Bay Area Scientists in Schools Presentation Plan

Lesson Title: Snack Tectonics
Presenters: Kathryn Watts, Leslie Hayden
Grade Level: 4th Grade Earth Science

California Science Standards

4-5.) Waves, wind, water, and ice shape and reshape the Earth's land surface.
4-5.a) There are slow and rapid processes that change the Earth (erosion, landslide, volcanoes, and earthquakes)

Next Generation Science Standards

4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.

4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena. (5-PS3-1) • Develop a model to describe phenomena. (5-LS2-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Identify the evidence that supports particular points in an explanation. (4-ESS1-1) Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2)	**ESS1.C: The History of Planet Earth** • Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2) **ESS3.B: Natural Hazards** • A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) *(Note: This Disciplinary Core Idea can also be found in 3.WC.)*	**Patterns** • Patterns can be used as evidence to support an explanation. (4-ESS1-1),(4-ESS2-2) **Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1),(4-ESS3-2) - **Influence of Engineering, Technology, and Science on Society and the Natural World** • Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2) - **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** Science assumes consistent patterns in natural systems. (4-ESS1-1)

Common Core State Standards Connections:

ELA/Literacy -

RI.4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. (4-ESS2-2)

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W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-ESS1-1),(4-ESS2-1)

W.4.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-ESS1-1)

Mathematics -

MP.2 Reason abstractly and quantitatively. (4-ESS1-1),(4-ESS2-1),(4- ESS3-2)

MP.5 Use appropriate tools strategically. (4-ESS2-1)

Abstract: In this lesson, we will learn about layers of the Earth and basics of plate tectonics using edible models. We will model all major types of plate boundaries and discuss how the San Andreas Fault was formed.

Vocabulary/Definitions:

Lithosphere: rigid outer layer of the Earth, made of plates that fit together like a jigsaw puzzle.
Asthenosphere: flowing layer of the Earth beneath the lithosphere that plates "float" on top of.
Divergent plate boundary: Area of the Earth where two plates are spreading apart from one another.
Convergent plate boundary: Area of the Earth where two plates are colliding.
Transform plate boundary: Area of the Earth where two plates are sliding past one another.
Continental crust: Thicker, and less dense type of crust that forms continents.
Oceanic crust: Thinner, and denser type of crust that forms the ocean floor.

Materials:

We will bring: poster with a cross section of the Earth and plate tectonics map, digital slides to show on computer, rocks, graham crackers, fruit roll ups, cups, frosting, wax paper sheets, plastic knives or spoons.

Classroom Set-up:

Students should be seated at desks or tables with a clear view of the presenters at the front of the room.

Classroom Visit

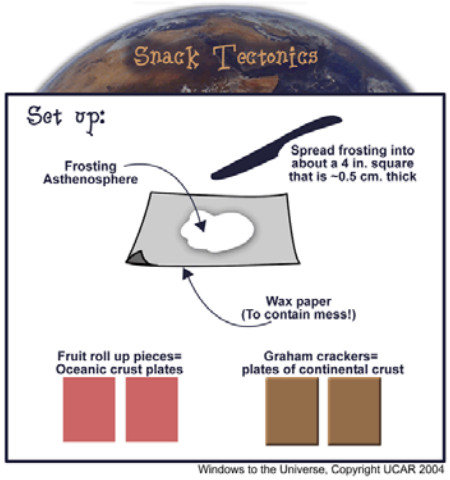
1. Personal Introduction and Topic Introduction: 5-10 minutes

Hi, my name is Kathryn and this is Leslie. We are geologists at the U.S. Geological Survey. Geology is the study of the Earth and what it is made of. A lot of the Earth is made up of rock. Usually when you see rocks it doesn't look like they are moving. But in fact, they are constantly moving. The whole earth is covered with huge slabs of moving rock, called tectonic plates. They float on top of the Earth's mantle on a flowing layer called the asthenosphere (show Earth cross section). If you look at a map of the Earth (show poster, overheads), you can see that some pieces of the continents look like they used to fit together like a jigsaw puzzle. This is because over time, they have spread apart. Right now, you're standing on a large tectonic plate that is moving towards Mexico! But it is going so slowly, that you don't notice. It's moving about as fast as your fingernails grow. Here in the Bay area we are at the boundary between two plates, separated by the San Andreas Fault. Has anyone heard of the San Andreas Fault? What is it? Today, we're going to learn about how the Earth's plates move using graham crackers, fruit roll ups and frosting. You can eat your science project when you're done!

2. Learning Experience: 35-40 minutes

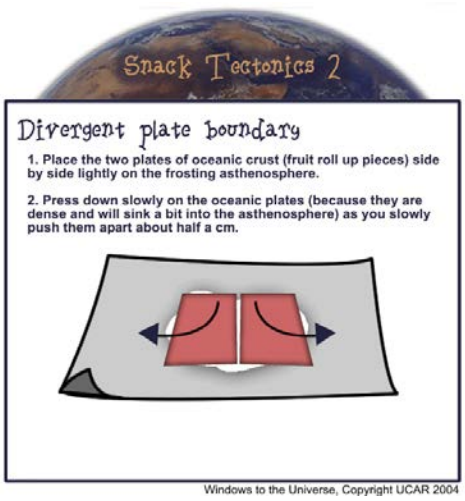
The Earth's crust has two main types: continental crust that forms the continents, and ocean crust that forms the ocean floor. Continental crust (graham cracker) is thicker and less dense than oceanic crust (fruit roll up). These plates "float" on top of the upper part of the Earth's mantle called the asthenosphere (frosting). The asthenosphere flows, allowing the plates to move around. Now we're going to explore how the Earth's plates move using our snack models.

