Classroom Teacher Preparation

Earth Science 18: Modeling the Mantle

Please use the following to prepare for the next SfS lesson.

Description:

The upper portion of the Earth's mantle, called the asthenosphere, is a special type of solid material that can flow under steady pressure over long time periods. Such a material is called a viscoelastic solid, and behaves as a liquid under steady pressure but as a solid in response to sudden shock. This lesson gives students hands-on practice with two different viscoelastic materials – Silly Putty & oobleck – that also exhibit the behaviors of both solids and liquids in order to promote understanding of the properties of the Earth's asthenosphere, and give them the opportunity to use these substances to model the movement of tectonic plates in contact with the asthenosphere.

Lesson Objectives – SWBAT ("Students Will Be Able To…"):

3rd-8th

- Characterize viscoelastic solids as compared to solids and liquids
- Use oobleck and *Silly Putty* as physical models for Earth's asthenosphere

Disciplinary Core Idea (DCI)

ESS2 Earth's Systems - ESS2.B Plate tectonics and large-scale system interactions

- (3rd-5th) Earth's physical features occur in patterns, as do earthquakes and volcanoes. Maps can be used to locate features and determine patterns in those events.
- (6th-8th) Plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history. Maps are used to display evidence of plate movement.

Science & Engineering Practice (SEP)

Developing and Using Models

- (3rd-5th) Develop and/or use models to describe and/or predict phenomena.
- (6th-8th) Develop and/or use a model to predict and/or describe phenomena.

Crosscutting Concept (CCC)

Systems and System Models

- (3rd-5th) A system can be described in terms of its components and their interactions.
- (6th-8th) Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

Scale, Proportion, and Quantity

- (6th-8th) Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Preparation:

Students should be familiar with the layered structure of the Earth, and know that the layers have different properties. *Earth Science 2: Intro to Tectonics* or recent coverage of this topic in the classroom are required for understanding and appreciation of this module topic.

Room Set Up for Activities:

Students will work in pairs while experimenting with Silly Putty and small samples of the cornstarch-and-water mixture known as “oobleck.” No special equipment is needed, but the oobleck has the potential to be messy. Instructors will be prepared with paper towels and a pitcher of water for rinsing hands; access to a dustpan and broom may be useful.

Safety:

There are no safety issues associated with this lesson.

Related Modules:

This lesson may be taught as part of a sequence or group of related modules on **Earth Science**, in particular regarding the structure of the earth or earthquakes. Modules include:

Earth Science 2: Introduction to Tectonics: Students work in pairs to construct a puzzle model of Pangea. They then analyze a modern-day map of the tectonic plates, model the plate boundaries using putty and tiles, and then return to the opening question about mountain formation.

Earth Science 15: Seismic Waves - An introduction to the concept that S- and P-waves travel at different speeds away from the epicenter of an earthquake. Students use triangulation to locate the epicenter of a theoretical earthquake.

Engineering 7: Earthquake-Resistant Buildings: This module focuses on model testing of various earthquake-resistant designs. Students will build different block configurations and test them using shake tables to determine which model provides the best protection in a simulated earthquake.

This lesson would also work well in relation to **Chemistry**, in particular:

Chemistry 11: States of Matter -- Students observe many of the transitions between the different states of matter using dry ice. For older students, this topic is connected to heat transfer and the flow of energy.

Chemistry 14: Viscosity – Students investigate viscosity by using falling sphere viscometers to examine the speed at which a marble drops through tubes of liquids with varying viscosities.

For other module sequences and groups, look here: www.sciencefromscientists.org/sequences

Standards Covered:

Please click the following link to our website to review the standards covered by this lesson, listed by state: www.sciencefromscientists.org/standards/

Lessons are matched to both national NGSS and local state standards.

After Our Visit:

Extend this lesson by inviting students to model tectonic plates and the asthenosphere with whipped topping and graham crackers.

Access this Extension activity by visiting the Classroom Post found on our website at sciencefromscientists.org/cohorts. Use the name of your school/cohort and password to log in.

To help Evaluate, check out our Open Response questions online at sciencefromscientists.org/open-response-questions. They are freely available for all of our lessons for current teachers. Use the password supplied by your instructor to log in.

Additional Resources:

- A two-day lesson plan on plate tectonics by PBS Digital Media: http://mass.pbslearningmedia.org/resource/ess05.sci.ess.earthsys.lp_platetectonics/plate-tectonics/
- Plate Tectonics: An introduction (video): http://mass.pbslearningmedia.org/resource/ess05.sci.ess.earthsys.plateintro/plate-tectonics-an-introduction/
- Dynamic Earth interactive: http://mass.pbslearningmedia.org/resource/fe7ae96f-b758-49bc-8da6-7b912892e484/fe7ae96f-b758-49bc-8da6-7b912892e484/
- Asthenosphere: Using Silly Putty as an Analogy (video): http://www.iris.edu/hq/inclass/video/asthenosphere_using_silly_putty_as_an_analogy
- Lesson on Viscoelasticity: (copy/paste link) https://www.teachengineering.org/lessons/view/cub_surg_lesson04