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Physical and Historical Geology

Lec. 5: Texture of Igneous Rocks

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Texture of Igneous Rocks:

Igneous Textures is used to describe the size, shape, and arrangement of its mineral crystals (Fig.).

Texture is an important property because it is refer to the environment in which the rock formed. This fact allows geologists to the origin of rock.

Three Factors Affecting Crystal Size and the textures of igneous rocks: (1) the rate of cooling of molten rock; (2) the amount of silica present; and (3) the amount of dissolved gases in the magma. Among these, the rate of cooling tends to be the dominant factor. A very large magma body located many kilometers beneath Earth's surface will cool over 10s- 100s thousands of years. **Slow cooling** permits elements to migrate freely to join crystalline structures. Consequently, slow cooling help to grow large crystals. **Rapid cooling** in a thin lava flow—the elements quickly lose their mobility and readily combine to form crystals. The result is a solid mass of tiny crystals. When molten material is cooling quickly, there may not have enough time for the elements to arrange into crystal system. Rocks that consist of unordered elements that are "frozen" randomly in place are referred to glass.

Types of Texture of Igneous Rocks:

Slow cooling promotes the growth of large crystals, whereas rapid cooling tends to generate small crystals.

1. APHANITIC (FINE-GRAINED) TEXTURE: Igneous rocks that form at the surface, or as small intrusive masses within the upper crust where cooling is

relatively rapid, exhibit a fine-grained texture, also termed an aphanitic texture. The crystals that make up aphanitic rocks are so small that individual minerals can only be distinguished with the aid of a polarizing microscope or other techniques (Fig. 3.5).

Therefore, we commonly characterize fine-grained rocks as being light, intermediate, or dark in color. Using this system of grouping, light- colored aphanitic rocks are those containing primarily light-colored nonferromagnesian silicate minerals. Common features of extrusive rocks are the voids left by gas bubbles. These nearly spherical voids are called vesicles, and the texture of rocks called a **vesicular texture**. Rocks that exhibit a vesicular texture usually form in the upper zone of a lava flow, where cooling occurs rapidly (Fig. 3.6).