Set-up:
Pass out materials to each student or student group depending on the number of students. Each group gets: a square foot of wax paper, large dollop of frosting to spread around about ½ cm thick with a knife or spoon, two square pieces of fruit roll ups, two graham crackers, and a cup of water.



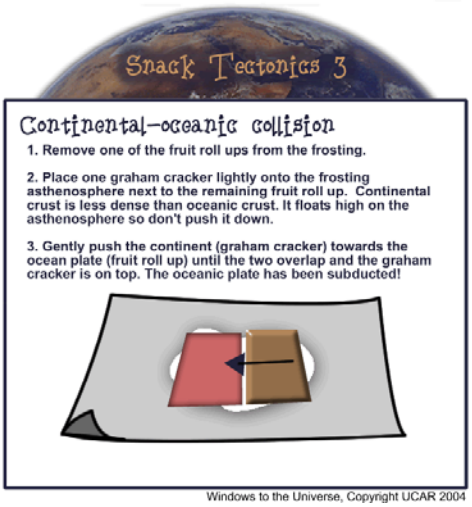
Divergent plate boundary:

a. Instruct students to place the two squares of fruit roll up (oceanic plates) onto the frosting right next to each other.
b. Press down slowly on the fruit roll ups (because they are dense and will sink a bit into the asthenosphere) as you slowly push them apart about half a cm.
c. Notice how the frosting is exposed and pushed up where the plates are separated? This is analogous to how magma comes to the surface where real plates are moving apart at divergent plate boundaries. Most divergent plate boundaries are located within the ocean crust.



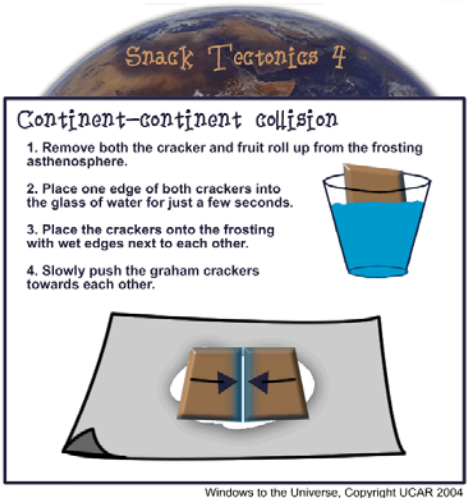
Convergent plate boundary (continental-oceanic collision):

a. Instruct students to remove one of the fruit roll ups from the frosting. (They can eat it if they wish!).
b. Tell students to place one of the graham cracker halves **lightly** onto the frosting asthenosphere next to the remaining fruit roll up piece. The graham cracker represents continental crust, which is thicker and less dense than oceanic crust (fruit roll up). It floats high on the asthenosphere so don't push it down.
c. Gently push the continent (graham cracker) towards the ocean plate (fruit roll up) until the two overlap and graham cracker is on top. The oceanic plate is subducted below the continental one. This type of plate boundary is where volcanoes form.



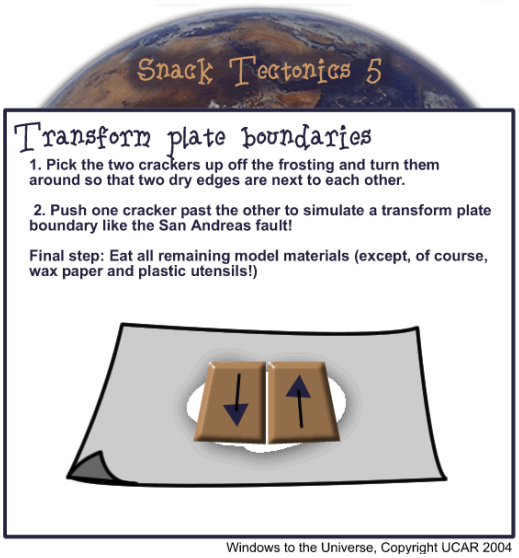
Convergent plate boundary (continent-continent collision):

a. Tell students that they will next model what happens when two continents collide. Have them remove both the cracker and fruit roll up from the frosting. (Students can eat or discard the fruit roll up.)
b. Place one edge of both crackers into the glass of water for just a few seconds.
c. Place the crackers onto the frosting with wet edges next to each other.
d. Slowly push the graham crackers towards each other.
e. Notice how the wet edges crumple? This is how mountains are made at convergent plate boundaries! When continents move towards each other, there is nowhere for them to go but up!



Transform plate boundary:

a. Pick the two crackers up off the frosting and turn them around so that two dry edges are next to each other.
b. Push one cracker past the other to simulate a transform plate boundary like the San Andreas Fault!



Final Step: Eat all remaining model materials (except, of course, wax paper and plastic utensils!)

3. Wrap-up: Sharing Experiences and Building Connections: 10 minutes

The Earth's surface is covered in tectonic plates that move. The way that plates interact with each other creates many of the geologic features we see on Earth. Depending on whether they are continental or ocean plates, and how they are moving past one another, you can get volcanoes, mountains, or earthquakes like those along the San Andreas Fault. We explored this process with graham crackers, fruit roll ups, and frosting. What did each of these represent?

Do you want to see what real rocks look like along the San Andreas Fault? Pass around rock samples with slickensides. See these marks on the surface of the rock? This is what happens when rocks slide past one another, like the graham crackers that slid past one another when we modeled the transform plate boundary.

4. Close: 5 minutes

Thanks and good-bye. Clean-up remaining model materials.

TOTAL: <u>60 Minutes</u>