  

Rocks & Minerals

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Making Connections 230-1431 *Science Hotline* 263-6226

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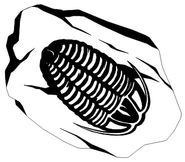
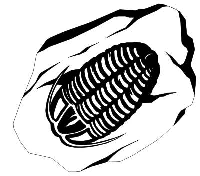
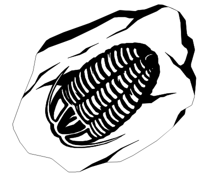



WORKSHOP OVERVIEW

The primary focus of the Grade 3 "Rocks and Minerals" unit is on observation and classification skills. However, the subject matter also provides an excellent opportunity for children to become more familiar with cause and effect relationships and the scientific method of investigation as they work through clues to identify a number of unknown samples.

This handout is intended as a teacher guide to give you a general background understanding of the material you will be teaching. It includes a summary of the curriculum as well as background information and a number of hands-on activities that will give children a more concrete sense of what rocks, minerals and soil really are, where they come from and how they benefit society. The handout is organized to correspond to individual Specific Learner Expectations (SLE's) from the Alberta Science Curriculum. For each SLE, there is a list of activities that can be used to reinforce those particular concepts. Several of the activities, however, can be used to address more than one SLE, and there is no set order that you need to follow.

At the end of the handout, we have also included a resource section that will give you some ideas about possible books, material sources, field trips and guest speakers that could be used to enrich your teaching unit. We highly recommend that your school purchase a class set of rocks and minerals for teaching purposes if you do not already have one available. You will need these to show the children specific properties that they will need to look for when identifying unknown rock and mineral samples.

GRADE 3 TOPIC A
ROCKS AND MINERALS

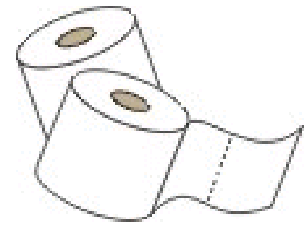
General Learner Expectation

Students will be able to demonstrate knowledge of materials that comprise the Earth's crust and will develop skill in classifying these materials.

Specific Learner Expectations (SLE)

- Compare samples of various kinds of rocks and identify various similarities and differences.
- Given a description of the properties of a given rock or mineral, identify a sample rock or mineral that matches those properties. Properties that students should be able to interpret and apply include:
  - Colour
  - Lustre (shininess) - shiny, dull, glassy, metallic, earthy
  - Texture - rough, smooth, uneven
  - Hardness - based on scratch test
  - Vinegar - acid test
  - Crystal shape for minerals or overall pattern of rock
- Describe and classify a group of rocks and minerals based on the above properties.
- Recognize that rocks are composed of a variety of materials and given a coarse-grained rock and magnifier, describe some of the component materials.
- Recognize and describe the various components within a sample of soil, i.e., clay, sand, pebbles, and decaying plants. Describe differences between two different soil samples.
- Describe ways in which rocks break down to become soil. Demonstrate one or more of these ways, i.e., by shaking a group of small, soft rocks in a jar of water.
- Demonstrate some common uses of rocks and minerals and identify examples of those used within school, home, and local community.

INTRODUCING OUR EARTH - THE "SETTING" FOR THIS UNIT



GEOLOGY is the study of the Earth. It is much more than just learning about rocks and minerals, although that is an important part of it. Children can think of geology as a search for buried treasure. They may be looking for gold, silver, oil, or precious gems. It may be knowledge of our past which is written like a book when you learn how to "read" the rocks, minerals and fossils. Whatever their interest is, they will find this unit absolutely fascinating!

The activities in this introduction are designed to give children a better sense of the enormous magnitude of time and size that geologists deal with as they study our planet. It is a good idea to give children this brief introduction to the earth as a whole before breaking it down into little pieces (rocks, minerals, and soil). By providing this background perspective, children will be able to put the knowledge they gain from this unit into a more realistic and workable framework to add onto as they learn more about the Earth.

Introductory Activity #1

Earth's Time Line

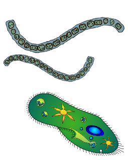
Background:
Geologists have been able to estimate the age of the Earth by studying the rocks and minerals and by dating radioactive isotopes contained within them. The current theory is that the earth is approximately 4.6 billion years old, but that is subject to change as new dating methods are being discovered. The oldest mineral actually dated is a piece of zircon that is 4.3 billion years old. Since its birth, our Earth has been in constant turmoil and motion. Continents have split and moved, and the crust continues to shift today. There have been several mass extinctions, islands have been born and buried, and climates have changed drastically. In this activity, your students will make a time-line from the earth's birth to present day that they can actually walk along in order to get a better idea of how old our planet really is.

Materials:
- 50 metres of adding machine paper (may need two rolls)
- Metre stick
- Marking pen

Procedure:
The 50 metres of paper (46 metres exactly) will represent the 4.6 billion (4600 million) years that the earth has been around. This is a scale of one cm equals one million years. Major events in the earth's history are marked onto the roll of paper. The following table gives you the names and dates of the geologic eras, as well as major events and life forms. It also tells you how many centimetres you should have between events on your time-line. Children can make pictures of the events on the paper. This time-line includes only major events, but you may want to have the children do some research to add on other dates such as when certain dinosaurs or other fossilized creatures appeared.

HINT: You will need a LOT of wall space to display your time line (hallway).

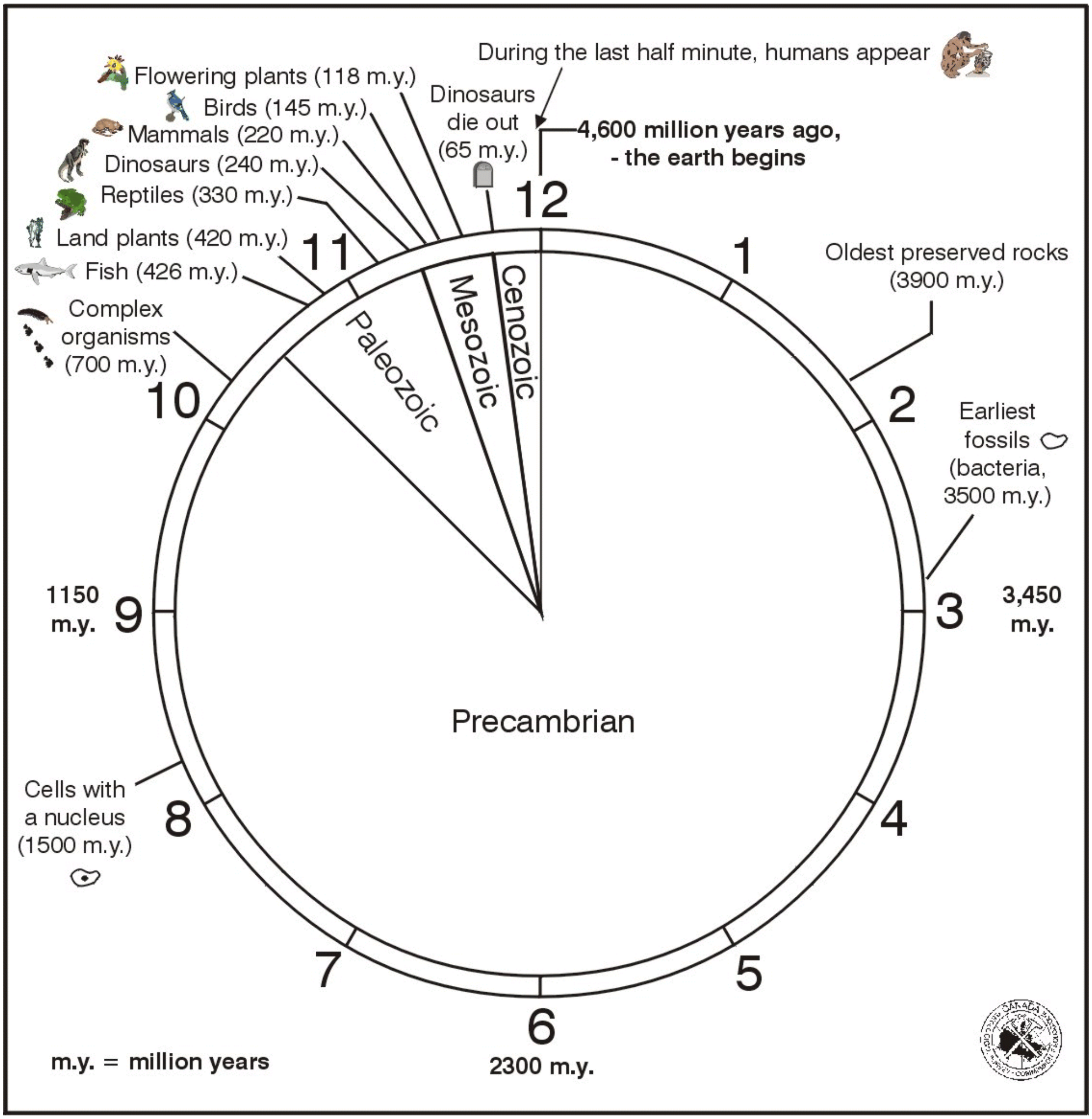
EARTH'S TIME-LINE

Era	Event	Millions (mm) of years ago	Centimetres added on
Cenozoic 	Present day	0	Beginning
	Homo Sapiens appear	1	+ 1
	Ice Age	2	+ 1
	First Primate	3	+ 1
	Mass Extinction (Dinosaurs, many marine species) Possible meteorite?	65	+ 62
Mesozoic 	Dinosaurs decline	70	+ 5
	Rocky Mountains form, First flowers	136	+ 66
	Pangea splits apart, Continents begin to separate	190	+ 54
	Flying Reptiles, Birds, Small Mammals appear	200	+ 10
	First Dinosaurs appear	210	+ 10
	Mass Extinction 75% of marine species wiped out	225	+ 15
Palaeozoic 	First Reptiles, Trees, Insects appear	350	+ 125
	First Land Plants, First Amphibians	395	+ 45
	First Fish	400	+ 5
	Horseshoe Crabs, Sharks appear	500	+ 100
	Trilobites, First Shell Bearing Organisms appear	570	+ 70
Precambrian 	Major Mountain Building	1000	+ 430
	Oldest Life Forms (Algae, Bacteria)	3400	+ 2400
	Formation of Earth from Gaseous Cloud	4600	+ 1200

Total Distance along tape: 4600 cm

EARTH HISTORY CLOCK

The immensity of time in our Earth's history can also be visualized by looking at a clock face and breaking the 4.6 billion years down into a 12 hour period.

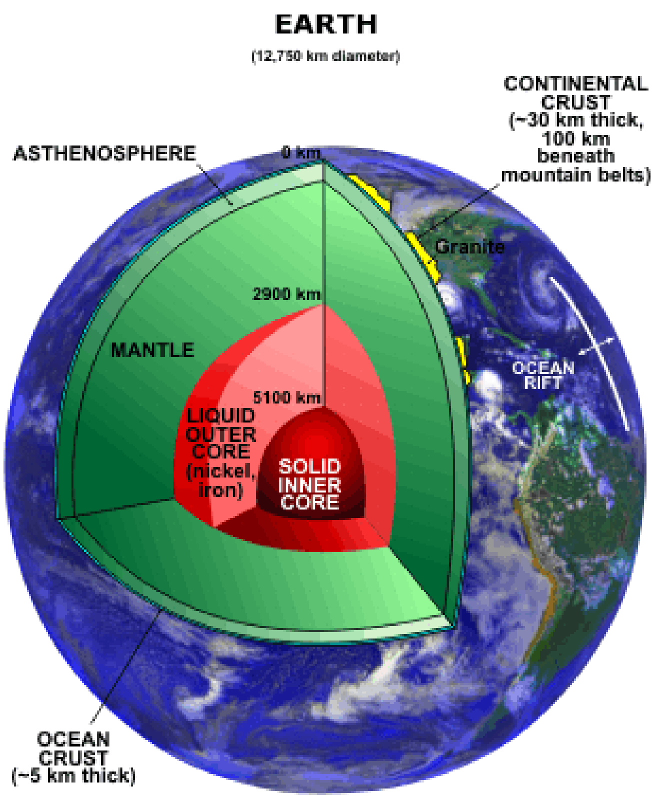


Intodactory Activity #2
Structure of the Earth

Background:

The Earth is actually a ball of rock that weighs 6.6 sextillion (6.6×10^{21}) tons. The outer layer cooled more rapidly and a crust formed. Gravity caused the heavier elements to settle toward the middle where they remain. There are three main zones within our planet:

- Crust - consists of solid rock and a very thin layer (centimetres to metres) of soil. The crust is approximately 8 km thick under the ocean and 32 km thick where there are continents.
- Mantle - this zone is 2896 km thick and consists of semi-solid rock. The temperature is around 871°C at the outer part where it meets the crust, but it gets progressively hotter downward. The mantle is in constant motion due to convection currents.
- Core - this can be divided into an outer core and an inner core. The outer core consists of melted iron and nickel at a temperature of 2200°C. The inner core is made of solid iron/nickel at a temperature of 5000 to 7000°C.



Materials:

- Hard boiled egg OR Apple
- Knife
- Overhead of cut-away Earth

Procedure:

- An interesting way to assess children's knowledge of the Earth before doing this activity is to have them draw a picture of what they think the inside of the Earth looks like. You can demonstrate the idea of looking inside the Earth by showing children a round globe and then holding up a ball (a rubber "bouncy ball" works well because it shows some structure and pattern). Explain that our Earth is like a ball and you want to know what they think is inside. Many will draw an Earth filled with dirt and plant roots because that is the only reference they have. It is important that they realize the Earth is much more complex than what we see on the surface, and this is a good time to give them a brief introduction to this concept
- Explain to the students that the earth is very much like an egg or an apple. The shell is thin and can be cracked easily. They can go ahead and do this, but tell them not to peel the shell off yet. Explain that the cracks are similar to faults and mountain belts within the Earth's crust.
- Have groups of children carefully cut an egg in half (you may want to do this for them). With a marker, they can make a dot about the size of a pea in the centre of the yolk. This represents the solid inner core of the Earth. The rest of the yolk is the outer core. The white is the semi-solid mantle, and the shell is the crust. The relative proportion in size between shell, white and yolk is a fairly accurate representation of the Earth's layers.
- The same activity can be done with an apple but it is not as representative. However, the room ends up smelling a lot better!

ACTIVITIES FOR SLE #1
Compare samples of various kinds of rocks and identify the various similarities and differences.

Background:
When we think of what makes up our Earth, the first thing that comes to mind is rocks. When we hike in the mountains, walk along a river bed, or sit on a beach, we constantly observe the rocks in our environment. Without realizing it, we automatically classify these rocks in our minds by observing particular features.

