Science Unit: ***Geology and Plate Tectonics***

Lesson 3: ***Making Rocks – Exploring the Rock Cycle***

School Year:	2011/2012
Developed for:	Laura Secord Elementary School, Vancouver School District
Developed by:	Linda (Hanson) Herbert (scientist); Lesley Chambers and Phil Green (teachers)
Grade level:	Presented to grade 6/7; appropriate for grades 2 – 7 with age appropriate modifications
Duration of lesson:	1 hour and 20 minutes
Notes:	Students should be familiar with the processes of weathering and erosion and have some prior exposure to the rock cycle. Lesson plans on Weathering (Lesson 2) and Erosion (Lesson 3) can be found in the Scientist in Residence Program Unit "The Earth Around Us: Air, Water and Soil". http://scientistinresidence.ca/science-lesson-plans/the-earth-around-us-air-water-soil/ Preparing the salt crystals in advance of the lesson requires 1-3 days.

Objectives

1. Explore how different types of rocks are created and transformed as part of the rock cycle.
2. Learn about crystal formation.
3. Practice making detailed observations.

Background Information

Rocks are constantly being created and destroyed. The rock cycle explains how sedimentary, igneous and metamorphic rocks form and how the three rock families change from one to another. Sedimentary rock form, as their name implies, from sediments that have been deposited as a result of weathering and erosion processes. As the sediments accumulate the weight of the overlying sediment compacts the underlying sediments into a solid mass. If the sediment deposit occurs in a body of water, or is exposed to water, dissolved minerals can act as a natural glue and cement the particles together into a slab of sedimentary rock. As this process is repeated over time the rock takes on a layered appearance as new layers of rock form on top of existing layers. Igneous rock is formed when molten magma cools and solidifies within the earth or molten lava (magma that has reached the earth's surface) cools and solidifies on the earth's surface. The rate at which the molten material cools affects the appearance of the final product. Igneous rock that form under the earth's surface can also be referred to as intrusive igneous rock while that that form on the earth's surface can be referred to as extrusive igneous rock. Metamorphic rock forms when existing rocks are subjected to intense heat and pressure (usually as a result of being buried deep under the earth's surface) which alters the original rocks. The new metamorphic rock may be altered in appearance, crystal composition, or structure. In general, it is also much harder than the original parent rock.

Vocabulary

Weathering:	The physical or chemical destruction of rock.
Physical weathering:	The breaking down of rock into smaller pieces with no change in composition.

Chemical weathering:	The decomposition of rocks due to exposure to water or water vapor, carbon dioxide or oxygen. The rocks are changed from their original state.
Erosion:	The movement of rocks or rock particles due to natural forces (wind, water, gravity).
Sedimentary rock:	Rock formed from sediments that become compacted and cemented together over time.
Igneous rock:	Rock formed when magma from the earth's interior cools and hardens.
Metamorphic rock:	Rock formed from pre-existing rocks due to the application of intense heat and pressure.
Magma:	Hot molten rock under earth's surface.
Lava:	Magma that has been forced out onto the surface of the earth.
Intrusive igneous rock:	Formed when magma cools under the earth's surface. Usually cools slowly and results in large crystals.
Extrusive igneous rock:	Formed when magma/lava cools on the earth's surface. Usually cools quickly and results in small crystals.
Foliation lines:	Lines or cleavage planes that form in metamorphic rock due to the realignment of minerals in the parent rock (caused by heat and/or pressure).

Materials

- Glass jars with lids (minimum 1 per group)
- sand
- pea gravel
- Small (~2 cm) stones
- silt or fine soil (optional)
- water
- Modeling clay or Plastercine (minimum two colours)
- butter knives or metal rulers
- small Petri plates (1 per group)
- saturated salt solution (250 mL), see below for instructions
- eye droppers or pipettes
- wax paper
- small Petri plates or similar (1 per student)
- 10X magnifiers (#S19006 from Fisher Scientific were used for this lesson); microscopes (if available).
- worksheets & pencils
- pencil crayons (optional)

In the Classroom

Introductory Discussion

1. Today each one of you is going to have a chance to be the rock cycle. We are going to simulate the rock cycle to explore how sedimentary, igneous and metamorphic rocks are made.

- Let's start by reviewing the rock cycle (students will have learned this in the last lesson). Have students contribute information to quickly draw a diagram of the rock cycle on the board. (For a review of the rock cycle see lesson 2 in this unit.)
- How are sedimentary rocks made?
- How are igneous rocks made?
- How are metamorphic rocks made?

2. Short description of other items to discuss or review.

- Review safety instructions.

3. Briefly describe science experiment/activity.

- Students will complete three mini-activities to explore different areas of the rock cycle. The students will work in small groups of ~4 students and all groups will conduct the same activities at the same time.
    - Activity 1: Sediments and sedimentary rock.
    - Activity 2: How does formation time influence crystal size?
    - Activity 3: Turning sedimentary rock into metamorphic rock.

