Inquiry-based Geological Explorations in the Bras d'Or Lake Biosphere

An Integrated, Multidisciplinary, Inter-Cultural Curriculum Resource for Elementary Classrooms

Bras d'Or Lake Biosphere Reserve Association
February 2020

FOR THE TEACHER:

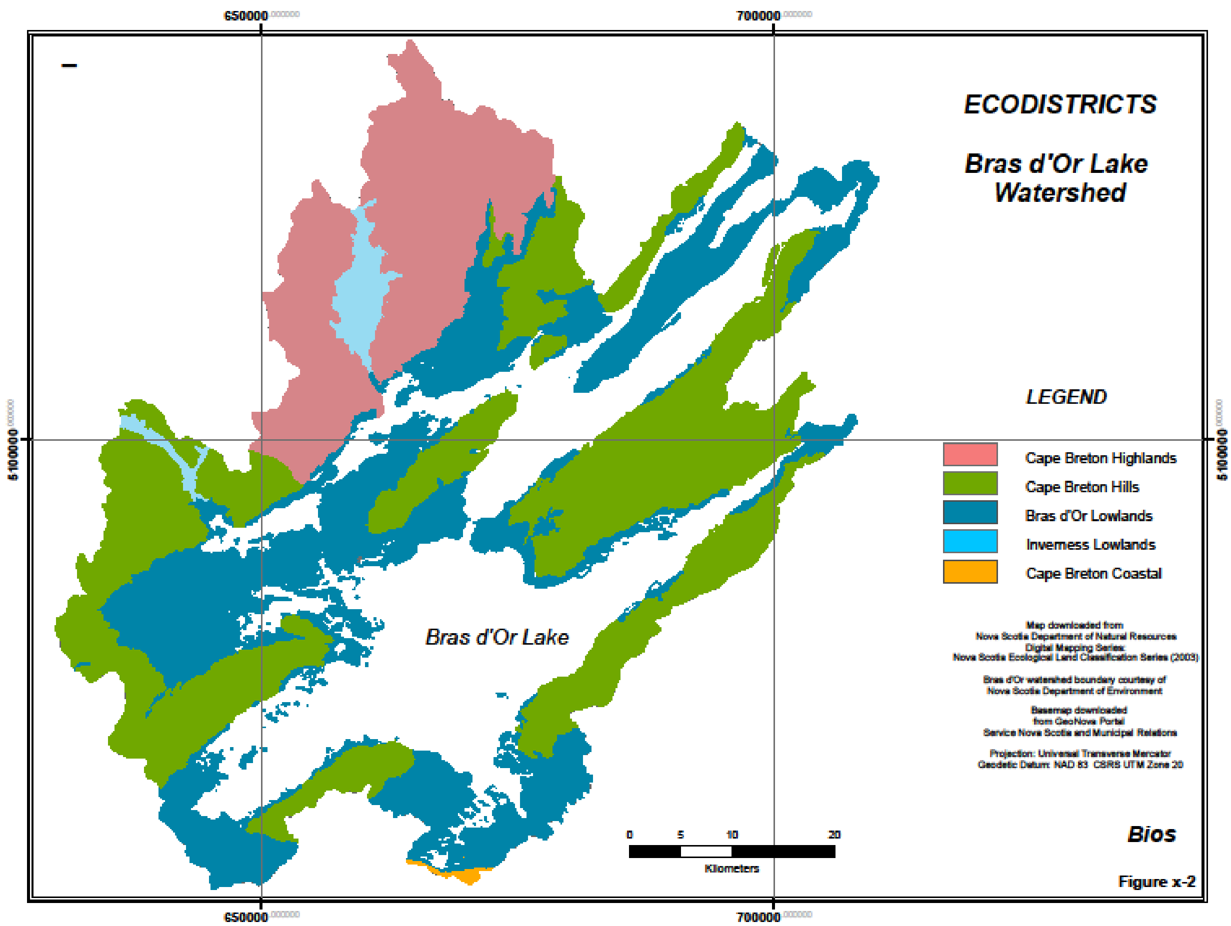
General Introduction

Cape Breton Island has a complex bedrock geology and is reflective of the earth's chaotic history over a long period of geologic time. Because of the variety of rocks and minerals, and the resulting landforms, it is commonly said with pride: *'Cape Breton is a geologist's paradise!'*

This Curriculum Resource is designed to help elementary students and their teachers to understand that part of Cape Breton that has been designated the 'Bras d'Or Lake Biosphere Reserve' (shortened in this text as BLBR), Canada's sixteenth UNESCO Biosphere Reserve. This Resource concentrates on 'Rocks, Minerals and Erosion' and has been guided by the Mi'kmaq Elders and Youth Advisory Council (Collaborative Environmental Planning Initiative, 2014). As an intercultural multidisciplinary resource, we follow the guiding principle of Two-Eyed Seeing (Mi'kmaq: Etuaptmumk) brought forward by Mi'kmaq Elder Albert Marshall (http://www.integrativescience.ca/Principles/TwoEyedSeeing/). The Resource has been developed by a committee composed of educators, scientists and planners and will feature Learning Experiences which are a mixture of school and field-based activities designed to provide a matrix of experiences, leading to a holistic appreciation of this unique and special part of the world.

What comprises the Bras d'Or Watershed area?

SETTING THE CONTEXT- Teacher Background Information



Map contributed by Lynn Baechler

THE BRAS D'OR LAKE WATERSHED

An eco-district is a subdivision of an eco-region based upon characteristics of physiographic features which set fairly large areas apart from one another.

Eco-districts

The Bras d'Or Lake watershed is dominated by three (3) major eco-districts:

1. The Bras d'Or Lowlands
2. The Cape Breton Hills
3. The Cape Breton Highlands

The other two eco-districts that fall within the watershed, while still significant, are much smaller. They are:

1. The Inverness Lowlands
2. The Cape Breton Coastal

Twelve (12) significant watersheds are found within the surrounding land adjacent to the Bras d' Or Lake. The total area of the entire watershed is approximately thirty-five hundred (3500) square kilometers.

There are many rivers and streams flowing into the Bras d' Or Lake. Four (4) large rivers comprise a large portion of the watershed. They are:

1. Baddeck River
2. Skye River
3. Middle River
4. River Denys

Many smaller streams flow directly into the Bras d'Or lake from the surrounding hills. Water comes from streams in the Cregnish Hills, the Northside Hills, the Boisdale Hills, the East Bay Hills, the Baddeck Highlands as well as from the North and South Mountains that border the West Bay of the Lakes.

Simplified Bed Rock Geology- Bras d'Or Lake Watershed

A Terrane is a fragment of crustal material formed on or broken away from one techonic plate and lying on another.

The simplified bedrock geology is depicted in three (3) terrane boundaries as noted on the map which follows. These terrane boundaries include:

1. The Mira area
2. The Bras d'Or
3. The Asby area

The Mira Area Terrane

This terrane contains numerous economically viable coal seams (with only the Donkin mine in operation) and houses a lot of sedimentary rock as part of its Upper Carboniferous features.

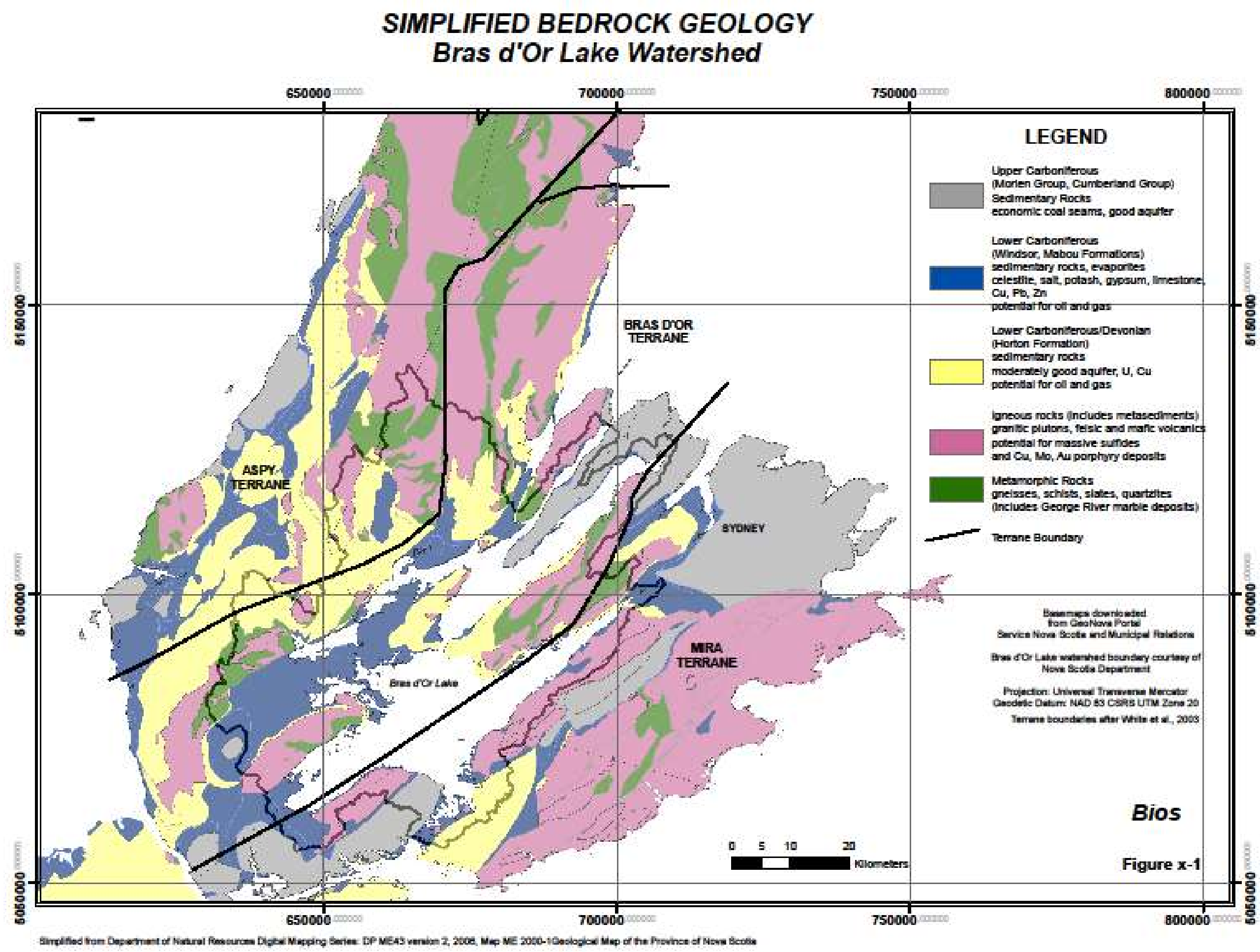
The pink area denoted within the Mira terrane has the potential for massive sulfides and contains some deposits of copper and gold.

The Bras d'Or Terrane

The west side of the Bras d'Or terrane and the central portion of this area are rich in gypsum and limestone, with copper and zinc deposits scattered throughout the area. There are large deposits of sedimentary rock found in this area.

The Asby Terrane

The largest deposits of metamorphic rock are found in the Asby Terrane of the Bras d'Or watershed. This area is recognizes for its marble, slate and quartz deposits.



Map contributed by Lynn Baechler

Legend: (reproduced from above)

Grey: Upper Carboniferous - (Marian Group, Cumberland Group) Sedimentary Rock

Blue: Lower Carboniferous – (Windsor & Mabou Formations) Sedimentary Rock evaporites

Yellow: Lower Carboniferous – (Devonian Horton Formation)

Pink: Igneous rocks (includes meta-sediments)

Green: Metamorphic Rocks

Features of this Resource

Experiential-based resource

This resource has been designed to provide tools to help teachers and students explore the rocks of the Bras d'Or Lake Biosphere so that they become knowledge-builders. The Learning Experiences have been presented in an order to help move students forward in their inquiry. It is important to have students frame questions so that they take ownership of them. This is often best done by keeping student ideas central and by engaging students in discussion during all phases of any experimentation or exploration.

The concentration is on the rocks and various processes that change them but the emphasis is on the CYCLE and our tiny snapshot based on what we observe in the present. These tools should be provided after the students have started to ask questions about the rocks, soils and landscape that surrounds the goal is to help students make the leap from natural curiosity to knowledge creation. It is important that students and teachers come together regularly to discuss each other's learning journey. Geological terms can be introduced into the 'common talk' of discussion. The" interesting words" for each activity may prove useful in this regard. Even very young children are capable of talking about such ideas as geological time if we let them and if we as teachers are willing to go there as learners ourselves.

Multidisciplinary Resource

It is essential for teachers to have an understanding of the big ideas of this curriculum resource. Another excellent Background Reference is 'The Last Billion Years', by the Atlantic Geoscience Society (2001). In following up ideas, inquiry-based learning blurs disciplinary boundaries. Skills such as reading and writing become important, relevant tools to aid a motivated student in their learning journey. Expression through writing and art help the student develop an understanding of their relationship with their 'place' and the rock structures that underlie it. It is important that students utilize a variety of tool to record their observations and to consolidate their findings.