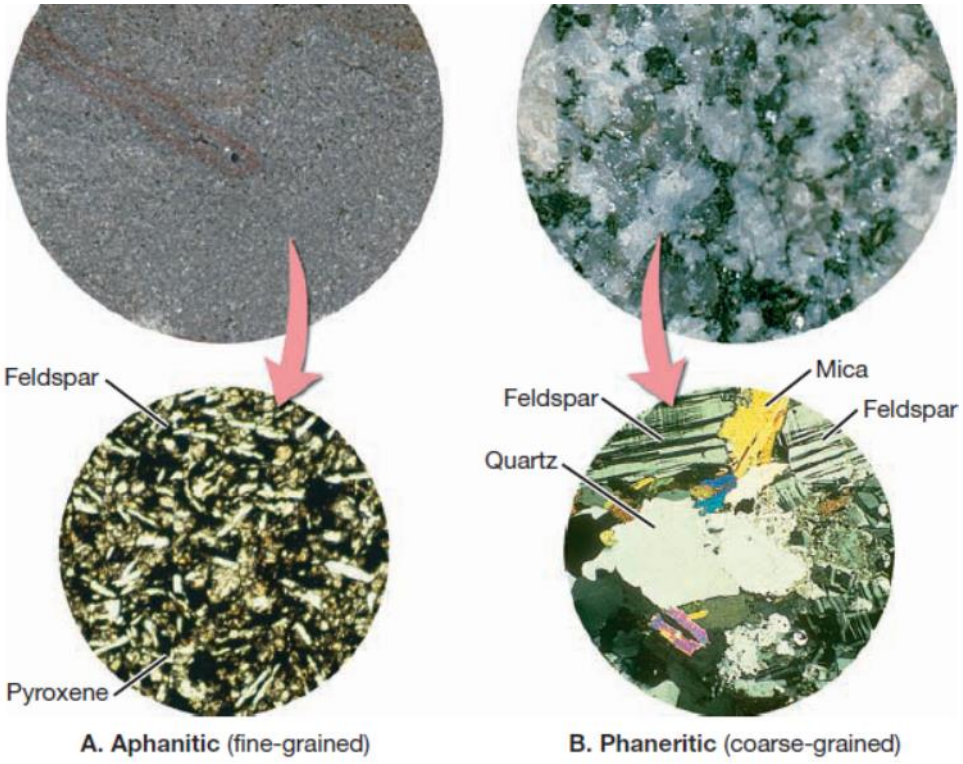


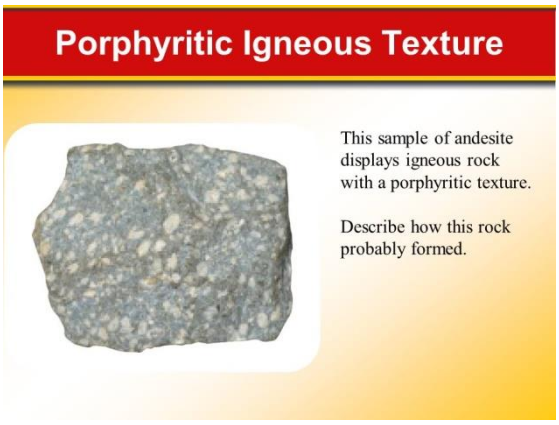
Fig. 3.5 Comparison of aphanitic (fine-grained) and phaneritic (coarse-grained) igneous rock textures. The smaller images were generated using a polarizing microscope. A. Basalt is a fine-grained igneous rock composed mainly of plagioclase feldspar and pyroxene. B. Granite is a coarse-grained igneous rock composed mainly of quartz, potassium feldspar, and lesser amounts of mica and dark minerals. (Photos courtesy of E. J. Tarbuck).

2.PHANERITIC (COARSE-GRAINED) TEXTURE: When large masses of magma slowly crystallize at great depth, they form igneous rocks of coarse-grained texture (phaneritic texture). Coarse-grained rocks consist of a mass of crystals that are roughly equal in size and large enough so that the minerals can be

identified without a microscope (Fig. 3.5B). Geologists often use a small magnifying lens to identifying minerals in a phaneritic rock.

3. PORPHYRITIC TEXTURE: A large mass of magma may require 10s- 100s of thousands of years to solidify. Because different minerals crystallize under different environmental conditions (temperatures and pressure), it is possible for crystals of one mineral to have different sizes.

Molten rock may be containing some large crystals move to the surface—the remaining liquid portion of the lava would cool more quickly. The resulting rock, which has large crystals embedded in a matrix of smaller crystals, is said to have a porphyritic texture (see Fig. 3.4D). The large crystals called phenocrysts, whereas the matrix of smaller crystals is called groundmass.

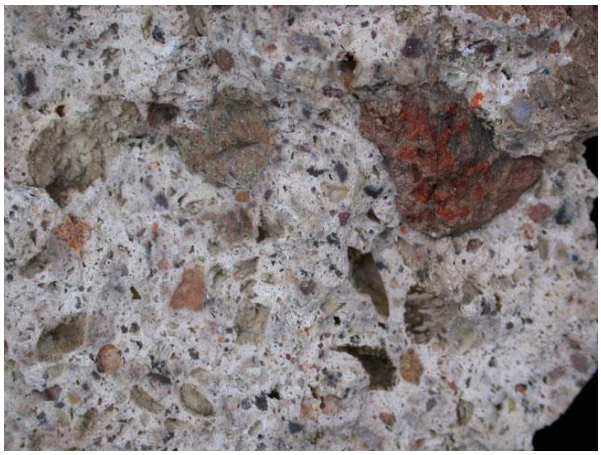


4. GLASSY TEXTURE: During some volcanic eruptions, molten rock is ejected into the atmosphere, where it is cool quickly. Rapid cooling of this type may generate rocks having a glassy texture. Glass results when elements are "frozen in place" before they are crystalline. Obsidian, a common type of natural glass, is similar in appearance to a dark glass (Fig. 3.7).

Because of its excellent conchodial fracture and ability to get a sharp, hard edge, obsidian was used as arrowheads and cutting tools (see Fig. 3.7).

Fig. 3.7 Obsidian, a natural glass, was used by Native Americans for making arrowheads and cutting tools. (Photo by E. J. Tarbuck; Inset photo by Jeffrey Scovil).

5. PYROCLASTIC (FRAGMENTAL) TEXTURE. Group of igneous rocks is formed from the consolidation of individual rock fragments that are ejected during a volcanic eruption. The ejected particles might be very fine ash, molten drops, or large angular fragments cutting from the walls during the eruption (Fig. 3.9).



