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Science

Grade Three

Rocks and Minerals

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Rocks and Minerals

Before You Begin

Children are curious about the variety of rocks and are quick to add any new ones to their collections. Through observations and classification they can discover the mysteries that shape and form these rocks. This study develops their understanding of cycles, structure and change.

Topic A: Rocks and Minerals

(Suggested time: 4-6 weeks)

Send a letter home to parents, introducing them to the new topic and informing them of field studies (if applicable). Use this opportunity to see if someone could provide expertise on a topic or lend a rock tumbler.

Before taking students out to collect specimens, it is important to check out a variety of locations (old creek beds, ponds, forests, playgrounds, quarries). Ensure that you obtain permission to do so from site authorities in advance of your trip. Also, follow any guidelines your school board has for field-trip safety and permission, and the safety cautions noted in the unit. Although a trip will quickly engage the students' interest, this lesson may also be successfully approached using a prepared rock and mineral collection. Good collections may be purchased from most science suppliers.

If you have to order a labelled rock and mineral kit from a science supply company, allow 2-4 weeks for delivery. Rock samples that can be chipped and crumbled are useful to have when identifying rocks.

This unit should be done during the fall or late spring months, when students are able to collect specimens. Growing crystals usually takes 1-2 weeks.

Several activities within the unit lend themselves to a centre-style learning approach. Suggestions for using this approach are discussed in both suggested textbooks.

Background Information

There are few households in Alberta that have not housed a rock and mineral collection at one time or another. Rocks and minerals are fascinating in their variety and are valued by *geologists* (people who study the Earth's crust) as solidified glimpses into the history of our planet's formation. Rocks and minerals are the major constituents of the Earth's crust, or *lithosphere*. The lithosphere is roughly five kilometres thick below the oceans and up to 50 kilometres thick where there are continents. During a significant portion of the 4.6 billion years since Earth's formation, the lithosphere has served as an immense cauldron in which rocks and mineral deposits form and transform at a slow but steady rate.

Exactly what is the relationship between rocks and minerals? Essentially, minerals are the building blocks of rocks. *Minerals* are chemical compounds made up of two or more of the naturally occurring elements. And, just as minerals are compounds of natural elements, *rocks* are large structures made up of one or more minerals.

Minerals

Combinations of only nine elements account for 95% of the minerals found in the lithosphere: the metals silicon, aluminum, iron, calcium, sodium, potassium and magnesium, plus the reactive elements oxygen and hydrogen. The elements carbon, chlorine and sulphur occur in smaller quantities but also form important components of many minerals. Only a few elements can show up in pure form, uncombined with other elements. These are the metals gold, silver, copper, mercury, platinum and iron; the non-metals arsenic, tellurium and sulphur; plus carbon (in the forms of diamond and graphite), an element that demonstrates characteristics of both metals and non-metals. Although possible, pure occurrences are relatively rare. These elements usually appear in combination with others.

Most minerals form when one of the metals mentioned above combines with another element. For example, pyrite (iron sulphide) is the chemical combination of iron and sulphur.

Minerals are classified according to their chemical composition, belonging to one of the following chemical categories: sulphide, oxide, halide, carbonate, borate, phosphate, sulphate, tungstate, molybdate, uranate or silicate. Many of these categories include hundreds of minerals. How do we go about identifying a single mineral sample?

Each mineral has unique properties that help identify it in conjunction with a good field guide. Consideration of the following factors can help you arrive at a positive identification or, at worse, narrow the field of possibilities.

Colour/Streak Test

Although colour is one of the most striking features of any mineral specimen, the use of colour in mineral identification is of limited value. In most cases, mineral colour is due simply to accidental presence of an impurity in the sample. Colour can help us narrow the search, however, as some minerals never appear in certain colours. This having been said, in a few cases colour is an intrinsic quality of a particular mineral and can be quite useful. For example, minerals consisting of copper compounds are always blue or green. But beware. This does not mean that because your sample is blue or green it is *necessarily* a copper compound. Some minerals totally unrelated to copper are blue or green too.

Sometimes minerals appear one colour in bulk and a completely different colour (their true colour) in powder form. You can see the true colour if you rub a mineral sample against a white porcelain surface, such as the unglazed back of a ceramic tile. Assuming your sample ranks seven or less in hardness (see Hardness below), a streak of colour will be left on the white surface. (Porcelain ranks seven in hardness.) This *streak test* can be particularly revealing for mineral samples that appear dark due to grain size and opacity. For example, it is possible for a brown-coloured sample to make a red streak on the porcelain.