Rocks are made up of minerals but they are not minerals themselves. Rocks usually have more than one mineral within them. The way that mineral grains are arranged in rocks are a good clue to their identifications. Rocks are grouped into three main types based on their origin. These are igneous, sedimentary, and metamorphic. The characteristics that we observe most easily in rocks, particularly the arrangement of mineral grains, helps us classify them according to these categories.

The **ROCK CYCLE** refers to how rocks are constantly being recycled in much the same way as our garbage and waste. When rocks break down due to erosion, the tiny pieces are carried off and eventually buried again. If they are buried deeply enough, they will melt into magma and will eventually be reborn as igneous rock. The rock cycle is illustrated below, and is an essential part of understanding rock classification and identification.

THE ROCK CYCLE

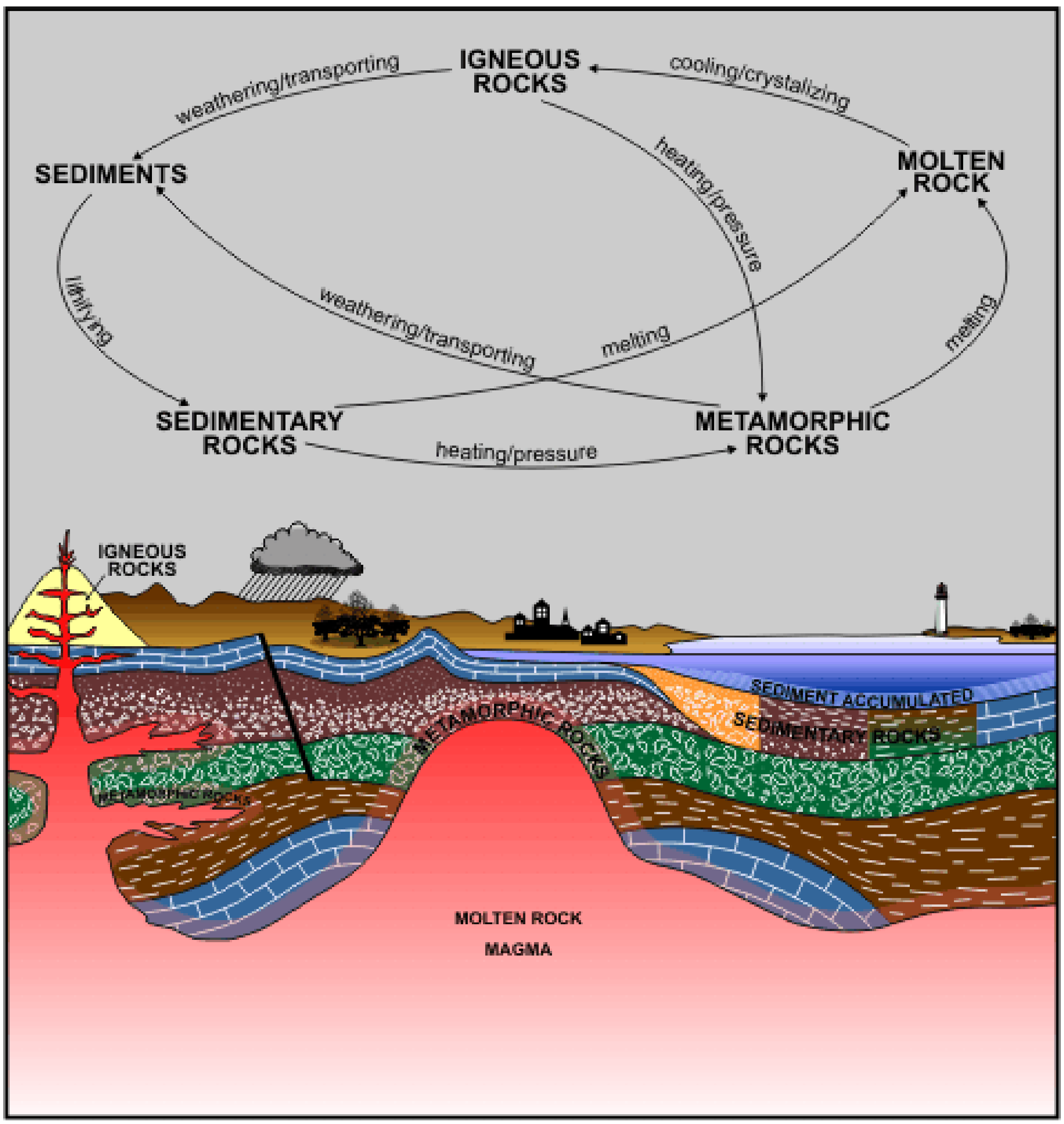
IGNEOUS ROCKS
These rocks are formed when melted rock (magma) deep inside the Earth cools and hardens. The word "igneous" means "formed by fire". There are three main types of igneous rocks:

- **GRANITE** - the most common igneous rock type. It forms deep within the Earth and is coarse-grained. Usually, it is multi-coloured (white, pink, grey, black). Granite is the most common rock type on Earth, although most of it is buried and hidden from view.
- **BASALT** - the most common volcanic rock. It forms when lava erupts from volcanos and cools and hardens quickly. It is usually black and fine grained, and often shows gas bubbles and flow patterns.

▸ **OBSIDIAN** - another volcanic rock that cools extremely quickly when it erupts directly into water. It is so fine-grained that it looks like black glass. That is because the crystals making up the rock did not have time to grow.

Pumice is a less common volcanic rock but is very interesting because it is the only rock that floats! It forms when escaping gases cause lava to foam up and harden, making it extremely porous and lightweight.

ROCK CYCLE



SE M **DI E**

NTARY ROCKS

Sedimentary rocks are formed from eroded gravel, sand, mud and carbonaceous material that has been carried long distances by water or wind. It settles on the bottom of rives, lakes and oceans. These loose sediments are deposited in thick piles that are slowly buried and harden due to pressure and chemical changes. They become sedimentary rock. There are four main types of sedimentary rocks:

- **CONGLOMERATE** - is formed when large, rounded pebbles (quartzite and feldspar) are carried by rivers, deposited, and cemented together by brownish sand or clay.
- **SANDSTONE** - is formed when sand is carried by rivers and deposited, or by wave-action on a beach. Sand grains are made of quartz and are cemented together. Often, you can see layers of different coloured grains in this rock. It feels much like sandpaper when you rub it.
- **SHALE** - may be made from clay, mud, and/or silt carried by rivers and deposited. It is a soft, smooth rock that may appear layered.
- **LIMESTONE** - is made of calcite from the skeletons and shells of millions of tiny sea creatures that rain down from above onto the sea floor. Usually, it is light coloured and it may contain fossils. Because it is primarily calcium carbonate, it will fizz in acid (vinegar, lemon juice or dilute muriatic acid).

- **COAL** - soft, black rock made from ancient decomposed plant material. Our primary source of energy in Alberta.

METAMORPHIC ROCKS

Metamorphic rocks were originally some other rock type (sedimentary, igneous or other metamorphic). Metamorphic means "changed in form". When already existing rock is subjected to extreme temperature and pressure due to deep burial or mountain building stresses, the original character changes drastically. Mineral grains tend to flatten and align and new minerals may actually form due to chemical changes. Common types of metamorphic rocks are:

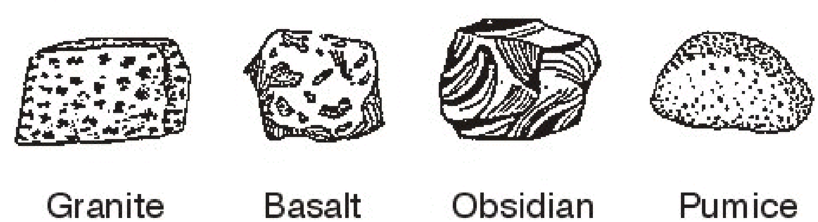
- **QUARTZITE -** is a very hard, light-coloured rock formed when sandstone is subjected to tremendous heat and pressure. It is one of the hardest rocks known, and is completely crystalline, showing no indication of the original sand grains.
- **SLATE -** is a dark-coloured, very fine grained rock that was originally shale.

It easily splits into very thin layers and may contain visible mica flakes. It is very hard and is often used for floor tiles.

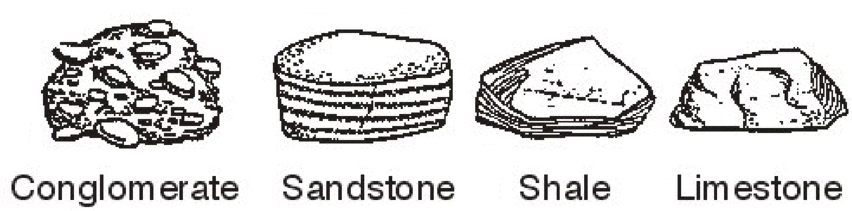
- **GNEISS (pronounced "nice") or SCHIST -** these are medium to coarse-grained rocks that are variable in colour. They may form from shale, slate, sandstone or granite. Irregular or interlocked bands are often visible and mica is a major component.
- **MARBLE -** is a soft, smooth, variable-coloured rock that forms from limestone that has been subjected to extreme heat and pressure. It may have inter-mixed coloured bands. It will fizz in acid since it is still carbonate-based.

When trying to determine rock types, you may find it helpful to have students follow an identification key like the one on the following page.

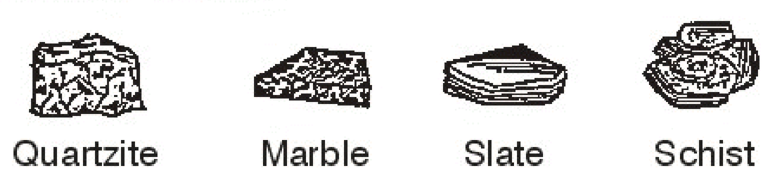
IGNEOUS ROCKS:



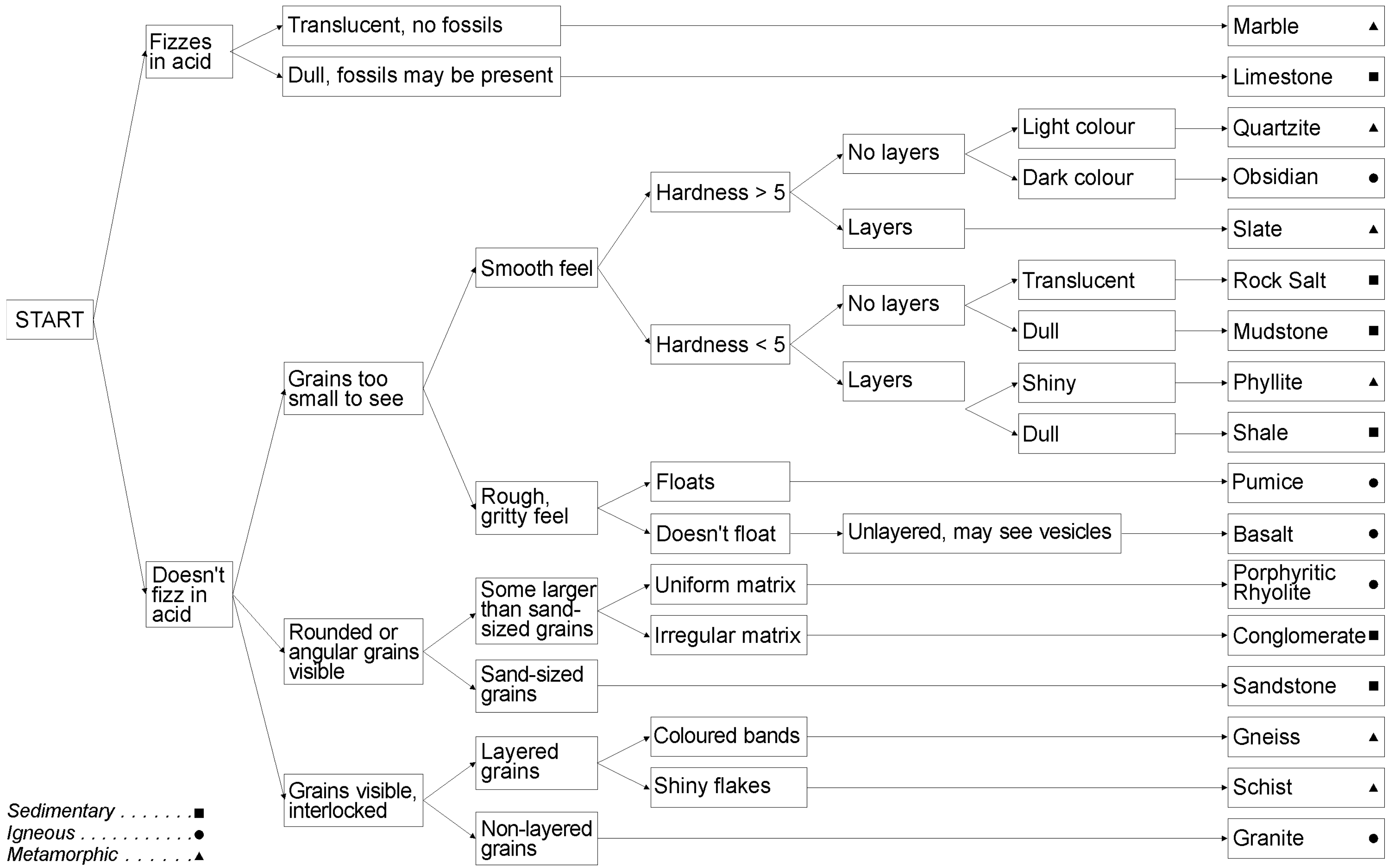
SEDIMENTARY ROCKS:

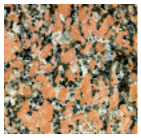
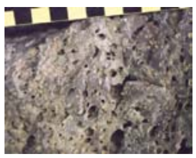


METAMORPHIC ROCKS:

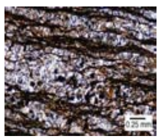


IDENTIFICATION OF ROCK TYPES TABLE



	ROCK NAME	***DESCRIPTION***	***ORIGIN***
IGNEOUS	***Granite*** 	Granite is a combination of light and dark coloured minerals. Light minerals include quartz grains, white or pink feldspar and silvery muscovite. Dark minerals include biotite and hornblende. Granite is a coarse grained rock with interlocking crystals randomly arranged.	An intrusive igneous rock that forms deep in the Earth's crust from cooling magma. The magma is usually silica (quartz) rich and the slow cooling produces large crystals that are visible without a microscope.
	Basalt 	Dark gray to black, made up of microscopic crystals, very hard, may contain evidence of gas bubbles (vesicular basalt).	Volcanic in origin, formed from magma that erupts from a volcano or a fissure as lava. Because it cools quickly, there was not enough time for grains to become large enough to see.
	Porphyritic Rhyolite 	Usually light coloured (gray, tan, reddish, greenish) with very large crystals scattered throughout a fine-grained matrix. It may show some evidence of gas bubbles or flow lines.	This started out as an intrusive rock as seen by the large crystals (phenocrysts). However, before more crystals could form the magma was suddenly ejected out of a volcano or fissure so the matrix is microcrystalline and the rock is considered extrusive.
	Obsidian 	Glassy and usually black, although there make be white crystals that look like snowflakes (snowflake obsidian) or red swirls. Glass-like conchoidal fracture which looks like a ridged semicircle.	An extrusive volcanic rock that forms from lava that erupts into cold water. It hardens so quickly that crystals have no time to form, thus the glassy texture.
	Pumice 	Very light gray to medium gray with lots of gas bubbles giving it a sponge-like appearance. Volcanic glass that is so lightweight it will float in water.	An extrusive igneous rock that comes from magma containing a great deal of trapped gas. This gas causes an explosive eruption, which results in a volcanic glass filled with air spaces when the magma suddenly cools.