Pyroclastic (fragmental) Texture

6. PEGMATITIC TEXTURE. These rocks are composed of crystals larger than a centimeter in diameter. Most pegmatites occur as small masses or thin veins situated around the margins of large intrusive bodies. Pegmatites form late in the crystallization of magma. Because free elements migration in the magma the crystals become large. The composition of most pegmatites is similar to that of granite. Thus, pegmatites contain large crystals of quartz, feldspar, and mica. However, some contain significant quantities of valuable elements (gold, tungsten, and beryllium.

Pegmatite Texture

Naming of Igneous Rocks:

Igneous rocks are most often classified, or grouped, on the basis of their texture and mineral composition (Fig. 3.10).

1. Felsic (Granitic) Igneous Rocks. Polished granite are commonly used for building stones.

Granite is a coarse-grained rock composed of about 25 percent quartz and roughly 65 percent feldspar. Quartz crystals, which are roughly spherical in shape, are often glassy and clear to light gray in color. By contrast, feldspar crystals are generally white to gray or pink in color. Other minor constituents of granite include muscovite and biotite and amphibole. Although the dark components generally make up less than 10 percent of most granites, dark minerals appear to be more prominent than their percentage would indicate.

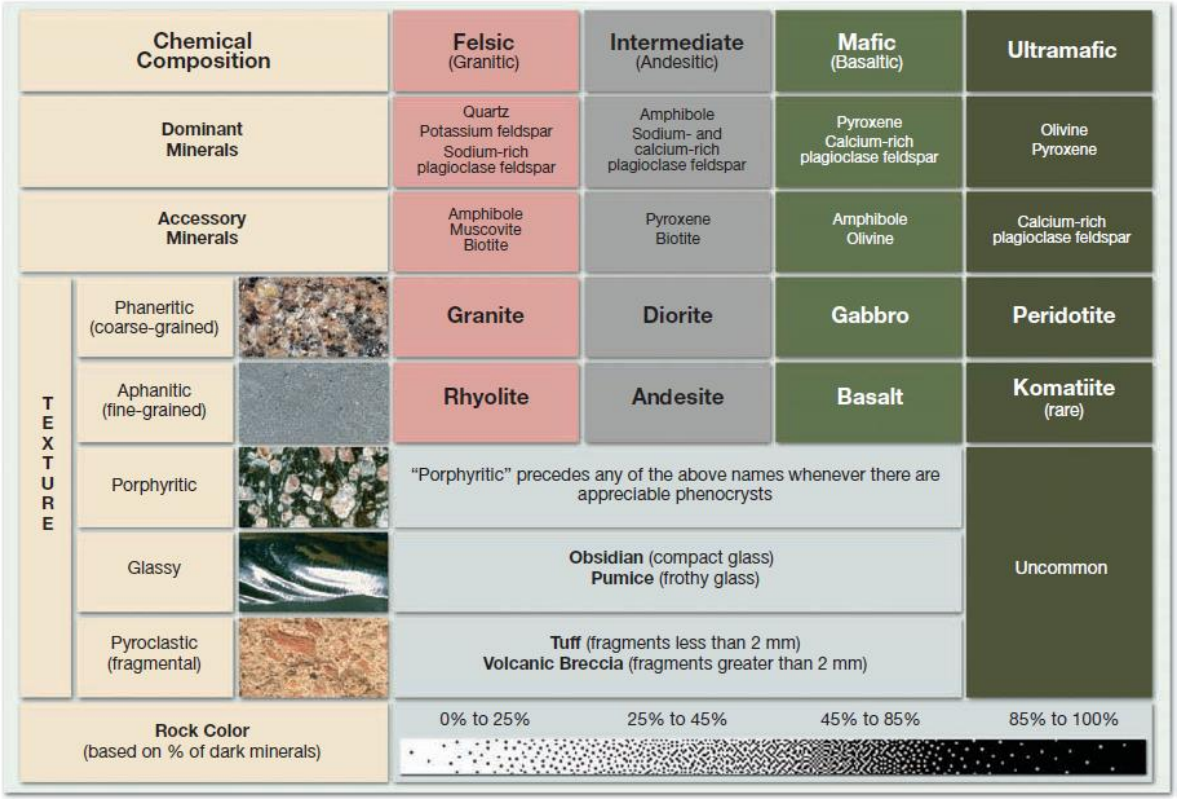


Fig. 3.10 Classification of major igneous rocks based on mineral composition and texture. Coarse-grained rocks are plutonic, solidifying deep underground. Fine-grained rocks are volcanic, or solidify as shallow, thin plutons. Ultramafic rocks are dark, dense rocks,composed almost entirely of minerals containing iron and magnesium. Although relatively rare at or near Earth's surface, these rocks are major constituents of the upper mantle.