Intercultural resource

Successful Earth Science curricula for any learner include an emphasis on outdoor education and inquiry-based experiences. The basic premise of Indigenous sciences is participating within nature's relationships. This resource combines traditional ways of knowing and Western scientific knowledge into a continuous pedagogical approach for all students. Techniques used by geologists are presented in the classroom as a means to answer student-driven questions rather than some foreign body of knowledge that is fundamentally separate. Students own culture and everyday experiences can be utilized to provide context for scientific instruction. This resource is developed around an Indigenous framework. However, there is a limit to a 'one size fits all' and local connections to Mi'kmaw culture are important to tie students to this place, the Bras d'Or Lake Biosphere Reserve, in the traditional (unceded) Mi'kmaw territory of Unama'ki (in English: 'land of fog'). The process of curiosity-driven inquiry is the basis of both Western and Native Science (Hatcher et al, 2009; Hatcher, 2012). Underlying inquiry-based learning is the idea that both teachers and students share responsibility for learning. It aligns with Indigenous philosophy of education where inquiry is guided by a knowledge holder and the learner forms a personal relationship with the knowledge. In the Indigenous worldview, we all stand on the shoulders of our ancestors. Successful inquiry-based learning follows this understanding.

"The most valuable questions are those that lead to other questions and provide germs for future investigations"(Lucas, Broderick, Lehrer, & Bohanan, 2005).

In Indigenous education, the learner is part of a family and community. Enthusiasm generated by the inquiry-based approach will provide a spark for students to discuss with their families and help the student share his/her developing understanding. Ideally, parents and guardians should be invited to share in the learning journey.

While Earth science education often has a significant classroom and laboratory component that is only lightly supplemented by field work, successful programs offered within First Nations communities typically rely on the field environment to a greater degree with less emphasis on classroom work (Riggs, 2004). This balance is beneficial for all students.

Here are some considerations for the teacher in Planning a Field Excursion.

To get the most from any field excursions, the teacher should:

1. Familiarize students with the physical location of the field trip relative to more familiar landmarks from their daily life (geographic preparation),

2. Prepare the students for the physical conditions they could expect, including weather, temperature, duration of the experience, time of arrival and departure, provisions for personal comfort (food, drink, etc.), and other personal factors so that they could minimize the separation between their personal expectations and the reality of the field environment (psychological preparation),

3. Have the students fully prepared in terms of necessary skills and prior knowledge from the content area that they could draw on to conduct meaningful investigations in the environment (cognitive preparation). (Riggs, 2004).

Using the Medicine Wheel in Elementary Science Education

This curriculum resource is multidisciplinary. However, the inquiry-based approach is closely aligned to what we think of as ‘science’ and the medicine wheel is a useful construct to understand the relationships between ‘science’ and other disciplines. The term ‘medicine wheel’ refers to a broad understanding of ‘medicine’ by many North American Indigenous cultures. Medicine is anything that promotes harmony. It is a symbol that helps to visualize balance in a person’s life, a mechanism to help restore health because ill-health is visualized as a result of the lack of balance either within one’s self or between one’s self and Mother Earth. The ‘medicine wheel’ was first used in the 1800’s to describe circular stone artifacts left by Indigenous inhabitants of Alberta and the northwestern United States. One of the most famous of these is the Bighorn Medicine Wheel in Wyoming.
(http://wyoshpo.state.wy.us/NationalRegister/Site.aspx?ID=60)

The Medicine Wheel or "sacred hoop" as it is sometimes called, is a good metaphor to unify science concepts and has been used in many education systems across Canada. For example, Manitoba and Alberta have re-designed elementary science curriculum using the medicine wheel model to unify science concepts, tie science to other disciplines and pay respect to the holistic principles inherent in the Indigenous world view. A useful resource has been developed by the Saskatoon Public Schools (Aikenhead et al., 2014) which outlines the use of the medicine wheel in school science.

There is no right or wrong way to draw a medicine wheel and its’ representation varies among groups and locations. However, all forms convey an understanding of the interconnectedness and interrelatedness of all things. The wheel simply begins as a circle with four equidistant points. The points divide four quadrants which are different colours. The points or the quadrants represent four teachings, four cardinal directions, four stages of life or any other relationships that can be expressed in sets of four. The medicine wheel metaphor can help us visualize things that are hard to understand as we might use a mirror to see behind ourselves. Within a medicine wheel there can be many rings of teaching which are constructed by considering a subject from four perspectives. It is important to re-visit the medicine wheel and revise understandings as students proceed in this inquiry-based project.

We will use the medicine wheel metaphor as per the guidance provided by Mi’kmaq Elder Murdena Marshall. The East quadrant is <u>red</u> for the colour of the rising sun. It is the direction of new beginnings, awareness and wholeness. The South quadrant is <u>yellow</u>. This is the direction where warm breezes originate and renew life through the cycles. The quadrant in the West is <u>black</u>, representing knowledge, experience and connectivity. The North quadrant is <u>white,</u> representing wisdom, balance and respect. To obtain that balance of the north, one needs to re-visit the other cardinal directions.

According to Lane et al (1984), the four First Principles for the medicine wheel are:

1. Everything is connected, and part of a larger whole.
2. All creation is in a state of constant change.
3. Changes occur in cycles, circles, or patterns.
4. A balance is important, because this honours all areas of reality, and all areas of the Medicine Wheel have an impact on all other aspects.

The Medicine Wheel and the Rock Cycle

In the Indigenous worldview, all areas of content knowledge are related in a holistic manner, and understanding that natural phenomena are viewed as arising from the operation of cyclical, interconnected systems through time (Allen & Crawley, 1998). However, it is difficult for many students to transfer from the concrete domain of the field environment to the abstract realm of long time scales, large spatial scales, and complex interactions. The medicine wheel is a way to integrate many phenomena and to understand and describe balance. It helps us understand that many things, such as water and rocks, are changed and renewed. Water is changed from a liquid to a solid in the autumn and winter in Cape Breton and then the solid returns to a liquid in the spring. Rocks change too, but over really long time periods. During our time on Mother Earth, we only see a tiny part of that cycle. This is a very important concept for your young students. They can think about that cycle as they investigate the different types of rocks in the Bras D'Or watershed and think about where they came from, how they have changed and will continue to change. This exercise will help us think in this large, connected way.

When we think about the water cycle, we realize that the water that we are drinking may have once been in an elephant's trunk in India, or the sewers of London. Mother Earth has a certain amount of water which is never gained or lost. However, it changes all the time through the processes of freezing, thawing, condensing, raining and snowing (precipitating) and being blown around the globe by winds and storms. Although it is hard to imagine in our short time frame, the same is true of rocks. The rocks in the Bras D'Or Lake Biosphere may have once been at the bottom of a deep ocean or attached to land which has moved from the southern part of the globe. These rocks have moved over immense distances because of 'continental drift', the movement of the Earth's crust. We will try to develop these understandings with the students.

Medicine wheels are used in many Indigenous Cultures as symbols to help us understand natural processes. The original medicine wheels were made of stone long ago (at least 600 years ago).

Now, let's start to think about the rock cycle in terms of a medicine wheel. We will start in the East, the place of new beginnings. We will need to determine what type of rock we place in this quadrant. We will then need to identify the processes that will drive the rock to the South, a place that represents rapid growth, development and strength. There are no right or wrong answers as these are ideas to explore with your students. To help us think about this, let's re-visit some basics about the rock cycle.

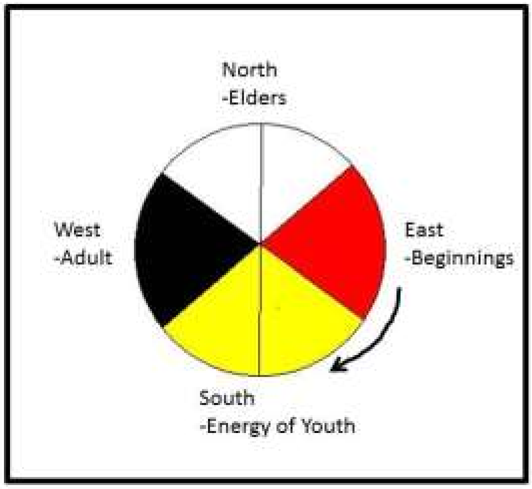


Figure 1: The medicine wheel

This resource concentrates on exercises to help students understand that all rocks and processes by which they form and decompose are related. Mother Earth is a large rock recycling machine. It is obvious that we can incorporate important holistic concepts that underlie the description of the rock cycle using a medicine wheel metaphor. These include:

1. Rocks are connected to each other and to all living things by natural processes that happen over temporal scales that are much, much longer than humans have inhabited Mother Earth.
2. The Rock Cycle has different and unique parts, but each part is connected to all the other parts.

The Rock Cycle

There are three basic types of rocks: igneous, metamorphic and sedimentary. Igneous rock is formed through the cooling and solidification of magma or lava. Metamorphic rocks have been changed over time by extreme pressure and heat. Metamorphic rocks can be formed by pressure deep under the Earth's surface, from the extreme heat caused by magma or by the intense collisions and friction of the Earth's crustal plates**.** **Intrusive igneous rocks** solidify below Earth's surface, and **extrusive igneous rocks** solidify above or on the Earth's surface. Much of the East Bay Hills and the Coxheath Hills consists of volcanic extrusive rocks (ie: *basalt*). In places there are intrusive rocks (ie: *granites*). The high land around the Bras d'Or Lake (upper parts of the watershed) is made up of both types of igneous rocks, along with metamorphic rocks. These are all hard rocks and are resistant to erosion when compared to the sedimentary rocks which underlie the lowland areas.

Sedimentary rocks originated as sediments and are usually found in layers, or "beds." Rain, wind, and waves caused the original rocks (all types) to weather and erode, producing sediments such as gravel, sand, silt and clay. These "**clastic**" sediments are washed away and are eventually redeposited in rivers, lakes or the sea or as sand dunes in deserts. The beaches that are such a delightful part of the Maritimes are made up of sediments produced by the erosion of older rocks. The layers of clastic sediments that accumulate, sometimes up to several kilometers thick, are changed into rock through compaction and through cementation. Some of these processes will be explored in the reference book (under construction). Sedimentary rocks are formed by precipitation of salts from sea water or salt lakes, especially under hot, arid conditions. These rocks are chemical, rather than clastic, in origin, and are called "**evaporites.**" They include salt and gypsum and are a very important component of the BLBR ecosystems.

Gypsum is a common mineral, with thick and extensive evaporite beds in association with some other types of sedimentary rocks. Because gypsum is soft and dissolves over time in water, gypsum is rarely found in the form of sand. Gypsum deposits in the BLBR have been sites where Mastodon fossils have been found, a reminder that organisms and habitats in the BLBR have not always been what we see today. Over geological time the Earth's crustal plates have moved, climates have changed many times and sea levels have risen and fallen.

Interactives. The Rock Cycle- Learner is a tool you may find useful. It can be found at:

http://www.learner.org/interactives/rockcycle/diagram html

This interactive resource serves a dual purpose in that it is a tool that can be utilized directly with the students as well as a refresher for the teacher.

The Learning Outcomes Framework

The Learning Outcomes Framework comprises a series of curriculum outcome statements describing what knowledge, skills and attitudes students are expected to demonstrate as a result of the cumulative learning experiences in the curriculum continuum.

Curriculum Outcomes are statements that identify what students are expected to know and be able to do at a particular grade level. A series of performance indicators identify the expectation associated with any given curriculum outcome.

Grade 4

Earth and Space Science: Rock, Minerals and Erosion

Outcome # 7 Concepts

Rocks are made up of minerals.

Minerals have unique properties.

Minerals are made from pure substances (elements) in the Earth's crust.

Outcome # 7

Students will explore the characteristics of rocks, minerals and fossils.

Outcome # 7 Indicators

Explore rocks in the environment, collect samples and record observations

Classify and compare rocks and minerals according to characteristics

Explore the uses of rocks

Infer how fossils can help us interpret past environments

Explore how fossils are formed

Outcome # 8 Concepts

Rocks can be classified by how they are formed

Fossils in rocks allow us to interpret ancient environments

Characteristics, comparison and uses of rocks and minerals

How soil is formed

How the earth's surface changes over time

Outcome # 8

Students will explore how the Earth's surface changes over time

Outcome # 8 Indicators

Explore the connections among the rock cycle, soil and weathering

Investigate an example of erosion

Learning Experience G1: The Rock Cycle on a Medicine Wheel

Objective:

This exercise is designed to place students' questions, ideas and observations at the centre of the learning experience. This first learning experience will help the student understand that rocks cycle over Mother Earth and that we have snapshots of various parts of that global cycle in the BLBR.

