

## EXTRUSIVE IGNEOUS ROCKS, PART 1

### BASALTS, DIABASES, ANDESITES, DACITES and RELATED ROCKS

The rocks in this set are all extrusive (erupted at the earth's surface) or hypabyssal (formed near the earth's surface). They correspond fields in Figure 2-3 in Winter (page 22). More information about these rocks is included in Chapter 6 and 7 of Moorhouse (on the bookshelf in PS 355 - DO NOT REMOVE).

**Basalt** - Generally extrusive igneous, although it may occur in dikes or sills. The major minerals are calcic plagioclase and a mafic mineral, usually clinopyroxene or olivine. Quartz and/or olivine may be present as accessories. The rock is fine-grained to Aphanetic. The plagioclase is usually labradorite and is often lath-shaped. The plagioclase generally shows extensive twinning. Basalt is the extrusive equivalent of gabbro. Many varieties exist. These may be based on texture, such as porphyritic, glass, or glomeroporphyritic. Other varieties are structural, such as scoria, aa, pahoehoe, vesicular, cellular, or columnar. Still other varieties may be mineralogical, based on content of orthopyroxene, olivine, biotite, hornblende, or various other minerals. Usually dark-gray in color, basalt often has a vesicular texture, preserving vestiges of bubbles produced by expanding steam as lava cools and solidifies. Also characteristic are pillow-shaped masses caused by rapid cooling of lava erupted on the sea floor. In addition to lava flows, basalt is also found in the form of dikes and sills. Columnar jointing, as exhibited by Devils Tower in Wyoming and the Giant's Causeway in Ireland, is a common feature of these shallow intrusive bodies. The name is from the Latin *basaltis*, meaning dark marble and possibly related to Egyptian, *bechen*, hard dark rock, or Hebrew, *barzel*, meaning iron.

**Diabase** - Generally hypabyssal, occurring in dikes or sills. Usage of this name varies from country to country. This description applies to the United States only. Diabase has the same general mineralogical composition as basalt, but it is fine to medium (occasionally coarse) grained. The pyroxene in both diabase and basalt is usually augite, pigeonite, or hypersthene. Some of the pyroxene grains are zoned, with the outer part (Fe rich) being darker. The texture is ophitic. Olivine and magnetite are sometimes present. The name is from the Greek *diabasis*, meaning crossing over. This may refer to the discordant nature of dikes, or to the grain size, intermediate between basalt and gabbro.

**Andesite** - Usually extrusive igneous, occasionally hypabyssal. Aphanetic, microcrystalline to glassy textures are common. Often porphyritic, with either feldspar or mafic phenocrysts. Essential minerals: sodic plagioclase, typically oligoclase or andesine, and one or more mafic minerals, hornblende, biotite, clinopyroxene (diopside or augite), and/or hypersthene. Zoning, particularly oscillatory zoning, is very common. Andesite is the extrusive equivalent of diorite. Rocks are commonly brown or reddish, and may be gray or greenish, but not black. The name is for the type location, the Andes mountains of South America. The Andes are stratovolcanoes formed above a subduction zone. Other occurrences include the Aleutian islands, the Cascades mountains, Japan, and Siberia.

**Dacite** - Extrusive igneous. The mineralogy is the same as the andesites, except that quartz occurs as an essential mineral, often as phenocrysts. The plagioclase is more sodic than in andesite. Extrusive equivalent of granodiorite. Mafic minerals are minor, generally biotite, hornblende, or pyroxene. The name is from the Roman name for Siebenbürgen (Transylvania), *Dacia*.

## **TERMS:**

The following list of terms are associated with rocks from this laboratory assignment. You will probably be familiar with some of these terms already. You should learn any terms that you are not familiar with as they may be tested on lab quizzes or the midterm.

