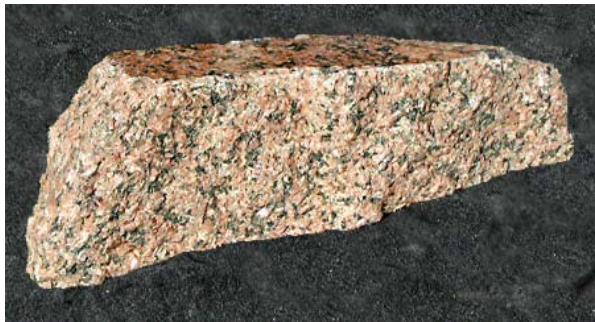


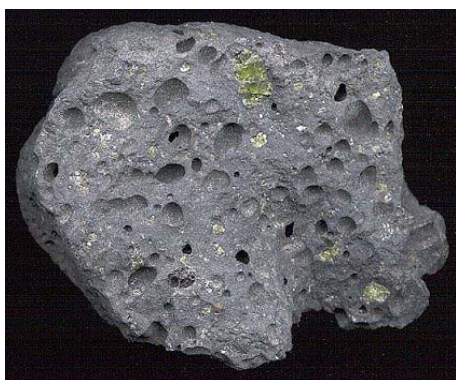
## Important Igneous Rocks: Basalt and Granite

**Basalt** and **granite** have the honor of being the most important rocks in the crust. Most of the ocean floor is basalt, and most of the continents are granite. Basalt and granite are igneous rocks, which means that they cooled from a magma, and are made up of minerals from the silicate group, so both have large amounts of silica and oxygen with smaller amounts of iron, magnesium, aluminum, calcium and other metals.

**Granite** is great stuff! It is without a doubt the most common rock type on the continental land masses. Yosemite Valley in the Sierra Nevadas and Mt. Rushmore are two notable examples of granitic rocks. But granitic "basement rock" can be found just about everywhere east of the Rockies if you're willing to dig through the soil and sedimentary rocks at the surface. Granite comes from magma that was trapped deep in the continental crust, and probably took a very long time to cool down enough to crystallize into solid rock. This allows the minerals which form granite plenty of time to grow, and results in a coarse-textured rock in which individual mineral grains are easily visible.



**Basalt** is produced by oceanic-origin magmas. The magma from which it cools breaks through the crust of the earth and erupts on the surface. The volcanoes that make basalt are very common, and tend to form in nearly all of the ocean basins. We now believe that these undersea volcanic areas represent huge spreading ridges where the earth's crust is separating. It's a lot like a cut on your arm, which will bleed until a scab forms. Basaltic magma is like the blood of the earth - it's what comes out when the earth's skin is cut the whole way through. As an eruption ends, the basalt "scab" heals the wound in the crust, and the earth adds some new seafloor crust. Because the magma comes out of the earth (and often into water) it cools very quickly, and the minerals have very little opportunity to grow. Basalt is commonly very fine grained, and it is often difficult to see individual minerals without magnification.



Both granite and basalt are silicate rocks, although basalts have much higher amounts of iron and magnesium, giving them a higher specific gravity and a darker color. Weathered basalt takes on a rusty red appearance as the iron minerals oxidize into iron, rust.

**Hydrologically**, granite and basalt are important mainly because they make up so much of the earth's crust. Because granite cools slowly underground, it has very low primary porosity. Basalt's primary porosity depends on how quickly it cools. Basalt develops large pores when bubbling, highly gaseous magma cools very quickly. This type of basalt is referred to as "vesicular" for the large pores formed by cooling gases. The quicker a basalt cools, the higher its primary porosity will be. Both granites and basalts may develop secondary porosity. Seismic activity and physical weathering may induce *fractures* (cracks). These cracks may be widened and deepened by chemical weathering of the minerals in igneous rocks. The final products of the chemical and physical weathering of once solid granite or basalt are clay minerals, aluminosilicate compounds that make up a large part of the clay fraction of surface soils. Granites and basalts that have been extensively fractured may serve as commercially viable aquifers.

Sources:

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# Important Sedimentary Rocks: Shale, Sandstone, Limestone

## Sandstone

**Sandstone** is a sedimentary rock composed mainly of sand-size (0.06 to 2.0 mm) pre-existing mineral or rock grains. The formation of a sandstone involves two principle stages. First, layers of sand accumulate as the result of the deposition of sand by water, as in a river, lake, or sea, or from air, as in a desert. Second, the sand layers become sandstone when the sand grains are cemented by the precipitation of minerals in the water within the pore spaces between sand grains. Sandstones typically have high primary porosity due to the large quartz grains and often incomplete cementing between individual particles.



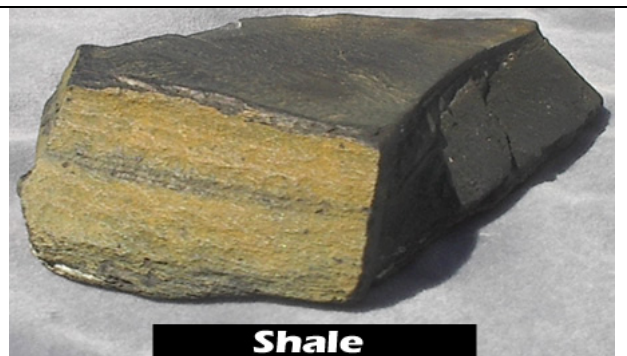
**Hydrologically**, rock formations that are primarily sandstone usually allow percolation of groundwater and are porous enough to store large quantities, making them valuable aquifers. Sandstones have moderate to high hydraulic conductivities. Fine grained aquifers, such as sandstones, are more apt to filter out pollutants from the surface than are rocks with large cracks and crevices due to chemical weathering such as limestones or igneous rocks (granite, basalt) fractured from seismic activity.



Sandstone near Stadtroda, Germany

## Shale

**Shale** is a fine-grained sedimentary rock whose original constituents were clay (mineral particles  $< 0.002$  mm) or mud (a mixture of water and clay). It is characterized by thin, usually parallel layers. The formation of shale is similar to sandstone. Shales contain very small, poorly connected pores.



Shales are typically formed in very slow moving water and are often found in lake and lagoonal deposits, in river deltas, on floodplains, and offshore of beach sands. Fossils, animal tracks/burrows, and even raindrop impact craters are sometimes preserved on shale bedding surfaces.

Since shales are typically formed in areas of low seismic activity and are created from already weathered sediments, they have low primary porosity and are unlikely to develop extensive secondary porosity.



**Hydrologically**, shales are more notable for impeding the flow of groundwater than for storing or transmitting it. They are often designated *aquicludes* or *aquitards* for retarding groundwater flow.

## Limestone

**Limestone** is a sedimentary rock composed largely of the mineral calcite (calcium carbonate:  $\text{CaCO}_3$ ). The primary source of the calcite is marine organisms. These organisms secrete shells that settle out of the water column and are deposited on ocean floors. Secondary calcite can also be the result of the precipitation of calcite dissolved in groundwater. This produces cave formations such as stalagmites and stalactites.



Limestone has low primary porosity. It is, however, dissolved by weak acids such as carbonic acid ( $\text{H}_2\text{O} + \text{CO}_2$ ) from meteorological and biological sources. Such dissolution can produce high secondary porosity. Extensively weathered limestone landscapes that contain caves and sinkholes are referred to as *karst*.

**Hydrologically**, weathered limestones may contain significant amounts of water that can be transmitted at velocities more commonly associated with surface streamflow.