Interesting Words

Rock Cycle	**Illumination**	**Healing**	**Reflection**
Balance	**Renewal**	**Wisdom**	
Sedimentary	**Igneous**	**Metamorphic**	**Solidification**
Sedimentation	**Precipitation**	**Sun-wise**	

Procedure:

1. Class brainstorming session:
   a. Let's start to think about rocks in terms of where and when they were produced .
   b. Let's think about the rock cycle using the medicine wheel.
   c. Draw a medicine wheel on the whiteboard or project it at the front of the class (template below).
   d. Provide students with a few descriptors for each quadrant (provided).
   e. Review the basic components of the rock cycle (outlined below).
   f. **Discuss:** If we enter the rock cycle from the east, what type of rock might be situated there? Why did you choose that one?
   g. Movement of the cycle is sun-wise, so what type of rock might be situated in the south? Why did you choose that? (*Note: 'sun-wise (moving from east to west in the direction of the sun) means clockwise in the Northern hemisphere. This is probably because of the use of the sun as an early timekeeper on sundials.)*
   h. Continue until you have completed the cycle and drawn it (include magma) with rocks at each quadrant and processes driving them around the medicine wheel in a sun-wise direction.

Medicine Wheel Descriptors

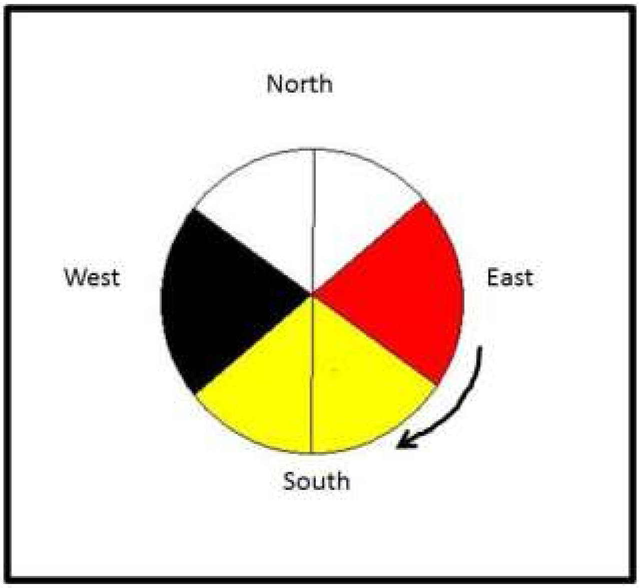
Medicine wheel descriptors *The medicine wheel is used in many contexts. Some of these descriptors (after Lane et al, 1984) are more useful than others for the rock cycle, and each student will focus on those that they can relate to.*				
Application	*East*	*South*	*West*	*North*
Path or direction	*Sun*	*Quiet*	*Looking within*	*Peace*
General	*Sunrise, New Beginnings*	*Curiosity*	*Sunset*	*Intelligence and Insight*
	Illumination (light)	*Exploration*	*Darkness, Power (thunder and lightning)*	*Balance*
Human	*Spiritual*	*Emotional*	*Physical*	*Cognitional*
Seasons	*Spring*	*Summer*	*autumn*	*Winter*
Lessons	*Rebirth, Renewal*	*Purification, Healing, Change*	*Cleansing, Reflection*	*Wisdom, Knowledge, Understanding*
Elements	*Air*	*Fire*	*Water*	*Earth*
Teachers	*Eagle, Mouse*	*Cougar, The Red Willow Tree*	*Black Bear, Turtle*	*The Great Mountain*

Consolidating Student Learning

What type of rock did you place in each quadrant and why did you choose to place that rock in that quadrant?

Quadrant	Rock Type	Reason
East		
South		
West		
North		

Outline of Medicine Wheel:



Evaluation considerations:

1. Process reflection by the students on their participation.
    a. Did I share ideas with my groups?
    b. Did I listen to others?
    c. Did I give others a chance to speak?
    d. Did I complete the reading?

2. The evaluation by the teacher revolves around assessing the thought that underlies the placement of rock types and processes on the medicine wheel after thought about what the quadrants represent in other contexts. For example, a student who has thoughtfully reviewed the teachings may place 'magma' in the east because the east represents rebirth, renewal or the beginning. The process of magma formation would come from the north and be represented as extreme heat and pressure. The student will then try to tie in this process with a move from earth to air or perhaps winter to spring.

Learning Experience G2: Our Biosphere shows us a snapshot of Mother Earth's rock cycle

The colored map of the three Terranes in existence within the Bras d'Or Lake Biosphere provides an indication of the rock formations present in each terrane within the Biosphere. The rock formations found on Cape Breton Island looks very different from those found in the rest of the Province. This is because most of our rocks are very old and have been through several periods of mountain building (volcanic activity, crustal uplift, plate movement) and global climatic changes over the last 600 million years.

Interesting Words

Terrane

Mother Earth

Volcanic activity:

Crustal uplift:

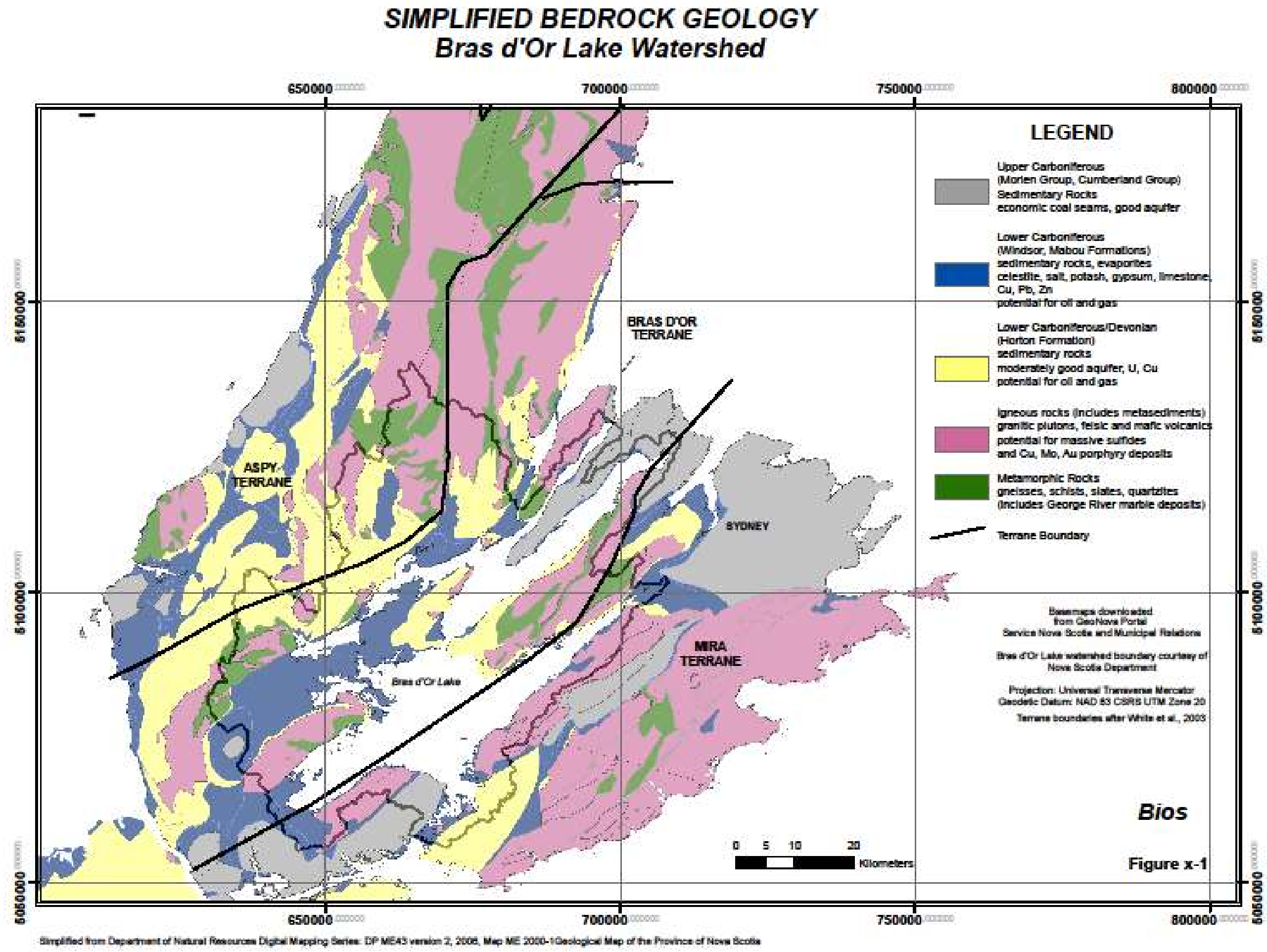
Plate movement:

Simplified Bedrock Formations in the Bras d'Or Lake Biosphere- What do I see?

Objective: To observe the various rock formations that exist within the Bras d'Or Lake Biosphere Reserve

Ask the students to utilize the map that depicts the simplified rock formations in the Bras d'Or Lake Biosphere and record their answers to the following questions.

1. **What type of rocks are found in great abundance in the Mira Terrane along the shores of the Bras d'Or Lake?**
2. **What do you observe about the types of rock formations found along the shores of the following sections of the Bras d' Or Lake in the Bras d'Or Terrane?**
   - **In the eastern section of the Bras d'Or Terrane?**
   - **In the northern section of the Bras d'Or Terrane?**
   - **In the western section of the Bras d'Or Terrane?**
3. **What two types of rock formations are most abundant in the Asby Terrane?**



Map contributed by Lynn Baechler

Legend: (reproduced from above)

Grey: Upper Carboniferous - (Marian Group, Cumberland Group) Sedimentary Rock

Blue: Lower Carboniferous – (Windsor & Mabou Formations) Sedimentary Rock evaporites

Yellow: Lower Carboniferous – (Devonian Horton Formation)

Pink: Igneous rocks (includes meta-sediments)

Green: Metamorphic Rocks

Learning Experience G3: The building blocks of Mother Earth

Objective:

To have the students collect rock samples, examine the samples utilizing their various senses and recording the results

Interesting Words

Mica	Pyrite
Calcite	Quartz

Materials

1. Rock collection (sedimentary, metamorphic and igneous rocks of various sizes and Shapes (can be purchased from Scientific Supply distributor)). The crystals that are most relevant for the BLBR are micas, salt, calcite, pyrite and quartz.
2. Magnifying lenses/ or hand lenses
3. Index cards (5" x 8")
4. Coloured pencils
5. Flipchart or whiteboard or computer to record the student's observations
6. Tape
7. Markers
8. Large bag or box for collecting

Preparation:

All students enjoy picking up and examining rocks. This is a good first exercise to engage the students and have them develop a geologist's 'eye'. Most elementary students have seen and touched rocks, and this exercise will give them a 'scientific' way to classify their observations.

1. Take the students on a rock collecting trip somewhere in the BLBR. It could be in their own schoolyard, although trips further afield may be more exciting.
2. Assemble the class around the rocks that they have gathered.
3. Pass the rocks around or divide them among the groups if you have a large class.
4. Discuss the questions below as a class or in smaller groups, and then have the groups share their answers with the class.
    a. What kinds of rocks are there?
    b. What are the differences? The similarities?
5. As the students are sharing their ideas, record their answers. Have them make piles of similar rocks. Ask the students "How are rocks the same and how are they different?"

   a. They will be working on this question for some time and the answers should be recorded. They will come up with some of the descriptors that Geologists use to identify rocks.

6. Divide the class into groups of about four students with each group sitting around a table.
7. Provide the students with the following tools for investigation:
   a. Hand lenses (1-2 per group)
   b. Rock sample (different one for each student)
   c. 2 index cards for each student
   d. Colored pencils to share
8. Tell your students that they may use four of their senses to investigate their rocks and make observations. (looking, feeling, smelling and listening). Tell them that it is not safe to taste the rock and that they should wash their hands after handling the rocks.
9. Tell your students that their job is to really study their rocks, using the hand lenses, and write down and draw their rock observations.
10. When they finish, line the rocks up.
11. Ask students to bring their record cards up to the row of rocks and find their own rocks and take them back to their places. If the class is large you may want to spread the rocks out in several groups to avoid crowding issues.
12. After students are settled, ask them to share what characteristics of the rocks were most useful in finding their own rocks. (shapes, colours, presence of visible crystals).
13. In groups of four, ask students to compare their rocks…differences and similarities. Ask students to record their observations on the second index card.
14. Hold a whole class discussion about how the rocks are similar and different. Make a list of these observations on a big piece of paper or a computer for later.
15. Ask your students to reflect on the "how are rocks the same and how are they different" question and how their answers may have changed as a result of this investigation.
16. Ask students what they now know about rocks that they didn't know before.

This activity modified from information presented in:

http://www.k5geosource.org/activities/invest/rock/q1/pg1.html
http://geology.about.com/library/bl/images/blrockindex.htm

Learning Experience G4: Are you a rock hound?

Scenario

These ‘rock hound’ exercises provide tools to answer basic questions about rocks. This inquiry should start with a hike or a walk around the schoolyard. Get the students to start a rock collection. Have them develop stories about their rocks. Maybe they were once in a volcano near the equator or at the bottom of a shallow sea. The teacher can guide this activity by explaining the basic properties of igneous (ie: volcanic origin) or sedimentary (ie: sea bottom) rocks. This will help the students play the part of rock detectives.

Background:

Do you collect rocks and/or minerals? Do you like to pick up rocks in the schoolyard or from a beach? Do you wonder where they come from? What makes one rock different from another? Do we need rocks and minerals? What they are used for? In these activities we are going to investigate some techniques to identify rocks and minerals that geologists use.

What is the difference between a rock and a mineral?