SEDIMENTARY	***Conglomerate*** 	Looks like a mixture of sand and different sizes of rounded pebbles. If the pebbles are angular, it is called Breccia.	Sand and pebbles collect on river banks or shorelines. As more sediment piles on top, the underlying layers compact and are cemented by material (usually quartz or calcite) dissolved in water that seeps through them.
	Sandstone 	Can be nearly white to red or brown. Composed of grains that are mainly the same size but size may vary slightly in layers. Can be fine, medium or coarse grained. This is usually determined by the "feel" of the rock.	Resistant quartz sand grains are produced by weathering of other rocks such as granites. Deposited in a basin such as an ocean or a river. Sediments are buried and compacted under the weight, and then cemented.
	Mudstone 	Colour may be tan, green, brown, gray, red or black, depending on the source of clay or mud. Massive and structureless with no layers. It crumbles easily. Smells like wet mud when moistened. A weaker rock than shale.	Mud and clay particles accumulate in a basin such as a deep lake or ocean. If they are not buried deeply enough, they will become a very weak rock that crumbles into powder when weathered.
	Shale 	Colour may be tan, green, brown, gray, red or black. Particles are too small to be seen by the unaided eye but you can usually see evidence of layers. Shale is weak and breaks along layers. When moistened, shale usually smells like wet mud.	When clay sediments settle in deep, quite water, they accumulate and can become deeply buried. If these layers are buried deeply enough, they will be compressed and converted into a soft rock called shale.
	Fossiliferous Limestone 	White, gray or tan, may be fine or medium grained but not crystalline, fossils are commonly visible, fizzes in dilute hydrochloric acid.	Formed in ocean water as a result of coral reefs being buried by mud or by lime mud being deposited on the sea floor, the product of calcareous organisms dying and raining down.
	Rock Salt 	Transparent to translucent, colourless to white, massive or cubic crystals, very soft (can be scratched by fingernail). Made up of the mineral halite.	Sometimes stretches of seawater become land-locked because of tectonic or climatic changes. As the water of an enclosed sea area evaporates, the result is a salt lake with a saline content higher than that of the ocean. Further evaporation leaves a large expanse of crystallized salt, which is buried by other sediment to become rock.

METAMORPHIC	***Marble*** 	Usually white but may be streaked with other colours, fine to coarse grained crystals, fairly soft, fizzes in dilute HCl.	Formed from limestone that has been subjected to extreme temperature and pressure.
	Phyllite 	Commonly silver or greenish. Shiny appearance depending on which direction it is seen from. This characteristic sheen often identifies phyllite. Corrugated appearance to layers. Very fine grained.	The parent rock for phyllite is slate. As slate becomes more deeply buried underground and pressure and temperature continue to rise, chlorite and mica crystals recrystallize into larger crystals, which reflect light more easily than slate. Transitional between slate and schist.
	Schist 	Layered rock with abundant shiny mica crystals (small, flaky crystals). Layers are usually thin with interlayered mica and quartz. Layers may be somewhat wavy. May be medium or coarse grains. Usually split easily along layers of mica.	Schists are usually formed from shales (parent rock). Often sea floor shales that are exposed to tremendous pressure and temperature during tectonic activity such as subduction.

ROCK IDENTIFICATION ACTIVITIES - SLE #1

① Whose Rock Is This?

This activity will introduce students to classifying rocks by comparing difference and similarities.

Materials:

- A variety of rocks (enough for one per child). Try and get a selection of igneous, metamorphic and sedimentary rocks for this activity.
- Container - box, ice cream pail, etc.

Procedure:

1. Have each child choose a rock from a box. Encourage them to become familiar with it by using as many senses as possible (sight, touch, smell, the sound it makes when rubbed). Ask the children to describe what they think makes their rock different from the others. Make a list of these differences on the board.
2. Collect all of the rocks and put them in the box. See if the children can find their own rock again by looking for the characteristics that they had mentioned before.
3. Have children classify the group of rocks by size, then colour, then shape, then smoothness, etc. You should be able to introduce the idea of grain size and have children sort the rocks on this basis.

② Rock Identification Key and Flow Chart

In this activity, students will use different classification criteria to identify rocks as either igneous, metamorphic or sedimentary.

Materials:

- Rock Identification Key Overhead
- Rock Identification Flow Chart Overhead
- Laminated Identification Flow Charts for student use. These may be made by enlarging the flow chart from this handout onto 11 x 17 paper.
- Student copies of Identification Keys.
- Sets of rocks containing one of each type on flow chart, if possible.

Procedure:

1. Review the identification key and flow chart with the students.
2. Pass out rock sets to groups of children, along with a copy of the identification key and flow chart.
3. Guide students through the process of classification and identification. They can actually put their rock on the circle that identifies it.

③ Making Sandstone and Conglomerate

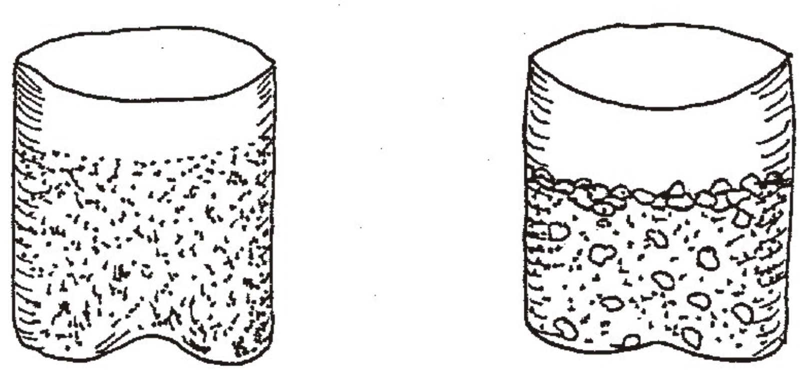
In this activity, students actually have a chance to make sandstone and conglomerate in much the same way that it is made in nature.

Materials:

- $\frac{1}{2}$ cup (118 ml) water
- Clear plastic pop bottle
  (cut off 10 cm from bottom)
- 2 $\frac{1}{2}$ Tb. Epsom Salt
- Stirring spoon
- $\frac{1}{2}$ cup (100 g) dry sand if making sandstone.
- 2 Tb. sand and 2 Tb. gravel if making conglomerate.

Procedure:

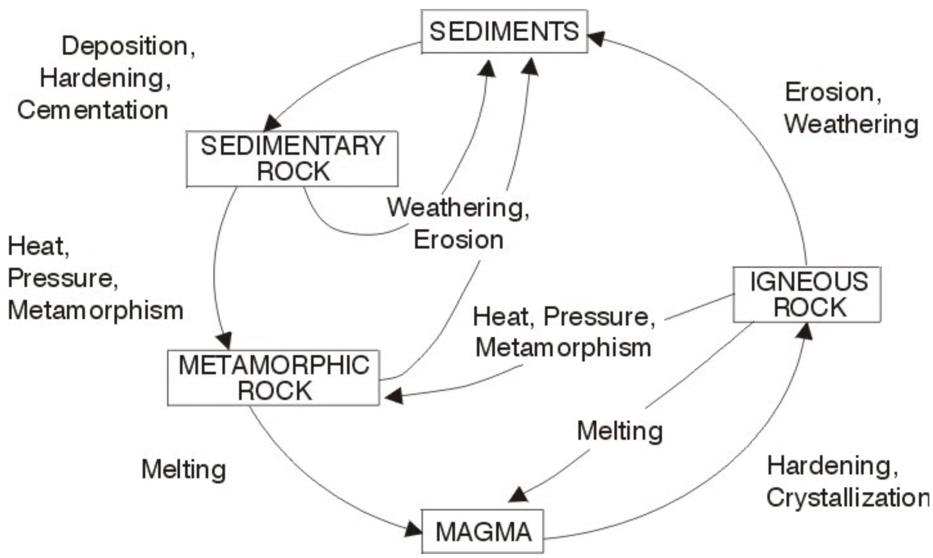
1. Pour water into bottom of cut-off pop bottle.
2. Stir in Epsom Salt and stir until dissolved.
3. Add sand (sandstone) or sand and gravel (conglomerate) and stir so that the dry materials are completely moistened.
4. Let this sit for several hours, periodically pouring off excess liquid from the top. When no more excess liquid comes out, set aside for at least a week until completely dry.
5. Remove from bottle bottom. You now have a cemented piece of sandstone or conglomerate.



Sandstone Conglomerate

④ Human Rock Cycle

In this activity, the students themselves "become" rocks moving through various pathways on the rock cycle.



Material :

- Giant copy of the Rock Cycle from handout - a sheet works well for this. You may also simply make stations to represent different stops along the cycle.
- Several cards with terms from the rock cycle that refer to changes that rocks undergo (erosion, hardening, melting, crystallization, heating, weathering, extreme pressure).
- Several cards with names of different rock types shown on the rock cycle (igneous, sedimentary, metamorphic, or sediments).

Procedure:

1. Place rock cycle on floor or set up stations. Position one child at each rock location around the cycle, making sure that they know what type of rock they are (igneous, metamorphic, sedimentary, or sediment).
2. Have one student who is sitting out draw a "change" card while another students draws a "rock type" card.
3. The student at that rock type will then do what the change card says, and move to that location, announcing what type of rock he or she has become. For example, if sandstone and heating is drawn, the child at sandstone will move to the metamorphic rock location.
4. There will be times when a rock cannot reach a change without going through another rock type first. When this happens, he/she must stay where they are.

For example, if sandstone and melting are drawn together, sandstone would have to become metamorphic first and then melt, so the move cannot be made.

5. Be sure to stress the characteristic changes that would occur after each move so children become familiar with how rock features form.

⑤ Rock Hard Food

Geological processes that form rocks are remarkably similar to many of the things that we do in the kitchen every day! The following foods are an excellent way of teaching children how some of the classification criteria that we use in rock identification are formed in nature, including grain size, sediment layering, mineral alteration, and cementation.

CHOCOLATE CHIP COOKIES

These are an excellent (and yummy) way for students to think about the difference between rocks and minerals. Minerals are made up of one kind of material only. Rocks are made up of several different kinds of minerals. The chocolate chips in the cookie represent this very well. Also, the ingredients that went into the cookie batter are like smaller mineral grains of different types (flour, salt, sugar). After the ingredients are mixed and buried, they heat up and harden into their new form. The individual minerals may not all be seen, but they are all there and give the cookie its distinctive characteristics.

SEDIMENTARY SANDWICH

Sedimentary rocks are formed when layer after layer of sediment is laid down, eventually hardening into rock. These layers are often different materials since this happens over thousands of years, and things tend to change in that amount of time. Bread at the bottom and top could be sandstone, peanut butter could be clay, jam with chunks of fruit could be conglomerate. It is very common to find these "sandwich-style" layers in natural sedimentary rock.

RICE CRISPY SQUARES

These are a good example of cemented sandstone. The rice cereal grains are gathered and cemented together by the marshmallow. This is very much like sand grains being cemented together by mineral-rich water over time.

PUFFED RICE CAKES

If the rice grains are subjected to extreme heat and pressure conditions, they lose their original character altogether. The result is an amorphous mass where original grains are "smeared" out and merge with neighbouring grains so that you can no longer distinguish one from another. This is analogous to sandstone being metamorphosed into quartzite.

CANDY GRANITES AND BASALTS

Sugar candy in various forms is an excellent way to show students the difference between granite (coarse-grained intrusive igneous rock) and basalt (fine-grained extrusive igneous rock). Granite is coarser-grained because the crystals had a longer time to grow as it cooled slowly underground. This is why you can see the individual grains interlocked. Rock Crystal Candy is made this way and the crystals can easily be seen. Basalt cooled very rapidly as it was ejected from a volcano directly into cool air or water. The crystals did not have time to grow and are invisible, giving the rock a smooth texture. If there are no air bubbles, it will look like glass (obsidian). This is how toffee or Candy Glass (made without the butter) would look. If there are air bubbles or gasses trapped during the quick cooling, the rock will have lots of little holes. This is how Spun Sugar Candy is made. It is very porous and much lighter in weight than other sugar candies.

PET  ROCKS 

SLE #2 IDENTIFYING MINERALS

Given a description of the properties of a given rock or mineral, identify a sample rock or mineral that matches those properties.

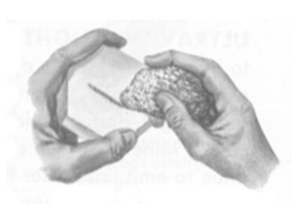
Background:

Minerals are naturally occurring, non-living substances found in the earth. There are over 2000 different minerals but only a few are commonly found in the crust. Each mineral has a characteristic chemical composition that determines its overall appearance in much the same way as DNA determines how we look. There are a number of characteristic properties that can be used to identify any mineral specimen. We will look at each of these separately.

MINERAL PROPERTY: COLOUR and STREAK

Most minerals have a characteristic **colour** but this alone is not a good way to identify all mineral specimens. Some minerals such as quartz can occur in a rainbow of colours including clear, purple(amethyst), rose, or even black, depending on minute chemical impurities.

Streak is a much more accurate way of identifying minerals correctly. Streak is the colour of the powdered mineral left behind after scratching it on a piece of unglazed tile (most retail tile outlets will give these to teachers for free). You can get a similar effect by taking a small piece of mineral and crushing it with a hammer. The powdered pieces will have the same colour as the streak on the tile. Some minerals have white streaks which are difficult to distinguish from one another. However, certain minerals have very characteristic steak colours. For these minerals, streak is an important identification test. They include galena (grey-black), pyrite (green-black), and hematite (red).