4. Briefly describe the processes of science that the students will focus on: Students will be recording observations and results and using this information to draw conclusions.

5. Briefly describe safety guidelines.

- Hold your jars securely (with two hands) when shaking them.
- Do not touch your face or mouth while conducting the activities and remember to wash your hands at the conclusion of the activities.
- Do not taste or eat the salt crystals.

Brief description of how students will work in groups or pairs: Students will sit in small groups (4 students) for the duration of the lesson. Some tasks will be done as a group and some will be done individually. Each student will record their observations individually.

Science Activity/Experiment

Activity Title: Sediments and sedimentary rock.

Purpose of Activity: To observe how particle size influences sedimentary rock formation.

Prediction or Hypothesis: Prior to starting the experiment, have students predict how the appearance of the final product will differ from the initial appearance.

Methods and Instructions:

Set-up prior to experiment: If the time available for the lesson is limited to 120 min it is suggested that the scientist and/or teacher prepare the sediment jars in advance. If additional time is available this step can be done by the students as part of the lesson.

- Layer the following in each of the clear glass jars, starting at the bottom: 1 cm soil/fine sediment, 1 cm sand, 1 cm pea gravel, 2-4 small stones. Once all of the layers are in place SLOWLY fill the jar with water (trying not to disturb the layers). It may help to pour the water over the back of a spoon. Replace and tighten the jar lid.

Brief description of how students will work in groups or pairs: Students will work in groups for this activity and record their observations individually.

1. See worksheet for detailed instructions.
2. Have students draw a “before” diagram. Remind them that they are drawing a scientific diagram.
3. Have each student take a turn shaking the jar to mix the sediments.
4. Once they are thoroughly mixed briefly discuss what the students see and then place the jars to the side to settle until the next two activities are completed (approximately 30 minutes).
5. Have the students complete the remainder of the *Sediments and sedimentary rock* worksheet.

Activity Title: How does formation time influence crystal size?

Purpose of Activity: To observe how rapidly formed crystals differ from slowly formed crystals.

Prediction or Hypothesis: Have students complete the first section of the worksheet and record their predictions.

Methods and Instructions:

Set-up prior to experiment (1-3 days in advance):

1. **Prepare a saturated salt solution:** Bring ~300ml (1 ¼ cups) of water to a boil and stir in ~100g (½ cups) of salt. Continue to stir until no more salt dissolves. If all of the salt does dissolve, add more salt ~25g at a time and continue stirring until no more salt dissolves. Pour solution into a glass measuring cup (or similar), cover and let cool. Once solution is completely cool decant the liquid into a new container (leaving the leftover salt behind).
2. **Prepare slowly formed salt crystals:** You will need to prepare one Petri plate/dish per group. Place a very thin layer of salt solution in the bottom half of each Petri plate (approximately 2 ml deep). Place the uncovered Petri plates in a cool place and allow them to sit undisturbed for 24-72 hrs (until all of the liquid has evaporated and large salt crystals are visible). Replace the lids to aid in transporting the crystals.

Brief description of how students will work in groups or pairs: Students will observe and record their observations individually but group discussion of their observations is encouraged.

1. Pass out materials to each group (one dish of slowly formed crystals, one empty Petri plate (or similar small dish) per student, magnifiers, microscopes if available.
2. Students will compare the prepared (i.e. slow) crystals to rapidly formed crystals that they will make. Use the worksheet as a guide.
3. Place 5-10 drops of saturated salt solution on each student's Petri plate. The goal is to create a very thin film of liquid in the bottom of the dish. If too much is added simply have students dump the excess out. Students can use a variety of techniques (depending on what is available) to evaporate the water in the solution and form their crystals. Some suggestions are: blowing on their solution, putting it under a hot desk lamp, putting it in a sunny window, putting it on the radiator, using a hair dryer etc.
4. Have students examine their crystal samples using the magnifiers (and microscope if available) and record their observations on their worksheet.

Activity Title: Turning sedimentary rock into metamorphic rock.

Purpose of Activity: To help students understand the origin of some of the visual characteristics that they may see in metamorphic rocks (e.g. foliation lines, wavy layers, swirls etc.).

Prediction or Hypothesis: not applicable.

Methods and Instructions:

Set-up prior to experiment: modeling clay (or Plastercine) can be divided into portions. Each student should receive a small chunk (approximately 2 cm by 2 cm by 2 cm) of two different colours.

Brief description of how students will work in groups or pairs: Students will complete this activity individually but discuss their observations and results with their group.

1. Use worksheets as a guide.
2. To keep desk clean it is suggested that students use small pieces of wax paper as work surfaces.