A mineral is a naturally occurring compound with a unique chemical structure and physical properties. A rock is often made up of minerals and other compounds. For example, quartz and feldspars are minerals, but when formed together, they make a rock such as granite.

Some minerals are also rocks. An example would be salt. Its’ rock name is salt and its mineral name is halite.
Another example is limestone. Limestone is a rock; it consists of the mineral calcite.

Physical properties of rocks

There are many physical properties of rocks and minerals that can be used for identification. Some of these properties are going to be investigated in this activity. An excellent online resource is:

http://www.oum.ox.ac.uk/thezone/minerals/define/index.htm

The "Acid Test" for Carbonate

Background Information for the Teacher

There are many carbonate rocks in the BLBR which are derived from the sediments of the shallow Windsor Sea which once covered much of Cape Breton (see 'The Last Billion Years' by the Atlantic Geoscience Society, 2001). A carbonate can be easily identified with a simple 'acid test'. Usually the acid test involves putting a drop of 10% hydrochloric acid on a rock. If carbonate is incorporated into the rock, it will fizz. The intensity of the fizzing indicates what type of mineral, how much is incorporated in the rock, the particle size of the carbonate and the temperature of the acid. There are many types of carbonate rock and the most common ones in the BBR are marble (metamorphic) or limestone (sedimentary). Occasionally you will find calcite (a mineral) as a filling in fractures of various rocks.

Because 10% hydrochloric acid can cause skin burns and holes in clothing, we will substitute acetic acid (vinegar) in this activity. The best type of vinegar to use is the pickling type as it has a higher acid content. The fizzing reaction to carbonate will still occur, but will be much weaker. Students will need a hand lens to observe. You may have to immerse the rock in the vinegar to see the reaction.

Hydrochloric acid, calcite and other carbonate minerals

When calcite or any carbonate rocks contact hydrochloric acid or vinegar they react to form carbon dioxide gas, water, dissolved calcium and dissolved chlorine. The carbon dioxide bubbles cause the fizzing which can be seen on the surface of the rock.

Please be aware:

Some carbonate minerals react strongly with acid and weakly with vinegar. Calcite will react most strongly with acid. If you place one drop of cold acid on a piece of dolomite (Calcium Magnesium Carbonate) the reaction may not be observable. You can produce an observable reaction by warming the acid or by producing a powder from the dolomite (scratch with a nail) and then exposing the acid to the powder. Be patient with the acid test. Sometimes it takes some time to observe the release of carbon dioxide even with a hand lens.

Some rocks contain carbonate minerals and the acid test can be used to help identify them. Limestone is composed almost entirely of calcite and will produce a vigorous fizz with a drop of hydrochloric acid. Marble is a limestone or a dolostone (rock composed mostly of dolomite) that has been metamorphosed and will react to acid less intensely. Many rocks contain small amounts of calcite or other carbonate minerals and will fizz in small pockets, where the carbonate occurs. Some sedimentary rocks are bound together with calcite or dolomite cement. Sandstone or conglomerates sometimes have calcite cement that will produce a vigorous fizz with cold vinegar.

It is always important to use more than one of the tests to identify an unknown sample. Each test adds more detail to our identification. To make sure that you are dealing with fresh material, avoid testing weathered surfaces. Instead, use a fresh surface which can usually be obtained by breaking the rock. If the rock is porous, some air may escape from a pocket when acid is dropped on, giving the appearance of an acid reaction To avoid this problem scratch the rock across a streak plate and test the powder or the grains.

This activity based on information in: http://geology.com/minerals/acid-test.shtml

Contamination

The student should become familiar with these procedures in the controlled setting of the school classroom or laboratory. They should be presented with materials that have known composition, hardness and colour to conduct their tests.

It is easy to contaminate surfaces, tools and other samples with calcite. Because calcite is one of the index minerals of the Mohs Hardness Scale it is used to test the hardness of mineral specimens. Therefore, in the elementary classroom, don't assume that a single acid reaction is correct. Test the specimen in a location away from the hardness testers if you suspect that contamination has occurred. In a mineral identification lab, barite is commonly confused with calcite because of contamination. There are barite deposits around Lake Ainslie. The barite might naturally contain small amounts of calcite or the hardness testing of a previous student might have left small amounts of calcite on a barite specimen. To test whether a sample is barite, check for cleavage (a bit of cracking) and hardness (not very hard). See how important it is to conduct more than one identification test?

Mineral samples that are used properly will need to be replaced or renewed frequently. All of the tests damage the specimen. To keep the acid test from damaging samples, have students rinse specimens after testing with acid and limit testing.

Learning Experience G5a: Carbonate fizzes- The Acid test

Objective: To determine if a rock sample contains carbonate.

Interesting Words

Volcano	**Halite**	**Calcite**	**Barite**
Mineral	**Carbonate**	**Dolomite**	

Materials:

1. Vinegar (pickling vinegar is best)
2. Bowl
3. Spoon
4. Magnifying glass
5. samples of different stones

Procedure 1:

1. Pour some vinegar into your bowl
2. Drop rock samples into the vinegar
3. Observations
4. If gas bubbles form, then the rock contains carbonate minerals

Procedure 2:

1. Drop a few drops of vinegar on each rock sample
2. Using a magnifying glass, watch the drops carefully
3. Observations
4. If you see a fizzing, it is because the vinegar is reacting with carbonate rock

Learning Experience G5b:
Let's have a closer look - Examining Rocks and Minerals

Background for the Teacher

An important tool of a geologist is a hand lens. A typical hand lens magnifies 10 times (10x). The magnification allows us to look at individual crystals or grains in a rock more carefully. To look at a mineral through a hand lens we may see differences in crystal form, Crystal form is one of several mineral characteristics which will allow us to identify a mineral and give it a name. For example if you look at salt through a hand lens you will see the crystal shape is a cube. Ideally quartz crystals are six sided prisms with 6 sided prisms at each end. Sometimes it is just subtle changes in the percentage content of a particular mineral in a rock that gives the rock its name.

Rock and mineral characteristics and the following exercises can be accomplished by the student without the aid of a hand lens. The hand lens will merely confirm what the student has already determined with his/her naked eye.

Objective: To have students compare rock samples and record their findings.

Hold the rock in the palm of your hand. Choose another rock of about the same size. What observations can you make by looking at, feeling and hefting the rock in your hand? Make 2 columns, one for each rock, and record what you see. A geologist, like other scientists must be good at making observations and keeping notes.

Are your rocks the same colour? Do they weigh the same? What does the rock surface feel like, is it gritty or smooth? Is it hard or soft (can you scratch it with your fingernail)? Is it smooth and polished or is it angular? (this might help you determine where the rock came from – do you know why?) you see any fossils? Does it react with dilute HCl? Is it made up of grains (rock fragments) or crystals? Can you see any shiny mineral in your rock? Are the grains or crystals the same size or many different sizes? Use a magnifying lens to observe your rock. Can you see the grains and/or crystals any better? In a sedimentary rock what do you think sticks the grains together? Fluids which were high in silica or calcite and/or iron moved around the grains. The fluids solidify either due to pressure or temperature changes or other chemical processes, cementing the grains and forming the rock you hold in your hand.

Draw a diagram of your rock. Are the sand grains and gravel mixed up or separate? Why or why not? In the BLBR we have a lot of sandstone, shale and conglomerate. By observing the grains in rocks, students should be able to recognize the difference.

One of the most important observations necessary for the identification of SEDIMENTARY rocks, is how they feel to your fingers. If the rock surface feels smooth and it's relatively soft, it is made up of fine grains (clay sized grains). As a rock it's called shale. Before it consolidated into a rock it was mud. Do you know what mud feels like between your toes? If the rock surface feels gritty (sandy), it's a sandstone. If the rock seems to be made up of many different sized grains, we call it a conglomerate.

Interesting Words Crystal Sandstone Shale Conglomerate

Learning Experience G5c: The grains (clasts) that make up sedimentary rocks

Background Information for the Teacher

The single particles in sedimentary rocks are called 'grains' and those grains form rock when they are compressed and glued together. Why do rocks tend to have similar grain sizes? The grains were sorted before the process which turned the individual grains into a rock actually started. When grains are deposited by water, air or ice they are called 'sediments'. One of the characteristics that we use to classify sedimentary rocks is grain size. This exercise will help you understand why some sedimentary rocks contain large grains and some contain small ones.

The grain (clast) sizes of sedimentary rocks are controlled by several processes which were operating when the rocks were originally formed. Various types of sedimentary rocks have characteristic grain size distributions. Conglomerates have grains which are gravel-sized (2 to greater than 256 mm in diameter). Sandstones are composed of sand-sized grains (0.06 to 2 mm in diameter). Siltstones are composed of grains which range from .004 to .6 mm in diameter and shales or mudstones are composed of grains which are less than 0.004 mm in diameter. Cementation is when new minerals stick the grains together, similar to mortar which holds the bricks in a wall together. Common cementing minerals are calcite, silica, iron oxides and clays.

Objective

The purpose of this activity is to help students understand why clast (grain) sizes of sedimentary rocks differ as a function of sorting processes before the rocks were formed.

In this activity, students will use a fairly simple process of visually inspecting settled materials to see how grain size determines rates of settling. This understanding will be reinforced when students examine sedimentary rocks in nature or when they walk along the side of a meandering stream, noticing the banks built up of gravels and the deltas at the mouth, where the water moves more slowly.

Interesting Words Grains Sediment Clast

Materials:

- A large glass jar with a lid
- Water
- Gravel (ie: aquarium gravel, pebbles from a stream)
- Sand (from beach or a children's sandbox)
- Clay or very fine dirt

Procedure:

1. Fill the jar ½ full of water.
2. Add a couple of handfuls of sand.
3. Add some handfuls of the dirt or clay.
4. Add some of the gravel.
5. You can add more sand and more dirt if you wish. Try to mix the different sized grains very well.
6. By the time that you finish adding sediment, the jar should be almost full.
7. Put the top on the jar and give it good shakes. However, don't shake it hard enough to break the glass! The grains (sediments) and water should be well-mixed. Swirl the jar so that the water and grains are moving around and around in the jar. Place the jar on a table and watch it closely for the next few minutes.
8. What settles to the bottom almost instantly? Why?
9. What settles out next?
10. How long does it take for all of the particles to settle out? (You may have to leave the jar for one or more days to answer this question)

Note: Activity adapted from http://thehappyscientist.com/study-unit/sorting-sediments

(http://www.geology2.pitt.edu/GeoSites/sedstructures.htm).

Consolidating Student Learning

1. After a few minutes, what do you see happening to the material in bottle?
2. Why do you think that the material settled to the bottom of the bottle, almost immediately?
3. Can you estimate how long it will take for all particles to settle to the bottom of the bottle?

Learning Experience G5d: Mineral colours

Interesting Words **Streak** **Density**

Background for the Teacher

Colour

Most minerals have a distinctive color that can be used for identification. For example, the pink rhyolite that is common in the Cape Breton Highlands is coloured by the mineral potassium feldspar. Some marble at Marble Mountain contains hematite which is a highly valued red colour substance. Higher concentrations of organics in other marbles make them black. Where impurities have been driven off during the metamorphic process, the marble is white.

Streak

Streak is the color of the mineral in powdered form. Streak shows the true color of the mineral because there is no effect of light reflection and refraction. The streak of metallic minerals is dark because of light absorption while non-metallic particles reflect most of the light so they appear lighter in colour. Streak is an accurate representation of a mineral's colour.

Common Mineral streaks

Minerals that contain metals create a streak at least as dark as the mineral itself. Non- metallic minerals often create a clear streak when rubbed. Iron Pyrite makes a greenish –black streak while hematite makes a reddish-brown streak. Calcite and gypsum make white streaks.

Objective: To utilize the color and streak of various minerals to assist in identifying them.

Materials:

1. *Piece of unglazed porcelain to use as a streak plate (back of a tile would do)*
2. *Assorted metallic and non-metallic minerals such as: (These should be ordered from a scientific supplier)*
    a. *Iron pyrite*
    b. *Quartz*
    c. *Mica*

Procedure:

1. Produce a table like the one below:

Mineral	Colour	Streak

2. Record the colour of the mineral sample in your table.
3. Rub the mineral sample across the streak plate. Record the colour of the streak. If the mineral is very hard, the colour will be that of the streak plate rather than the mineral its

Learning Experience G5e: How hard are these minerals?

Background for the Teacher

Hardness is a common diagnostic for mineral identification. In this context, hardness is a measure of the mineral's resistance to scratching. In 1812 the Mohs scale of mineral hardness was devised by the German mineralogist Frederich Mohs. He chose ten minerals and set them on an arbitrary scale of relative hardness. The softest mineral, talc, has a Mohs scale rating of one and Diamond, the hardest mineral, has a rating of ten. The following is a listing of the minerals of the Mohs scale which occur in the BLBR and their rating:

Mineral	**Hardness**	**Object of similar hardness**
Gypsum	***2.5***	***Fingernail***
Calcite	***3***	***Copper wire or coin***
Feldspar	***6***	***Window glass***
Quartz	***7***	***Steel file***
Diamond	***10***	

The MOHS scale:

Why are some minerals harder than others? Hardness is a function of how strongly their atoms are bound together at the molecular level! The relative hardness of a sample will give you a clue about what type of rock that it may be.