Lustre

Lustre (shininess) has two main categories: metallic and non-metallic. Non-metallic lustre has several sub-categories. A glassy shine is a vitreous lustre; the brilliant but greasy look of a raw diamond is an adamantine lustre; a resinous lustre is a little less shiny than an adamantine luster; a finely fibrous mineral can have a silky lustre; and a mineral that has a shiny, iridescent surface that looks like mother-of-pearl is said to have a pearly lustre.

Hardness

The standard scale of hardness is the Mohs Hardness Scale. It's based on the relative hardness of 10 different minerals, the softest being talc (rated at 1) and the hardest being diamond (rated at 10).

1. Talc
2. Gypsum
3. Calcite
4. Fluorite
5. Apatite
6. Orthoclase
7. Quartz

8. Topaz
9. Sapphire (Corundum)
10. Diamond

Each of these minerals will scratch minerals lower or equal in number (hardness) to it. A mineral sample is tested by determining the highest rated mineral it can scratch and the lowest rated mineral that can scratch it. For example, pyrite (fool's gold) will scratch orthoclase but not quartz. This would normally give it a hardness rating of 6.5; however, some samples can, in turn, be scratched by orthoclase. This makes pyrite's hardness rating 6 to 6.5.

Cleavage

Cleavage is the tendency of a mineral to break in smooth, flat planes. Whether it will cleave, and at what angles it will cleave, reveals a good deal about the underlying molecular structure of the sample. When minerals solidify from the molten state, or separate from solutions in open spaces, they are free to take on whatever form is dictated by their internal molecular structure. When angular, smooth-faced shapes result, they are called *crystals*.

Because the shapes and angles of crystalline minerals are determined by their molecular structure, *crystallography*, the study of crystal-line structures, is of great importance to a mineralogist attempting to identify mineral specimens.

Specific Gravity

If you could pick up a volume of water equal in size to your mineral sample, you would notice a relative difference in weight. The weight of the mineral sample compared to the weight of an equal volume of water is known as the mineral's specific gravity. Diamond, for example, has a specific gravity of 3.52 (it is 3.52 times heavier than water), copper's specific gravity is 8.9 and gold's is 19.3.

Reaction to Vinegar

Minerals containing carbonates dissolve in acid (some more readily than others), releasing bubbles of carbon dioxide. Household vinegar, which contains 5% acetic acid, can be used in the classroom to test whether or not your sample is a carbonate.

Rocks

Unlike minerals, **rocks cannot be identified by a series of tests.** Rather, their identification rests on their appearance. There are three types of rock—igneous, sedimentary and metamorphic—each produced under unique circumstances.

Igneous Rocks

These rocks are the cooled remains of *magma* (molten rock) that either solidified quickly as it flowed out of volcanoes, or cooled and solidified slowly in place below ground. Obsidian and basalt are good examples of the first case and granite is an excellent example of the second. In addition to obsidian, basalt and granite, the major categories of igneous rocks include felsite, porphyry, diabase, diorite, gabbro and peridotite.

Sedimentary Rocks

Sedimentary rocks are created when particles of older rocks and minerals settle into stratified deposits that slowly merge to form cemented masses. Due to the methodic build-up of these deposits, sedimentary rocks sometimes contain trapped fossil remains. A large amount of North America is covered in sedimentary rock, as is most of Alberta. Only a tiny portion of the northeastern corner of our province yields the metamorphic rocks of the Canadian Shield. The major categories of sedimentary rocks include sandstone, shale, limestone, dolomite, conglomerate, breccia and arkose.

Metamorphic Rocks

These are igneous and sedimentary rocks transformed (or *metamorphosed*) by the extreme heat and high pressure encountered deep below the Earth's surface. Moisture, oxygen and carbon dioxide absorbed from the air are pressed out of the rocks, bringing about a recrystallization or an alternation of the rock's chemical composition through the formation of new minerals. There are three metamorphic processes at work. When sedimentary rocks are metamorphosed by the heat of hot new igneous rocks trying to make their way to the surface, the process is called *contact metamorphism*. The heat and pressures that result from *orogeny* (mountain building) bring about *regional metamorphism* of sedimentary rocks.