Streak Plate

Crushed Minerals

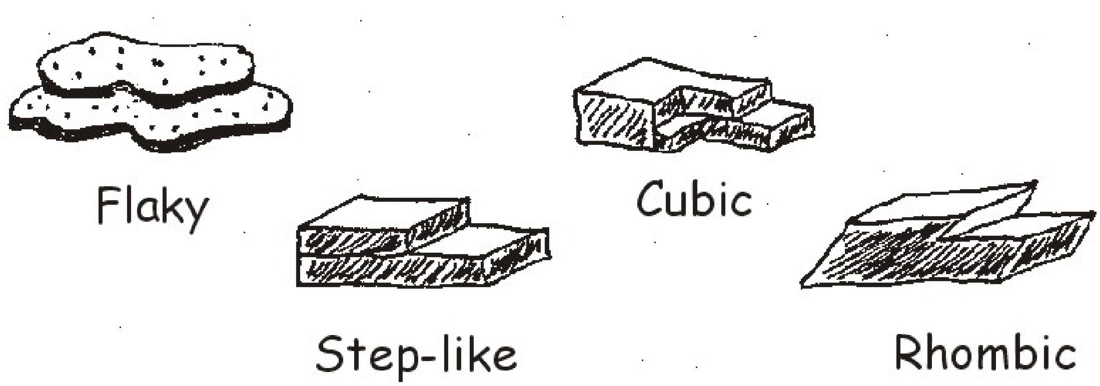
MINERAL PROPERTY: LUSTRE

Lustre is a way a mineral appears to reflect light. There are two main categories. They are metallic and non-metallic. Non-metallic minerals can be further divided into glassy, greasy, pearly, waxy, or earthy lustres. Common examples of metallic minerals are galena and pyrite. Quartz is glassy, graphite is greasy, feldspar is pearly, talc is waxy, and hematite is earthy. It is a good idea to have a sample of lustres set out for student to compare their specimens to. An example is shown on the following page.

MINERAL PROPERTY: CLEAVAGE

This property describe the way a mineral breaks, and it can be very characteristic of certain specimens. The most common types of cleavage are flaky (as in mica), step-like (as in feldspar), cubic (as in pyrite and galena), and rhombic (as in calcite). These are shown below. Some minerals have no cleavage but they break in characteristic patterns (fracture). Quartz has conchoidal fracture that is exactly like thick window glass that has been chipped.

Readily available classroom materials can be used to demonstrate cleavage. For example, fridge magnets stuck together illustrate flaky cleavage such as mica. Stacking cubes put together are a perfect example of cubic cleavage such as in halite or pyrite. Diamond-shaped attribute blocks can be built up to show rhombic cleavage such as in calcite.



LUSTRE CHART

METALLIC LUSTRE

(broken chain)

NON-METALLIC LUSTRE

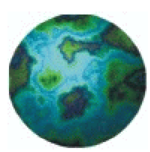
	(gem from costume jewelry)	**Glassy**
	(soap)	**Greasy**
	(costume jewelry pearl)	**Pearly**
	(candle)	**Waxy**
	(clay pot piece)	**Earthy**

Sources for lustre examples: Bead or craft shops are ideal places to find pearly or glassy lustres. Earthy lustre could be a piece of natural clay pottery. Waxy could be paraffin. Greasy could be a piece of plastic tupperware container or soap. Different metallic lustres could be coins, bolts, paper clips, etc.

MINERAL PROPERTY: HARDNESS

Minerals come in several different hardnesses, again depending on their atomic structure. In the early 1800's, a German Mineralogist named Friedrich Mohs developed a ten-point scale of hardness that is still being used by geologists today. This test is based on the premise that a mineral will scratch itself and any softer object. On the scale from 1 to 10, 1 is the softest and 10 is the hardest. Diamond has a hardness of 10 and is the hardest known material at this time. The scale is listed below and includes hardness, an example of a mineral having that hardness, and a material that you can use to test the hardness. In order to determine the hardness of an unknown mineral, you would first try scratching it with your fingernail. If the mineral did not scratch, go to the next hardness up and try scratching it with a penny, etc. etc. The table on the next page is an example of how you might have the students work through the hardness test. They could then order then from softest to hardest.

HARDNESS	MINERAL	TEST MATERIAL
1	Talc	Soft pencil lead
2	Gypsum	Fingernail (H 2.5)
3	Calcite	Penny (H 3.5)
4	Fluorite	Iron Nail (H 4.5)
5	Apatite	Glass (H 5.5)
6	Feldspar	Steel nail
7	Quartz	Steel file
8	Topaz	Sandpaper
9	Corundum	No common equivalent
10	Diamond	No common equivalent

HARDNESS TEST	
Does your fingernail scratch it? 	**Yes: Hardness $\leq$ 2**
	No: Hardness $\succ$ 2 (Try the next test down)
Does a copper penny scratch it? 	**Yes: Hardness $\leq$ 3**
	No: Hardness $\succ$ 3 (Try the next test down))
Does an iron nail scratch it? 	**Yes: Hardness $\leq$ 4**
	No: Hardness $\succ$ 4 (Try the next test down)
Does a glass marble scratch it? 	**Yes: Hardness $\leq$ 5**
	No: Hardness $\succ$ 5 (Try the next test down
Does a steel file scratch it? 	**Yes: Hardness $\leq$ 7**
	No: Hardness $\succ$ 7

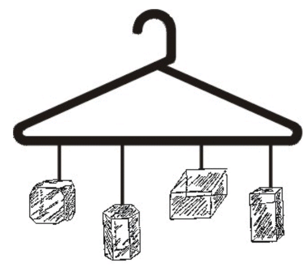
$\leq$ means less than or equal to $\succ$ means greater than.

Note: You will not find many local minerals with a hardness greater than 7. These are more often gem quality minerals such as topaz, emeralds and diamonds. However, our most common mineral (quartz) has a hardness of exactly 7.

MINERAL PROPERTY: CRYSTAL SHAPE

Many minerals have distinctive and beautiful crystal forms. These are visible as flat, clean surfaces on a mineral specimen. There are seven crystal systems but only four are commonly found. These are:

- Cubic (example - galena, pyrite)
- Hexagonal (example - quartz)
- Tetragonal (example - zircon)
- Rhombic (example - calcite)

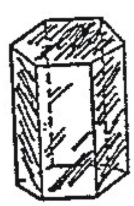


These crystal shapes are pictured to the side, and there are patterns for making three-dimensional models of each of these (plus others) on the following pages.

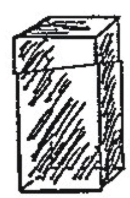
Students are not expected to know the names of these crystal shapes. That is for your information only. However, they should be able to describe their characteristics and differences, and to recognize the similarities between models and crystal shapes that they find.

Students enjoy decorating their models with glitter or coloured marker, and hanging them up for display.

