Metamorphic Rocks

Overview

In this 1-class-period activity, students work with six metamorphic rocks to classify them. Students observe common key characteristics of metamorphic rocks and consider some common starting rocks that produce metamorphic rocks. This activity is conducted like the previous activities on igneous and sedimentary rocks.

North Carolina Essential Science Standards

6.E.2.3 Explain how the formation of soil is related to the parent rock type and the environment in which it develops.

Background

Metamorphic rocks are created by heat and pressure on other rocks. Tectonic forces moving the crust and upper mantle create the heat and pressure. Metamorphic rocks form in a wide range of heat and pressure conditions. The type of rock being changed and the amount of heat and pressure determine the type of metamorphic rock. Quartzite is sand that has metamorphosed. Marble is limestone that has metamorphosed. Slate is shale that has metamorphosed. Layering is a common characteristic of metamorphic rocks. The layers can be distinct like those in slate or like dough with streaks of chocolate, like those in gneiss. Metamorphic rocks have not actually melted, although some have gotten hot enough for crystals to dissolve and reform, producing layers based on the shape of the crystals. For example, garnet gneiss has crystals reformed in loose bands, and the mica crystals in schist have reformed into sheets.

Materials

Materials for the Teacher

- A teacher set of identified samples.
- Ability to Project SD-3, Metamorphic Rock Stories

Materials for teams of 4

- One set of metamorphic rock samples
- 1 bottle of dilute acid (0.75 molar). The dilute acid is not dangerous. However, always explain proper handling to students: wear safety glasses and avoid acid contact with skin, eyes, and clothing. After exposing samples to acid, rinse and dry them before storing.
- 2 hand lenses
- a small pad of paper
- one copy of SD-1, Metamorphic Rocks Chart
- one copy of SD-2, Metamorphic Rocks Identification Sheet

- *safety glasses
- *science notebooks

* to be supplied by the teacher

Preparation

Make a copy of SD-1, Metamorphic Rocks Chart and SD-2 Metamorphic Rock Identification Sheet for each team of 4.

Exploration

1. Set up teams of 4 and provide each team with a small pad of paper and a set of metamorphic rock samples. Explain that these are metamorphic rocks.
2. Without identifying the sample, choose a metamorphic rock from the teacher set for the whole class to look at. Either walk around the classroom to show every team, or project it with a document camera. Ask teams to find this sample in their box and place it on a piece of paper from their pad.
3. Ask teams to observe the rock closely, and write as detailed a description of it as they can.
4. Discuss some of the characteristics that students observed.

Procedure

1. Give out hand lenses. Students should still have their set of 6 metamorphic rocks. Ask teams to lay each sample out on a separate sheet of paper. On that sheet of paper, ask them to describe the rock carefully, including as many characteristics as they can. Ask them to do this with all 6 rocks.
2. Ask for observations. If students have read about metamorphic rocks, ask them to compare what they see with what they know about metamorphic rocks. If the class has not read about metamorphic rocks, explain that metamorphic rocks come from heating and compressing other kinds of igneous and sedimentary rocks we have already studied.
3. Give each team a copy of SD-1, the Metamorphic Rocks Chart, and SD-2, the Metamorphic Rock Identification Sheet. Ask students to use the Metamorphic Rocks Chart to place the rocks in the correct blank squares of the Metamorphic Rock Identification Sheet. Do not give out the acid bottles yet.
4. After students finish, as a final test, give out the acid bottles and require students put on safety glasses, explain the test procedure, and ask students to use it to confirm the identity of the marble sample. The test procedure is to place 2-3 drops of dilute acid on the sample and look for fizzing. A hand lens makes it easier to see the fizzing.
5. As groups finish, ask them to look at other groups' placement of rocks and observations to compare with their own. Ask for ideas about how some of the rocks might have formed, based on their appearance.

6. Project SD-3, Metamorphic Rock Stories, and go through the stories with the class. Let the class know that each story is about one of the rocks in their set of 6 metamorphic rock samples. Ask each team to predict which rock each story is about. Ask for reasons for predictions. The Answer Key is below. Included with the answer key are some helpful YouTube videos and website images.
7. EXTENSION: Bring out igneous and sedimentary rock samples. Ask students to look at these to try to find a starting rock for a particular metamorphic sample. Ask them to record their ideas in their notebooks, especially reasons for the matches. An obvious pair is shale and slate. Other pairs are sandstone and quartzite (both are silicon dioxide), and limestone and marble (both are calcium carbonate and react with acid).