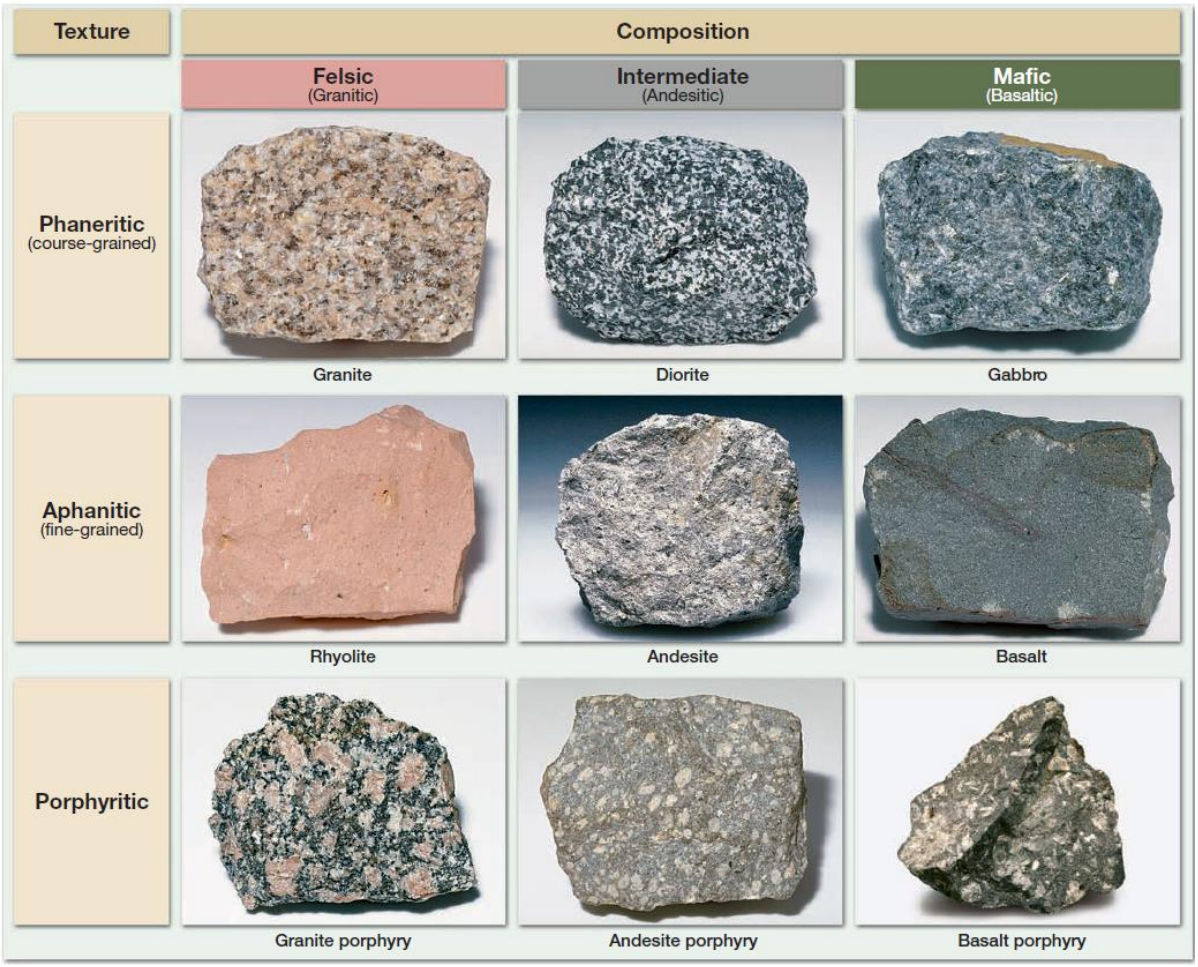


Fig. 3.11 Common igneous rocks. (Photos by E. J. Tarbuck).

RHYOLITE. Rhyolite is the extrusive equivalent of granite and, like granite, is composed essentially of the light-colored silicates (see Figure 3.11). This fact accounts for its color, which is usually orange to pink or occasionally very light gray. Rhyolite is fine-grained and frequently contains glass fragments and voids, indicating rapid cooling in a surface environment.

