

**Women in Mining: Games: Minerals through Geography**
Find out where in the world we get the rocks and minerals we use in our everyday lives.
*http://www.womeninmining.org/Geography.htm*

**Edible Geology**
Make your own gelatin rock cycle with eroding cookie crumbs. Just follow the directions on this web site about edible geology.
*http://minerals.state.nv.us/forms/educ/EdibleGeology.pdf*

# Activities and Worksheets

# Shifty Sandy

## Problem

To understand how sand is eroded and deposited along a shoreline

## Materials

stream table or other large rectangular container
block sand ruler
watch or clock with second hand

## Procedure

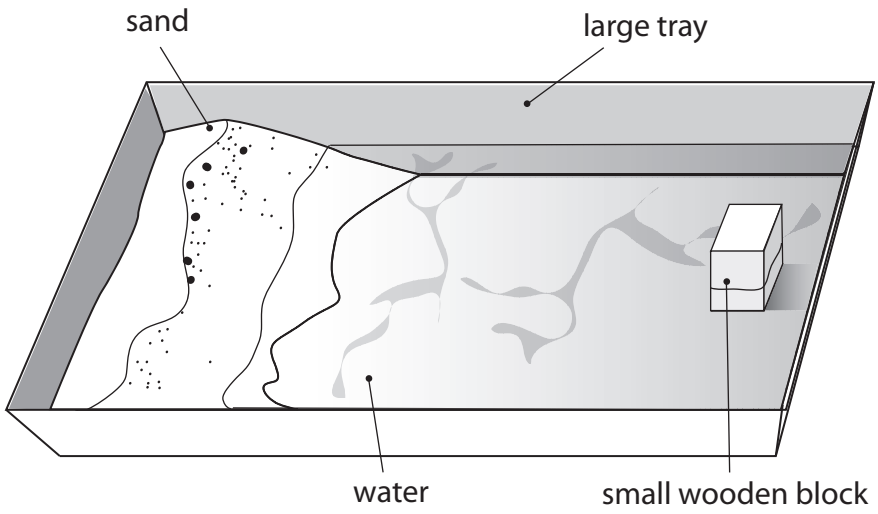
1. If using a stream table, tape or plug the drain to prevent water from seeping out.
2. Fill the stream table or large rectangular container with 2.5 cm of water.
3. Pour clean sand at one end of the container and shape it to simulate a beach.
4. In your science journal, illustrate the beach profile and record your observations.
5. Place the block at the end of the stream table opposite the beach.
6. Move the block very slowly to create small waves for 3 minutes. The waves should be just large enough to barely move the sand.
7. Observe the beach profile. Illustrate and record your observations.
8. Move the block more rapidly, creating larger waves for 3 minutes.
9. Observe the new beach profile. Illustrate and record your observations.

## Conclusion

1. Compared to the large waves, how did the small waves affect the beach?
2. How would seasonal changes affect the beach profile? (summer vs. winter)
3. What other factors might affect beach erosion?

## Extension

Place structures to simulate jetties, seawalls, and bulkheads along the shoreline and repeat the experiment to learn how they affect erosion.



# To Erode or To Deposit, That Is the Question

## Purpose

To study coastal erosion and deposition by waves and sea level rise at a particular area

## Materials

graph paper
ruler
pencil

## Background

To observe changes in sea level, scientists regularly measure the sea level at certain areas around the world. They look at data from previous years to determine any trends and patterns so they can predict what will happen to the sea level in a particular place. They are interested in knowing whether the sea level at the beach has been rising or falling over the past years. They also need to know whether the sand has been decreasing (erosion) or increasing (deposition) due to the rising and falling of the sea level. After careful evaluation and analysis of the data, scientists can try to predict erosion trends and deposition for various areas.

**Table–Lefaga, Samoa**

| **Year** | 1972 | 1973 | 1974 | 1975 | 197 |
|---|---|---|---|---|---|
| **Sand Volume ($m^3$)** | 268 | 331 | 192 | 394 | 201 |
| **Year** | 1977 | 1978 | 1979 | 1980 | 1981 |
| **Sand Volume ($m^3$)** | 185 | 386 | 252 | 323 | 351 |
| **Year** | 1982 | 1983 | 1984 | 1985 | 1986 |
| **Sand Volume ($m^3$)** | 364 | 385 | 343 | 349 | 377 |

## Procedure

1. Carefully examine the table that shows a study of the estimated volume of sand on a part of the beach at Lefaga, Samoa.
2. Note the volume of sand for each year.
3. Create a graph with "Time in Years" on the horizontal axis (x) and "Volume of Sand" on the vertical axis (y). Determine the increments for each.
4. Plot the information given for each year.
5. Look at the graph and analyze any noticeable trends (patterns).

## Conclusion

1. Which years showed erosion? How do you know?
2. Which years showed deposition? How do you know?
3. Looking at the trends, predict what will happen to the beach over a long period of time (50–75 years).