Objective: To provide an opportunity for students to test the hardness of some minerals

Interesting Words Gypsum Pyrite Calcite Quartz Mica

Materials:

1. Five mineral samples. These should be ordered from a scientific supplier. The following can also be found in the BLBR:
    a. Gypsum
    b. Calcite
    c. Mica
    d. Quartz
    e. Pyrite
2. 1 fingernail (your own is fine)
3. 1 copper penny or a piece of copper wire
4. 1 steel nail
5. 1 piece of quartz
6. Pencil and lined or graph paper

Procedure:

1. Create the data table like this:

Mineral	Fingernail (2.5)	Copper (3)	Steel (5.5)	Quartz (7)	Hardness

2. In the 'Mineral' column write the names of your minerals.
3. Start with your first mineral and test how hard it is by trying to scratch it. First try to scratch it with your fingernail, then the penny, then the nail and then the quartz.
    a. Make sure that you actually have a scratch. Sometimes the material that you are scratching with will be softer than the material that you are trying to scratch and there will be a line of powder that looks like a scratch. Rub it with your thumb. If it is a line of powder it will rub off but a real scratch will still be there.
    b. If you can scratch the material with your fingernail, put an 'X' in the Fingernail column.
    c. If you can't scratch the mineral with your fingernail, leave the Fingernail column blank and move to the penny. If that scratches the mineral, put an 'X' in the penny column.
    d. Keep going until you have tried scratching the mineral with all of the hardness testers.
    e. If none of your testers leaves a scratch, leave all of the columns for that mineral blank.

f. Fill in the last column. If your tester produced a scratch on a mineral, it means that the hardness of the mineral is the same as the tester or somewhere in between the tester and the one before it. For example, if the quartz and the nail leave scratches but the penny doesn't, the hardness of the sample is probably between copper (hardness 3) and steel (hardness 5.5). So, you should take a rough average and call it 4 on the MOHS hardness scale. Write down that number in the last column, 'Hardness'.
g. Do the testing for all of your mineral samples and fill in the columns on the table..

Comments from Field Geologist (Lynn Baechler)

When I am in the field and want to identify a rock I chip off a piece from the outcrop (bedrock exposed at the surface) with my rock hammer, or if it laying on the ground, I chip off a piece so I can see the fresh surface of the rock. I make note of my observations. I look to see if the grains are visible to the eye. I check the rock, or a mineral I am not familiar with, for hardness. If I think the rock may be limestone or marble, I put a drop of hydrochloric acid on the sample and see if there is a reaction. Gypsum is easy to identify because it is soft, limestone is easy to identify because it reacts with acid, granite is easy to identify because quartz, feldspar and mica crystals are visible to the naked eye. Sandstones, shales and conglomerate are easy to identify because of their texture (grain size), barite is easy to identify because it is heavy for its size. Quartz, even though it can be many different colors (clear, grey, pink, purple, white) is easy to identify because of its hardness. Quartz is one of the most common minerals on earth, and it is a big component of many rocks, including sandstone and granite, two totally different rocks!

I never use a streak plate because most of the minerals I work with have a white streak. It is not part of my field gear!

The rocks, I've mentioned above are all common in the watershed although barite is more common in the Lake Ainslie area).

A common iron mineral is pyrite. Some call it "fools gold" because of its colour, however, pyrite is much harder than gold and is usually seen in its crystal form (cubic) or in massive sulfide deposits. Gold is soft and seldom found in its crystal form. It is usually found as small grains or nuggets in river or stream sediments, where accumulated after weathering out of its host rock. Gold is much denser (heavier) than pyrite and is easy to "pan" as it stays in the bottom of the pan.

Iron minerals weather to red, yellow or orange minerals called oxides. These minerals sometimes coat the surfaces of fractures in rocks and make it difficult to identify them. Hematite and Limonite are common iron oxides, rust is an iron oxide and forms when an iron mineral oxidizes. If you see a lot of rusty rock surfaces, or rock surfaces coated in hematite (deep purple red) this may be a good area for a prospector, interested in sulfide mineralization to work.

Learning Experience G6: Visiting the BLBR: I am a rock detective – Field Excursion

Background for the Teacher

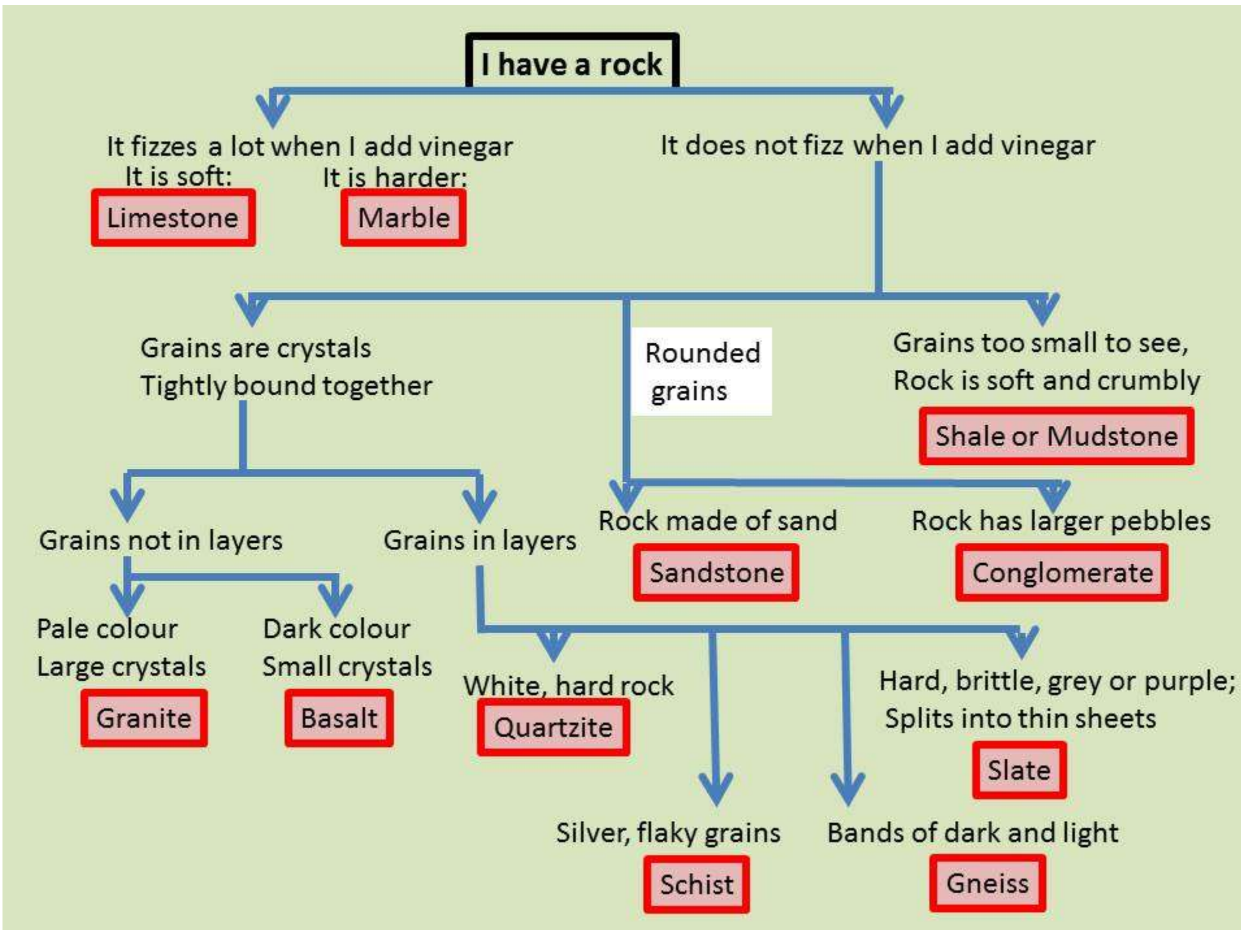
You may live within the BLBR or you may visit it with your family or your schoolmates or both. When you are there, take a look around and try to identify some of the rocks that you see by sight. To do that we are going to give you a framework to make decisions about your rock that will help you identify it. This activity should be undertaken after the students become familiar with some of the terms used to describe the characteristics of rocks.

Materials:

1. A nice day to be outside
2. Transport for the students to an interesting place
3. The rock guide
4. A field notebook or journal for each student
5. Other equipment may include a camera or cell phone to take photos

The rock guide

This guide is meant to be used by the teacher to help students identify rocks found outside using some of the terms that they learned in the previous activities. Follow the paths from the top 'I have a rock'. The first decision to make is whether it fizzes when vinegar is applied. If it does it is either a limestone or marble, as a function of whether the rock is soft or hard. If it does not, the next decision to be made is based on the grains. If they are too small to see then the rock is likely a shale or mudstone. If they are rounded and able to be seen it is probably a sandstone or conglomerate and if the grains are crystals which are tightly bound together there are more decisions to make and so on.


I have a rock
It fizzes a lot when I add vinegar
It is soft:
Limestone
It is harder:
Marble
It does not fizz when I add vinegar
Grains are crystals
Tightly bound together
Rounded grains
Grains too small to see,
Rock is soft and crumbly
Shale or Mudstone
Grains not in layers
Grains in layers
Rock made of sand
Sandstone
Rock has larger pebbles
Conglomerate
Pale colour
Large crystals
Granite
Dark colour
Small crystals
Basalt
White, hard rock
Quartzite
Hard, brittle, grey or purple;
Splits into thin sheets
Slate
Silver, flaky grains
Schist
Bands of dark and light
Gneiss

Learning Experience G7: How does Mother Earth make sedimentary rocks?

Background for the Teacher

In this activity students will employ similar processes that occur when sedimentary rocks are formed on Mother Earth. However, they are going to do it much faster.

Sedimentary rocks are made up of pieces of other rocks, minerals and remains of animals and plants (fossils) such as the Mastodon found in the Little Narrows gypsum quarry. Sedimentary rocks in the Bras D'Or Biosphere include sandstone, limestone, gypsum and conglomerates.

Sedimentary rocks are important in the BLBR because of their abundance, the impact that erosion of these rocks has on the aquatic habitats and the preservation of past habitats and inhabitants. The discovery of Mastodon fossils in the BLBR is due to their preservation in sedimentary rock formations! That is such an interesting story that we are going to highlight it in a separate section. The sedimentary rocks of the BLBR are an echo of the past, when most of the watershed was at the bottom of the vast Windsor Sea. Sedimentary rocks forms layers called strata which can often be seen in exposed cliffs. This activity will help the students understand the process of sedimentary rock formation and how the strata developed.

The place of the sedimentary rocks in the global rock cycle is as an end product of erosion for all rock types. Erosion will be examined in further activities. Many sedimentary rocks are also precursors of other rocks after the changes brought about by pressure and heat change the rock's structure and composition. For example, metamorphosis turns limestone into marble, sandstone into quartzite and mudstone into slate.

Sedimentary rocks are not greatly changed from the grains that they are made up of. They are usually the colour of the sediment (light brown to grey). The grains are called 'clasts' by geologists, so the granular sedimentary rocks are called 'clastic'. The end product is a function of the size of the grains. Sand becomes sandstone; clay becomes shale; if gravel is incorporated it becomes conglomerate. When the sedimenting material is part of a living organism, the sedimentary rock is called 'organic'. Limestone of the BLBR is composed of the calcium carbonate shells of plankton that fell to the bottom of the Windsor Sea and chert is composed of the silica shells of other planktonic forms. The extensive coal deposits in parts of the BLBR result from compacted peaty plant material that has been buried and compacted for long time periods.

Objective: To have students model how sedimentary rocks are formed in nature.

INTERESTING WORDS

Mastodon	Limestone	Strata
Erosion	Mudstone	Silica

Materials:

- wax paper
- magnifying glass
- water
- sugar
- gravel
- sand
- spoon
- paper cups

Procedure:

1. Pour a spoonful of sand into a paper cup. Pour a spoon full of gravel into the same cup.
2. In another mug put a spoonful of water. Stir in 5 teaspoons of sugar until dissolved. You may have to heat up the water a bit.
3. Pour the sugar/water mixture slowly into the cup of sand and gravel until it is moistened. Pour off any excess liquid.
4. Let the rock dry and then carefully tear off the paper cup. Sit the rock on a piece of wax paper.
5. Let the rock sit and harden for at least a week. It needs to be in a rather dry atmosphere, away from sugar-eating insects such as ants.
6. Use a magnifying lens to observe your rock.
7. Draw a diagram of your rock.

Note: Activity modified from:

http://www.education.com/science-fair/article/making-a-rock-in-a-cup/

Consolidating Student Learning

1. What did you observe during the week your rock was hardening?
2. What did you conclude holds the rock together?
3. Are the grains of sand and the gravel mixed together or are they separate?
4. What evidence do you have for your conclusion?

