School of Hard Rocks

Grades 3 - 6

Go on a science scavenger hunt to see what geological samples you can find! Make a case for how to classify your samples based on your observations of key features, just like a geologist would, and be ready to test your system with a final surprise sample!

Background Information

Geologists study rocks and minerals to understand the world around us and to get a sense of what has happened on and inside the Earth throughout its history. Geologists use different techniques to gather information from rocks and minerals to unlock the secrets that they contain. One of those techniques is classification, which means grouping together similar samples to find patterns in their appearances, textures, and other qualities. At its most basic level, geological classification defines two groups**: minerals** and **rocks**.

A mineral contains a single substance that is usually organized into a crystal structure. You can picture that crystal structure like the framework skeleton of beams and connectors that supports a skyscraper. The crystal framework is too small to see but forms a repeating pattern that can grow into a giant crystal!

Crystals have a framework structure like those used to support buildings, including the Halifax Central Library (Credit: Halifax Libraries)

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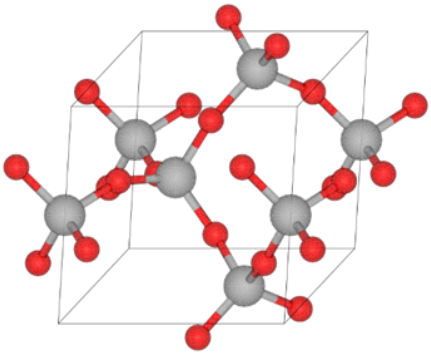
Background Information Cont.

The crystal structure framework of quartz



A repeating pattern that's too small to see with the human eye can yield giant quartz crystals, like this one found in Brazil (Credit: T. McGuire)

When two or more minerals combine, they form a rock. The type of rock that is made depends on what mineral the rock contains; the conditions it is formed under (like temperature and pressure); and how long it takes to form, grow, and change.

To best understand rock types and how they relate to one another, geologists organize rocks into three categories or "classes" based on these conditions: **igneous** (or "volcanic"), **sedimentary**, and **metamorphic**. No matter what class a rock belongs to, it can be melted, broken up, heated and squished, or otherwise changed to become another type of rock, meaning that a rock's materials can be constantly recycled. We call this process of recycling the **Rock Cycle**. Just like the Water Cycle recycles and carries water around us and around the world, the Rock Cycle changes, recycles, and renews rocks and minerals over and over again! Let's explore a couple of examples of each type of rock and compare their attributes and uses.

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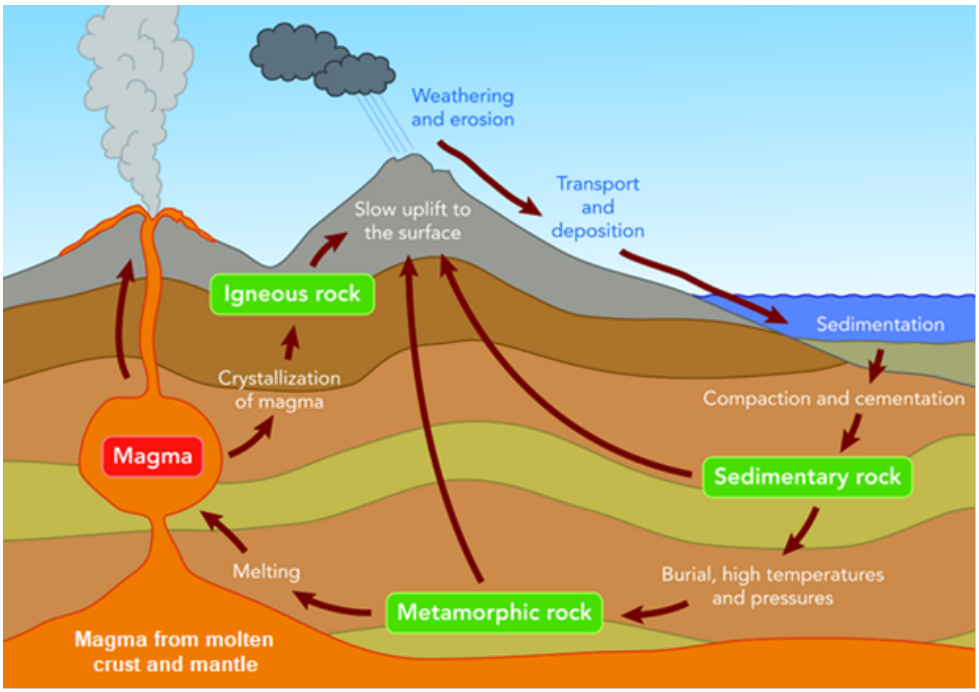
Background Information Cont.



