

Metamorphic Rocks Transformation at Work

Metamorphic rocks are one of the three types of rock classifications, the other two being igneous and sedimentary. Rocks are classified by the processes under which they were formed. The differences in formation account for variations in the appearance of the rocks and, with some practice, you can learn to recognize the different types by sight.

Metamorphic Rocks are rocks that have changed form due to **heat and pressure**. Metamorphic comes from the Greek words **meta** and **morph**. Meta means change and morph means form. So we get metamorphic meaning to change form.

Metamorphic rocks were once sedimentary, igneous or even other metamorphic rocks that have been changed by heat and pressure.

There are two kinds of metamorphism.

- **Contact metamorphism**
- **Regional metamorphism**

Contact metamorphism occurs when magma intrudes or forces its way into existing rock. The heat of the magma bakes the surrounding rocks causing them to change. This is a local event. The changes due to contact metamorphism are relatively small and are said to be low-grade metamorphism. An example of contact metamorphism is the metamorphic rock marble. Marble is created from limestone that has been subjected to heat.

Regional metamorphism by contrast takes place over large areas and is high-grade metamorphism. Regional metamorphism is associated with mountain building.

The Causes or Agents of Metamorphism

The causes or **agents of metamorphism** are heat, pressure, and hydrothermal solution. But where does this heat and pressure come from? And what is hydrothermal solution? Well read on...

The heat and pressure comes from inside the earth. From the upper mantle up to within a few kilometers of the surface of the earth there is a tremendous amount of heat and pressure. This heat and pressure increase with depth. It is estimated that the temperature increases about 20° to 30° C per kilometer of depth.

Plate Tectonics Adds Heat and Pressure

There is something else that adds to both the heat and pressure, and that is plate tectonics. When the plates of the earth collide, they squeeze the rocks at the borders with unbelievable force. This force increases the pressure in this and surrounding areas. Friction is also created by the plates grinding together. This friction generates enough heat to melt the rocks at the point of contact.

Heat

For metamorphism to occur **energy** is needed to fuel the chemical reactions. Heat is the primary source of this energy.

Pressure

The pressure within the earth is the result of gravity pulling the crust of the earth downward. Like heat, pressure increases with depth. This pressure can actually squeeze the spaces out of the minerals within the rock. This makes the rocks denser. The heat and pressure together cause the rock to flow instead of break or fracture. The mineral grains become realigned. They flatten out and get longer.

Hydrothermal Solution

Magma contains many different gasses including H₂O. That's right water! Or more properly steam. Minerals are carried by the steam. When this hot fluid escapes from the magma it is called Hydrothermal Solution. These hot fluids can change the crystallization in rock by dissolving the minerals and then depositing new ones. Rocks that come in contact with this hydrothermal solution can have their composition altered as a result of this recrystallization.

The Classification of Metamorphic Rocks

Metamorphic rocks are classified as **foliated** or **nonfoliated**.

Foliated metamorphic rocks appeared banded or layered.

Nonfoliated metamorphic rock usually contains one mineral. It is uniform in texture.

Examples of Common Metamorphic Rocks

Quartzite



Quartzite is a coarse-grained metamorphic rock derived from sandstone.

Heat and pressure combine to fuse grains of quartz sand to make up the composition of quartzite

It has a uniform texture (non-foliated) and is very hard, 7 on the Moh's Scale.

Quartzite is resistant to weathering.

Quartzite is usually white or grey and sometimes pink to red if iron oxides are present as in this example.

Marble

Marble is a metamorphic rock that comes from metamorphosed limestone or dolomite. Limestone is mostly calcite or calcium carbonate, CaCO_3 .

Dolomite $\text{CaMg}(\text{CO}_3)_2$ is related to limestone but is rich in magnesium.

Marble has a uniform texture (non-foliated).

There is a lot of variation in the color and texture of marble. The two main influences are the kind of limestone that makes up the parent rock and the kind and degree of metamorphism.