OBSIDIAN. Obsidian is a dark-colored glassy rock that usually forms when silica rich lava is cool quickly (Fig 3.13). the ioelements in glass are unordered. Consequently, glassy rocks such as obsidian are not composed of minerals in the same sense as most other rocks.

PUMICE. Pumice is a volcanic rock with a glassy texture that forms when large amounts of gas escape through silica-rich lava (Fig. 3.14). In some samples, the voids are quite noticeable. Because of the large percentage of voids, many samples of pumice will float when placed in water. Moreover, pumice and obsidian can often be found in the same rock mass, as alternating layers.

Fig. 3.14 Pumice, a glassy rock, is very lightweight because it contains numerous vesicles. (Inset photo by Chip Clark)

2. Intermediate (Andesitic) Igneous Rocks:

ANDESITE. Andesite is a medium-gray, fine-grained rock of volcanic origin. Its name comes from South America's Andes Mountains, where numerous volcanoes are composed of this rock type.

DIORITE. Diorite is the plutonic equivalent of andesite. It is a phaneritic rock that looks somewhat similar to gray granite. However, it can be distinguished from granite by the absence of visible quartz crystals and because it contains a higher percentage of dark silicate minerals. (see Fig. 3.11).

3. Mafic (Basaltic) Igneous Rocks:

BASALT. Basalt is a very dark green to black, aphanitic rock composed primarily of pyroxene and calcium-rich plagioclase feldspar, with lesser amounts of olivine and amphibole (Fig. 3.11). Basalt is the most common extrusive igneous rock. Many volcanic islands, such as the Hawaiian Islands and Iceland, are composed mainly of basalt.

GABBRO. Gabbro is the intrusive equivalent of basalt (see Figure 3.11). Like basalt, it tends to be dark green to black in color and composed primarily of pyroxene and calcium-rich plagioclase feldspar. Although gabbro is uncommon in the continental crust, it makes up a significant percentage of oceanic crust.

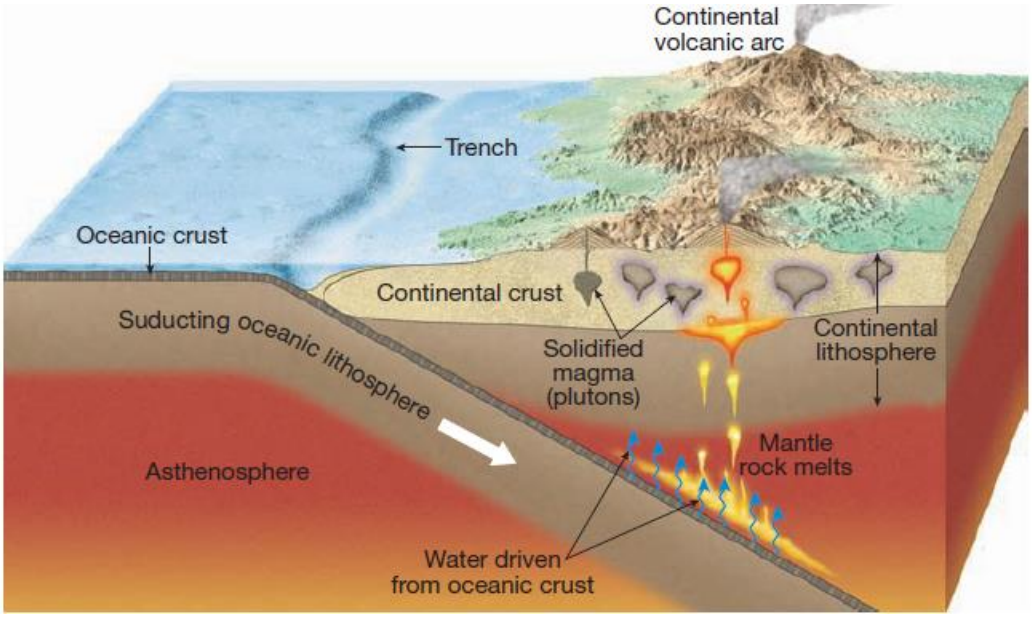


Fig. 3.19 As an oceanic plate descends into the mantle, water and other volatiles are driven from the subducting crustal rocks into the mantle above. These volatiles lower the melting temperature of hot mantle rock sufficiently to trigger melting.