Learning Experience G8: The Birth of a Salt Flat - Enrichment Activity

Background for the Teacher

Evaporites occur in the Bras D'Or Lake Biosphere. Rocks that are formed by the minerals left behind when the water that they were dissolved in evaporates are called 'evaporites'.The extensive deposits of evaporites in the BLBR are chemical sedimentary rocks. They are of marine origin from the time when the area was covered by the shallow tropical Windsor Sea. As the relative sea level dropped and pockets of marine waters were trapped, minerals which were dissolved in the seawater were laid down in deposits on the bottom. Because of different rates of solubility, minerals were deposited in defined orders. Carbonates are precipitated first, followed by gypsum followed by halites (salts). These are important rock-formers. This activity mimics the natural process using salt (halite). By alternating dirty and clean salt solution, the students can appreciate the origin of the formation of bands in evaporites.

Objective: To provide students with an opportunity to model the development of a salt flat.

Materials:

- Glass or ceramic pie plate (metal will be corroded by the salt)
- 4 cups hot water
- Spoon
- 2 cups salt
- 2 tablespoons baking soda
- 2 tablespoons soil

Procedure:

1. Slowly stir a half cup of salt, one tablespoon of baking soda and one tablespoon of soil into one cup of hot water until the salt dissolves completely. Let it rest for a minute and then stir it again. Let it rest for another minute.
2. Pour the mixture into the pie plate and put it somewhere in the open where it will not be disturbed. Wait until the water evaporates completely. To speed up this process, you can set the plate in the sun. The evaporite in the bottom of the plate resembles a layer of sedimentary rock which water has transported somewhere and then evaporated.
3. Repeat steps one and two but only use half of a cup of salt and no soil or baking soda. This layer should be cleaner-looking and have bigger crystals. This is because there are no impurities to interfere with the process of crystallization.
4. Repeat steps one through three. Now you will have model salt flats which alternate dirty and clean layers, showing clearly how the layers are formed. Salt flats are formed in much the same way, with water that has lots of salt and minerals in it evaporating, leaving minerals behind and

forming layers. That is the complicated story of the Windsor formation; cyclic deposits of halite, potash, anhydrite, carbonates and clastic sediments.

Activity modified from:
http://www.education.com/science-fair/article/Miniature-salt-flats/

Consolidating Student Learning

1. **What did you observe when you repeated steps 1 and 2**
2. **Can you provide an explanation as to why the evaporite appears different in step 3 of the experiment?**
3. **What conclusion, if any, can you draw after the completion of several repetitions of the steps outlined in the experiment?**

Learning Experience G9: How does Pressure Change Rocks?

Background for the Teacher

Metamorphic means 'to change form'. Any rock (igneous, sedimentary, or metamorphic) can become a **metamorphic** rock if exposed to heat and pressure without melting. These metamorphic changes occur deep within Mother Earth at high temperatures and pressures. If heat is extreme and the rock melts, magma is formed and the rock cycle starts all over again (keep this in mind when working with the medicine wheel).

The type of metamorphic rock is a function of:

- the temperature and pressure conditions in which the rock was formed
- the composition of the parent rock

Geologists are detectives. By the composition of the metamorphic rock they can make deductions about the environmental conditions within which the metamorphosis took place and this aids in an interpretation of the geological history of an area.

Changes in the temperature and pressure conditions cause the minerals in the rock to either reorient themselves into layers (foliation) or recrystallize into larger crystals, without undergoing melting. If pressures are very high and unequal (greater in one direction than another), the original crystals in the rock reorient themselves with the long, flat minerals aligning perpendicular to the direction of greatest pressure. This gives the rock a striped look (foliation).

Foliated metamorphic rocks are identified on the basis of their texture:

Slate = formed at low temperatures and pressures, rock breaks along nearly perfect parallel planes (found behind Whycocomaugh and Boisdale Hills)

Phyllite = formed at low to intermediate temperatures and pressures; slightly more crystallized which gives the rock a more shiny appearance (more in western Cape Breton)

Schist = intermediate to high temperatures and pressures; crystals are larger with the grains aligned in parallel to subparallel layers (Common in Cape Breton Highlands)

Gneiss (nice) = very high temperatures and pressures; coarse grained texture of alternating light and dark mineral bands (look for it on Kelly's mountain)

http://www.mineralogy4kids.org/?q=rock-cycle/metamorphic-rocks

Metamorphic 'Foliated' rocks

Objective: To provide an opportunity for students to understand the impact pressure has on a rock

Interesting Words: Heat Pressure Phyllite

Gniss Schist Foliated

Materials:

- Lump of clay (plastocene)
- Handful of long grain rice
- Rolling pin
- Rolling surface
- Sample of granite
- Sample of gneiss (or picture below) (You might use limestone and foliated marble as examples. Both are readily available in the watershed. Although it will be a bit of a field trip to Glenco to get a picture of foliated marble)

Procedure:

1. Flatten the clay (plastocene) and shape it into a bowl shape.
2. Fill the bowl with the grains of rice and pinch the top shut so that the rice is inside a ball.
3. Knead and squish the clay and rice until the rice grains are evenly distributed.
4. Compare it to the granite sample. Like the granite, the clay ball has formed without too much pressure so the grains go in every direction.
5. Put the ball on the surface and roll it flat with a rolling pin.
6. Fold it over and roll out again, in the same direction. Keep folding and rolling it out flat in the same direction each time. After many rolls, you will notice that the rice grains are mainly pointing in the same direction, and maybe forming bands and layers.
7. Compare the folded-and-flattened clay to the sample of gneiss or of limestone. Like the clay, the gneiss has been compressed and the minerals in it tend to line up in the same direction and form layers.

Activity modified from; http://www.education.com/science-fair/article/pressure-mineral-rock/

Consolidating Student Learning.

1. What do you notice when you compare the clay ball to the granite sample

Rock	Observation
Granite	______________________________
Clay Ball	______________________________

2. After flattening and folding the clay ball and rolling it in the same direction several times, what do you observe about the rice grains in your clay?

____

____

3. Compare the folded and flattened clay to a gneiss and limestone sample. What do you observe?

Sample	Observation
Clay	______________________________
Gneiss	______________________________
Limestone	______________________________

Learning Experience G10: Soil Erosion

Background for the Teacher

In the BLBR there is a lot of sedimentary rock which erodes readily. The sediment resulting from that erosion impacts the habitats, flora and fauna of Bras d'Or Lakes. Because the estuary is such an enclosed system, products of erosion are not easily flushed out and we have to live with the results of erosion for very long time periods! Thus, erosion is a highly significant process in the watershed and one that we have to pay attention to when we consider logging and development practises.

Erosion can be mechanical or chemical. In the BLBR, forestry practises and roadwork cause increased exposure of rock and soil to runoff. Topsoil is carried by the tributaries into the estuary. This material is caught by plants such as cordgrass and marshes develop. Sediment causes many impacts in the BLBR. If it is carried into a river it could settle among the larger gravel on the bottom making the habitat unsuitable for salmon to lay their eggs in. The sediment clogs the spaces among the gravel, restricting the flow of oxygenated water, suffocating the developing eggs. If the sediment rushes into the Bras d'Or Lake, it will eventually settle to the bottom. If sediment delivery isn't too rapid, it becomes incorporated into the substrate of the extensive eelgrass beds. If delivery is too rapid, it smothers and kills the eelgrass which leads to a barren bottom-scape. The eelgrass provides habitat for many other species so this smothering has far-reaching consequences. Over time the shifting bottom of the estuary has provided habitat for eelgrass but not for the large, perennial brown algae that are common in similar depths in nearby coastal environments. These algae need the stability of large rocky substrates to anchor them, and this type of bottom is uncommon in the Bras d'Or Lakes. This impact of erosion on underwater habitat has impacts on all flora and fauna and on the productivity of the whole estuary.

The most obvious chemical erosion in the BLBR is the dissolution of limestone and gypsum by surface and subsurface runoff. Because of this erosion we have a window into the past with the Mastodon remains in Little Narrows, trapped by a fall into an eroded cavern. In fact, the deep St. Andrew's channel may have been formed by chemical erosion of the Windsor evaporate deposits!

To learn more about erosion, the Bill Nye -the science guy- you tube presentation demonstrates the simple principles of erosion:

http://www.youtube.com/watch?v=J-ULcVdeqgE

The watershed of the Bras d'Or Lakes is largely sedimentary rock which is easily eroded. The waters of the Bras d'Or are generally quite cloudy because of the input of sediments that were originally derived from these rocks. Soil erosion and deposition is an important geologic process in the watershed. Some erosion and deposition is natural (wind, water, wave and ice action) and some is accelerated by human activities (road construction, land clearing, wharf construction). This is a geologic process that students can see after a heavy rain and again when it's windy (no rain) when costal currents move the previously deposited sediments.

A good example of soil erosion can be seen in the Skye River. There, the main Channel of the Skye River runs from an area of Skye Glen (an agricultural area) and is laden with sediment (high turbidity). At its confluence with the Indian brook tributary, you can see the water is clear and mixes with the turbid water at it flows downstream. The Indian Brook tributary is underlain by mostly metamorphic rocks, which are more resistant to erosion. Another thing about suspended sediment in water is that it carries available bacteria (mainly harmless soil bacteria but possibly some harmful ones as well) into the area of deposition. The sediment would also bring metals (if they are available) and other potential contaminants into the deposition area. Thankfully we do not have many sources of contaminants (except bacteria) in the watershed.

Because of the suspended sediments in nearshore waters, plants only grow on the bottom in shallow waters. They don't get enough light in deeper depths. This affects many animals that use the plant communities as habitat. So, erosion is a very important process in the BLBR!

Objective: To examine and measure the rate of erosion of a mound of soil through a series of experiments.

Measuring Erosion I

Equipment - a board

- soil and/or sand
- an empty milk jug
- scissors

- water
- a small piece of clay or playdoh

Procedure:

1. Place the board on the ground.
2. Place a layer of soil over the entire board. It should be about 2 to 3 cm deep.
3. Tilt the board so that it is not level. One end should be 7 to 10 cm higher than the other end. Use some rocks to prop it up at one end.
4. Cut a 13 mm hole in the bottom of the milk jug using the scissors. It does not have to be perfectly round, but it should be close to 13 mm.
5. Plug the hole in the milk jug with a ball of clay (plastocene) or play doh so that the jug holds water.
6. Fill the milk jug with water. Place it on the high side of the board.
7. Remove the clay (plastocene) or play doh plug so the water can flow out of the hole.
8. Observe what happens to the soil on the board.

Measuring erosion II.

Let's build a mountain of soil and measure the rate of erosion. This is going to be a lot of fun! It can be done in the schoolyard. Make sure that the students come properly dressed as they will likely get dirty.

Equipment:

- Bare area with exposed soil in a flat area that can be protected from interference (ie: from children jumping on it or dogs and cats digging in it)
- Shovels and muscle-power
- Rain gauge installed nearby
- Data or field book
- Measuring tape and long, straight stick

Procedure:

1. Make a mountain of soil in your protected area. Make it as large as you can and try to replicate the shape of real mountains. Pat down the soil with the shovel.
2. Each week, make measurements of your mountain and fill in a chart with the measurements. When you measure the height, use the straight stick level with the top and then a measuring tape to the ground. This will take a few students to do accurately. Take the measurement several times until you get the same answer several times in a row. This increases the precision of your measurement. If it rains, wait until the mountain has dried out before you measure it.

3. A team should be in charge of measuring the amount of rain that falls and when it falls. After it rains, measure the amount of rain in the rain gauge and record the amount in your field journal.
4. The chart that you build should look like the one hereafter.
5. You should continue this experiment for at least 12 weeks.

The chart should look like this:

Erosion Data Table				
Date (week number)	Mountain height *	Mountain width	Observations	Rainfall amount (mm)
May 2 (1)	150 cm	300 cm	Nice cone	0
May 9	147	300	Water forming a small river-like course on side facing school	1
May 16	102	350	Top flattened and river bed deepened; clump of mud on side remains same size	8.5
May 23	98	348	Muddy ring around bottom, weed growing out of mud clump, river bed deeper	0.5

- Each week you should draw a sketch of your mountain. Have the same student stand beside it each week and include him/her in your sketch and in a photograph.

Measuring Erosion III:

Have you been wondering whether different types of sediments erode at different rates? Do tall, steep mountains of sediment erode faster than shorter, wider piles (with the same volume)? What effects do plants have if they start to grow on the mounded sediments? With your teacher, brainstorm ideas to do experiments to answer these questions. It may be as simple as duplicating your mountain experiment with different types of sediments or after planting seeds on them.

Now that you know what to look for, maybe you should go on a field trip to look for signs of erosion.

Here is an experiment that may help you answer the question related to the effects of plants on sediment erosion:

Equipment:

- Plastic cup with small holes punched in bottom to act as a sprinkler

Procedure

- Take two planting flats (or shallow trays with small holes in the bottom for drainage). Place a layer of soil in each which is about 3 to 5 cm deep.
- Sprinkle grass seed on one soil-covered flat and cover with a thin layer of soil.
- Water both flats each day with the sprinkler cup until the grass is 5 cm tall.
- Prop the ends of both flats up at moderate angles with bricks. They both should be at the same angle.
- Sprinkle each flat with equal amounts of water until you observe soil erosion

Consolidating Student Learning

In your journal, make observations and answer these questions:

1. In which tray did the soil erode faster? More?
2. What do you think that the effect of removing trees from a steep mountainside might be?
3. How could you control soil erosion in a steep place?
4. What other factors do you think might affect soil erosion?