The extremely high temperatures and crushing pressures found at great depths are responsible for *plutonic metamorphism*, the mechanism that transforms the igneous rock granite into the metamorphic rock gneiss. Slate, phyllite, schist, gneiss, quartzite and marble are the major categories of metamorphic rocks. Slate, phyllite and schist are shale in progressive stages of recrystallization. Gneiss results from the transformation of either sandy shale, shaly sandstone or granite. Quartzite is formed from sandstone, and marble can come from either limestone or dolomite.

An important step in this great rock recycling process is *erosion*, the wearing away and breaking down of existing rock formations. Erosion is accomplished in several ways. Minute airborne particles pick away at rock faces when the wind blows. Similarly, flowing water carries with it small particulates that wear away rock surfaces. Water also contributes to erosion in three other ways: over time, it dissolves many minerals; it widens existing cracks in rock faces when it expands upon freezing; and when combined with carbon dioxide from the air, water forms a mild acid (carbonic acid) that corrodes surface minerals and exposed metal ores.

Soil

Once broken down, rock particles spend an indefinite period of time as a component of soil before undergoing further changes. Soils vary from place to place depending on mineral content, the size of rock particles included, the proportion and type of organic matter mixed in, and the acidity of local water supplies. For example, the *podsol* soil found under the coniferous forests of Alberta's foothills and north has a *humus* (organic component) rich in fulvic acid. Borne downward by water, this acid leaches the soil, leaving an ashen-coloured surface layer – not at all like the more fertible, organically rich, dark-brown and black soils *(chernozems)* of Alberta's prairies and parklands.

Elementary Science Program of Studies

General and Specific Learner Expectations

The following general and specific learner expectations have been taken directly from the 1996 Elementary Science Program of Studies. The specific learner expectations (SLEs) are referred to by number in the second column of the activities table.

General Learner Expectation

Students will be able to:

Demonstrate knowledge of materials that comprise the Earth's crust and demonstrate skill in classifying these materials.

Specific Learner Expectations

Students will be able to:

1. Compare samples of various kinds of rocks, and identify similarities and differences.
2. Supplied with 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 or "shininess" for example, shiny, dull, glassy, metallic, earthy;
   - texture; for example, rough, smooth, uneven;
   - hardness, based on scratch tests with available materials;
   - presence of carbonates; note that the presence of carbonates can be tested with vinegar or another mild acid; and
   - crystal shape for minerals, or overall pattern of rocks.
3. Describe and classify a group of rocks and minerals based upon the above properties.
4. Recognize that rocks are composed of a variety of materials, and given a course-grained rock and magnifier, describe some of the component materials.
5. Recognize and describe the various components within a sample of soil, for example, clay, sand, pebbles, decaying plants, and describe differences between two different soil samples.
6. Describe ways in which rocks break down to become soil, and demonstrate one or more of these ways; for example, by shaking a group of small soft rocks in a jar of water or striking rocks together. Note: safety goggles should be used.

Cross-curricular Connections

7. Describe some common uses of rocks and minerals, and identify examples of those used within the school, home or local community.

Mathematics

•Estimate weight and size.

• Graph the symmetry of crystal.

Language Arts

• Complete a glossary of rocks and minerals terminology.

• Research rocks and minerals.

Activities

Classroom teachers have identified the following activities that address the Specific Learner Expectations (SLEs) in the Program of Studies. The list is not prescriptive and teachers may select activities that are most appropriate for their students.

Activities have been listed under two headings. Key Activities and Extension Activities. Key activities are supported by authorized resources and identify "powerful and practical" means for achieving learner expectations. Extension activities represent alternative ways of achieving or supporting learner expectations.

