Volcanic rocks

EPSC 240, Geology in the Field

Nov 5, 2018

Key concepts for Week 10:

Classification of igneous rocks

Igneous rocks are classified by composition and texture. The broadest classification is the division between *felsic* and *mafic* rocks (see Week 7 notes if you have forgotten). The rocks are further divided into *intrusive* (rocks formed from magma cooling underground) and *extrusive* (rocks formed when magma erupted through the earth's surface and cooled in air or water). Intrusive rocks are usually coarser grained than extrusive rocks because they retain more volatiles and cool more slowly (but there are exceptions!). Thin dykes cooled quickly near the surface are fine-grained and have textures more similar to extrusive rocks even though they are technically intrusive (e.g., basalt dykes on Mt Royal).

	Mineralogy	**Extrusive**	**Intrusive**
Felsic	Feldspar dominated, contains quartz, usually <10% mafic minerals. In bulk rock chemistry, >65% SiO_2.	Rhyolite, dacite, tuff, obsidian	Granite, granodiorite, pegmatite
Intermediate	Abundant feldspars, minor or no quartz. Increased abundance of mafic minerals (pyroxenes, hornblende, biotite). Bulk chemistry is 55-65% SiO_2.	Andesite, tuff	Diorite
Mafic	No alkali feldspar, lots of plagioclase. Up to 50% or more mafic minerals (pyroxenes, amphiboles, biotite).	Basalt	Diabase, gabbro
Ultramafic	Mostly pyroxene and olivine. <45% SiO_2 by weight.	Komatiite	Peridotite

Texture of volcanic/extrusive rocks

Volcanic rocks have some distinctive textural characteristics that distinguish them from their intrusive counterparts. The matrix (often called *groundmass*) of the rocks is usually very fine-grained, to the point of grains being invisible even with a hand lens (*aphanitic*). The matrix may be massive (homogenous) or may be banded, particularly if the lava was flowing. *Obsidian*, a volcanic glass of rhyolite composition, is the most well-known example (*and handy for dispatching White Walkers, Slayer!*).

The rapid cooling (*quenching*) of lava also releases volatiles (water, CO_2) that were dissolved in the melt, so it is common to preserve bubbles (*vesicles*) in the matrix if quenching trapped these bubbles before they could reach the surface of the lava and escape to the atmosphere. Late vapours escaping the quenching rock, or subsequent water flowing through, sometimes deposits crystals inside the vesicles, making spherical or ellipsoidal pods of quartz or calcite called *amygdales*. Rocks with a large proportion of vesicles have a hollow, spongy texture – these are called *pumice* (so many trapped air bubbles it floats on water!) or *scoria* (still very low density for a rock, but sinks in water).

Larger crystals are often found floating in the matrix. In many cases, these are crystals that formed in the magma chamber prior to eruption, so are older than the matrix of the rock. They are called *phenocrysts*. Both feldspars, hornblende, biotite, sometimes even quartz form phenocrysts. A rock containing phenocrysts in a fine groundmass is a *porphyry* or has *porphyritic* texture.

Diatreme is a type of eruptive feature (a type of volcano) that only erupts once or for a very short period of time, and is very explosive. Often explosions are triggered by rising magma encountering groundwater and generating huge volume expansions of steam. This causes explosion and fragmentation of the wallrock and of the magma itself, creating hot steam-driven clouds of molten ash particles. When they fall back to earth, these particles can fuse together to form very hard and porous, spongy rock (*welded*), or if they cool before falling, may fall as unconsolidated layers of ash (*poorly welded*). Volcanic rocks with explosion textures are sometimes referred to as *pyroclastic* rocks, and *volcanic breccias* if they contain large angular fragments. Clasts or fragments of foreign rock (derived from wallrock) are called *xenoliths*. Clasts or fragments of the igneous rock itself, presumably early-crystallizing components of the same magma, are called *autoliths*.