It can be most any color including white, black, reds, greens, and more. It is usually coarse grained though fine-grained marble is found in some places and is highly prized for creating sculptures. Marble is used as building materials for its strength and beauty.

Marble will fizz when in contact with acid. Vinegar can be used as a test.

Slate

Slate is a fine grained metamorphic rock.

Shale is the parent rock. It is made up of clay minerals. Shale can metamorphose into **slate**, phyllite, schist or gneiss depending on the degree of heat and pressure. Slate is the least metamorphosed of this group; meaning that it has been subjected to the least amount of heat and pressure (low-grade metamorphism). It is associated with regional metamorphism and with mountain building.



Slate is foliated and easily splits into thin, flat, parallel planes. This along with its chemical inertness and thermal stability make slate useful for many purposes. It is used for roofing shingles, floor tiles, pool tables and laboratory benches.

Phyllite

Phyllite is a fine grained metamorphic rock.

Shale is the parent rock. It is made up of clay minerals. Shale can metamorphose into slate, **phyllite**, schist or gneiss depending on the degree of heat and pressure. Phyllite has a greater degree of metamorphism than slate but less than schist. It is associated with regional metamorphism and with mountain building.



It is primarily composed of quartz, sericite mica, and chlorite.

Phyllite has larger crystals than slate. This gives it a greater degree of light reflection or sheen. The sheen is used to distinguish phyllite from slate.

Schist

Schist is a coarse grained metamorphic rock.



Shale is the parent rock. It is made up of clay minerals. Shale can metamorphose into slate, phyllite, **schist** or gneiss depending on the degree of heat and pressure. Schist has a greater degree of metamorphism than phyllite but less than gneiss.

It is classed as a medium-grade metamorphic rock and is associated with regional metamorphism and with mountain building.

The crystals in schist are large enough to see with the naked eye. They are flattened and elongated. Schist contains more than 50% platy and elongated minerals.

Schist is foliated or layered in appearance. Quartz, micas, and amphiboles are primary minerals in schist.

Schist comes from a Greek word meaning "to split"

Gneiss

Gneiss is a medium to coarse grained metamorphic rock.



Shale is the typical parent rock. It is made up of clay minerals. Shale can metamorphose into slate, phyllite, schist or **gneiss** depending on the degree of heat and pressure. Gneiss has the greatest degree of metamorphism in this group. It is classed as a high-grade metamorphic rock and is associated with regional metamorphism and with major mountain building.

Igneous rocks especially granite, can also make up the parent rock for gneiss.

This is a foliated dense rock that has light and dark colored banding. It is typically composed of feldspars, quartz, micas, and amphiboles. Because of the high heat and pressure, the minerals contained in gneiss have been mostly recrystallized.

Gneiss is a very common metamorphic rock.

Metamorphic Rock Classification

Metamorphic rock is classified by texture and composition. The texture can be **foliated** or **nonfoliated**.

Foliated metamorphic rocks appear banded or layered. Foliated rocks can be ordered in terms of increasing metamorphism. In the example chart below, notice how each of the first three rocks become the parent rock for the next. In each of these it takes more heat and pressure to move to the next level of metamorphism. Nonfoliated metamorphic rock usually contains one mineral. It is uniform in texture.

Grain size is another characteristic of texture. It ranges from very fine to coarse.

Classification of Metamorphic Rocks				
Name of Rock	Parent Rock	Texture	Grain Size	Notes
Slate	Shale, mudstone, siltstone	Foliated	very fine	smooth dull surfaces
Phyllite	Slate		fine	glossy sheen
Schist	Phyllite		medium to coarse	micaceous minerals
Gneiss	Schist, granite, volcanic rocks		medium to coarse	mineral banding
Marble	limestone	Nonfoliated	medium to coarse	interlocking calcite or dolomite grains
Quartzite	quartz sandstone		medium to coarse	fused quartz grains
Anthracite	bituminous coal		fine	black, shiny, organic rock

Sources:

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