



Activity: Edible Geology

Purpose: To provide an opportunity for students to infer the physical characteristics of some of the Franciscan Complex rocks by comparing rock samples to familiar candies.

Duration: 20 to 30 minutes

Materials required:

- 1 2 oz. cup (plastic or paper) per student
- 1 Jelly Bean per student
- 1 Jolly Rancher® per student
- 1 Gum Drop or Spice Drop per student
- 1 piece of green Saltwater Taffy per student
- 1 *Edible Geology* worksheet per student
- Worksheet key for teacher reference
- *Franciscan Rocks of the Marin Headlands Terrane* poster (in map tube or at <http://www.nps.gov/goga/forteachers/upload/Franciscan%20Rocks%20poster.pdf>)
- *Geology of the Golden Gate Headlands* poster (in map tube or at <http://www.nps.gov/goga/forteachers/upload/San%20Francisco%20Bay%20Geology%20poster.pdf>)

Directions:

- ✓ Hang geology posters in the classroom for reference.
- ✓ Ask all students who feel they are **experts** in rock identification to raise their hands.
- ✓ Ask all students who feel they are very knowledgeable about candy to raise their hands (you should see a few more hands!).
- ✓ Let the students know that today's activity will give them a chance to apply their knowledge and experience with candy to rocks. They will be learning the physical characteristics a geologist looks for when identifying rocks, and about the weathering agents that change these rocks.
- ✓ Distribute an *Edible Geology* worksheet to each student. Review some of the

physical characteristics that are helpful to observe, including color, texture (smooth or rough), and shape. Review the definition and agents of weathering. Have students guess what the icons on the bottom of the worksheet represent:



Rain, ice, wind, human activity, waves, plants (roots). Students may be surprised to learn that rainwater breaks down rocks faster than ocean waves. All rain contains some amount of mild acid (even in environments with unpolluted air), which dissolves the clay minerals found in some rocks. Franciscan rocks, which have the most clay minerals, tend to weather the fastest.

Note: Geologists refer to unweathered rocks as “fresh,” even though the rocks may be very, very old!

IMPORTANT!
NO NIBBLING YET!!

- ✓ Distribute a cup with the four candies to each student.
- ✓ Ask the class to name the four “rocks” (candies) in their cups. Write the four “rock” names on the board:
- ✓
 - Jolly Rancher®
 - Gum Drop (or Spice Drop)
 - Saltwater Taffy
 - Jelly Bean
- ✓ Have students work in pairs. Share the first rock story with the class. Ask the pairs to discuss which candy has some of the same physical characteristics as the rock in the story, and which candy most closely matches the rock in the story. Ask several pairs to share their thoughts with the rest of the class. When the class reaches a consensus, identify the Franciscan rock and proceed with the next rock story. Have students fill out their worksheets as you progress through the rock stories.

ROCK STORY #1

This rock erupts from underwater volcanoes. Imagine a volcanic eruption on the deep, deep ocean floor. How will this eruption be different from a volcano on land? *The pressure of the seawater will keep the lava near the vent. You won't see big clouds of ash.*

The lava erupts in distinct blobs, with each new blob forming over the older ones. Imagine the hot lava erupting into cold, cold seawater (the temperature of deep seawater is about 0°C, but the very high pressures at these depths prevent it from freezing).

What happens to the lava when it comes in contact with the cold seawater? *It hardens.*

Will the entire blob harden immediately? *No.*

Which part of the lava blob will harden first? *The outside. The interior of the blob can stay warm and squishy for hours or days.*

Which candy is the most similar to this rock?

Look for these characteristics:



- Shaped like a rounded blob
- Smooth and shiny exterior
- Squishy interior

It's the Jelly Bean! Geologists call this rock **pillow basalt** (the rounded shapes of the rocks look like pillows). The jelly-bean shapes you see in rock outcrops are about one meter long—giant jelly beans! “Fresh” pillow basalt is usually dark gray, green, or black. Pillow basalt contains lots of iron. What happens to something like a bicycle when it's left out in the rain? *It rusts.* When pillow basalt is exposed to rain, the iron in the rock oxidizes and the rock turns reddish-brown. Weathered pillow basalt is rough and crumbly, and has a rusty color.