The Rock Cycle recycles rocks! When older rocks are **uplifted** ("raised" or "pushed") **to the surface**, they are exposed to rain and ice, becoming **weathered** and broken up (or "**eroded**"). These sediments ("smaller pieces of rock") are **transported** from higher land by rivers and gravity to lower areas like lakes and the ocean where they are **deposited** ("dropped") through a process called **sedimentation**. Once they are deposited, sediments are **compacted** ("squished") by the weight of new sediments deposited on top of them and are **cemented** ("glued") together by mud, clay, or minerals to become **sedimentary** rocks. When rocks are buried, heated, and compressed even further, they become **metamorphic** rocks. Finally, when rocks are completely melted and **crystallized** ("cooled and hardened"), they become **igneous** rocks.

(Credit: modified from Thunderbolt Kids).

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Background Information Cont.

Igneous rocks are made when magma, melted rock deep below the Earth's surface, rises and begins to cool. Different igneous rocks will be formed depending on how quickly that magma cools. When magma cools slowly in layers below the Earth's surface, it forms rocks like **granite**, which contain large crystals that have had plenty of time to grow as they cooled. When the magma goes above the Earth's surface, such as during a volcanic eruption, it can cool so quickly and smoothly that it looks like glass! This volcanic glass is called **obsidian**.

Slow cooling granite: Peggy's Cove, NS granite containing a piece of older basalt (a xenolith, or "foreign rock") that was trapped in the magma as it cooled. This granite has large pink minerals (feldspar), black minerals (biotite), and clear minerals (quartz). Granite is very hard and tough and is often used in building structures and kitchen counters (Credit: M.C. Rygel)

Fast cooling obsidian: Glass-like obsidian from the collection of the National Museum of Prague, Czech Republic. Obsidian can be very sharp and was used long ago to make knives, spears, arrows, and tools (Credit: K. Jakubec)

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Background Information Cont.

Sedimentary rocks are formed when existing rocks are broken down through **weathering** and **erosion** into smaller pieces or **sediments**. These sediments are **transported** by rivers or gravity, which carry them from higher land to lower lying areas like plains, lakes, or the ocean, where they are **deposited** ("dropped"). Through the process of **sedimentation**, these older sediments get buried under new sediments that get deposited later. Over time, sediments get squished (or **compacted**) by the weight of newer layers of sediments lying on top of them and are glued or **cemented** together by mineral or mud filling the spaces between them. Sedimentary rocks are usually defined by the size and shape of the sediments that they contain. **Breccia** is an example of a sedimentary rock with very large pieces of sediment (sometimes as big as boulders!) glued together by mud. **Sandstone**, on the other hand, is formed from sand-sized pieces, sediments that are more eroded and worn down than those that make up breccia.

Very large, sharp edged sediments make breccia: McCoy Brook breccia (from Wasson Bluff, NS). The wide ranges of hardness and toughness of breccia, even within the same piece of rock, means that it isn't useful when building structures, but can be polished and used to make flooring and tiles (Credit: M.C. Rygel)

Sand-sized sediments make sandstone: McCoy Brook sandstone (from Wasson Bluff, NS) showing the world's smallest dinosaur footprints. The red colour of this sandstone suggests that it was deposited by the wind or during a flood. Being left out in the air gave the iron in the sand lots of time to rust. Sandstone is often used in building structures (Credit: E. George)

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Background Information Cont.

Metamorphic rocks are formed through change, or “metamorphosis”! When existing rocks are buried deeply enough under new deposits of sediments and rock, they are heated and compressed even more, which can lead to changes that completely alter their colour, texture, and hardness. The large, rounded minerals of granite are squished and folded into lines and waves when it is transformed into **gneiss**, while the sand in sandstone becomes pearly, shiny, and polished when it is changed into **quartzite**!

Wavy bands of alternating colours in gneiss: Gneiss, like this sample from Staoinebrig, Great Britain, is formed when granite crystals are squished and folded into beautiful patterns. While it is hard enough to be used to build structures, gneiss is so hard that it is difficult (and expensive) to work with. It is often used for decorating flooring and walls because of its beauty, or, due to its hardness, for gravestones and other objects meant to last a long time (Credit: A. Burgess).

Shiny, hard, polished quartzite: Painted quartzite statue of King Tutankhamun from ancient Egypt. Quartzite is prized for building structures and carving statues due to its hardness and beauty.