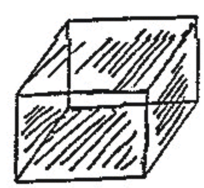
cubic



hexagonal

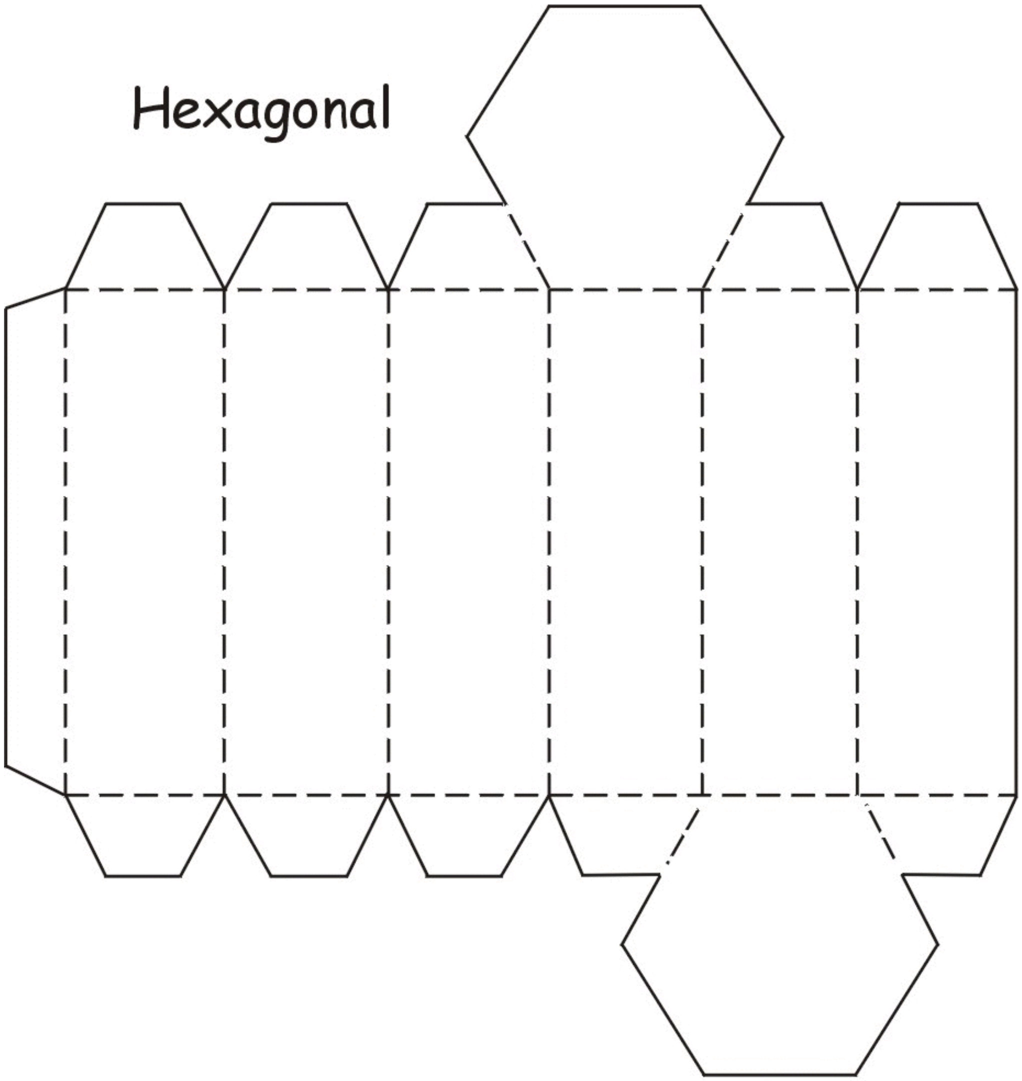


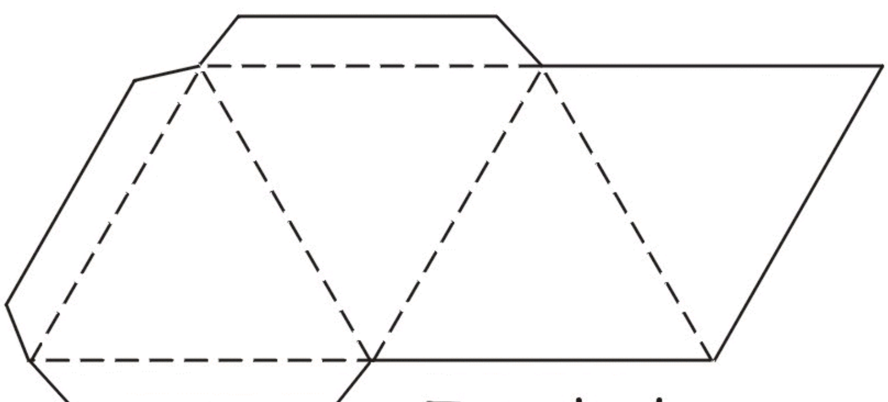
tetragonal



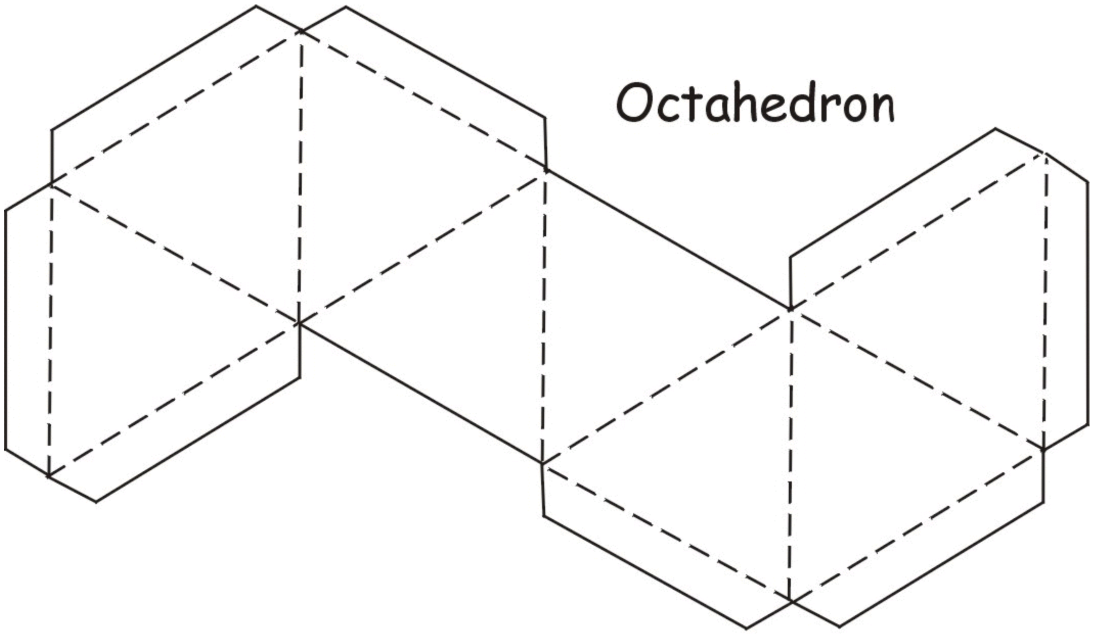
rhombic

Hexagonal

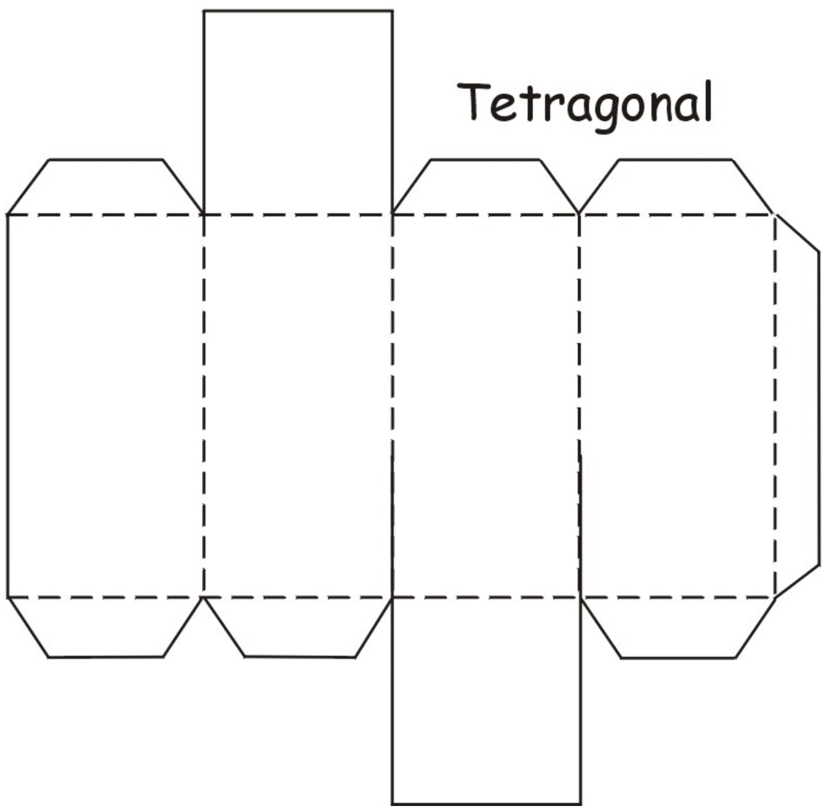




Tetrahedron



Octahedron

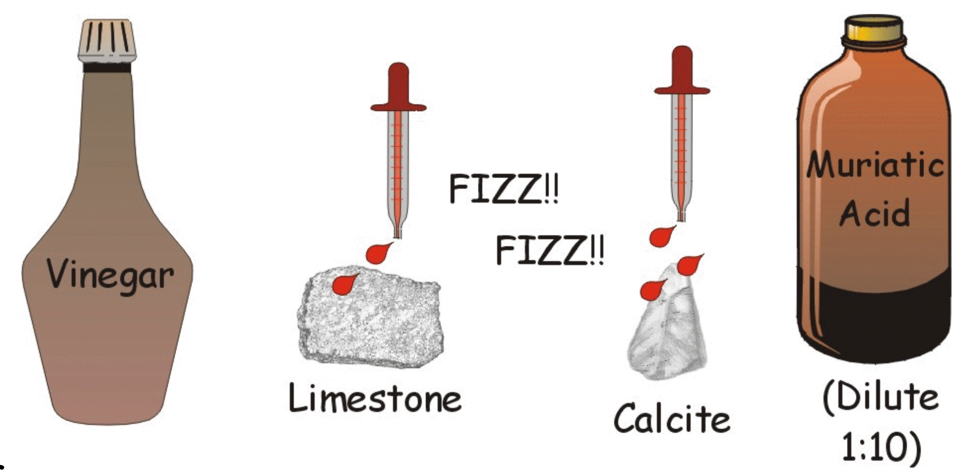


Tetragonal

MINERAL PROPERTY: EFFERVESCENCE (FIZZES IN ACID)

Certain minerals will chemically react to an acid that has come in contact with them. This chemical reaction is called effervescence, and it is characterized by the creation of bubbles, or fizzing. If you have ever added baking soda and vinegar together, you will know what this reaction looks like. The mineral calcite is similar in appearance to quartz and several other common minerals, but it can be distinguished easily by performing the "acid test". That is because it is made up of calcium carbonate which reacts with acid. Materials making up most other minerals do not react this way. In this test, you drop a very small amount of an acid onto the mineral or rock and watch for fizzing. The acid will react with the carbonate and cause gas bubbles to form. You may have to scratch the mineral or rock first and drop the acid onto the powder in order to see a reaction. This same test is done on rocks to determine if it is limestone since it also consists of calcium carbonate.

You can use an acid such as vinegar or dilute muriatic acid (available in hardware stores and used for etching concrete to prepare it for painting - dilute to 1 part acid : 10 parts water). You may find the vinegar is simply too weak to produce a reaction which is why we suggest using dilute muriatic acid. It is much more impressive and allows the students to observe the reaction easily. However, **THIS SHOULD ONLY BE DONE AS A DEMONSTRATION BY THE TEACHER. NO ACID, EVEN VINEGAR, SHOULD BE CONSIDERED COMPLETELY SAFE AROUND CHILDREN.**



IDENTIFICATION ACTIVITIES

① **Looking at Minerals**:
In this activity, children look at a variety of minerals and identify their characteristics based on hardness, colour, lustre, steak, crystal shape, and effervescence. You may want to set these up as a "centers" approach, or you may prefer to do each activity separately.

Materials:

- Mineral samples for groups of students. If you want the students to describe these minerals on a form, they should be numbered. A spot of "White-out" on the mineral allows you to write a number on it using permanent marker.
- Property testing kits for each characteristic. These kits should have the materials and information sheets from the previous section (i.e. for lustre, have the lustre sample sheet, for hardness have the hardness sheet and suggested testing materials, etc.)
- Sheet for students that allows them to record their observations for each mineral.
- Hand lenses
- If possible, it is very helpful to have a large mineral identification chart in the room. These are available at teacher supply stores or through catalogues.
- Books on minerals that show coloured pictures. These are readily available at all libraries.

Procedure:

- Allow students to explore properties of minerals until they are confident in recognizing distinctive characteristics. They can then record their observations for specific minerals. Some may want to use their information to actually identify the mineral if you have a book or poster available to aid them.

Possible Worksheet headings:

Sample #	Colour	Lustre	Streak	Hardness	Crystal shape	Fizz in acid?	Other observations

② Growing Crystals:

There are numerous ways that crystals can be grown in a classroom. Some of these are very simple and some are more complex. Some are even edible! Children are fascinated by these activities and they are an excellent tool for teaching students observation and recording skills as they watch the changes in their crystals.

Sugar, Alum and Epsom Salt Crystals

There are many different methods for growing these crystals but we recommend the following as being the easiest, and by far the most successful way found to date. The resultant crystals form quite quickly (within a day or two) and they are very large compared to some other methods. This allows the students to easily study and compare them using a hand lens.

Materials:

- Kettle for hot water
- Disposable plastic saucers (available at any grocery store)
- Sugar, Alum (available in spice section of grocery store) and Epsom Salt (available at pharmacies). You will probably need about 3-5 Tb. of each dry material.
- Shatterproof, heat resistant container - approximately 1 litre capacity. Science room beakers are perfect for this if available.
- 2 spoons - one for dry material, one for stirring.

Procedure:

- Prepare saucers for students by putting their names on them with permanent marker. Write "alum", "salt" or "epsom salt" on saucer as well.
- Boil water in kettle. When it comes to a boil, pour approximately 500 ml into your beaker.
- Add one Tb. at a time of dry material (whichever one you want to use). After adding it to the hot water, stir until it is completely dissolved. Then add another Tb. Continue this process until you notice that a few, tiny grains remain on the bottom of the beaker and just won't dissolve. At that point, you have a **saturated solution** and you are ready to make crystals. If you notice that you are reaching saturation point (it takes quite a while for all of the material to dissolve but it eventually does) then add smaller amounts until you

reach actual saturation. If you add too much dry material and you have quite a few grains left on the bottom of the beaker undissolved, then just add a bit more water. It is a lot like cooking - just add a bit here and there until you get it just right!

- Pour enough of the saturated solution into the bottom of the saucer to cover it to a depth of approximately 3-5 mm. Set aside.
- Check each day for crystal growth. You will see them for change daily. Students can make measurements and record this progress. If you have different solutions (salt, alum, epsom salt) students will see a big difference in the shape of each crystal and they can draw these shapes as part of their observations.

Crystal Rock Garden

This is similar to the previous activity where crystals are grown in saucers. The crystals are the same, but this one allows student to see how crystals grow naturally whereas the previous activity is better for allowing children to study larger, perfectly formed crystals.

Materials:

- For alum garden: 1 cup boiling water to 1/4 cup alum.
- For salt garden: 3/4 cup boiling water to ½ cup salt.
- For epsom salts: ½ cup water to 1 cup epsom salts.
- Kettle for boiling water
- 2-liter pop bottles cut off so that about 15 cm remain at the bottom.
- Collection of small rocks that will fit on bottom of pop bottle.
- Optional: green florists clay will hold rocks firmly to the bottom of bottle.
- Optional: if you have a geode, this is a good example from nature of what the students are creating in the classroom.

Procedure:

- Prepare rock garden by placing rocks in bottom of cut-off pop bottles
- Prepare crystal solution by boiling water and then adding dry material to it. Stir until as much of the powder has dissolved as possible.
- Pour liquid solution over rocks in pop bottle.
- Set aside and get ready to make observations. Within a few hours, crystals will start to form. After a few days, there will be a beautiful “garden” to look at

and the children can take these home with them.

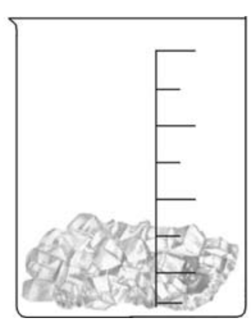
Geodes, and many other rock crystals are being formed in this way when water, saturated with minerals, seeps into spaces in rocks. When the liquid evaporates, the crystals are left behind.

Bluing Garden
Materials:

- Dry sponge
- Aluminum pie plate
- Glass measuring cup
- Mixing bowl
- Metal spoon
- 60 ml table salt
- 60 ml water
- 60 ml laundry bluing (Mrs. Stewart's - available in laundry section)
- 30 ml household ammonia
- Food colouring - the more colours, the better

Procedure:

- Place sponge in pie plate.
- Pour salt water, bluing, and ammonia into bowl and stir.
- Pour over sponge making sure to include any solid particles.
- Sprinkle food colour randomly over sponge.
- Set aside where it will not be disturbed for a few days. Observe crystals with hand lens. These beautifully coloured, very delicate crystals are fragile and will disintegrate if touched so it is best just to look!



Charcoal Garden

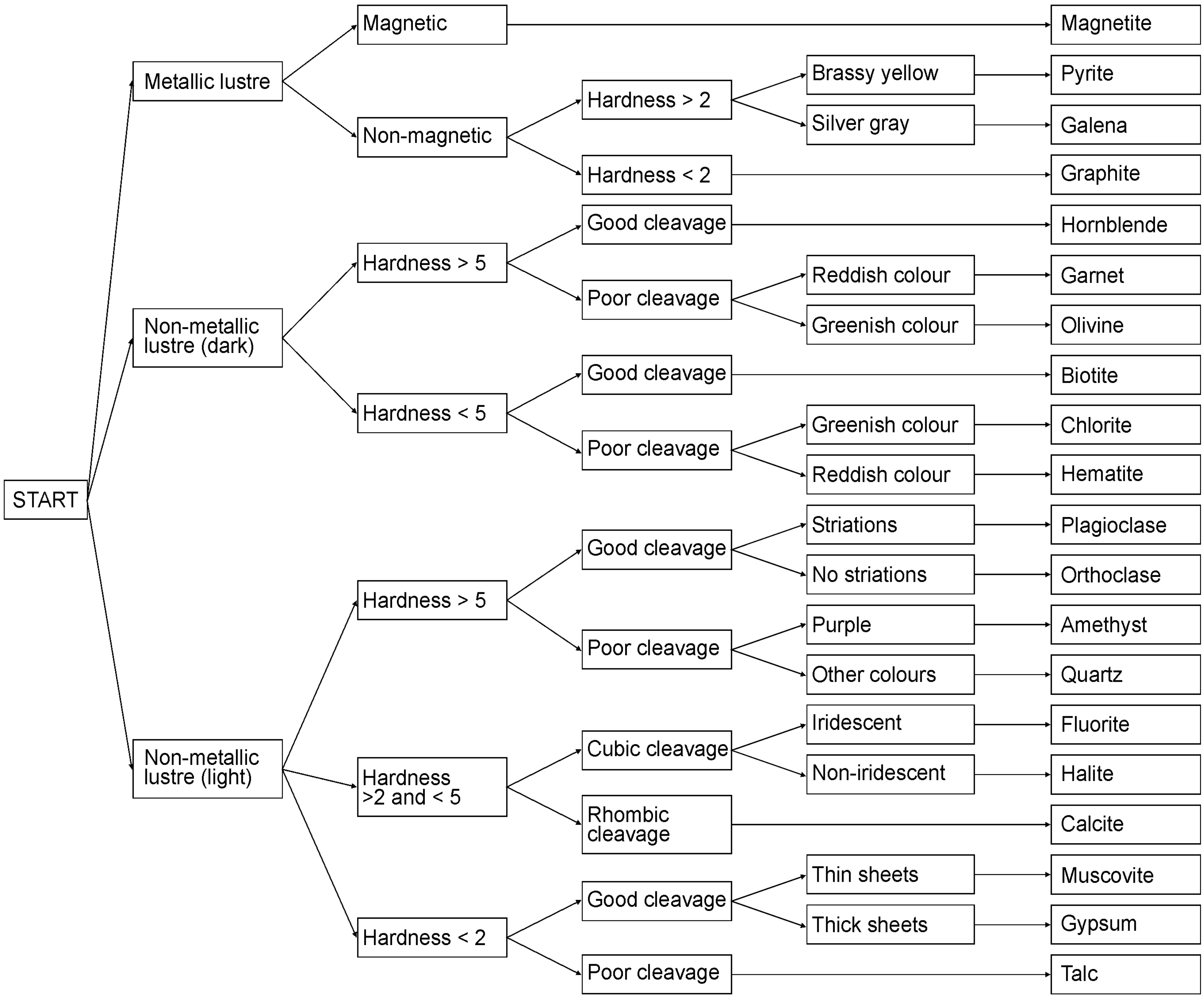
Materials:

- Several pieces of charcoal (briquettes or aquarium filter material)
- Aluminum pie plate
- 250 ml boiling water
- 100 to 200 ml salt
- 60 ml vinegar
- Food colouring - variety of colours

Procedure:

- Scatter charcoal onto bottom of pie plate.
- Fill measuring cup with 250 ml boiling water.
- Stir salt into water until no more dissolves (saturated solution).Add 60 ml vinegar to salt solution.
- Pour over charcoal. The top of the charcoal should be above the liquid level. Put several drops of food colouring over the charcoal.
- Place the container where it will not be disturbed for a few weeks. Observe crystals with hand lens. These crystals are very fragile and will break if container is handled roughly.

