Competitive Exams: Rocks

What is a Rock?

Everyone knows what a rock is, until you ask what it is exactly. After some thought and discussion, most people will agree that rocks are more or less hard solids, of natural origin, made of minerals. But all of those criteria have exceptions.

Rocks Are Natural

Not entirely. The longer humans stay on this planet, the more that concrete accumulates. Concrete is a mixture of sand and pebbles (aggregate) and a mineral glue (cement) of calcium silicate compounds. It is a synthetic conglomerate, and it acts just like the natural rock, turning up in riverbeds and on beaches. Some of it has entered the rock cycle to be discovered by future geologists. Brick, too, is an artificial rock in this case, an artificial form of massive slate.

Another human product that closely resembles rock is slag, the byproduct of metal smelting. Slag is a complex mixture of oxides that has many uses, such as in road building and concrete aggregate. It too has surely found its way into sedimentary rocks already.

Rocks Are Made of Minerals

Many are not. Minerals are inorganic compounds with chemical formulas and mineral names, like quartz or pyrite (see “What Is a Mineral?”). But what about coal? Coal is made of organic material, not minerals. The various types of stuff in coal are instead called macerals. Similarly, what about coquina, a rock made entirely of seashells? Shells are made of mineral matter, but they aren't minerals any more than teeth are:

Rocks Are Hard

Not necessarily. Some common rocks can be scratched with your fingernail: Shale, soapstone, gypsum rock, peat. Others may be soft in the ground, but they harden once they spend time in the air (and vice versa). And there is an imperceptible gradation between consolidated rocks and unconsolidated sediments. Indeed, geologists name and map many formations that don't consist of rock at all. This is why geologists refer to work with igneous and metamorphic rocks as “hard-rock geology,” opposed to “sedimentary petrology.”

Rocks Are Solid

Most are complete solid. Many rocks include water in their pore spaces. Many geodes hollow objects found in limestone country hold water inside them like coconuts. And the fine lava threads called Pele's hair, and the fine open meshwork of exploded lava called reticulite, are barely solids.

Then there's the matter of temperature. Mercury is a liquid metal at room temperature (and down to 40 below zero), and petroleum is a fluid unless it's asphalt erupted into cold ocean water. And good old ice meets all the criteria of rockhood too, in permafrost and in glaciers.

Rocks like these are not controversial, but they have their own category: Biogenic rocks. Perhaps concrete and slag could be added to that category too. Concrete would fit in with the others, being essentially sedimentary, but slag would probably be a biogenic igneous rock.

Finally we have the exception of obsidian. Obsidian is a rock glass, cooled so quickly that none of it has gathered into crystals. It is an undifferentiated mass of geological material, rather like slag but not as colorful. While obsidian has no minerals in it per se, it is unquestionably a rock.

Types of Rocks

- Igneous: A tough, frozen melt with little texture or layering; mostly black, white and/or gray minerals; may look like lava.
- Sedimentary: Hardened sediment with layers (strata) of sandy or clayey stone; mostly brown to gray; may have fossils and water or wind marks.
- Metamorphic: Tough rock with layers (foliation) of light and dark minerals, often curved; various colors; often glittery from mica.

Size and Hrdness

Grain Size: “Coarse” grains are visible to the naked eye (greater than about 0.1 millimeter), and the minerals can usually be identified using a magnifier; “fine” grains are smaller and usually cannot be identified with a magnifier.

Hardness: Hardness (as measured with the Mohs scale) actually refers to minerals rather than rocks, so a rock may be crumbly yet consist of hard minerals. But in simple terms, “hard” rock scratches glass and steel, usually signifying the minerals quartz or feldspar (Mohs hardness 6 – 7 and up); “soft” rock does not scratch a steel knife but scratches fingernails (Mohs 3 – 5.5); “very soft” rock does not scratch fingernails (Mohs 1 – 2). Igneous rocks are usually hard.

Origin of Igneous Rocks

“Igneous” comes from the Latin for fire, and all igneous rocks began as hot, fluid material. This material may have been lava erupted at the Earth's surface, or magma (unerupted lava) at shallow depths, or magma in deep bodies (plutons). Rock formed of lava is called extrusive, rock from shallow magma is called intrusive and rock from deep magma is called plutonic.