LEARNING EXPERIENCE - G 11 - Having Fun with Fossils

Background

Fossils provide a valuable record of the plant and animal life and environmental conditions from millions of years ago. An effective study of fossils involves developing concepts in a logical and sequential order. Students should first understand what a fossil is, the differences between fossils and other natural objects and that not all plants and animals become fossilized.

Objectives

To examine how fossils are formed.

To understand how fossils provide evidence of plants and animals that lived long ago

Materials

Internet access for pairs of students to work together

For each Student:

- Paper plate
- Plaster of Paris (enough to fill the plate)
- Natural objects that can be used to make a fossil (twigs, shells, flower petals, plant stems)
- Doll (optional)
- Earth materials
- Cardboard Box

For the Teacher: Lesson Preamble

Tell the students they are going to make models of fossils. Review with the students what models are, how they are similar to and different from the actual process of fossilization.

Prior to the lesson, prepare the Plaster of Paris so that it is ready to spread on the paper plates of the individual students or student groupings.

What is a Fossil?

Building on student knowledge

Utilizing Fossils- Student record sheet #1, ask the students to record what the word fossil means to them.

On the Board or on a sheet of chart paper, write the word "fossil" and ask students to share what they think the word is and what the word might mean. Record the responses of the students.

Tell the students that they will now have the opportunity to create their own fossils
Begin by giving each student (pairs or small group depending on your instructional strategy) a paper palate filled with moistened, prepared Plaster of Paris. Ask the students to press one of the natural objects that they brought from home (or that you provide) into the plaster. Once the impressions have been made, instruct the students to remove the objects from the plaster. Remind the students not to touch the plaster when removing the objects from the plaster as the plaster will need time to harden and dry. Using Fossils record sheet #2, have the students record their observations. Have the students share their observations with other students. Students should set aside both the fossil models and their notes so that they can refer to them later on.

Optional Activity

Becoming a fossil

In teams of two, utilizing the internet have the students view " Becoming a fossil" (/resource/tdc02.sci.life.evo.becfossil/) a Quick Time Video

This resource depicts how the Australopithecus afarensis skeleton known as Lucy could have been fossilized.

Consolidating Student Thoughts- Student record sheet #3

How do scientists think that Lucy may have died?
What made her bones turn to stone?
What natural events made it possible for her fossilized bones to be discovered?

You can re-enact the process during the discussion (as a demonstration) or have each student (group of students) do so. To re-enact the process, fill a box with earth materials and place the doll in the material ensuring that the doll is completely covered.

Conclusion - A final thought

This curriculum resource is based on the geology of the Bras d'Or Lake Biosphere but many of the exercises are transferable to other ecosystems. It is oriented to upper elementary students (Grade 4 and 5) having Learning Experiences that can be used on their own or adapted for other grade levels.

The geology of the Bras d'Or Lake Biosphere is the underlying theme for this integrated, multidisciplinary, inter-cultural curriculum resource for elementary classrooms. Learning is collaborative and inquiry is student-centred. It is important that students spend time to reflect on the completed Learning Experiences so that student learning is consolidated.

The students' learning journeys guided by this curriculum resource can be integrated by an exercise based in the language arts, or the time-honoured tradition of story-telling. Have the students tell a story about a rock. The mode of communication can be a story, poem, presentation, dance or artwork. To generate the story, the students should have:

- a good understanding of sedimentary, igneous and metamorphic rocks.
- a good understanding of depositional environments (i.e coarse sediments settle out closet to the source, fine grains settle furthest away from their source). Fine grained igneous rocks were formed at or near the earth's surface (quick cooling = fine crystals), coarse grained igneous rocks formed deep in the earth's crust (slow cooling larger crystals).
- a good understanding of the continuum from mud, to shale to slate (metamorphic rock), from loose sand, to sandstone to quartzite (metamorphic rock.
- a good understanding of the erosion process; which rocks are more resistant to weathering processes than others.

Literature Cited

Aikenhead , G. (Editor), Brokofsky, J., Bodnar, T., Clark, C., Foley, C., Hingley, J., Isbister, D., Johanson, T., Lauze, C., Myers, S., Roadhouse, T., Rioux, T., Elder Darlene Speidel, Waokiye Don Speidel, Strange, G., 2014. Enhancing school science with Indigenous Knowledge: What we know from teachers and research. Saskatoon Public Schools (Inspired Learning), 137 pp.

ADI Ltd. Bras d'Or Lakes State of the Environment Report: Freshwater Resources. Technical Report, Sydney: Unima'ki Institute of Natural Resources, 2006.

Allen, N. J.,&Crawley, F. E. (1998). Voices from the bridge: Worldview conflicts of Kickapoo students of science. Journal of Research in Science Teaching, 35(2), 111 –132.

Atlantic Geoscience Society. 2001. The Last Billion Years – A Geological History of the Maritime Provinces of Canada, Nimbus Publishing Ltd, Halifax, NS. 212 p.

Bras d'Or lake Biosphere Reserve. "UNESCO Submission Document" 2010

Ellison W., The Bras d'Or Lakes, Cape Breton University Press, Sydney, N.S. 2014

Grant, D. R. 1194. Quaternary Geology, Cape Breton Island, NS. Geological Survey of Canada, Bulletin #482. 158p.

Hatcher, A., Bartlett, C., Marshall, A., 2009. Two-eyed seeing in the classroom environment: Concepts, Approaches and Challenges., *Canadian Journal for Science, Mathematics and Technology Education 9(3); 141-153.*

Hatcher, A., 2012. Building cultural bridges with Aboriginal learners and their 'classmates' for transformative environmental education. J Environ Stud Sci DOI 10.1007/s13412-012-0088-6, published online Aug. 7, 2012.

Lucas, D., Broderick, N., Lehrer, R., & Bohanan, R. (2005). Making the grounds of scientific inquiry visible in the classroom. Science Scope,29(3), 39–42.

Marsman, E. Contributor. "The Rock Cycle - A Review"

Marshall, M. Contributor. "The Medicine Wheel"

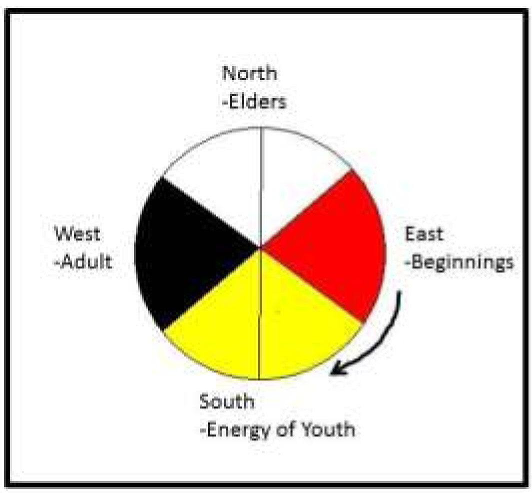
Neiley,P., Quigley, E., Benjamin, L., Stewart, B., and Duke, T. 2003. Ecological Land Classification for Nova Scotia. DNR Report 2003-2

Acknowledgements

This resource was developed by the Education Resource Committee of the Bras d'Or Lake Biosphere Reserve Association. Annamarie Hatcher, Unama'ki College (Cape Breton University) developed the structure and many of the Learning Experiences. Simon Sylliboy (Mi'kmaw educator and Masters student) and Annamarie guided the resource to be inter-cultural. Kathy Snow (Professor at Cape Breton University's Department of Education) reviewed the resource and made suggestion to develop it as an integrated unit. Elise Marsman, a summer student, added content and many some suggestions for revisions. The geological insights were provided by Lynn Baechler, a hydrogeologist, who was the inspiration for this resource. Betsy Jardine, a resource specialist with the Strait Center for Education (formerly the Strait Regional School Board) contributed material on fossils. Ian Doucette provided current information on the revised curriculum outcomes. Jim Burton, Chair of the BLBRA Education Resource Committee did final draft edits and Christine Christiansen, Science Consultant, with the Department of Education and Early Childhood Development provided guidance to the working committee and filtered the resource through the administrative process for bias.

APPENDICES

THE MEDICINE WHEEL



G-1

MEDICINE WHEEL DESCRIPTORS RECORD SHEET

Applications	East	South	West	North

G-2 Student Record Sheet -

Observing Rock Formations in the Bras d'Or Lake Biosphere

1. From your observations of the map, what types of rocks are found in great abundance in the Mira Terrane along the shores of the Bras d' Or Lake?

____

____

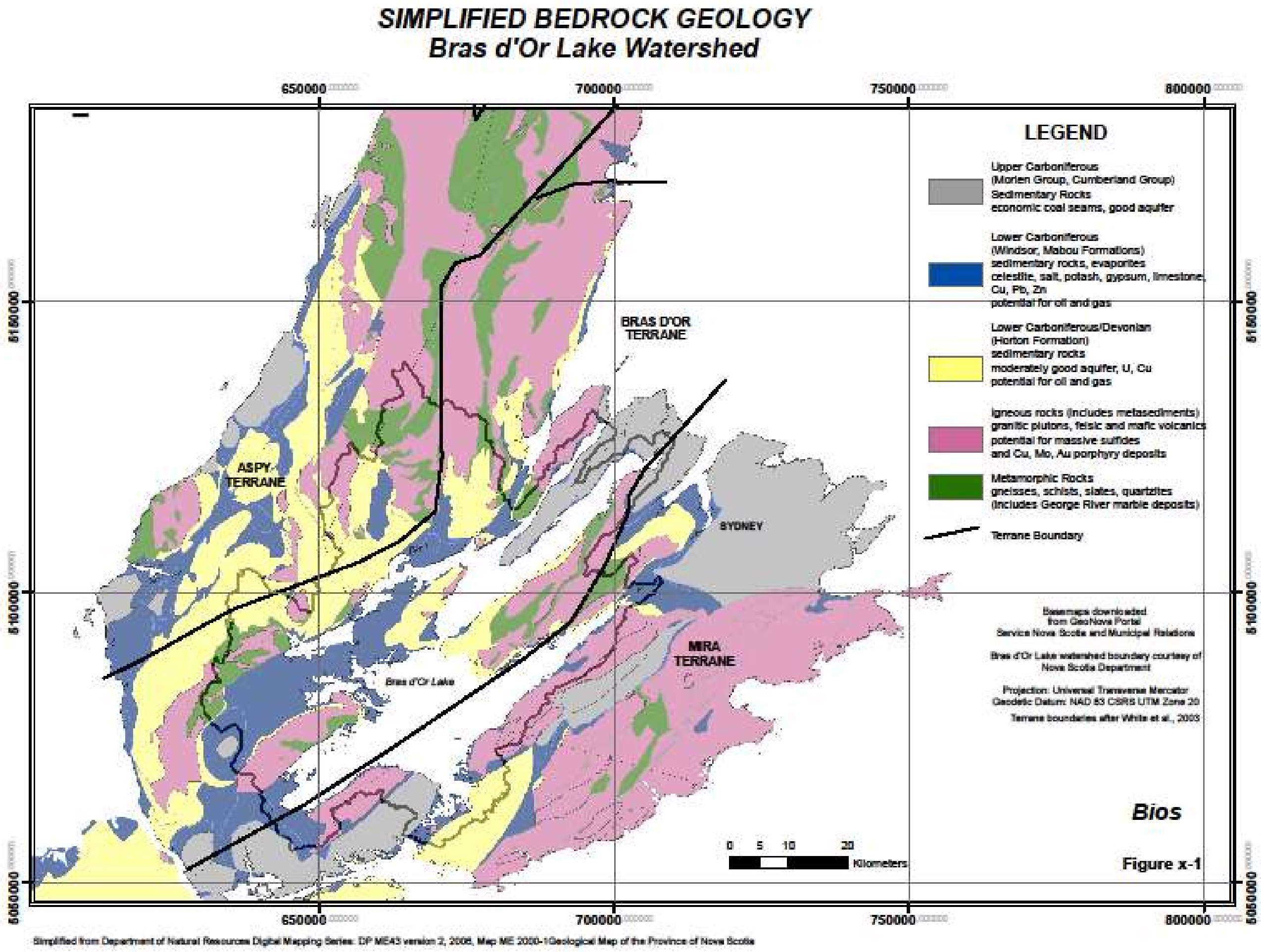
2. What do you observe about the types of rock formations found along the following sections of the shore of the Bras d' Or Lake in the Bras d' Or Terrane?