MINERAL IDENTIFICATION KEY



MINERAL IDENTIFICATION TABLE

Mineral	Lustre	Hardness	Cleavage/ Fracture	Crystal Habit	Colour	Streak	Other Distinguishing Characteristics
Graphite	metallic/ greasy	1.5	perfect, flaky	massive, scaly	black/ silver	black/ gray	very lightweight, marks paper
Halite	glassy	2	perfect, cubic	cubes or massive	usually colourless but may be variable	white	very lightweight, salty taste
Biotite	glassy/ pearly	2.5	perfect, platy	tabular	black/ brown	white	flexible cleavage plates
Muscovite	glassy/ pearly	2.5	perfect, platy	tabular	white/yellow/ gold	white	flexible cleavage plates
Calcite	glassy to dull	3	perfect, rhombic	variable, common rhombic	variable, colourless to dark gray	white	reacts with acid, may be iridescent
Galena	metallic	3	Perfect, cubic	cubic, massive or granular	gray, bluish tint common	gray	very heavy
Fluorite	glassy	4	cubic or octahedral	cubes, octahedra or massive	very variable- purple, yellow, blue	white	may be iridescent and/or fluorescent
Magnetite	dull metallic	5.5	no cleavage, conchoidal	massive or granular	Black	black	magnetic
Orthoclase (Feldspar)	glassy to dull	6	nearly cubic	blocky, nearly square	variable- shades of orange to white	white	
Pyrite	metallic	6.5	indistinct cubic	massive or cubic	brassy yellow	green-black	striations common
Quartz	glassy to waxy	7	no cleavage, conchoidal	hexagonal prisms topped by pyramid or massive	very variable- white to black	white	agate shows convoluted colours
Amethyst (Quartz)	glassy	7	no cleavage, conchoidal	hexagonal prisms topped by pyramid	massive, scaly	white	

MINERAL IDENTIFICATION WORKSHEET

Specimen #	Mineral ID	Lustre	Hardness	Cleavage/ Fracture	Crystal Habit	Colour	Streak	Other Distinguishing Characteristics

SLE #3

Describe and classify a group of rocks and minerals based on properties discussed in SLE #1 (rocks) and SLE #2 (minerals).

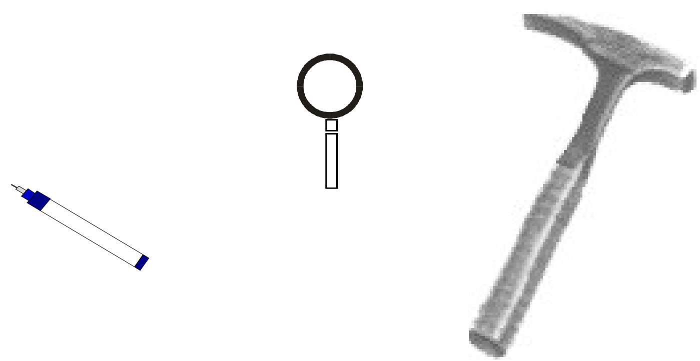
The best way to address the learning expectations described above is to have the children bring in their own rock and mineral collections. Many children already have these at home. Others will be anxious to start their own after this unit has been introduced.

In order to find rocks and minerals, you can look anywhere rocks tend to be uncovered. This includes mountains, stream beds, construction sites, beaches, road cuts, quarries, etc. In order to have a good variety of rocks to study and display in your classroom, it would be a good idea to take your students on a field trip to collect specimens. The children will be keen to share and identify their own rocks and if each student is encouraged to collect five to ten specimens (2 to 10 cm is a good size), you should have a good variety.

Rock Hound Kit

Before going on your rock collecting expedition, you should make sure to have a well-prepared bag of equipment that you will need. This includes:

- A rock hammer (square on one end and pick-shaped on the other)
- Safety goggles
- Gloves
- Strong knapsack
- Hand lens
- Masking tape
- Marker
- Plastic bags
- Old cloth
- Newspaper
- Good shoes



Field trip rules

When you go with your students, be sure to stress safety at all times. Goggles should be worn when using the rock hammer. Loose hillsides and rock faces should not be climbed. Never go alone! Treat other people's property with respect!

When choosing specimens, encourage children to look for freshly broken pieces of rock since weathered surfaces tend to hide the rock's actual appearance. Remind them to take only the best specimens they find and limit the number that they will be allowed to bring back. As children collect their specimens, have them wrap a small amount of newspaper around each one and label by placing masking tape around the rock. Students can write their name and sample number on the tape. If the students are expected to carry their own specimens, they will be more likely to choose appropriate sizes.

Breaking bigger rocks into smaller pieces

Often times, students will want to take a sample that is too large to carry. It is possible to break larger rocks into manageable pieces using the following method. This also provides better surfaces on which to observe rock properties for identification purposes:

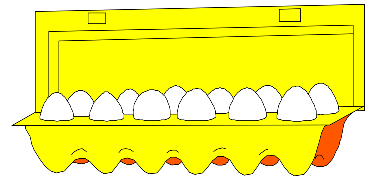
- Put safety goggles on.
- Place rock in plastic bag and squeeze air out.
- Place in another plastic bag and cover with cloth.
- Place on concrete or another large rock and hit with hammer until broken.

Preparing rocks for display

Before setting up rock and mineral samples in the classroom, have students paint a small, white patch on the specimen's bottom side. They may use tempera paint, latex paint or white-out. On the white dot, a sample number should be written with a marking pen. The student may also want to put their initials on the dot so that they get their rock back. For each numbered sample, you can make an index card that will go along with the specimen when it is displayed. This card can include information such as specimen number, date collected, name of rock or mineral if known, where found, and name of collector. When this has been done, rocks and minerals are ready to be sorted, classified and identified using the property tests and flow charts described under SLE # 1 and SLE # 2.

Collection Boxes

Children love to make special boxes to display and save their rocks. Decorated egg cartons are ideal for this!



SLE # 4

Recognize that rocks are composed of a variety of materials and given a coarse-grained rock and magnifier, describe some of the component materials.

Most rocks are mixtures of two or more different minerals, although this is not always the case. If the rock is too fine grained, you will not be able to tell if there are different minerals or not since they are too small to distinguish from one another. The best rock types to use in addressing this SLE are coarse-grained **granite** (igneous rock) and **conglomerate** (sedimentary rock).

These rock types are very common in the mountains and you can easily find large pieces that adapt themselves well to this activity. Many of the very large, rounded pebbles that you find on road cuts or along rivers and streams are granite or conglomerate but they are so weathered on the outside that it is difficult to tell this. If you break them open using the method described under SLE #3, you will have a fresh surface for the students to observe.

You will also want several mineral samples, ideally of the same type of mineral that the rock specimens are made from. These will probably be quartz, feldspar, mica, and/or hornblende.

Activity:

- Have students first look at the mineral samples and describe their characteristics using SLE #2 activities.
- Next, have them look at the rock specimens and describe them in as much detail as possible, paying particular attention to differences or similarities that they observe.
- See if students can pick out individual mineral grains. They should be able to recognize grains such as glassy quartz, white or pearly pink feldspar, shiny black flakes of mica, or dull, black hornblende.

Chocolate Chip Cookie Analogy:

Chocolate chip cookies are the perfect way to discuss this SLE with your students. This was discussed under SLE #1 as one of the activities, but we will just quickly talk about it again here. The cookie is something that the children are very familiar with but they may not have given a lot of thought to what makes it up. The whole cookie would be the "rock", and the individual ingredients would be the "minerals". Some of these minerals are more easily recognizable than others, but that does not mean that only those ingredients that can be identified using the naked eye are really there. You could even have your students make the cookies themselves and talk about how the flour, sugar, salt, baking powder and chocolate chips are all different minerals, each with their own special characteristics. As these ingredients are mixed together and formed into a "layer" to harden in the heat of the oven, the mineral grains become a recognizable rock!

SLE # 5

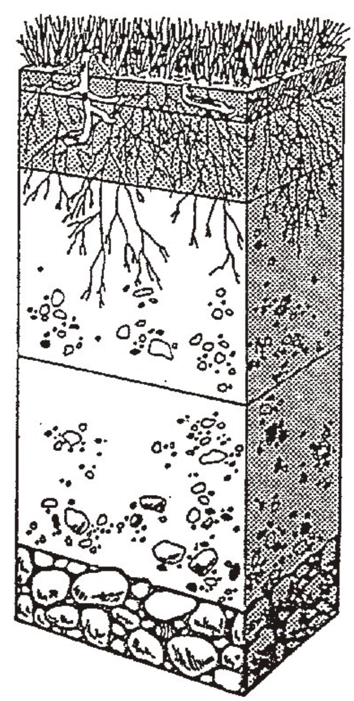
Recognize and describe the various components within a sample of soil, i.e., clay, sand, pebbles, and decaying plants. Describe differences between two different soil samples.

Scientists who study soil are called "pedologists". Soil is made from a combination of rocks and minerals that have been ground up and mixed with water, air, and remains of dead plants and animals. All soils are different and can be classified based on certain characteristics such as composition, texture and acidity.

Soil develops in three layers:

- Topsoil is the uppermost layer. It contains the most organic matter (humus) and is therefore the best for growing things in. Consists of leaves, bark, branches, and roots of dead plants. Home to microorganisms, bacteria, worms, ants, rodents, spiders, etc.
- Subsoil is the second layer and is more tightly packed. It is also lighter in colour and contains very little organic material. If the topsoil is missing, this is almost impossible to grow anything in.
- Transition layer contains pieces of underlying bedrock and overlying subsoil. Bedrock is the parent rock material from which the overlying soil was made.

Soil Layer Cross-Section



Soil may be anywhere from a few centimetres to hundreds of metres thick, but it almost always becomes finer upward. Without healthy topsoil, life on our planet would be in danger.

Soil Characteristics

Most soil is approximately 80% rock and mineral particles and the rest is humus. The largest mineral particles are usually grains of sand. There are also silt particles that can barely be seen and clay particles that are invisible without a microscope. When looking at soil, the following characteristics should be observed:

- Colour
- Texture - rocky, sandy, fine, or sticky. To test the texture, moisten a bit soil and rub it between your fingers. Sandy soil will feel gritty, clay-rich soil will feel sticky, and silty soil will be somewhere in between. Loam is a rich mixture of silt, sand, clay and humus and it will feel gritty and sticky at the same time.
- Smell - sweet, sour, earthy
- Ingredients - types of organic matter, particles, evidence of living things
- Acidity - may be acid or alkali. Acidity is tested using a pH scale that ranges from 1 to 14. A pH below 7 is an acid, 7 is neutral, and a pH of 8 or more is alkali (base).

Soils may also be classified according to the climate they occur in:

- Soils in cool, damp forests are usually predominantly humus, and acidic in nature because of the coniferous trees.
- Desert soils have almost no humus and are very salty because of the high evaporation rates.
- Prairie soils, where light rains predominate, are black and humus-rich which is why they are good for growing crops.
- Tropical forest soils are very deep and red to yellow in colour because of the high iron oxide content.

ACTIVITIES FOR SLE # 5

①Digging a Hole

Materials:

- Shovel
- Hand lens
- Measuring tape
- White paper
- Glue

Procedure:

- Find a spot where you have permission to dig a hole.
- Examine material lying on the surface of the ground. What types of decaying plant material do you see? If you can see stringy white threads it is an indication that bacteria and molds are growing.
- Dig a hole with straight sides. It should be around 50 cm deep. Count the numbers of layers you can see and carefully observe similarities and differences in each layer, paying particular attention to grain size and colour.
- Try and determine composition of each layer by rubbing a small amount between moistened fingers. You can also do the smell test at this time.
- Fold your sheet of paper down the centre lengthwise and fill the crease with glue. Carefully add soil from each layer to the glue, making sure that you put it in the same order from top to bottom. After the glue dries, shake off excess dirt and label the layers. Fill the hole back up.

②Making Your Own Soil

Materials:

- Large jar (oversize mayonnaise jar from fast food chain-free for the asking)
- Plastic bags for collecting decaying material on top of soil
- Sand and clay (available at craft shops, or in your own back yard).
- Water
- Seeds

Procedure:

- Collect decaying materials in bag and then mix them by thoroughly kneading them with your hand (in nature this is done by worms, rodents and roots).
- Mix bag contents with sand and clay (vary amounts so you have variety).
- Place dry soil mix in jar and cover with water (about 2 cm above top of soil).

- Put lid on and shake thoroughly so that all ingredients are in suspension. Then, set down and let settle. Notice how the layers automatically form just as in nature (organic on top, grain size coarsens downward).
- Leave the lid off and allow to evaporate for several days. Plant some seeds in your jar and compare how soils of different composition affect the plants.

SLE # 6

Describe ways in which rocks break down to become soil. Demonstrate one or more of these ways.

Only 8% of the Earth's surface is covered with top soil that is rich enough to grow crops. The existence of the human race is vitally dependent on this precious resource. It takes hundreds of years to form a few centimetres of soil, and yet we are currently using up available topsoil at an alarming rate. In the 1930's, farmers on the prairies learned a hard lesson about the need to conserve topsoil. For years, they had over-planted their field and burned their crops without adding any nutrients to replace those that were lost. When drought came, the soil could not hold what little moisture was available because there was no humus left. The soil turned to dust and was carried away by the wind. Where a few years before that had been 25 cm of thick rich topsoil, only 12 remained. It would take 1000 years to replace this. We now realize this and drastic measures are being taken to conserve what topsoil we have left.

Soil begins to form when rocks are broken down into minute particles. These particles provide a home for simple plants and animals such as lichens and insects. As time goes on, living organisms die and decay, and the remaining organic matter begins to collect and build up among the rock particles. Over time, enough of this organic-rich material begins to accumulate to form a layer of topsoil in which larger plants can grow. This process is illustrated below.

Erosion:
Over time, any rock that is exposed on the Earth's surface will be worn away and broken down by a process called erosion. Agents of erosion are wind (hoodoos in Drumheller), water (Grand Canyon, Bay of Fundy), ice (glacial valleys), roots (sidewalks and driveways), temperature (potholes), and chemicals (forming underground caves). Over millions of years, processes of erosion can wear down

mountains and dig huge canyons. Places to look for erosion are gullies, steams, hillsides, etc.

ACTIVITIES FOR SLE # 6

① Wind Erosion

Materials:

- Several different kinds of rock,   White paper

Procedure:

- Take two pieces of rock and rub them tegether over a piece of paper for approximately two minutes. Do any particles fall?
- Explain to students that this is the same as wind erosion. Wind carries tiny particles of sand that blow against other rocks and act as an abrasive to break and wear down rock material.
- Choose two other kinds of rocks and try the same experiment. Do some types of rock wear more easily than others?

② The Power of Roots

Materials:

- Shallow container (aluminum pie plate works well), Large spoon.
- Plaster of Paris
- Paper towels, Water
- Bean seeds

Procedure:

- Discuss how roots can actually break up rocks because of the force they exert as they grow (look at sidewalks and driveways).
- Mix Plaster of Paris (actually the mineral, "gypsum") according to package directions. Have students wear a mask if they are doing this.
- Pour into aluminum pie pan.
- Place bean seeds on wet plaster.
- Cover with damp paper towels. Leave seeds for one to two weeks, making sure that paper towels are kept moist.
- Remove seeds and observe structure in plaster where roots once were. Do you think plants are strong enough to break rock?