3. Have students cut each chunk of their clay into thin slices using the butter knives or metal rulers. (Some students may prefer to flatten out layers of clay between two pieces of wax paper).
4. Have students create small layered sedimentary "rocks" alternating their two colours of clay. They should have a minimum of 3 layers of each colour.
5. Have a group discussion about the ways that pressure and rock movement within the Earth's crust could affect a sedimentary rock (like the one students' have just made) buried deep in the earth's crust.
6. Have students select the type of pressure they want to apply to their sedimentary rock. Remind them that their actions should mimic something that could conceivably occur in nature. Some suggestions: lightly squishing their rock from both sides, lightly "flattening" their rock, squishing their rock from one side, etc.

Have students complete the activity *Sediments and sedimentary rock*.

Closure Discussion

1. You may choose to review the results of each activity (and have the associated closure discussion) at the conclusion of the activity or do them all at the end of the lesson.
2. How does particle size influence sedimentary rock formation? How will sedimentary rock formation be affected by other natural forces? Erosion? Weathering? Currents, tides etc.
3. What shape are your salt crystals? What type of cleavage would you expect if you fractured a sample of rock salt?
4. (Samples are helpful for this part of the discussion.) What size of crystals do we see in obsidian? Where do you think it is formed? What size of crystals do we see in granite? Where do you think it is formed?
5. If available, hold up an igneous rock sample with a Porphyritic texture (i.e. some large crystals embedded in a matrix of much small crystals). Have students suggest how this rock may have formed (lava cooled at different rates – it started off cooling slowly forming some large crystals and then cooled very rapidly resulting in the small crystals).
6. What characteristics (or patterns) did you observe in your metamorphic rocks?
7. How can you use your new found knowledge to help you decide if a layered rock sample is likely sedimentary of metamorphic?

References

1. Chapman, Anita, David Barnum, Carmen Dawkins and William Shaw. 2005. BC Science Probe 7. Nelson.
2. Zim, Herbert and Paul Shaffer. 1957. Rocks and Minerals: A Guide to Familiar Minerals, Gems, Ores and Rocks. Golden Press.

Extension of Lesson Plan

1. Making sandstone (see extension activities in lesson 2 of this unit).
2. Fossil making (see extension activities in lesson 2 of this unit).
3. Growing edible crystals – have students grow their own rock candy from a saturated sugar solution.

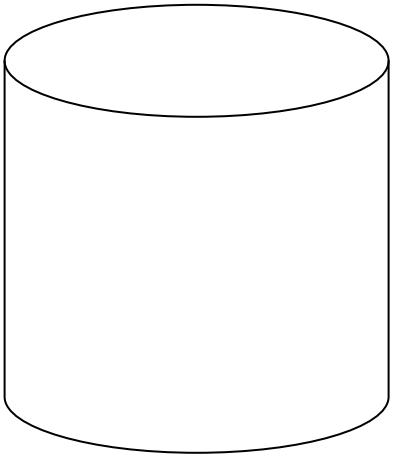
SCIENTIST IN RESIDENCE PROGRAM

Scientist: _____

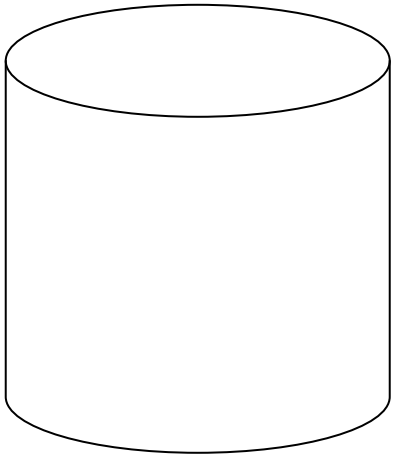
Date: _____

SEDIMENTS AND SEDIMENTARY ROCK

Draw and label a picture of your sediments before mixing.



Draw and label a picture of your sediments after mixing.



Describe how the sediments are arranged. Where are the small sediments? The large sediments?

Before mixing: _____

_____

After mixing:_____

_____

What can you conclude about the relationship between sediment size and sedimentary rock formation?

_____

_____

IGNEOUS ROCK: How does formation time influence crystal size?

When magma/lava cools slowly crystals have _____ time to form.

When magma/lava cools quickly crystals have _____ time to form.

I predict that crystals that form slowly will be _____ than crystals that form quickly.

Use the magnifiers to examine the crystal samples. Draw a picture comparing the two crystal samples and describe your observations below (colour, lustre, shape etc.).

_____

_____

CONCLUSIONS: How does formation time influence crystal size?

_____

_____

Where (in nature) would you expect to find igneous rock with small crystals? _____

METAMORPHIC ROCK: Turning sedimentary rock into metamorphic rock

The two forces that can change sedimentary rock or igneous rock into metamorphic rock are _____ and _____.

Draw a picture of your modelling clay “sedimentary rock” below and describe how you will transform your sedimentary rock into a metamorphic rock_____

_____

Before (sedimentary)	After (metamorphic)

Draw a picture of your new metamorphic rock in the box above and describe how your “rock” has changed.

_____

_____