Key Activities

Key Activity	SLE	Print Resources	Essential Materials	Comments
Exploring rocks		*Explorations in Science, Level 3, Rock Talk (Free Exploration), p. 6* *Explorations in Science, Level 3, Rock Solid (Free Exploration), p. 7* *Rocks and Minerals Teacher's Guide* (National Science Resources Center) *(Sharing What We Know About Rocks), p. 15*	collection of labelled rocks, resource books, protective eye wear, chisel, hammer, magnifying lenses	Students are given the opportunity to observe rocks and make notes on what they observe. This can be used to determine students' prior knowledge and skills. Look for the ability to recognize differences between rocks and suggest what the important features of each are.
Collecting, comparing, classifying rocks	1	*Explorations in Science, Level 3, Rock Talk (Let's Go Collecting!), p. 10*	bags or boxes	When students collect rocks, encourage them to observe and record a rock's surroundings. Always monitor collecting so children are not collecting more than they need. **Note:** egg cartons are excellent containers for collected specimens.
		Explorations in Science, Level 3, Rock Talk (Describing our Rocks), p. 11	collected rocks	
		Explorations in Science, Level 3, Rock Talk (Let's Sort Rocks), p. 13	collected rocks	
		Explorations in Science, Level 3, Rock Solid (Which Rock Is Which?), p. 10	collection of rocks, measuring tape, magnifying lenses, line master 1	
		Innovations in Science, Level 3, Let's Go Rocking (Crack A Rock), p. 8	safety goggles, hammers, sorting containers, collection of rocks, measuring tape, magnifying glasses, newspaper, soil samples	

Key Activity	SLE	Print Resources	Essential Materials	Comments
Exploring the colours of rocks	2, 3	*Explorations in Science, Level 3, Rock Talk (What Colour Are Your Rocks?), p. 14*	collected rocks, magnifying lenses, line master 1, dishes of water	Rocks may be made up of several minerals. One way to recognize how many different minerals there are in a rock is to look at the different colours it contains. This is not a conclusive way of distinguishing one mineral from another, but for young children it is a good starting point.
Exploring the texture of rocks	2, 3	*Explorations in Science, Level 3, Rock Talk (Rock Texture), p. 15*	collected and labelled rocks, line master 1	
Testing various minerals for hardness	2, 3	*Explorations in Science, Level 3, Rock Solid (How Hard Is That Rock?), p. 12-13* *Innovations in Science, Level 3, Let's Go Rocking (Crack a Rock, Extending the Experience), p. 11* *Explorations in Science, Level 3, Rock Talk (Hard as a Rock!), p. 16*	penny, steel nail, glass, protective eye wear, hammer, chisel, variety of rocks collected and labelled rocks, line master 1, materials to test hardness (paper clips, table knife, nails, pins, pennies, nail files), safety goggles	Rock hardness is found by using the scratch test. A rock that scratches another rock is harder than the other. The Mohs Scale of Hardness can be used to describe the hardness of a rock. The Mohs Scale goes from 1 to 10. One is soft (for example, talc) and 10 is hard (for example, diamond).
Describe component materials in rock	4			
Testing various rocks for the presence of calcite	2, 3	*Explorations in Science, Level 3, Rock Solid (Does It Bubble and Fizz?), p. 16*	seashell, limestone, chalk, hammer, vinegar, steel file, small dishes	Calcite (calcium carbonate) is a mineral commonly found in rocks that have been formed in water. Limestone and marble are mostly calcite. When a weak acid such as vinegar or lemon juice is exposed to calcite, it bubbles, producing carbon dioxide gas. The evaporation process may take several days.
Exploring common uses of rocks and minerals	7	*Explorations in Science, Level 3, Rock Solid (Rocks About the House), p. 27* *Explorations in Science, Level 3, Rock Talk (How Are They Used?), p. 20*	chart paper rocks	

Key Activity	SLE	Print Resources	Essential Materials	Comments
Examining the effects of weathering and erosion of rocks	6	*Explorations in Science, Level 3, Rock Solid (Jack Frost Comes to Call), p. 24*	small glass jars, plastic coffee cups and lids, porous rocks (sandstone), water, freezer, pictures of rocky environments	
		Explorations in Science, Level 3, Rock Talk (Rocks Change), p. 19	sharp, jagged rocks, plastic containers, box with lid, sieve, can, water	
		Explorations in Science, Level 3, Rock Talk (Let's Make Sand!), p. 22	collected rocks, materials requested by the children	
		Innovations in Science, Level 3, Let's Go Rocking (Worn Out!), p. 37	small balloons, Plaster of Paris, milk cartons, bowls	You will need access to a freezer to store the cartons overnight.
Collecting and observing the various components of soil	5	*Explorations in Science, Level 3, Down to Earth (Getting the Feel of It), p. 10*	soil samples, magnifying lenses, spoons, newspapers	
		Explorations in Science, Level 3, Down to Earth (A Closer Look), p. 12	aluminum or paper plates, nails, soil samples, magnifying lenses	
		Innovations in Science, Level 4, Down Under (The Soil Hunt), p. 8	shovels, wide-mouth containers, labelling materials	Make sure samples come from a variety of locations. Use fast-sprouting seeds such as beans or marigolds.