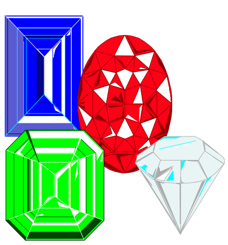
SLE # 7

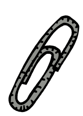
Demonstrate some common uses of rocks and minerals and identify examples of those used in school, home, and local community.

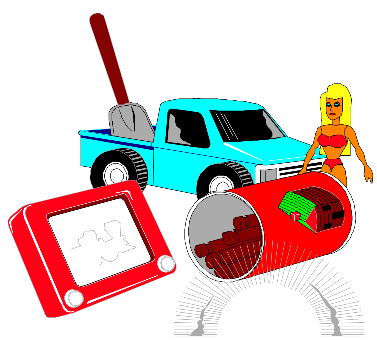
Historically, man has used rocks and minerals for just about every conceivable purpose. One million years ago, during the Stone Age, early man used rocks and minerals for tools, weapons, and building material. Since that time, we have found more and more uses for these natural resources.

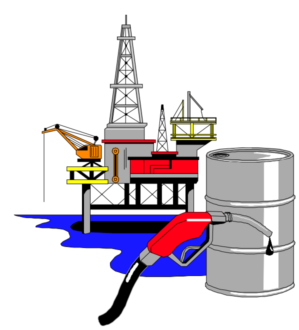
Every product that we use comes from either plant, animal, mineral, or a combination of the three. By far the most common product source is mineral. Even products that are not made from minerals directly are made from metal machines (metal is made from minerals). It is estimated that each person will use an average of 16 000 to 18 000 Kg of rock and mineral products each year! In a lifetime, the average person will use 350 Kg of lead, 380 Kg of zinc, 680 Kg of copper, 1 450 Kg of aluminum, 41 000 Kg of iron and steel, 250 000 Kg of coal, and over 500 000 Kg of stone, gravel, cement and clay. The computer industry alone uses almost every type of mineral mined today for either hardware or software, and we are finding more uses for mineral products every day.

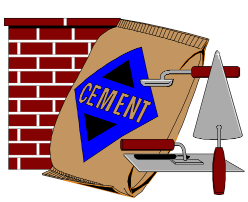
The table on the next page contains many of the more common rock and mineral uses. This list is by no means complete and you and your students should be able to easily add onto it.

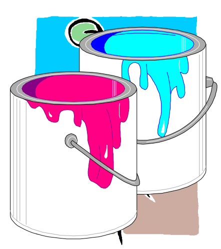


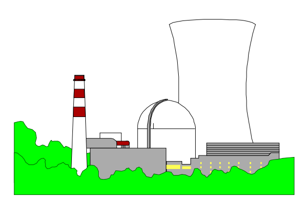












ROCK AND MINERAL RESOURCE LIST	
Rock or Mineral Name	Value to Man
Quartz	Glass, sand, gems, radio transistors, silicon chips, quartz crystals for computers and watches, lenses for glasses, binoculars and telescopes
Gypsum	Chalk, plaster, gyp rock, filler in candy, paint filler
Talc	Talcum powder, crayons, paint
Mica	Spark plugs, insulation
Halite	Table salt, soap, fertilizer
Fluorite	Fluoride for toothpaste
Galena	Lead
Hematite	Iron and steel
Aluminum	Several metal products
Silver	Coins, jewelry, film, silverware
Gold	Coins, jewelry, electrical components
Sylvite	Potassium for fertilizer
Sodalite	Fertilizer, semi-precious stone
Diamond	Gemstone, industrial drills, needles for record players (antiques)
Graphite	Pencils, lubricant
Sulphur	Fertilizer, industrial uses
Bauxite	Abrasive cleaners, metal, bricks, alum
Turquoise	Semi-precious stone
Corundum	Gemstones (sapphires, rubies), sandpaper
Clay	Bricks, pottery, ceramics, tile
Granite	Building stone, monuments
Marble	Building stone, monuments
Slate	Floors, roofing, blackboards
Limestone	Cement, building stone
Dolomite	Building stone, epsom salt
Oil	Fuel, plastic
Coal	Fuel

ACTIVITY FOR SLE # 7

① Animal, Vegetable, Mineral Game

This is a game you can play with your students that will reinforce not only what rocks and minerals are, but also how they are used by our society. Make a number of cards with products from animals, plants, or minerals. For example:

Animals:

- Belt
- Milk
- Steak
- Fur coat
- Wool sweater
- Glue
- And so on...

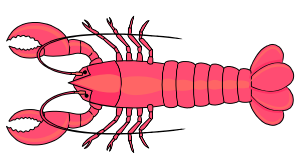
Plants:

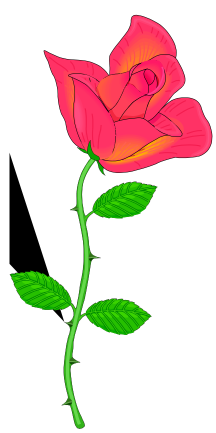
- Desk
- Paper
- Jeans
- Peanuts
- Rubber Band
- Juice
- And so on...

Minerals:

- Rubber Duckie
- Window
- Computer chip
- Nail
- Milk jug
- Brick
- And so on...

Students take turns choosing cards and must tell you whether their product is an animal, vegetable or mineral product. You can have one student list these under three columns on a piece of chart paper as you play the game. You might want to have extra mineral cards since so many of the products in your classroom will be made from this resource.





GEOLOGY IN THE CITY OF CALGARY

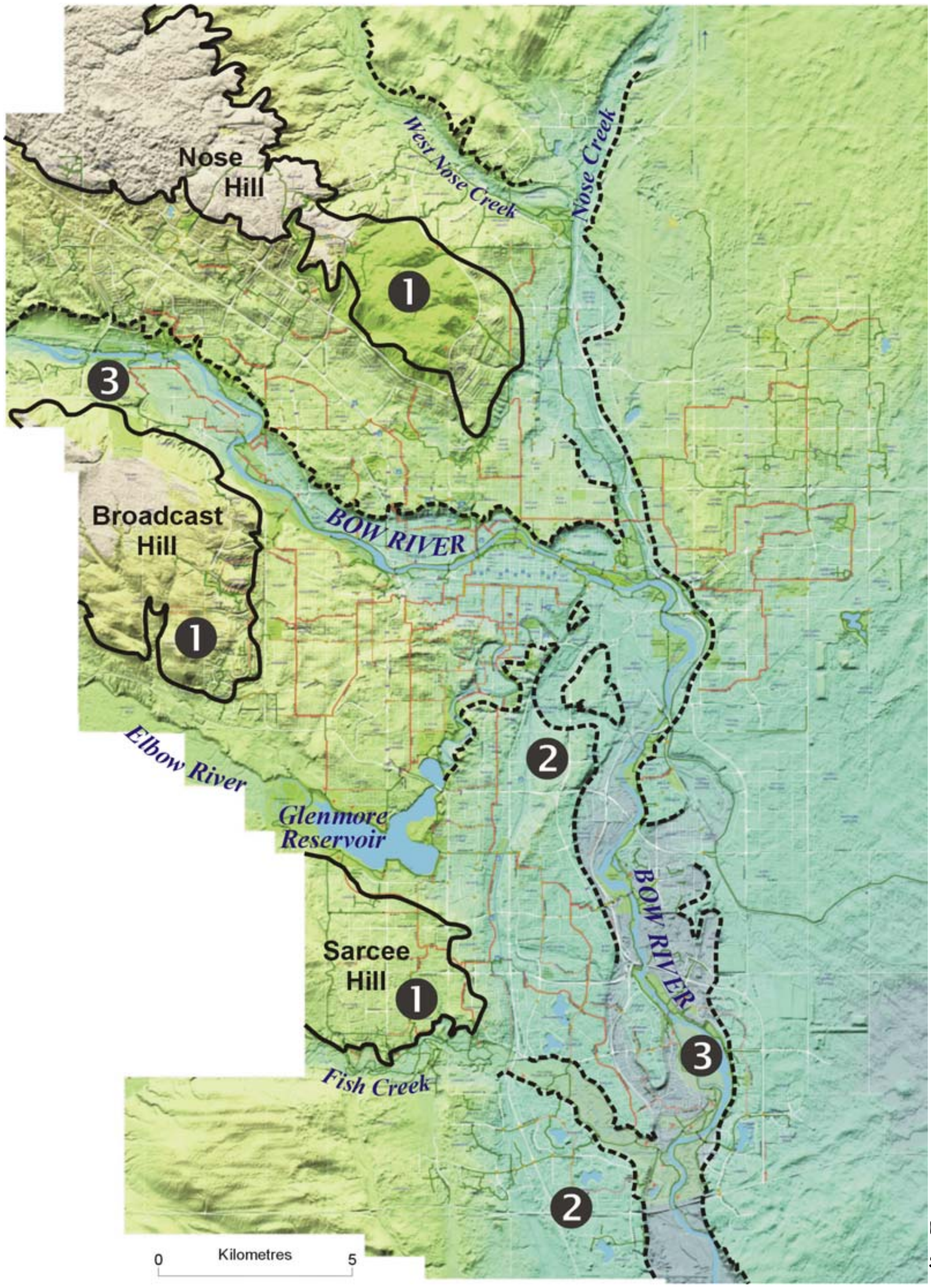
General

The City of Calgary was founded at the confluence of the Bow and Elbow rivers near the west edge of the Canadian plains. These plains slope gently northeastward, away from the Rocky Mountains. The undulating topography in the city has a relief of about 175 m. It is mainly the product of erosion by the rivers in Quaternary times (the last 1.6 million years) and generally reflects the underlying bedrock surface.The are three main levels in the topography of Calgary:

The highest level consists of the mostly flat-topped uplands that have a bedrock core and comprise erosional remnants of old river plains. The bedrock is Paskapoo Sandstone of Paleocene age (early Tertiary), about 58-65 million years old. The upland areas are Nose Hill, Broadcast Hill and Sarcee Hill that rise to elevations of 1270 m, about 175 m above the Bow and Elbow river beds.

The middle level is an undulating plain that fills the space around and between the hills. The surface at this level is generally glacial till but may also contain river deposits related to streams. In northwest Calgary, this area is covered by hummocky moraine deposited by glaciers.

The lowest level consists of the river flood plains, which are in places up to 2 km wide and cut down about 35 m below the middle level. Downtown Calgary is situated on this level.



The map above shows the geography of the City of Calgary with the key topographic levels identified. The solid lines represent escarpments bordering bedrock-cored uplands (level 1, above). The dashed lines indicate distinct rims separating the intermediate topographic level from modern flood plain. Where dashed lines are missing, the intermediate level slopes gradually down to river level. From Osborn and Rajewicz (1998).

Bedrock Geology
Outcrops of bedrock are rare in the Calgary area. Where it occurs, it generally consists of fine- to medium-grained sandstone and shale of early Tertiary (Paleocene) age. It represents the deposits of meandering rivers that were eroding the Rocky Mountains as they were being created during the period of mountain building known as the Laramide Orogeny. These rivers spread enormous amounts of sediment eastwards from the mountains during the Tertiary. The whole unit is about 600 m thick beneath Calgary and is generally referred to as the Paskapoo Sandstone, although it has also been divided on a finer scale into the lower Paskapoo Formation (with volcanic rock fragments) and an upper Porcupine Hills Formation (with sedimentary rock fragments).

Outcrops occur in several places, notably the Edworthy ravine at Edworthy Park, the Spruce Cliff area downstream along the Bow River, the southwest slope of Nose Hill and the north shore of Glenmore Reservoir. Other less impressive outcrops occur along the Bow River at various places, such as Silver Springs. Locally, plant fossils and fossil clam shells are common within the sandstone. However, most of the bedrock is covered by unconsolidated sediments related to the latter stages of glaciation and associated river and lake deposits of Quaternary age.

The sandstone has been quarried over the years as building stone, in particular, following the devastating fire of 7 November 1886 that destroyed the wooden buildings in downtown Calgary. The old part of our city hall built in 1911 at 800 Macleod Trail East is a fine example of the use of local sandstone.

If a hole were drilled beneath Calgary it would pass through more than 4000 m of sedimentary rocks before striking the crystalline, metamorphic and igneous rocks of the Precambrian.

Deposits of the Glacial Era
The unconsolidated sediments overlying the bedrock in the Calgary area vary greatly in thickness. They average about 10-15 m on the uplands and 0-80 m thick at the intermediate and lower levels. In general three, distinct layers are recognized:

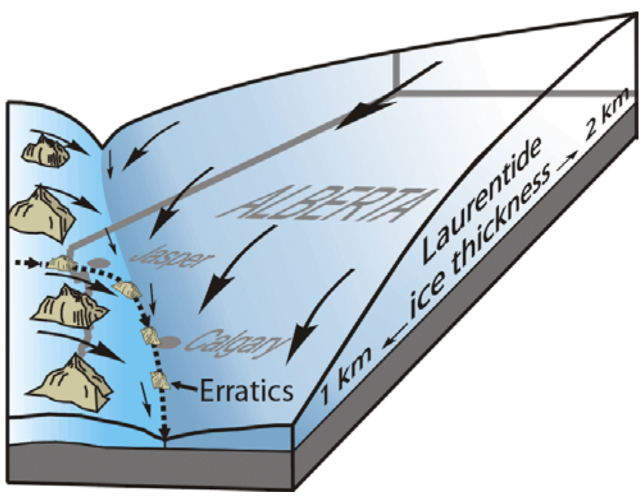
Early to preglacial sediments

The lowest level is represented by bodies of gravel that lack any pebbles of crystalline rocks. These are generally thought to predate the main glaciation (because of the lack of pebbles from the shield) and may be of early Pleistocene age (about 1.6 milion years old).

Glacial tills and river sediments

The next level is a complex body of tills (unsorted sediment deposited directly beneath glaciers) and deposits laid down by rivers. The story is complicated because the glaciers that deposited these sediments came from different directions. The largest ice sheet (Laurentide Ice) was moving material from the centre of the continent towards the margins. Smaller glaciers in the mountains (the remnants of which we can still see today - for a little while longer, anyway) extended out from the mountains and moved material from there. A third body of ice, the Athabasca Valley ice, has been suggested to have been moving from north to south through the region as well.

This diagram shows the ice sheets thought to be responsible for glacial and fluvial deposits in the Calgary area.