# Riding the Waves

## Problem

To observe waves in action

## Materials

1 clear plastic bottle with a screw-on lid
clear baby oil or cooking oil
water
food coloring
Teflon® tape

## Background

All waves share certain characteristics. Each wave has a crest, which is its highest point, and a trough, which is its lowest point. The wave height is the distance from the crest to the trough. The wavelength is the distance from the crest of one wave to the crest of the following wave. Water rises and falls as the wave passes. The wave moves forward on the ocean's surface, but the water itself does not move forward. A particle bobbing on the waves, such as a twig, will rise on the crest, moving forward just a little, and drop on the trough, moving a little backward. This circular loop means that the twig ends up just about where it started.

The speed of the wind and how long the wind blows determine the height and wavelength. As wind blows across the water's surface, it pushes up tiny waves into larger waves. When a wave reaches shallow water, its wavelength gets shorter. The ocean bottom pulls at the wave and slows it down. The crest gets ahead of the rest of the wave and begins to tilt forward. When the front end of the crest is unsupported and the wave collapses, it is called a breaker. After a wave breaks, the foaming water rushes up the beach. The particles no longer move in circles as they did in the wave. The water actually moves forward, taking whatever it is carrying with it. Strong storm waves beating against the shore can change the shape of the shoreline. Gentle waves lapping at the beach may deposit or carry away sand.

## Procedure

1. Fill the bottle 1/3 full of water.
2. Add food coloring to get the desired color.
3. Fill the bottle almost to the brim with oil.
4. Wrap the bottle threads with Teflon® tape.
5. Screw the lid on tightly.
6. Turn your bottle on its side and gently move it back and forth.
7. Record the wave action you see in the bottle.

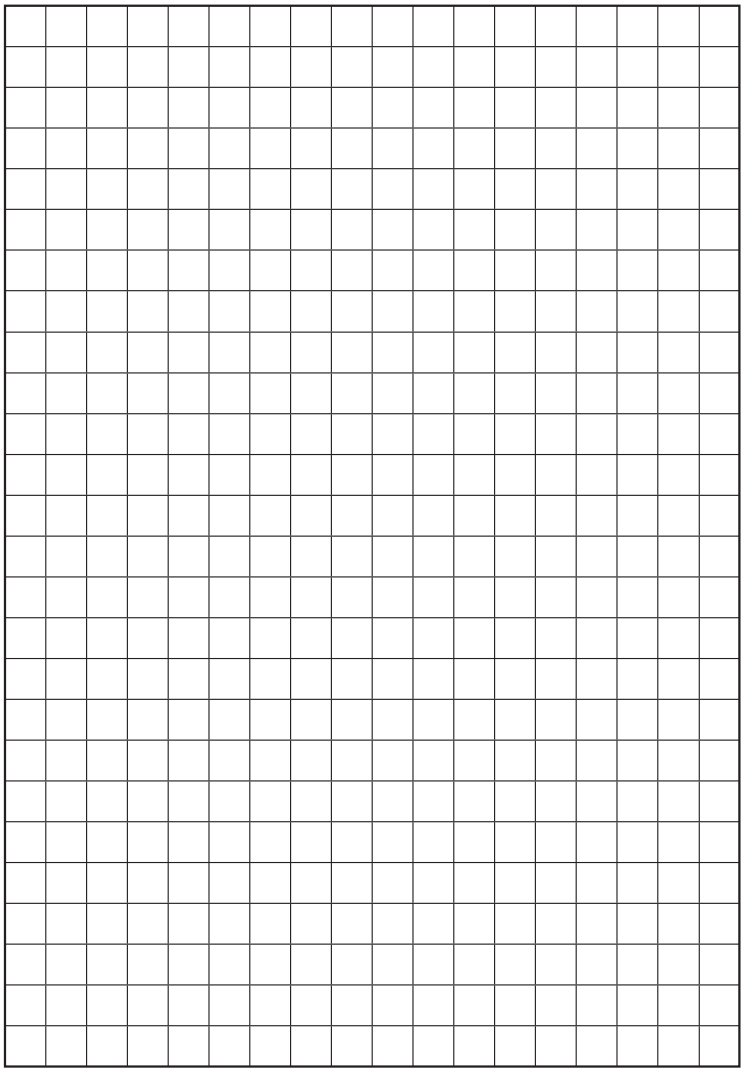
## Conclusion

1. What causes the motion inside the bottle to change?
2. How are the movements inside the bottle like those in the ocean?
3. How do waves affect the shore?
4. What can the tree house detectives learn from watching a wave machine?

## Extensions

Try adding small pebbles (aquarium gravel works well) or clean sand to the bottle before it is sealed. Observe what happens to the sediment when the waves move. Does it move in the same direction as the waves? Where does it end up when the waves stop?