Igneous rocks form in three main places: Where lithospheric plates pull apart at mid-ocean ridges, where plates come together at subduction zones and where continental crust is pushed together, making it thicker and allowing it to heat to melting.

People commonly think of lava and magma as a liquid, like molten metal, but geologists find that magma is usually a mush. a liquid carrying a load of mineral crystals. Magma crystallizes

into a collection of minerals, and some crystallize sooner than others. Not just that, but when they crystallize, they leave the remaining liquid with a changed chemical composition. Thus a body of magma, as it cools, evolves, and as it moves through the crust, interacting with other rocks, it evolves further. This makes igneous petrology a very complex field, and this article is only the barest outline.

Igneous Rock Textures

The three types of igneous rocks apart by their texture, starting with the size of the mineral grains. Extrusive rocks cool quickly (over periods of seconds to months) and have invisible or very small grains. Intrusive rocks cool more slowly (over thousands of years) and have small to medium-sized grains. Plutonic rocks cool over millions of years, deep underground, and can have grains as large as pebbles. Even a meter across. Because they solidified from a fluid state, igneous rocks tend to have a uniform texture, without layers, and the mineral grains are packed together tightly. Think of the texture of a fruitcake, or the pattern of bubbles in a piece of bread, as similar examples.

In many igneous rocks, large mineral crystals “float” in a fine-grained groundmass. The large grains are called phenocrysts, and a rock with phenocrysts is called a porphyry; that is, it has a porphyritic texture. Phenocrysts are minerals that solidified earlier than the rest of the rock, and they are important clues to the rock's history. Some extrusive rocks have distinctive textures. Obsidian, formed when lava cools very quickly, has a glassy texture. Pumice and scoria are volcanic froth, puffed up by millions of gas bubbles. Tuff is a rock made entirely of volcanic ash, fallen from the air or avalanched down a volcano's sides. And pillow lava is a lumpy formation created by extruding lava underwater.

Basalt, Granite and Other Igneous Rock Types

The main minerals in igneous rocks are hard, primary ones: Feldspar, quartz, amphiboles and pyroxenes (called “dark minerals” by geologists), and olivine along with the softer mineral mica.

The two best-known igneous rock types are basalt and granite, which differ in composition. Basalt is the dark, fine-grained stuff of many lava flows and magma intrusions. Its dark minerals are rich in magnesium (Mg) and iron (Fe), hence basalt is called a mafic rock. So basalt is mafic and either extrusive or intrusive. Granite is the light, coarse-grained rock formed at depth and exposed after deep erosion. It is rich in feldspar and quartz (silica) and hence is called a felsic rock. So granite is felsic and plutonic.

These two categories cover the great majority of igneous rocks. Ordinary people, even ordinary geologists, use the names freely (Stone dealers call any plutonic rock at all “granite.”). But igneous petrologists use many more names. They generally talk about basaltic and granitic rocks among themselves and out in the field, because it takes lab work to determine an exact rock type according to the official classifications. True granite and true basalt are narrow subsets of these categories.

But a few of the less common igneous rock types can be recognized by non-specialists. For instance a dark-colored plutonic mafic rock, the deep version of basalt, is called gabbro. A light-colored intrusive or extrusive felsic rock, the shallow version of granite, is called felsite or rhyolite. And there is a suite of ultramafic rocks with even more dark minerals and even less silica than basalt.

Where Igneous Rocks Are Found

The deep sea floor (the oceanic crust) is made of basaltic rocks, with ultramafic rocks underneath. Basalts are also erupted above the Earth's great subduction zones, either in volcanic island arcs or along the edges of continents. However, continental magmas tend to be less basaltic and more granitic.

The continents are the exclusive home of granitic rocks. Nearly everywhere on the continents, no matter what rocks are on the surface, you can drill down and reach granite eventually. In general, granitic rocks are less dense than basaltic rocks, and thus the continents actually float higher than the oceanic crust on top of the ultramafic rocks of the Earth's mantle. The behavior and histories of granitic rock bodies are among geology's deepest and most intricate mysteries.