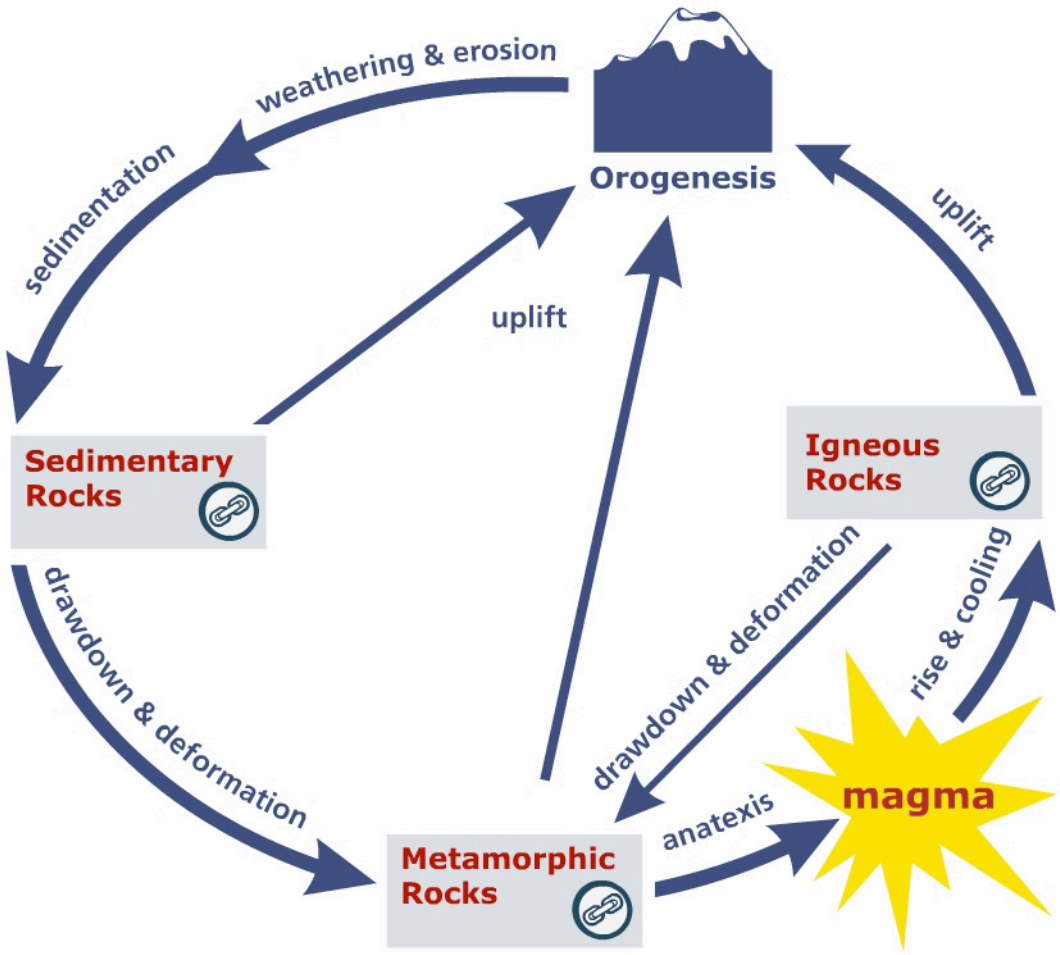
ALPECOLe – Lesson A1: The rock cycle

The dynamics of the rock cycle diagram and text



Orogenesis

Mountains can consist of all rock types (metamorphic, igneous and sedimentary rocks). Many mountains are built by more than one rock type. Orogenesis mainly occurs at plate margins.

Weathering and erosion

Weathering and erosion are the main processes to which the surface of the earth is exposed. The velocity of weathering mainly depends on climate, rock type and duration of exposure. There are two types of weathering. Chemical weathering alters the chemical composition of the rocks or even dissolves rocks. Physical weathering is the process that mechanically decomposes and reduces rocks to small pieces. Weathering produces sediment particles and soils, which are partly transported by water, ice, wind and other erosive processes.

Sedimentation and diagenesis
Sedimentation is the final stage of a process that begins with erosion and transportation of eroded materials to sites of deposition. It describes the settling out of suspension or deposition of particles in a layer. Chemical and physical changes after deposition (diagenesis) convert soft sediment into rock and cause many other alterations of composition and texture.

Sedimentary rocks
If rocks reach the earth surface, weathering and erosion takes place, especially in high-elevated mountain regions. The particles are transported by rivers, glaciers, wind and other processes and then again deposited. Over time, they consolidate and sediments form. There are three main types: clastic sediments (e.g. sandstone), chemical sediments (e.g. salt, limestone) and biochemical sediments (e.g. coal, corals), which were formed by or consist of organisms.

Drawdown and deformation
If the rocks subside into the crust and upper mantle, temperature and pressure increase with depth and alter the texture and mineralogy of the rocks. Texture and mineralogy are the pressure gauges and thermometers of metamorphism, since they indicate the intensity of alteration. Foliation and lineation of rocks imply the kind and direction of deformation.

Metamorphic rocks
Metamorphism describes what happens to rock when it is baked and squeezed in the earth. This process, by which pre-existing rocks (igneous, sedimentary and older metamorphic rocks) are altered by temperature and pressure, is controlled by geothermal gradients and deformation patterns that ultimately stem from plate motions. In general, mineral composition, texture and the orientation of particles alter considerably, dependig on the degree of metamorphism.

Rise and cooling
If magma rises, it cools down and minerals are formed at specific temperatures. This process results in volcanic or plutonic rocks.

Igneous rocks
If magma rises into the crust, it cools down. If it gets stuck in the upper mantle or crust, the cooling process is slow, over thousands of years. Therefore, there is enough time for the formation of big mineral crystals, which are well visible e.g. in granite. These rocks are called plutonic rocks. If the magma reaches the earth's surface rapidly, e.g. by volcanic eruption, the cooling process happens very rapidly. Since

there is hardly any time for mineral formation, only small minerals develop, embedded in a massive compound. This rock type is called volcanic rock, of which basalt is a classic example and the most widespread rock type of the earth's crust.

Uplift

An uplift is mainly triggered by plate movements at convergent plate margins. Famous examples are the uplift of the Alps, the Himalaya or the Andes. Uplift can also occur for isostatic reasons, when a glaciated region becomes ice-free, as in e.g. Norway.

Anatexis

If the temperatures in subsiding rocks are very high, the metamorphic rocks start to melt (anatexis) and magma will be produced. The cycle can start again and either volcanic or plutonic rocks evolve.

Magma

Magma is molten rock material that forms igneous rock upon cooling. If magma reaches the surface due to volcanic activity, it is called lava. When magma is cooling, the magmatic differentiation plays an important role. A uniform parent magma may lead to rocks of a variety of compositions, because different mineral phases crystallize from a melt at different temperatures.