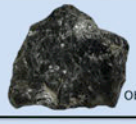
4.3 MAKING IGNEOUS ROCK INFERENCES

How do geologists identify igneous rocks?

IDENTIFY IGNEOUS ROCK TEXTURES

The cooling of magma and lava results in the crystallization of minerals and the formation of an igneous rock. Magma that cools and crystallizes below the surface forms intrusive (plutonic) rocks. These rocks are observed at the surface after periods of uplift and the erosion of overlying rocks expose them. At the surface lava solidifies and volcanic debris (pyroclastic material) forms extrusive (volcanic) rocks. Where these rocks cool and solidify results in textures that are specific to their formation. Textures are based on the overall appearance of the rock including size, shape, and the arrangement of mineral crystals. Intrusive phaneritic (coarse–grained) igneous rocks result in fewer but larger visible mineral crystals due to the slower rates of cooling. Extrusive aphanitic (fine-grained) rocks have many small microscopic crystals as a result of the rapid cooling of the lava at the surface. Some igneous rocks undergo a complex cooling history as a result of the movement of magma to a different environment from which the initial cooling began resulting in large crystals (phenocrysts) embedded in a fine grained small crystal matrix (groundmass) resulting in a porphyritic texture.

Igneous Rock	Texture	Definition	How it's Formed
 Pegmatitic Granite	Pegmatitic	Crystals usually larger than 2.5 cm in size (1 inch)	Intrusive rock, formed as magma cools extremely slow to allow the growth of extra large crystals
 Granite Diorite Gabbro	Phaneritic	Coarse grained igneous rocks. Individual crystals are large enough to see	Intrusive rock, formed as magma cools slowly to allow for the growth of large crystals that can be seen by the human eye
 Rhyolite Basalt	Aphanitic	Fine grained igneous rocks. Individual crystals are not large enough to see by the unaided eye	Extrusive rock, formed as magma cools rapidly at or near the Earth's surface
 Porphyritic Andesite	Porphyritic	Composed of both coarse and fine grained igneous crystals	Formed as magma cooled at two separate temperatures or environments. The earlier crystals formed as magma cooled slowly, while rapid cooling caused the crystallization of the remainder of the magma to solidy into a fine grained matrix
 Obsidian	Glassy	Glassy apearance due to no crystal formation	Formed during some volcanic erruptions when the magma is cooled so rapidly that no crystallization occurs
 Pumice Scoria	Vesicular	Low density, composed of many cavities in the rock	Formed as gas bubbles trapped in the rock escape during the rapid cooling of gas-rich magma. The magma cools so quickly that the atoms cannot arrange themselves into a crystalline structure
 Volcanic Breccia	Pyroclastic	Composed of a mixture of angular rock fragments, pumice, and volcanic ash	Occurs when explosive eruptions blast magma into the air, resulting in fragmented material to fall to the ground as a volcanic bomb, lapillus, or ash

Refer to rock samples 1B, 2B, 7B, 8B, 9B, 10B, 11B, and 12B and match the sample number with the correct textures you described above. (*Hint: there are no repeating textures.*)

Pegmatitic	Phaneritic	Aphanitic	Porphyritic	Glassy	Vesicular (meringue)	Vesicular (bubbly)	Pyroclastic

REFLECTION

Explain the processes responsible for the formation of the voids that are visible in igneous rock you identified as having a vesicular texture.

4.3 MAKING IGNEOUS ROCK INFERENCES CONTINUED

INFER THE ORIGIN

When igneous rocks cool and crystallize they either do so as magma underground (intrusive), as lava on the earth's surface (extrusive), or some experience complex cooling histories which result in what appears to have textures representative of both intrusive/extrusive origins. The rates of cooling are directly related to crystal grain size, igneous rocks that cool quickly results in mineral crystals too small to identify with the naked eye. Igneous rocks that form from slow cooling magma results in large visible mineral crystals that are identifiable with the naked eye.

Refer to rock samples 1B, 2B, 7B, 8B, 9B, 10B, 11B, and 12B and infer their possible origin as either **intrusive**, **extrusive** or **both** (complex cooling history that shows mineral grain sizes representative of both intrusive and extrusive origins).

Texture	**Origin**
Pegmatitic	
Phaneritic	
Porphyritic	
Aphanitic	
Glassy	
Vesicular (meringue)	
Vesicular (bubbly)	
Pyroclastic	

REFLECTION

Based on the observations of samples 1B, 2B, 7B, 8B, 9B, 10B, 11B, and 12B, describe the changes in grain size you see from samples that are intrusive versus those that are extrusive in origin.

4.3 MAKING IGNEOUS ROCK INFERENCES CONTINUED

INFER THE RATES OF COOLING

The size of mineral crystals in an igneous rock generally indicates the rate at which the lava or magma cooled to form a rock. We can use the textures to infer the rate of cooling that the igneous rock went through during their formation.

Infer the rates of cooling as **fast**, **slow**, or a **variable** cooling rate (fast/slow) based on the rock textures and origins of the rocks. Complete the table below using rock samples 1B, 2B, 7B, 8B, 9B, 10B, 11B, and 12B:

Texture	Rate of Cooling
Pegmatitic	
Phaneritic	
Porphyritic	
Aphanitic	
Glassy	
Vesicular (meringue)	
Vesicular (bubbly)	
Pyroclastic	

REFLECTION

1. Based on your observations of mineral size in this lesson, explain how both slow and rapid cooling create various igneous rock textures.
2. How can exposure to the atmosphere impact the rate of cooling in extrusive rocks compared to intrusive rocks?