TEACHING ROCKS IN THE CONTEXT OF PLATE TECTONICS

Natalie Juda, Graduate student at Scripps Institution of Oceanography, **Joe Krupens**, teacher of 9th grade Earth Sciences and AP Environmental Science at University City High School

Abstract

The purpose of this unit is to teach students about rocks in relation to plate tectonics in a 9th grade Earth Science classroom setting. It is intended for students with previous knowledge of plate tectonics and volcanoes.

To that end, an important aspect of learning was bringing hands-on access to rock specimens to students who would previously have disregarded rocks. Also imperative was allowing them time to explore and describe the rocks think about how they formed.

In addition to activities involving actual rock specimens, other hands-on activities were developed to better develop student understanding of processes of rock formation using proxies for rocks that can be manipulated within a class period.

This unit is formulated to fit a 5 "E" learning method format (Engage, Explore, Explain, Extend, Evaluate) over the course of one to two days.

- Students "engage" when answering a key question relating to each day's lesson in their notes and sharing their ideas with the class.
- Following this, an activity is introduced where students "explore" a particular aspect of the lesson.
- Students then "explain" what they learned. With additional information provided by the teacher, the students have a better understanding of the concept.
- To "extend", the students apply the information gained to a second activity, furthering their knowledge. In addition, they apply the methods of rock formation to plate tectonic settings
- Finally, they are "evaluated" through verbal communication of understanding throughout the lessons and worksheets summarizing the knowledge learned.

Setup

Features of the Ocean Floor - Remote Sensing and Topographic Maps

Objective: Simulate remote sensing for determining what features are present on the sea floor and creating topographic maps

Materials used:

6 Boxes, each with a model of features of the ocean floor and lids with grid of holes
Lined up, the boxes are a representation of the Indian ocean from Africa to Indonesia as closely to scale as possible.

6 Wooden stick "sounding rods"

Using the wooden stick as a "sounding rod", measure the depth from the top of the box (representing sea level) to the bottom of the ocean directly beneath the hole.
Write measurements on graph paper with the same grid as the box lid.
Draw contour lines at regular contour intervals, creating a topographic map of the sea floor features in each box.

Figure 1. (a.) Photographs of the set of boxes representing parts of the sea floor (left to right: Passive continental margin, half of mid-ocean ridge, second half of mid-ocean ridge, abyssal plain, seamount, trench at continental margin). (b.) Individual box with wooden stick "sounding rod".

(a.)

(b.)

Daily Activities

Rocks and Minerals

Rocks and Mineral Identification

Objective: Distinguish between rocks and minerals and classify rocks by type

First hands-on rock identification activity(beginning of unit):
Set of 10 rocks and minerals per table of students (2-3 of each kind: mineral, igneous rock, sedimentary rock and metamorphic rock)

Final hands-on rock identification activity (end of unit):
Set of 15-20 rocks of varying kinds

Describe each rock in as much detail as possible, particularly size of particles, kind of particles, shape of particles, color, patterns (especially alignment), etc. From the description and information provided, determine what kind of rock type it is.
For the final activity, also determine the subcategory of whatever rock type it is and the name of the rock. See figures 2, 3, 4 for possible rocks to identify.
For each type of rock, a set of representative samples will be analyzed by the students using the classification criteria provided.

Igneous Rocks

Crystallization activity

Objective: Determine the relationship between the rate of cooling and the size of crystals formed from a melt.

Material used:
Salol crystals (aka phenyl salicylate), a chemical with a low melting temperature that when cooled, forms discrete crystals within a short amount of time

Condition 1: Melt cooling at room temperature
Simulates cooling within the earth
- Cooling rate is slower
- Crystals are larger

Condition 2: Melt cooling on ice
Simulates cooling at the surface of the earth
- Cooling rate is faster
- Crystals are smaller

Figure 2. Photograph of a select group of igneous rock samples (clockwise from top: basalt, granite, obsidian, pumice, rhyolite)

Sedimentary Rocks

Sediment Settling Activity

Objective: Sediment characterization and determination of processes governing sedimentary deposition

Materials used:
Clear containers allowing for at least 1cm thick layers of sediments within half the volume
Sediments (at least three different types differing in size and possibly other properties)

Describe each sediment individually, remarking upon properties like size, shape, weight.
Pour each sediment into the container to form visible layers. Add water. Shake or stir to suspend all sediment. Let settle.
Some slight mixing may occur but settling tends to form layers (largest to smallest)

Figure 3. Photgraph of select sedimentary rocks (clockwise from top: conglomerate, coquina, sandstone, shale, coal).

Metamorphic Rocks

Clay Deformation

Objective: Determine what forces metamorphose rock
Use different colored clay to make "sedimentary" rock layers (some thin flat like silt and some made of larger "cobbles")
Compress layers until flattened together (e.g. regional metamorphism)
Drop onto table to create localized deformation (e.g. contact metamorphism)

Figure 4. Photograph of select metamorphic rocks (clockwise from upper left: schist, marble, slate, gneiss)

Rock Cycle

Sugar Rock Cycle:

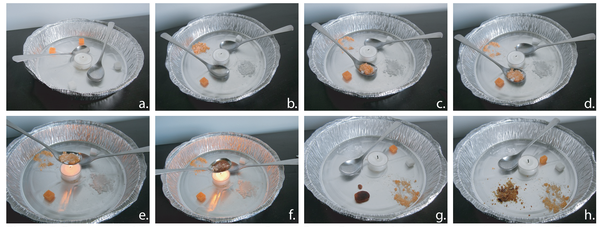

Figure 5. Photos of different stages of the Sugar Rock Cycle activity: a. setup of activity, b. Stage 1 (weathering and erosion), c. Stage 1 (deposition), d. Stage 2 (compaction), e. Stage 3 (metamorphism), f. Stage 4 (melting), g. Stage 5 (cooling and crystallization), h. Stage 6 (weathering and erosion).

Starting point: Sugar Cube (represents a cemented chemical sedimentary rock)

1. Sedimentary rock ⟶ Sediment
   Crush sugar cube (weathering and erosion)
2. Sediment ⟶ Sedimentary rock
   Move crushed sugar into spoon (erosion and deposition)
   Press down onto crushed sugar (compaction)
3. Sedimentary rock ⟶ Metamorphic rock
   Press as hard as possible (metamorphism)
   Place spoon with sugar over flame until bottom begins to soften (contact metamorphism)
4. Metamorphic rock ⟶ Magma
   Completely melt the sugar (melting)
5. Magma ⟶ Igneous rock
   Pour sugar out of spoon and set aside (cooling and crystallization)
6. Igneous rock ⟶ Sediment
   Crush the solidified sugar (weathering and erosion)

Figure 6. Concept Map of Rock Cycle