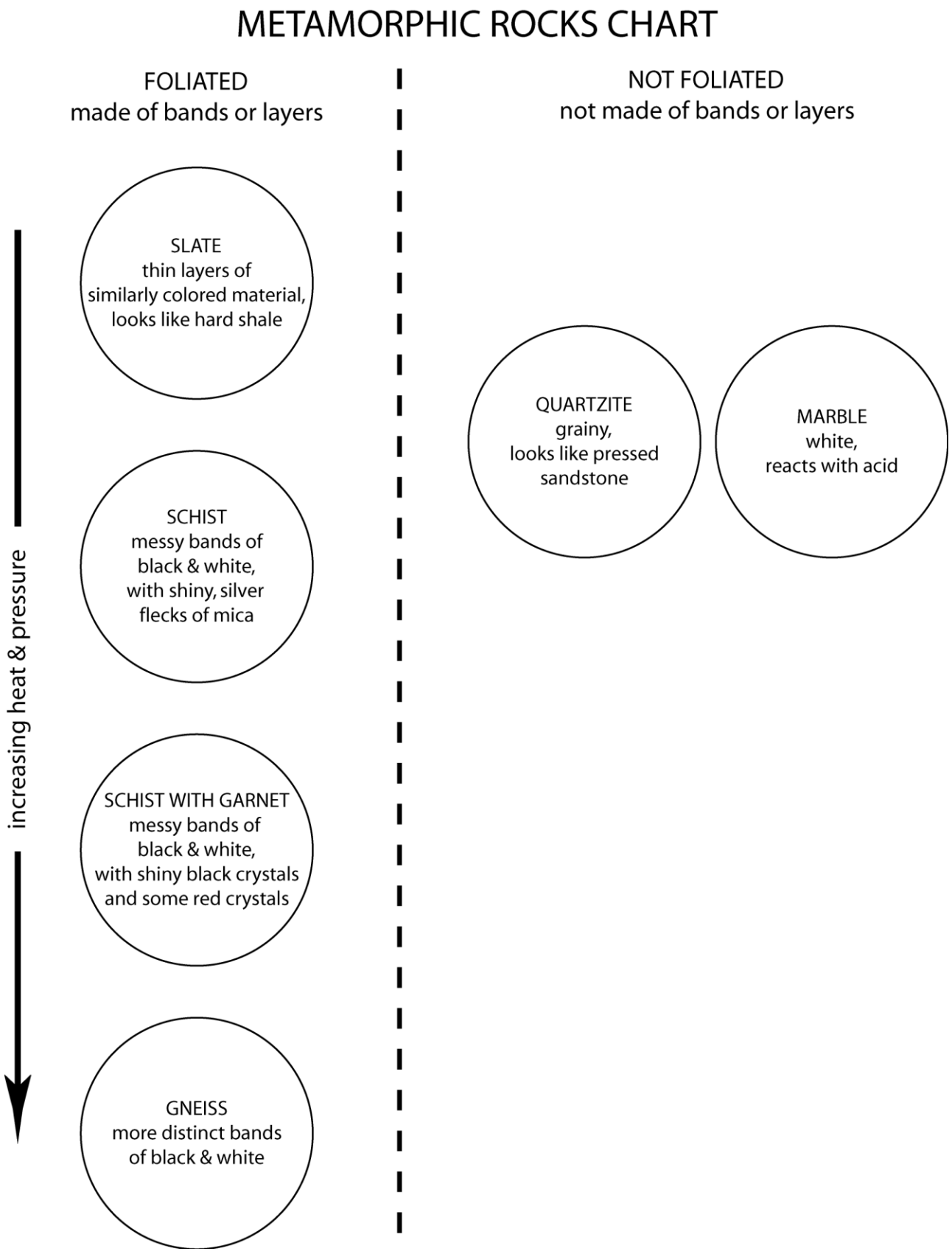
ANSWER KEY

Slate often forms in basins between convergent plate boundaries where a shale-type sedimentary rock made of clay or volcanic ash is subjected to heat and pressure. Compared with other metamorphic rocks, relatively little heat and pressure are needed to make it. It is extremely fine-grained, with many thin layers. Its color is largely determined by the amount of iron it contains, but it is normally a shade of gray. Images of a slate quarry and commercial slate are at: http://www.bangorblueslate.com/

Gneiss forms when intense heat and pressure partially melt and compress granite or sedimentary rocks. These high temperatures and pressures occur as tectonic processes such as continental collisions or subduction push rock deep in the Earth. In the case of gneiss, the materials it is composed of (minerals) stay more or less the same. However, their structure changes to become much more layered, producing clear alternating layers. Gneiss has clear layers representing alternating layers of different minerals. This image of gneiss clearly shows the layers:
https://en.wikipedia.org/wiki/Gneiss#/media/File:Gneiss.jpg

Marble forms when limestone is compressed at high temperature. This happens when limestone is pushed deep into the earth by tectonic forces. The heat and pressure cause the calcite that makes up limestone to re-crystallize into a denser rock. The denser rock is made up of calcite crystals that are all about the same size, and more compact. The stripes and swirls of colored marble are impurities such as clay, silt, sand, or iron oxides that were in the original limestone. Here is an image of a marble quarry in Italy:
http://www.staechelin.de/enUS/the-history-of-marble/how-marble-is-formed.htm

SD1 – Metamorphic Rocks Chart



SD 2 – Metamorphic Rock Identification Sheet

Slate	**Schist**
Schist With Garnet	**Gneiss**
Quartzite	**Marble**

SD 3 – Metamorphic Rock Stories

Story 1

This rock often forms in basins between convergent plate boundaries where a shale-type sedimentary rock made of clay or volcanic ash is subjected to heat and pressure. Compared with other metamorphic rocks, relatively little heat and pressure are needed to make it. It is extremely fine-grained, with many thin layers. Its color is largely determined by the amount of iron it contains, but it is normally a shade of gray.

Story 2

This rock forms when intense heat and pressure partially melt and compress granite or sedimentary rocks. These high temperatures and pressures occur as tectonic processes such as continental collisions or subduction push rock deep in the Earth. With this rock, the materials it is composed of (minerals) stay more or less the same. However, their structure changes to become much more layered, producing clear alternating layers.

Story 3

This rock forms when limestone is compressed at high temperature when limestone is pushed deep into the earth by tectonic forces. The heat and pressure cause the calcite that makes up limestone to re-crystallize into a denser rock. The denser rock is made up of calcite crystals that are all about the same size, and more compact. The stripes and swirls of colored versions of this rock are impurities such as clay, silt, sand, or iron oxides that were in the original limestone.