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Background Information Cont.

Where the Water Cycle is great at recycling and transporting water, the Rock Cycle is great at recycling rocks and minerals! What's more, any rock can be changed and recycled into any other class of rock. We can see this process in action in the examples above, where an igneous rock like granite can be broken up and become part of a sedimentary rock like breccia. It can also be heated and changed to become a metamorphic rock like gneiss. That piece of granite can even be completely melted and re-cooled to become a new igneous rock, even a new granite! Due to this recycling, rocks act as a snapshot of the conditions that existed when they were formed, so can give geologists lots of information – as long as those scientists stay organized and keep an eye out for patterns in the attributes of their samples!

Now it's your turn to become geologists and collect some samples around you! Examine your samples to identify key features and qualities, using a piece of paper or the chart provided to keep track of your observations. While geologists talk about the similarities and differences between rocks and minerals, or between the three rock classes, there are many ways to group your samples! Geologists might describe rocks and minerals based on their colour, shininess, smoothness, hardness, how we use them, and how they were formed. What qualities do you notice first in your rocks and minerals? How are your samples similar or different? Use your observations to craft at least three groups within which to organize your samples. Do you find it difficult to place any of your rocks and minerals into a single grouping? How would you fit a new sample into the groupings you've created?

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Materials

- 5 to 10 geological samples such as different kinds of rocks and minerals. These samples can be pictures you take or find online, physical objects (such as the rocks used in the wall of a building, the tiles in a bathroom, a statue, pieces of jewelry, your kitchen counter, boulders on a hiking trail, etc), or even some of the rocks and minerals on page 11!
- A piece of paper or the chart provided (at the end of the instructions) and writing materials to record your observations
- A space on a table, counter, or the floor to organize any small physical samples into different groupings or to use as a writing surface.
- Items to help you explore different features of your samples such as a magnifying glass, penny, iron nail, your own fingernail

Instructions

1. Gather your geological samples.
2. Identify different attributes, or features, that your samples have! Find whatever similarities or differences between your samples you can and record them on a piece of paper or on the chart provided (at the end of the instructions). Are your samples similar in size, shape, or colour? Are some harder than others? Where did you find them? Can you figure out how they were formed?

   Tip: Some ways you can establish hardness is by trying to scratch your rock or mineral with your fingernail or an iron nail, or by scraping it on a porcelain tile, penny, or against another sample.

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Instructions Cont.

3. Sort your samples into different groups based on their features! Are your samples similar to each other or unique? How many groups do you have? Think about how you grouped your samples. Why did you place your samples into those groups? Is there a different way you could have grouped them?

4. Given a new geological sample (such as the one below) how would you add it to one of your groups? Why did you choose to add it to that group? If you could rearrange your groups or create a new group, how would you reorganize your samples and why?

Lycopod bark imprint from Joggins, Nova Scotia: Sedimentary rock made of compressed mud, which is made of tiny sediments that are even smaller than sand. The mud was pressed against the bark of a giant, ancient fern tree over 300 million years ago during a flood. Since the mud was not left out in the air long enough for the iron in it to rust (as happened with the sandstone example, above), the sediments in the mudstone remained grey. This sample is too hard to scratch with your fingernail, but is easily scratched with an iron nail. The sample feels slightly bumpy, but mostly smooth, with the imprint (or pattern) of the fern tree bark it was pressed against. The Discovery Centre uses this sample to teach people about fossils and geology, though many other fossils like this are studied by geologists and paleontologists to better understand ancient life and ecosystems!

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Things to Consider

- Try to include at least 3 different groups when choosing how to sort your samples
- Play around with how specific your attributes and features are for your groups. Is it easier to sort your samples when your criteria are general or specific?

Questions for Reflection & Activity Extensions

- Go for a walk and find everyday examples of where igneous, sedimentary, and metamorphic rock may be used in day to day life. What sorts of things do we use at home, at school, or in our communities that are made of rocks and minerals?
- Can you think of any examples of rocks or minerals that are used by animals or that animals eat?
- Give your samples to someone else. Do they sort your samples in the same way you did?
- Are there any other geological samples you would like to add to your groups? How would you sort a dinosaur bone into your existing groups? Would a plant fossil be grouped differently?

Sample name or number *Type of rock or mineral, a number, or description (to help keep your samples organized)	Is it a rock or a mineral?	Attributes and features *Colour, texture, patterns, hardness, etc.	Other notes *Colour, texture, patterns, hardness, etc.	Ideas for groupings