Constructing the Rock Cycle - Directions

OBJECTIVE: In this activity you will identify rock samples and place them in the tectonic environment in which they form to construct the rock cycle.

- Begin by laying out the Constructing the Rock Cycle poster and assembling as many rock samples and materials from the following list as you have available:

Andesite	**Bituminous Coal**	**Dolostone**	**Granite**	**Obsidian**	**Rhyolite**	**Shale**
Anthracite Coal	**Breccia**	**Gabbro 1**	**Greenstone**	**Peat**	**Sandstone**	**Siltstone**
Basalt - Massive	**Conglomerate**	**Gabbro 2**	**Limestone**	**Pumice**	**Scoria**	**Slate**
Basalt - Vesicular	**Diorite**	**Gneiss**	**Marble**	**Quartzite**	**Schist**	**Tuff**

We will link these samples with the geologic environments where they form to see how the rocks relate to one another. We are going to draw on some of your experience with plate tectonics for this task.

- Take out the personal diagram showing a cross section through the Earth's crust. Like the poster, this diagram portrays a mid ocean ridge, a subduction zone, a volcanic mountain range, and a continent with a river valley cutting across plains, past a swamp, to a passive coastal margin with an off shore coral reef. From left to right this diagram is roughly what one would encounter if you started in the Pacific Ocean off the coast of Washington and Oregon and travelled south east across the mountains to the Mississippi River Valley and the coast of the Gulf of Mexico.
- Begin by sorting the rock samples into igneous, sedimentary and metamorphic rocks. Igneous rocks possess randomly oriented crystals or a glassy composition. Some may have crystals so small that a hand lens will be needed to see them. Sedimentary rocks are composed of components of pre-existing rocks such as pebbles, sand, silt or clay as well as shells and plant fragments. These are often best identified by the feel of the rock as much as by sight. Metamorphic rocks are made of crystals that are either fused together or oriented in layers (foliation). Again, use your hand lens to help you see the finer crystals.

IGNEOUS ROCKS

- Start with the igneous rocks. Igneous rocks are classified initially by their texture. **Intrusive** igneous rocks cool from magma below the Earth's surface over millions of years. This time allows crystals to grow large enough to be seen with the naked eye. **Extrusive** igneous rocks form from lava that cools rapidly at the Earth's surface. They cool so quickly that they remain in an amorphous glassy structure or form crystals too small to be seen with the naked eye. Examine the igneous rocks you identified. Which samples are **intrusive** (big crystals) versus **extrusive** (glassy or crystals too small to see). Can you see the distinction?
- The second way in which we classify igneous rocks is by their color, specifically how light or dark the overall mixture of minerals makes them. Magma dominated by dark, iron rich minerals is called **mafic** magma and results from melting of mantle rocks. Magma with a more even mixture of iron and silica rich minerals has a medium color and is called **intermediate** magma. Lastly, magma dominated by silica rick minerals is generally very light in color and called **felsic** magma. Continental rocks are dominated by the lighter colored silica minerals while oceanic rocks are dominated by darker mafic minerals. Examine your igneous rocks again. Based on the overall color of the rock, dark, medium or light, can you guess which magma type cooled to form that rock?
- Now examine the poster and hand out of the oceans and continent. Different types of magma are shown forming below the mid ocean ridge and in the subduction zone under the volcanic mountains. Based on the magma types indicated, place the **intrusive** igneous rock samples over the boxes that match the magma from which they formed. Remember that to be **intrusive** the rock must form from magma BELOW the Earth's surface.
- Next note that lava flows and violent eruptions occur where the different magmas reach the Earth's surface at volcanic vents. Each magma type produces a particular kind of lava and its own **extrusive** igneous rock. These rocks contain crystals that are too small to see with the naked eye, but are not made of glass. Similarly, some volcanic eruptions are so violent that the material is thrown in the air to form glassy igneous rocks. Besides being crystal free, these ash and rocks are sharp as glass and often very light weight (low density) because they contain gasses trapped in bubbles that could not escape the magma.
- Let's start with these glassy rocks. Based on the lava type present at a particular vent, place the glassy **extrusive** igneous rock samples over the boxes that match the lava from which they formed. Note, some of these boxes are interchangeable as ash and larger fragments thrown out from a particular volcanic source appears similarly on this

diagram. This leaves the crystalline **extrusive** igneous rocks. These rocks are made of crystals and generally denser than the glassy rocks. Place your samples over the appropriate box reflecting the lava and magma source that the rock's overall color indicates.

- Examine your work so far. Does the texture of the igneous rocks fit with the locations of their formation? Do the overall colors of the igneous rocks formed from a common magma source match? Are there some igneous rocks that can form in multiple environments?

SEDIMENTARY ROCKS

- Once rocks are exposed at Earth's surface they are subject to weathering giving us both solid and dissolved sediments. Boulders, pebbles, sand, silt and clay arise from mechanical weathering. When these sediments are deposited and lithified they produce **clastic** sedimentary rocks. Similarly, sediments dissolved from calcite, dolomite and silica give rise to **chemical** sedimentary rocks when evaporation and biological activity create the right conditions. Plants also can create organic matter which can create **biogenic** sedimentary rocks. Examine the sedimentary rocks you identified previously. Which samples appear to be made of fragments of pre-existing rocks? Where would such sediments accumulate on the Earth's surface?
- Return to the diagram with the continent and oceans. Some surface processes and labels have been added to indicate depositional environments. Rock falls, river channels, river levees, swamps, beaches, reefs and the sea floor are all indicated. Which sediments get deposited where? Consider that most sediment is transported by moving water. The ability of water to transport sediment is dependent upon the energy available and decreases as the water slows. Consider the depositional environments available. Which **clastic** sedimentary rocks will deposit in high energy environments capable of moving large fragments? Which will deposit in low energy environments where only the finest sediments are mobile? Place the **clastic** sedimentary rocks on the boxes for the appropriate depositional environment based on the size of the grains from which they formed. **Chemical** and **biogenic** sedimentary rocks are also deposited in particular environments based on their composition. Where will plant fragments accumulate? Where will shells and their fragments come to rest? Add these to the appropriate boxes on the diagram.

METAMORPHIC ROCKS

- Once igneous and sedimentary rocks form, they can be altered by heat, pressure and chemically active fluids to form metamorphic rocks. Similarly increasing the heat and pressure on metamorphic rocks can transform them into new, higher-grade metamorphic rocks. Directional pressure can impart foliation (crystal layering) on many of these metamorphic rocks. Examine the metamorphic rocks you identified. Some are foliated and others are not.
- Now return to the diagram with the continent and oceans. Notice that many of the existing rocks have an arrow coming out of their box indicating a metamorphic process such as heat or pressure. The original rock from which the arrow comes is the parent. The arrow points to its daughter metamorphic rock. Using the composition of the parent rock and the metamorphic stress provided by the environment, place the metamorphic rocks on their appropriate boxes. Remember that the physical and chemical composition of the parent rock will determine what daughter metamorphic rock forms.

THE ROCK CYCLE

- Examine your completed diagram. It shows how common rocks are related through the rock cycle.
  - Are there some rocks whose proper place remains unclear?
  - Are there rocks that can form in multiple environments?
  - Do you see the relationships between the 3 rock types?
  - Can Earth processes act on rocks to change them from one kind into another?
  - Do you see how individual rocks fit within the rock cycle?
  - Are some rocks related to others in much the way that people descend from their parents and grandparents?
- Before returning the rocks to the box, be sure to complete your personal diagram of the rock cycle by writing the name and number of each rock type on a line in the appropriate rock category. You may have to add lines to accommodate all your samples.