Area of Observation	Student Observation
In the Eastern Section	
In the Northern Section	
In the Western Section	

3. What two types of rock formations are most abundant in the Asby Terrane

____

____



Map contributed by Lynn Baechler

Legend: (reproduced from above)

Grey: Upper Carboniferous - (Marian Group, Cumberland Group) Sedimentary Rock

Blue: Lower Carboniferous – (Windsor & Mabou Formations) Sedimentary Rock evaporites

Yellow: Lower Carboniferous – (Devonian Horton Formation)

Pink: Igneous rocks (includes meta-sediments)

Green: Metamorphic Rocks

G- 4- a

How do Geologists identify rocks? - Record Sheet

WHO	DESCRIPTORS	
Individual Student	________________	______________
Pair of Students	_________________	______________
	________________	______________
Four Students	________________	_______________
	________________	_______________
	________________	_______________
	________________	_______________

G-5 STORY STARTER RECORD SHEET

The rock that I am holding in my hand was ____________________

____

____

____

____

G-5- a RECORD SHEET

	Sample 1	Sample 2	Sample 3	Sample 4
Procedure 1				
Procedure 2				

G - 5 - b COMPARING ROCKS

Characteristics	Rock # 1	Rock # 2
Weight		
Surface Texture		
Color		
Hardness		
Reaction To HCL		
Grains or Crystals		

G- 5 - c OBSERVATION SHEET

1. After a few minutes, what do you see happening to the material in the bottle?

____

____

____

2. Why do you think that this material settled on the bottom almost immediately?

____

____

____

3. Can you estimate how long it will take all the particles to settle to the bottom of the bottle?

ESTIMATE
____ HOURS _____ MINUTES _____ SECONDS

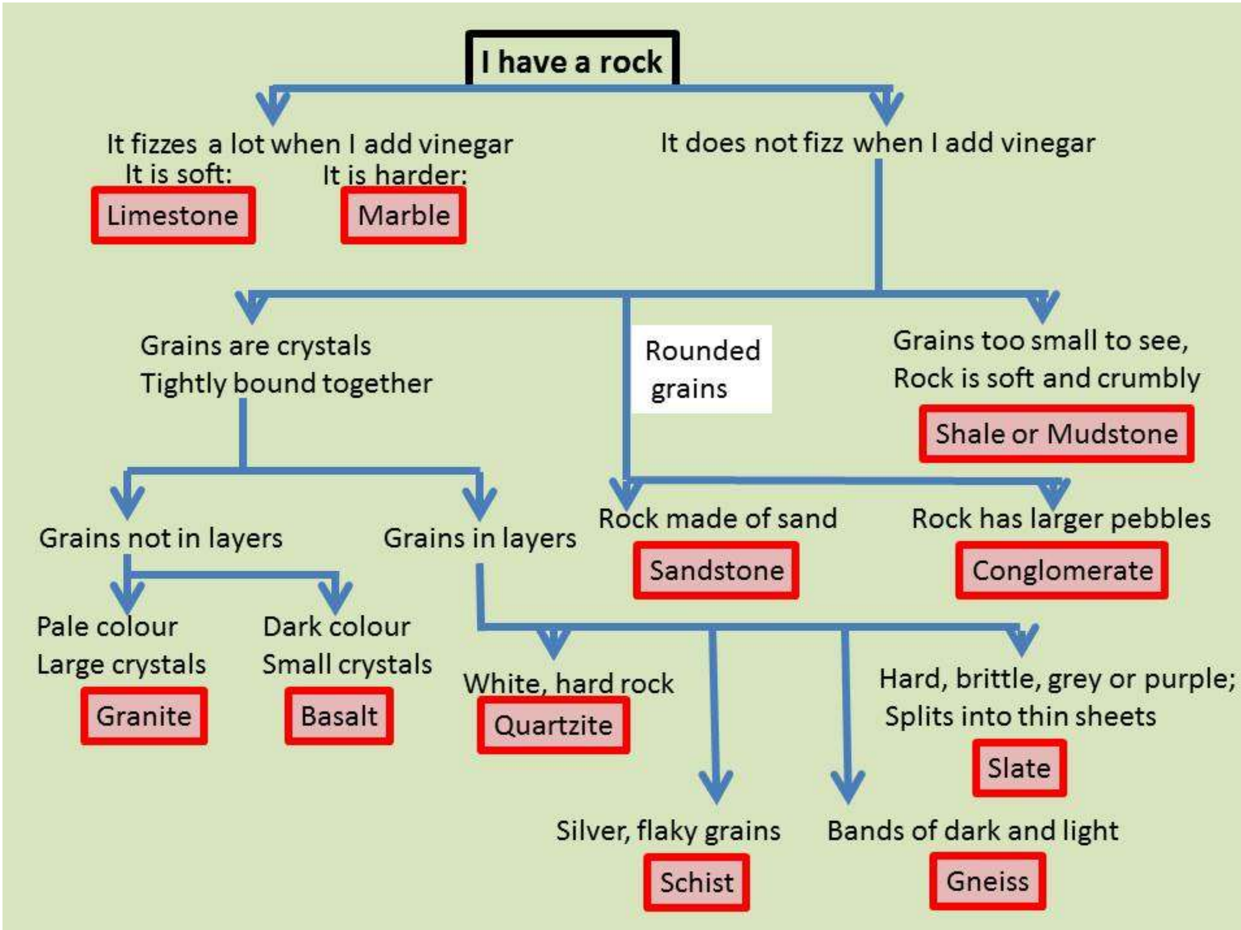
G-5-d - MINERAL COLORS TABLE –

MINERAL	COLOR	STREAK

G-5-e - HARDNESS OF A ROCK

MINERAL	HARDNESS	OBJECT OF SIMILAR HARDNESS

G - 6 - THE ROCK GUIDE



G -7 - ACTIVITY RESPONSE SHEET

1. What did you observe during the week when your rock was hardening?

____

____

____

2. What did you conclude causes the grains to stick together?

____

____

____

3. Are the grains and gravel mixed up or separated?

____

4. What evidence do you have for your conclusion?

____

____

5. Draw a picture of your rock.

G-8 Enrichment Activity- Modelling the Creation of a Salt Flat

Consolidating Student Learning?

1. What did you observe when you repeated steps 1 and 2 of this experiment?

____

____

2.Can you provide an explanation as to why the evaporite appears different in step 3 of the experiment?

____

____

3 What conclusion, if any, can you draw after the completion of several repetitions of the steps outlined in the experiment?

____

____

____

G-9 - How does pressure change Rocks?

Record sheet
Consolidating Student Learning:

1. What do you notice when you compare the clay ball to the granite sample?

Rock sample	Observation
Granite	________________________________
Clay Ball	________________________________

2 After flattening and folding the clay ball and rolling it in the same direction several times, what do you observe about the rice grains in the clay?

____

____

3 Compare the folded and flattened clay to a gneiss and Limestone sample.

Sample	Observation
Clay	________________________________
Gneiss	________________________________
Limestone	________________________________

G - 10 - EROSION DATA TABLE

Date /week #	Mountain Height	Mountain Width	Rainfall Amount in mm	Observations

G - 10 - Measuring Soil Erosion

1. In which tray did the soil erode faster?

____

2. In which tray did more soil erode?

____

3. How would you control soil erosion in a steep place?

____

____

____

4. What factors do you think might cause soil erosion?

____

____

____

____

G-11 - Fossils

Fossils- Student Record Sheet # 1

I think fossils are ____

____

____

____

____

Fossils- Student Record Sheet # 2

Object removed from Plaster of Paris	Observation

Fossils- Student Record Sheet # 3

Consolidating Student Thought

1. How do scientists think that Lucy may have died?

   ____

   ____

   ____

2. What made her bones turn to stone?

   ____

   ____

   ____

3. What natural events made it possible for her fossilized bones to be discovered?

   ____

G-1 - INTERESTING WORDS

Medicine Wheel - This is a sacred hoop used by indigenous people for health and healing.

Rock Cycle - This is the basic geological concept that describes the time-consuming transition of rocks.

Balance - In an indigenous culture, balance among the various aspects of wellness is nurtured to create a holistic level of well-being.

Illumination - this is the amount of lighting that is present on an object or in a particular place.

Renewal - This is an instance where an activity or situation resumes after an interruption to the activity or situation.

Healing - This is a process of repairing relationships that once celebrated peace and friendship.

Wisdom - An application of the long-standing tradition among indigenous people of solving problems by learning from other species and by applying natural processes to a problem in order to satisfy the situation.

Sedimentary Rock - These are rocks that are formed through deposits of sediment especially those sediments transported by water.

Metamorphic Rock - These are rocks that once existed in one form but were transformed into a new form due to the application of heat or pressure.

Igneous Rock - These are rocks that are formed as a result of the cooling and solidification of molton materials.

Solidification - This is a process by which a gas or a liquid turns to a solid.

Sedimentation - this term is used to describe the disposition or accumulation of sediments.

Precipitation - This term has two different meanings in science. 1) It is a process to extract a substance from a solution. 2) It is a term used to describe snow, rain or hail that falls from the atmosphere to earth.

Sun-wise - Indigenous people use the term sun-wise to refer to moving of an object from east to west as in the direction the sun moves in the northern hemisphere.

G-2 INTERESTING WORDS

Mother Earth - This is a term used to refer to our planet earth in which the earth is considered as the source of all its living and inanimate things.

Volcanic Activity - This is what scientists say when a volcano erupts and spreads ash and lava from the mouth of the volcano.

Crustal Uplift - This is when there is movement under the crust of the earth that causes crust of the Earth to rise.

Plate Movement - This is the movement of the crustal plates when the plates slide under, collide with or move past other crustal plates that are near to each other.

G-3 INTERESTING WORDS

Lithosphere - The solid crust and upper portion of the Earth

Asthenosphere - The less rigid region of rock below the lithosphere that allows seismic waves to be transmitted through the earth.

Seafloor Spread - This is a process by which a new ocean floor is created as molton material from the core of the earth rises and spreads between the layers of rock on the floor of the ocean.

Viscous - This is a material that has sticky properties and has a relatively high resistance to flow.

G-4 INTERESTING WORDS

Hand lens - These are small magnifying glasses that are held in the hand for viewing an object.

G-5 a) - INTERESTING WORDS

Volcano - This is an eruption of the earth's crust from which lava, rock fragments and vapor escape.

Minerals - These are solid inorganic substances that occur in nature.

Halite - This is a colorless cubic crystal of sodium chloride that occurs asa mineral.

Carbonate - This is a salt of carbonic acid.

Calcite - This is a white or colorless mineral consisting of calcium carbonate.

Dolomite - This is a see-through mineral consisting of calcium carbonate and magnesium that forms a sedimentary rock.

Barite - This is a mineral consisting of barium sulfate that occurs as a thin white flake or colorless crystal

G-5 b - INTERESTING WORDS

Crystal - This is a solid material whose parts are arranged in a highly organized fashion forming a crystal lattice.

Sandstone - This is a sedimentary rock consisting of sand cemented together by silicon or clay

Shale - This is a rock with layers

Conglomerate - This is a course sedimentary rock that has grains consisting of rounded fragments running through it.

G- 5 c - INTERESTING WORDS

Grains - These are rough textures or rough surfaces found in rocks

Sediments - Sediments pieces of a rock that has been broken away from the rock either by weathering or erosion.

Clast - These are pre-existing minerals or pieces of a rock that are clustered together to form a rock.

G- 5 d - INTERESTING WORDS

Streak - This is a long line or mark of a different substance or color from its surroundings.

G-5 e - INTERESTING WORDS

Gypsum - This is a white or gray mineral consisting of hydrated (water) calcium sulfate.

Pyrite - This is a shiny yellow mineral occurring in cubic crystals and made up of iron di-sulfide.

Quartz - This is a hard white or colorless mineral consisting of silicon di-oxide and found in all forms of rocks.

Mica - This is a shiny silicate mineral with a layered structure found in granite rocks.

G-6 – INTERESTING WORDS

Fizzes - This word refers to the presence of gas bubbles in a liquid.

G-7 – INTERESTING WORDS

Mastodon - A massive elephant –like animal that flourished in North America in ancient times.

Limestone - A sedimentary rock usually consisting of calcium carbonate formed from the skeletons of marine micro-organisms.

Strata - This is a layer of material usually found in the earth's surface.

Erosion - This is a process by which the surface of the earth is worn away.

Mudstone - This is a rock consisting mostly of clay but with a texture and composition of slate.

Silica - This is a form of silicon occurring as quartz, sand and flint that is often used in the production of glass.

G-8 – INTERESTING WORDS

Evaporites - These are any sedimentary rocks that are formed by precipitation from evaporating seawater.

Solubility - This term is used to describe any substance that has the ability to dissolve in a solvent such as water.

Salt Flats - This is an area of land whose surface is covered with salt.

G-9 - INTERESTING WORDS

Heat - This word is used to identify the quality of an object being hot.

Pressure - This is a continuous force being exerted on an object.

Phyllite - This is a type of metamorphic rock created from slate that appears in a layered structure.

Schist - This is a medium grade metamorphic rock that is often interwoven with quartz and feldspar.

Gniss - This is a metamorphic rock consisting of layers of feldspar, quartz and mica.

Foliated - This is a geological term used to describe the repetitive layers found in metamorphic rock.

G-10 – INTERESTING WORDS

Algae - This is a simple, non-flowering plant typically found in water.

Turbidity - This is cloudiness or haziness of a fluid caused by the presence of different particles.

Erosion - This is a gradual wearing away of soil by glaciers, water, wind or waves.

Rain Gauge - This is a calibrated instrument used to collect and measure rainfall.

G - 11 - INTERESTING WORDS

Plaster of Paris - This is a fine white powder that hardens when added to water and allowed to dry.

Fossils - These are remains or impressions of pre-historic organisms that appear in a petrified form.