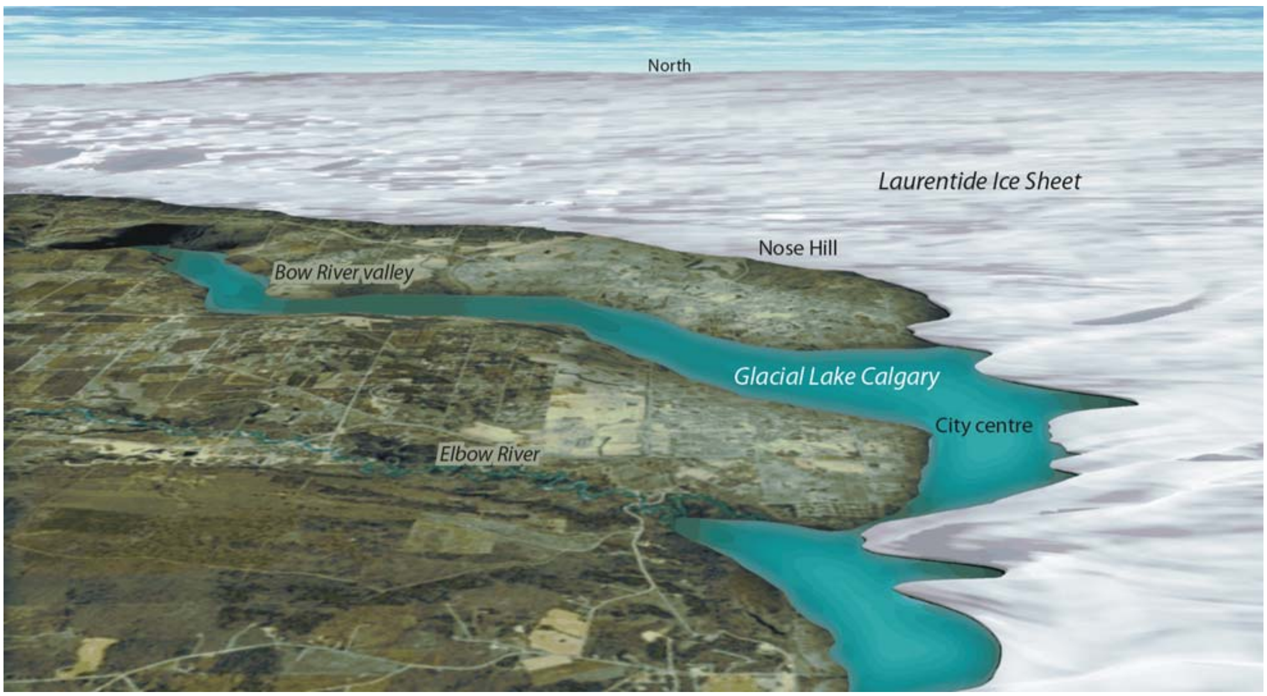
The three operating sanitary landfills in Calgary are based in these glacial deposits. The east Calgary and Shepard landfills are contained in finer grained sediments, but the Spy Hill operation has many coarse deposits within it. As a result, liquid disposal is not permitted at the Spy Hill facility.

Glacial Lake Calgary Deposits

Finally, in central and northwest Calgary, there are lake deposits associated with an ice-dammed lake called Glacial Lake Calgary. This lake extended up the Bow Valley past the town of Cochrane and its highest level is reckoned to have been 1220 m. The lake is thought to have existed until about 11,000 years ago.

The lake sediments are mainly silts but also include clay and fine sand. Locally there are pebbles, large blocks and/or lenses of gravel that were presumably rafted into

the lake by surface ice. The overall texture of the sediments can change over relatively short distances.
Some of these silts cause significant problems for construction in Calgary and may also cause slope failures following heavy rainfalls. Many central and northwest structures are built on these sediments. However, large buildings like the Foothills Hospital and the University of Calgary facilities are founded on piles that transfer the load of the building to the lower tills.



This image shows a hypothetical configuration of glacial lakes in the Calgary area. This is the concept of "Glacial Lake Calgary".

In an excellent paper on the urban geology of Calgary, Osborn and Rajewicz (1998) explain the following incident at the time of construction of Banker's Hall downtown:

"One of the more serious problems caused by the silts to date occurred during the 1987 excavation for the foundation and basement parkade of Bankers Hall, a high-rise office building in downtown Calgary. Many borehole logs for downtown construction projects show bodies of silt, most likely lacustrine, between post-glacial alluvium and underlying till; such bodies, cohesionless and saturated, were encountered several metres below grade during the excavation. Running of silts through lagging boards of the shoring walls caused loss of ground underneath adjacent 9th Avenue, which is the major downtown artery. Silt fans formed in the excavation, a crack appeared in the street, a crane toppled and the shoring wall tilted a small amount. Work was halted while the excavation, and indeed the substructure of the building, was redesigned. Litigation followed the eventual late completion of the building."

The ability of these silts to flow when saturated also causes slope failures in Calgary. Most of these slope failures occur along the bluffs and headlands of the former lake and most move slowly. One can look upon most of these movements as a result of the quest for slope stability following the downcutting by the river, however, some have a decidedly human cause. It is thought that watering of lawns in areas adjacent to river bluffs is the main cause of slope failure, because it elevates the level of the natural water table.

There are several areas with slope stability problems, including the Spruce cliff area (with the very obvious scar of the Wildwood slide), slopes above the Elbow River in the Parkhill area, the slopes separating Crescent Heights from Sunnyside, and perhaps the most prominent at Home Road on the edge of Varsity Estates.

Deposits of the Post Glacial Era

Volcanic deposits

One interesting deposit that caps much of the glacial sequence is the so-called Mazama tephra. This is the result of a massive volcanic explosion in southern Oregon that occurred about 6850 years ago and laid down a huge area of ash and volcanic debris over northwestern North America.

Formation of our present landscape

Following the glaciation and the release of Glacial Lake Calgary, the local rivers began cutting through the lake sediments and other deposits to form the landscape we know today.

Further reading:

Jackson, L.E. and Wilson, M.C. (Editors) 1987. Geology of the Calgary Area. Canadian Society of Petroleum Geologists.

Osborn, G. and Rajewicz, R. 1998. Urban geology of Calgary. *In* Urban Geology of Canadian Cities, P.F. Karrow and O.L. White (editors), Geological Association of Canada Special Paper42, p. 93-115.

Wilson, M.C. 1983. Once upon a river: Archeology and geology of the Bow River at Calgary, Alberta, Canada. Archeological Survey of Canada, National Museum of Man, Mercury Series, Paper 114, 464 p.

RESOURCE SUGGESTIONS FOR ROCKS AND MINERALS UNIT

Books For Teacher Use:

A Traveller's Guide to Geological Wonders in Alberta (Ron Mussieux and Marilyn Nelson, 1998) The Provincial Museum of Alberta, 1998, 245 p.
Earth Through the Ages (Philip B. Carona)
Explorations in Science (Level 3) *Rock Solid*
Explorations in Science (Level 3) *Rock Talk*
FOSS Earth Material Module (Gr. 3-4)
Geology Crafts for Kids (Alan Anderson and Gwen Diehn, 1996)
Hands-On Minds-On Science - Geology (Teacher Created Material 1994)
Innovations in Science (Level 3) *Let's Go Rocking*
Let's Do Science (Science Alberta Foundation)
Overhead and Underfoot (AIMS Teacher Resource)
Planet Earth (Milliken, 1984)
Rocks and Minerals (Carson-Dellosa Publishing 1994)
Rocks and Minerals (National Science Resource Centre)
Rocks, Minerals and Fossils (Carson-Dellosa 1994)
Rocks, Sand and Soil (Windows on Beginning Science)
Science Is... (Susan Bosak)

Shake, Rattle and Roll (Spencer Christian, 1997)
Simple Earth Science Experiments with Everyday Materials (Louis Loeschnig)

Books For Teacher and Student Use:
Caves (Scholastic)

Dancing Elephants and Floating Continents (John Wilson) Key Porter Books, 2004, 47 p.

Dr. Art's Guide to Planet Earth (Art Sussman) Chelsea Green, 2000, 122 p.

Fossils - A Guide to Prehistoric life (Rhodes, F.H.T., Zim, H.S. and Shaffer, P.R. Golden Press, New York 1962)

Gemstones - Planet Earth Series, Time Life Books

Geology (Rhodes, F.H.T., Golden Press, New York, 1991)

How the Earth Works - Reader's Digest (1992)

The Land Before Us: The Making of Ancient Alberta (Royal Tyrrell Museum, Red Deer College Press, 1994)

Make It Work - Earth (Scholastic)

Our Petroleum Challenge: Exploring Canada's Oil and Gas Industry (CentreforEnergy.com 7th Edition - due May 2004) Excellent summary of all aspects of the industry revised after the Petroleum Communication Foundation.

The Quicksand Book (Tomie de Paola)

Rocks and Minerals - A guide to familiar minerals, gems, ores and rocks (Zim, H.S. and Shaffer, P.R., Gloden Press, New York, 1957)

Rocks and Minerals (Illa Podendorf)

Rocks and Minerals - Eyewitness Books (Dr. R.F. Symes)

Rocks and Soil (Scholastic)

Stone Wall Secrets (Book plus teacher's guide) 1998 publication, Kristine and Robert Thorson, Tilsbury House Publishers, Maine

The Last Billion Years (Atlantic Geoscience Society) Nimbus Publishing, 2001

Posters and Music:

- Colour Poster Prints from "The Land Before Us". The beautiful prints depicting various geological times in Alberta's history are available at a very reasonable price from the local artist himself - Dennis Budgen. He can be contacted at 282-0031.

- Geoscape Posters from Natural Resources Canada http://geoscape.nrcan.gc.ca/

- Climate Change posters for Canada – free for teachers; contact the Geological Survey of Canada (see below) http://adaptation.nrcan.gc.ca/posters/

- Rocks and Water - Geology concepts set to music in this fun tape by Chris Rawlings. Available through Cooking Fat Music, 67 Wrenson Road, Toronto, Ontario M4L 2G5 or contact e-mail address wrenfolk@interlog.com

- See Geological Survey of Canada publications (below)

Publications From Geological Survey of Canada:

Contact the Geological Survey of Canada Bookstore to find out what they have available. Many of the publications are free, particularly folded posters on minerals, rocks, fossils, meteorites and gemstones. The phone number for the Calgary office is 292-7030.

Kits and Crates:

- Minerals, Metals and Meteorites - a "Museokit" available from Glenbow Museum in Calgary. Loan period two weeks. Cost: $40 for two week period. Call 268-4110.

- Science Alberta Foundation Science Crates including:
  Bedrock Basics
  Junior Paleontologist
  Rock Stars and Mineral Superheroes

  Cost is $25 per crate for a 3-week rental period. Contact Science Alberta Foundation at (403) 220-0077 ext. 222 or e-mail at crates@sciencealberta.org

- School Boards will often have rock and mineral kits available for teachers. Contact your local board if you are not sure.

- Top quality rock and mineral specimens at a very reasonable price are available locally (Calgary) through Dwarven Mountain Rock and Minerals Ltd., Mike Clark, Box 63, Site 3, RR1, T1P 1J6, Strathmore, Alberta, phone 934-4965.

- Rock and Mineral Sets are also available from several supply catalogues including Wards Scientific, Northwest Scientific, and Boreal Scientific.

Guest Speakers:
Possible resource people could be geologists, archaeologists, jewelers, local rock-hound clubs, etc.

There are five Science Hotlines in Alberta and these are an excellent source for both information and guest speakers on any scientific topic. They provide a free service that links teachers to volunteers who can answer questions, give presentations, lead field trips, judge science fairs, etc. Their addresses are:

- Calgary Science Hotline - Calgary Science Network
  Contact Julia Millen at 263-6226
  e-mail scihot@telusplanet.net
  Internet: www.calgarysciencenetwork.ca

- Edmonton Science Hotline - Contact 448-0055

- Medicine Hat Science Hotline - Contact 527-5365

- Red Deer Science Hotline - Contact 309-2211

- Peace Country Science Hotline - Contact Susanne Kuechle at 539-9847

Field Trip Suggestions:

- Glenbow Museum Calgary- The Rock Cycle and Our World (Grade 3/4) and From Geodes to Gems (school program Grade 3-4). Phone 268-4110.

- Nose Hill in Calgary - natural area where students can observe glacial till, erratics, erosion features, etc.

- Creek or River Beds

- Road cuts

- Excavation sites

- Lapidary shops

Teacher Workshops:

Making Connections (Calgary Science Network) puts on excellent science workshops for teachers throughout the year. Contact Elspeth Snow at 230-1431 for more information. Information on Internet at : www.calgarysciencenetwork.ca These workshops are VERY reasonably priced!

Internet Connections:

- SchoolNet
  http://www.schoolnet.ca/home/e/
  Contains lots of links to teaching resources.

- Geological Survey of Canada
  http://www.nrcan.gc.ca/gsc/
  and select Educational Materials for earthquakes, landslides, images of Canada's landscape with geological explanations and much, much more.

- GeoScience K-12 Resources
  http://www.cuug.ab.ca:8001/~johnstos/geosci.html

This web site was designed for Alberta teachers and consists of lists of relevant, educational web resources that have been categorized by grade level.

- EarthNet
  http://www.gsca.nrcan.gc.ca/education/EarthNet/
  An online searchable database of teaching resources related to earth sciences.

- Calgary Science Network - Calgary Science Hotline and Making Connections
  http://www.calgarysciencenetwork.ca
  This site has links to relevant science sites on the net for geology and other science topics.

- Natural Resources Canada
  http://www.nrcan.gc.ca/mms/wealth/intro-e.htm
  Interactive site on the use of minerals.

- Ecole des Mines in Paris
  http://cri.ensmp.fr/gm/photos.html
  This site has photographs of minerals

- Geology Link
  http://www.geologylink.com/
  A good information site for all levels from Houghton Mifflin

- EdGEO Workshops in Earth Sciences
  http://www.edgeo.org/
  The web HQ of the organization that funded the rock and mineral kits provided with this workshop

- Ground Work: Exploring for Minerals in Canada
  http://www.sciencenorth.ca/
  An interactive site on mineral exploration put together by Science North and the Canadian Institute of Mining; click welcome, learn and play, cool science, groundwork.

- Royal Tyrrell Museum of Palaeontology

http://www.tyrrellmuseum.com/
An excellent site for information on fossils

- Miller Museum of Geology, Queen's University
  http://geol.queensu.ca/museum/museum.html
  An excellent site on the early history of the Earth

- Calgary Science Centre
  http://www.calgaryscience.ca/
  Local information on science happenings

- An Internet Rock Shop
  http://mineral.galleries.com/
  Information on minerals of all kinds

- http://www.bbc.co.uk/education/rocks/
  BBC education site- very well done illustrations, links, earth science activities - excellent rock cycle resource

- http://www.geocities.com/RainForest/canopy/1080
  "The Stupid Page of Rocks" - kind of an online "rocks for dummies"

- Volcano World
  http://volcano.und.nodak.edu/vw.html
  A comprehensive site on volcanoes