Extension Activities

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Designing experiments to examine variables that affect crystal growth		*Explorations in Science, Level 3, Rock Solid (Crystal Clear), p. 17*	sugar, string	These are edible.
		Explorations in Science, Level, 3, Rock Solid (Growing a Better Crystal), p. 20	alum, salt, sugar, pickling salt	Focuses on manipulating variables.
		Innovations in Science, Level 3, Let's Go Rocking (Crystal Faces), p. 12	sugar cubes, sugar, rock salt, alum	Allow up to two weeks for growth.
Looking at stalagmite and stalactite formations by growing crystals		*Explorations in Science, Level 3, Rock Solid (Do They Grow Up or Down), p. 19*	Epsom salts, baby food jars, cotton string, kettle, water, shallow container, washers or small weights, paper	
Investigating the formation of different types of rock		*Innovations in Science, Level 3, Let's Go Rocking (Fire Rock), p. 17* *Innovations in Science, Level 3, Let's Go Rocking (Under Pressure), p. 23*	candy thermometer, baking supplies, freezer, stove, sandwich materials, bricks	Adult supervision needed. Materials can be brought from home. Make mock rocks one week before observation activity.
		Innovations in Science, Level 3, Let's Go Rocking (Layer Upon Layer), p. 26	alum, coarse sand, gravel, oyster shell pieces, granite, mineral samples	
Creating an extraction process for separating a mineral from an ore sample		*Innovations in Science, Level 3, Let's Go Rocking (Rocking Across Canada), p. 41* *Innovations in Science, Level 3, Let's Go Rocking (Strike It Rich), p. 44*	table salt, sand, sieves, magnets, spoons, water, containers, toothpicks, magnifying glasses	
Testing for magnetism and conductivity in rocks		*Explorations in Science, Level 3, Rock Solid (That's Quite an Attraction), p. 14*	collection of rocks, magnets, string	
		Explorations in Science, Level 3, Rock Solid (All Lit Up), p. 15	insulated wires, D batteries, flashlight bulbs	Teacher demonstration.
Creating and excavating fossils		*Explorations in Science, Level 3, Rock Solid (Fossil Find), p. 22*	modelling clay, Plaster of Paris, dish soap, large pan, objects to make fossils	
		Innovations in Science, Level 3, Let's Go Rocking (The Prints of Time), p. 29	milk cartons, Plaster of Paris, safety glasses, safety gloves	Allow mixtures to dry overnight before the excavating begins.

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Using rocks to build a functional or decorative object	7	*Explorations in Science, Level 3, Rock Solid (Rocky Construction Company), p. 30*	collected rocks, mortar, water, large container, stirring sticks, sand	
Observing erosion and creating jewellery from tumbled rocks		*Explorations in Science, Level 3, Rock Solid (Rock Tumbler), p. 32*	rock tumbler, tumbler grit, small rocks, glue gun, jewellery, googly eyes	Outdoor activities—a school site field study can be done to discover evidence of weathering and erosion.
Writing with rocks		*Explorations in Science, Level 3, Rock Talk (Does It Write?), p. 17*	collection of rocks including some "soft" rocks such as soapstone or coal	
Making bricks		*Explorations in Science, Level 3, Rock Solid (Brickworks), p. 28*	large bowl, dirt or clay, water, grass clippings, empty cardboard milk or juice cartons, Vaseline, brick samples, chart paper	Students could visit a brickyard or have a brickyard worker speak to them before the activity begins.

Assessment

For a broader discussion of science classroom assessment techniques see *Assessing Student Learning* in the introduction of this publication on p. 15. Good places to begin looking for the unit-related ideas are *Explorations in Science* assessment handbooks, *Innovations in Science* teaching notes, Unit tests and Portfolio ideas, Alberta Education sample tests at **www.education.gov.ab.ca** and Alberta Assessment Consortium at **www.aac.ab.ca**

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