**3- Metamorphic rocks**

**Metamorphic rocks** arise from the transformation of existing [rock](http://en.wikipedia.org/wiki/Rock_(geology)) types, in a process called [metamorphism](http://en.wikipedia.org/wiki/Metamorphism), which means "change in form". The original rock ([protolith](http://en.wikipedia.org/wiki/Protolith)) is subjected to heat (temperatures greater than 150 to 200 Â°C) and pressure (1500 [bars](http://en.wikipedia.org/wiki/Bar_(unit))), causing profound physical and/or chemical change. The protolith may be a [sedimentary rock](http://en.wikipedia.org/wiki/Sedimentary_rock), an [igneous rock](http://en.wikipedia.org/wiki/Igneous_rock) or another older metamorphic rock.

Metamorphic rocks make up a large part of the [Earth](http://en.wikipedia.org/wiki/Earth)'s [crust](http://en.wikipedia.org/wiki/Crust_(geology)) and are classified by texture and by [chemical](http://en.wikipedia.org/wiki/Chemical) and [mineral](http://en.wikipedia.org/wiki/Mineral) assemblage ([metamorphic facies](http://en.wikipedia.org/wiki/Metamorphic_facies)). They may be formed simply by being deep beneath the Earth's surface, subjected to high temperatures and the great pressure of the rock layers above it. They can form from [tectonic](http://en.wikipedia.org/wiki/Plate_tectonics) processes such as continental collisions, which cause horizontal pressure, friction and distortion. They are also formed when rock is heated up by the [intrusion](http://en.wikipedia.org/wiki/Intrusion_(geology)) of hot molten rock called [magma](http://en.wikipedia.org/wiki/Magma) from the Earth's interior. The study of metamorphic rocks (now exposed at the Earth's surface following erosion and uplift) provides information about the temperatures and pressures that occur at great depths within the Earth's crust. Some examples of metamorphic rocks are [gneiss](http://en.wikipedia.org/wiki/Gneiss), [slate](http://en.wikipedia.org/wiki/Slate), [marble](http://en.wikipedia.org/wiki/Marble), [schist](http://en.wikipedia.org/wiki/Schist), and [quartzite](http://en.wikipedia.org/wiki/Quartzite).

## Metamorphic minerals

Metamorphic minerals are those that form only at the high temperatures and pressures associated with the process of metamorphism. These minerals, known as [index minerals](http://en.wikipedia.org/wiki/Index_mineral), include [sillimanite](http://en.wikipedia.org/wiki/Sillimanite), [kyanite](http://en.wikipedia.org/wiki/Kyanite), [staurolite](http://en.wikipedia.org/wiki/Staurolite), [andalusite](http://en.wikipedia.org/wiki/Andalusite), and some [garnet](http://en.wikipedia.org/wiki/Garnet).

Other minerals, such as [olivines](http://en.wikipedia.org/wiki/Olivine), [pyroxenes](http://en.wikipedia.org/wiki/Pyroxene), [amphiboles](http://en.wikipedia.org/wiki/Amphibole), [micas](http://en.wikipedia.org/wiki/Mica), [feldspars](http://en.wikipedia.org/wiki/Feldspar), and [quartz](http://en.wikipedia.org/wiki/Quartz), may be found in metamorphic rocks, but are not necessarily the result of the process of metamorphism. These minerals formed during the [crystallization](http://en.wikipedia.org/wiki/Crystallization) of igneous rocks. They are stable at high temperatures and pressures and may remain chemically unchanged during the metamorphic process. However, all minerals are stable only within certain limits, and the presence of some minerals in metamorphic rocks indicates the approximate temperatures and pressures at which they formed.

[**Foliation:**](https://en.wikipedia.org/wiki/Foliation_(geology))[](https://en.wikipedia.org/wiki/File:Migma_ss_2006.jpg)

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The layering within metamorphic rocks is called [*foliation*](https://en.wikipedia.org/wiki/Foliation_(geology)) (derived from the [Latin](https://en.wikipedia.org/wiki/Latin) word *folia*, meaning "leaves"), and it occurs when a rock is being shortened along one axis during recrystallization. This causes the platy or elongated crystals of minerals, such as [mica](https://en.wikipedia.org/wiki/Mica) and [chlorite](https://en.wikipedia.org/wiki/Chlorite_group), to become rotated such that their long axes are perpendicular to the orientation of shortening. This results in a banded, or foliated rock, with the bands showing the colors of the minerals that formed them.

Textures are separated into foliated and non-foliated categories. Foliated rock is a product of differential stress that deforms the rock in one plane, sometimes creating a plane of [cleavage](https://en.wikipedia.org/wiki/Cleavage_(geology)). For example, [slate](https://en.wikipedia.org/wiki/Slate) is a foliated metamorphic rock, originating from [shale](https://en.wikipedia.org/wiki/Shale). Non-foliated rock does not have planar patterns of strain.

**Types of metamorphism:**

1. **Contact metamorphism**:

Is the name given to the changes that take place when magma is injected into the surrounding solid rock ([country rock](https://en.wikipedia.org/wiki/Country_rock_(geology))). The changes that occur are greatest wherever the magma comes into contact with the rock because the temperatures are highest at this boundary and decrease with distance from it. Around the igneous rock that forms from the cooling magma is a metamorphosed zone called a *contact metamorphism aureole*. Aureoles may show all degrees of metamorphism from the contact area to unmetamorphosed (unchanged) country rock some distance away. The formation of important [ore](https://en.wikipedia.org/wiki/Ore) minerals may occur by the process of [metasomatism](https://en.wikipedia.org/wiki/Metasomatism) at or near the contact zone**.**

1. **Regional metamorphism**:

Also known as dynamic metamorphism is the name given to changes in great masses of rock over a wide area. Rocks can be metamorphosed simply by being at great depths below the Earth's surface, subjected to high temperatures and the great pressure caused by the immense weight of the rock layers above. Much of the lower continental crust is metamorphic, except for recent igneous intrusions