ROCK STORY #2

This rock covers the deep ocean floor. It's formed by billions and billions of microscopic skeletons of plankton called Radiolaria. Radiolarian plankton have beautiful, ornate skeletons made of silica. When they die, their skeletons drift down to the ocean floor, forming an ooze. This ooze eventually turns into a hard, blocky silica (quartz) sedimentary rock. The blocky, rectangular-shaped rocks often contain many different-colored layers. This rock contains almost no clay minerals, so it resists weathering.

Which candy is the most like this rock?

Look for these characteristics:



- Blocky, rectangular shape with some smooth surfaces.
- Hard—it will last the longest in your mouth!
- Many different colors

It's the Jolly Rancher®! Geologists call this rock **radiolarian chert**. If you have a magnifier, sometimes you can see very small, gray spheres in the pieces of lighter-colored chert. The gray spheres are the skeletons of the radiolaria that make up the rock. Indigenous people of the Bay Area used this rock to make arrowheads and spear points. Because it contains almost no clay minerals, it weathers the most slowly of the four common Franciscan rocks.

ROCK STORY #3

This rock forms during the underwater earthquakes and landslides that occur along the edges of continents. The sediments are a mix of continental-based and ocean sediments. They are transported quickly underwater during quakes and slides. The jumbled sediments form a gritty, sandy rock. This rock feels rough, and often you can scrape off grains of sand from weathered samples. In the headlands of the Golden Gate, this rock almost always feels gritty, like sandpaper. The rock contains different-sized angular sand grains as well as iron and clay minerals, so it weathers pretty easily, becoming rusty-looking and crumbly.

Which candy is most like this rock?

Look for these characteristics:



- Rough
- Feels gritty
- Rock fragments (sugar crystals) weather (fall off) easily when rubbed

It's the Gum Drop (or Spice Drop)! Geologists call this rock **graywacke sandstone** (gray-WAK-ee). The name, graywacke, comes from an old German mining term, meaning gray, mixed-up gravel rock. Geologists use the term for gritty, gray sedimentary rocks containing angular (not rounded) grains of different sizes and colors. To help you recall the name of this mixed-up sandstone, remember that a "wacky" person is a bit mixed-up.

ROCK STORY #4

This rock is pretty mysterious. Geologists think it forms beneath the crust, in the Earth's mantle. It behaves like warm plastic, getting squeezed into cracks in the Earth's oceanic crust. During formation, seawater becomes part of its chemical make-up. Many of the minerals that form this rock are shades of green and blue-green.

Which candy is most like this rock?
Look for these characteristics:



- Green color.
- Soft, like warm plastic
- Contains saltwater!

It's Saltwater Taffy! Geologists call this rock **serpentine** or **serpentinite** (the state rock of California). Serpentinite can be several colors, but often it is green or bluish-green. It feels soapy or waxy. Seawater is incorporated into the rock as it forms in the deep crust. It forms clayey soils of various colors. It contains lots of clay minerals, so serpentinite weathers the most easily of the four Franciscan rocks we are working with today.

Now you may “weather” your “rocks!”

O.K. TO NIBBLE NOW!!

Things to think about while nibbling:

- Which part of the process of eating the candy is most like chemical weathering?
Digestion and the action of saliva dissolving the candies. This is similar to the effect of rain dissolving the clay minerals in rock.
- Which part of the process of eating the candy is most like physical or mechanical weathering?
Chewing. This is similar to the breakdown of rocks during landslides, earthquakes, or bulldozer activity.

To place the rocks in the context of an oceanic sequence, have students fill out the *Environments of Formation* worksheet on the back of the *Edible Geology* chart.

Check to make sure students have filled out their worksheets, and that they have written their names on them. They can refer to these worksheets when they investigate the traveling trunk rock hand specimens during the *Questioning the Franciscan Rocks* activities.