

## Some Notes about Metamorphic Rock

Metamorphic rock is rock that changed from some original state (igneous, metamorphic, sedimentary) because of changes in the surrounding environment up to (*but not including*) melting.

Important factors in metamorphism include (1) **pressure** and **stress**, (2) **temperature**, (3) **chemistry**/reactivity, (4) **pre-existing rock fabric**, and (5) **time**.

**Pressure** is a system or field of forces directed perpendicular to all surfaces of a given solid object with the same magnitude everywhere.

**Stress** is a system or field of forces acting on a surface in which the magnitude of the force at any given point is dependent on the orientation of the surface. Stress is force applied over an area. Pressure is a special case of stress, in which the magnitudes of all of the force vectors are equal. That equality is not true for other stress cases, in which there is a greater force in one direction and lesser forces in other directions.

Types of metamorphism include (1) **contact** metamorphism, (2) **burial** metamorphism, (3) **regional** metamorphism, and (4) **hydrothermal** metamorphism due to hot water.

Grades of metamorphism include (1) **low-grade** involving slightly elevated pressure/temperature/stress (P/T/S) conditions and more water-bearing minerals such as clays, micas, amphiboles and “wet” quartz, (2) **intermediate grade**, and (3) **high-grade** involving significantly elevated P/T/S conditions up to the point of partial melting, and more “dry” minerals such as garnet, kyanite and sillimanite

Foliated metamorphic rock types include

- (1) **slate**, which displays slaty cleavage and is a metamorphosed mudstone/shale,
- (2) **phyllite**, which displays phyllitic layering,
- (3) **schist**, which displays schistosity, and
- (4) **gneiss**, which displays gneissic layering or compositional banding and looks like a layered intrusive igneous rock

Generally non-foliated metamorphic rock types include (1) **quartzite**, which may display relict bedding and is a metamorphosed quartz sandstone, and (2) **marble**, which may display relict bedding and is a metamorphosed limestone

Some metamorphic processes include (1) **recrystallization**, which is a closed chemical system in which a mineral in the pre-metamorphic rock is recrystallized to form the same type of mineral in the metamorphic rock, (2) **neomorphism**, which is a closed chemical system in which the minerals in the pre-metamorphic rock are changed to different minerals during metamorphism, and (3) **metasomatism**, which is an open chemical system in which the minerals in the pre-metamorphic rock are not the same as those in the metamorphosed rock.

**Prograde** metamorphism involves increasing the magnitude of environmental variables (P/T/S), while **retrograde** metamorphism involves decreasing the magnitudes. Weathering of igneous rock can be seen in part as a form of retrograde metamorphism.