# Rockin' and Rollin' Crossword Puzzle



*Use the words below to create your own crossword puzzle.*

## Vocabulary

| | |
|---|---|
| rock cycle | igneous |
| metamorphic | sedimentary |
| hot spot | subduction |
| weathering | erosion |
| mountain | mineral |
| rock | sand |
| gemstone | glacier |
| gravity | water |
| mechanical | chemical |
| Moon rocks | lava |

## Add your own:

_____

_____

_____

_____

## Across

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

## Down

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

# Lost on the Beach Word Search

*You don't need a pail or shovel to find the words on this beach. Use the word bank below to "dig" up the words in the word find below.*

**Word Bank**

| | | | |
|---|---|---|---|
| metamorphic | sedimentary | igneous | rock cycle |
| weathering | gravity | Moon | mountain |
| plate tectonics | lava | magma | divergent |
| convergent | subduction | erosion | glaciers |
| striations | dome | Mohs | mineral |
| gemstone | luster | color | Earth system |

S E D I M E N T A R Y N E A P P A M O O N S
S N M O U N T A I N B A B E H U G U Y I N I
D A C A M O R P M E T S Y S H T R A E M D G
I O F D E P E R I A K M E I C L I P E O E N
P N M A A I O M B N G E M S T O N E H T R E
M H E E L T I U A I R A U X S Y L I S H R O
E K A I W O R K N K I N E T I C I O I Y O U
T J I L I E S N M D C C I L P L L E R D C S
A L P L A T E T E C T O N I C S A G O R K U
M A I E H E R G E H Z N I E S T R V A I C S
O S M W E T I P E I T V E T H R C A R E Y A
R Z Q U I C L I A T O E M Y F I T E P U C W
P N L D S A I N D N R R C T I A N A V A L E
H G E A R S Z A I E V G O U R T N E Y A E A
I I V E R T S S N G P E D N A I E N D J K T
C S N Y K O R Z O R Y N Y I I O W L B O N H
H I R T J E S C I E W T E L L N U I I D A E
M E N E I G Y A T V T R K C I S A C S T R R
U E R C P G S I C I Z U A A T R I S H I C I
A K A T I I T G U D T B I E B I L L I I I N
M L B E S B E K D S R I R Y O Y T I V A R G
G A E M O H S O B T A W P F I S L I Z Q U E
A G W I N C H E U N Y N I K K I N Y I R P V
M F A E B Z X R S W R O R L F N O I S O R E

# Answer Key

### Shifty Sandy

1. Answers will vary but should include that the smaller waves did not erode the beach as much as the larger waves did.
2. Winter storms cause more erosion than occurs in summer.
3. Answers will vary but might include human activity and obstructions such as jetties, seawalls, and bulkheads.

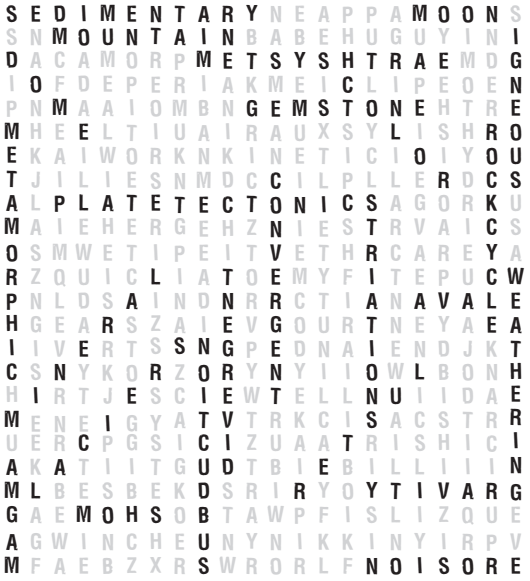
### To Erode or To Deposit; That Is the Question

1. 1974, 1976, 1977, 1979, and 1984. The volume of sand was less.
2. 1973, 1975, 1978, 1980, 1981, 1982, 1983, 1985 and 1986. The volume of sand increased.
3. Answers will vary.

### Riding the Waves

1. The back and forth rocking motion caused the oil and water mixture to move back and forth.
2. The movement inside the bottle is similar to the movement of water in the ocean in that the water moves forward and then back again.
3. Waves affect the shore by depositing sand as the waves break on the beach; however, if wave action is very strong because of a storm or other force, it can cause erosion.
4. If the tree house detectives were to watch a wave machine, they would see that gentle waves slowly move the water and its contents toward the shore. If the wave action is more violent, they would see that waves are capable of eroding the shoreline.

### Lost on the Beach Word Search




## On the Web

### The Rock Cycle

1. The shavings are different sizes because each was scraped and removed from the crayon slightly differently with each turn of the pencil sharpener.
2. Rocks come in many different sizes, shapes, and kinds because they come from different parent rock and weather differently.
3. Wind, rain, water, ice, gravity, plants, animals, and human beings all cause weathering.
4. Deposition is the deposit of sediments that have been moved or transported by water, ice, or wind. Wind and ice deposits are not neatly layered—the different size particles are all mixed up. Water layers sediments according to particle size and density when they are deposited.
5. Heat, pressure, and the actions of liquids and gases are factors that create metamorphic rocks.
6. Answers will vary.