- Aa** - A type of viscous lava that moves slowly and is covered with tough, cindery rock called clinker. The term is Hawaiian.
- Amygdaloidal** - Vesicular rock in which the vesicles are filled with secondary minerals such as quartz, calcite, chalcedony, zeolites, etc.
- Aphanetic** - Texture in which most of the grains are not visible to the unaided eye. From the Greek *aphanes*, not showing.
- Ash** - Volcanic ash is fine pyroclastic material (less than 2.0 mm diameter). The term generally refers to unconsolidated material, but is sometimes usually for its consolidated counterpart, more correctly called tuff.
- Block** - In the IUGS (International Union of Geologic Sciences, Subcommittee on the systematics of Igneous Rocks) classification, a block is a pyroclast with a mean diameter exceeding 64 mm, whose commonly angular to subangular state indicates that during formation it was in the solid state. (Also called volcanic block).
- Bomb** - Formed by lava that is ejected while still in a viscous state. It is rounded while in flight. The size requirements are not precisely defined, being either a minimum of 32 or 64 mm. (IUGS size requirement is a pyroclast with mean diameter exceeding 64 mm, wholly or partly molten during its formation and subsequent transport. Most bombs are basaltic. Also called a volcanic bomb).

- Breccia -** The general meaning of this word is a rock consisting of consolidated angular clastic fragments of any kind of mineral or rock, whose size is greater than sand (either 2 or 4 mm). From the Italian *breccia*, fragments of stone. This word is used in many different ways and should be accompanied by a modifying adjective. A pyroclastic breccia consists chiefly of angular to subangular blocks (not bombs) of more than 32 mm in diameter, lying in a matrix that is usually tuffaceous but may be more vesicular and pumiceous. The IUGS definition differs slightly: pyroclastic rock whose average size exceeds 64 mm and in which angular pyroclasts predominate. A tuff breccia is an intermediate rock between a tuff and a pyroclastic breccia, and is a mixture of ash and blocks.
- Cellular -** A rock texture characterized by openings or cavities, which may or may not be connected. No specific size limitations, although openings are usually larger than pores and smaller than caverns. The term vesicular is usually preferred when describing igneous rocks.
- Dike -** A wall-like intrusion of igneous rock, cutting across other strata of preexisting rocks, originally formed by a flow of molten rock into a fissure in which it cooled and solidified. A dike may range from a few centimeters to thousands of meters thick and from a few meters to many kilometers long. Frequently the rock material of the dike is harder than the surrounding rocks, and as a result it may be left standing by itself after the neighboring rock has weathered away. Similar intrusions of igneous rock that lie parallel to the enclosing layers are known as sills.
- Epiclastic -** A rock formed at the earth's surface by consolidation of fragments of preexisting rocks.
- Extrusive -** An igneous rock that has been erupted onto the surface of the earth. Extrusive rocks include lava flows and pyroclastic rocks.
- Glomeroporphyritic -** A porphyritic igneous rock containing clusters of equant crystals of the same mineral.
- Granophyre -** An irregular microscopic intergrowth of quartz and alkali feldspar.  
**Hypabyssal -** An igneous intrusion, or the rock of that intrusion, whose depth is intermediate between abyssal or plutonic and the surface.
- Intrusive -** An adjective which refers to the process of emplacement of magma in pre-existing rock, and the rock so emplaced.

- Lahar -** A mudflow consisting chiefly of volcanoclastic materials on the flank of a volcano. The debris in the flow contains pyroclasts, blocks from primary lava flows, and epiclastic material. A disastrous mudflow triggered by an eruption that melted ice and snow on Colombia's Nevada del Ruiz volcano in 1985 claimed more than 25,000 lives.
- Lava -** Molten rock that has flowed out to the surface of the earth through cracks or fissures. "Lava" applies both to the rock in a molten state and to the solid rock formed after cooling. The chief varieties of ordinary lava rocks are rhyolite, basalt, and obsidian. Fresh lava ranges from 700° - 1,200° C in temperature and glows red hot to white hot as it flows. Enormous quantities of lava, enough to flood the whole countryside, may be produced by the eruption of a major volcano. During the eruption of the volcano Mauna Loa in Hawaii in 1887, about 2.3 million metric tons of lava per hour poured out for more than six days. Some lavas are liquid enough to flow downhill at 35 miles (55 kilometers) per hour. Others move at the rate of only inches per day. The speed of the flow depends on the temperature and composition.
- Magma -** Molten, or hot liquefied, rock located deep below the Earth's surface. When it flows out of the volcano or crack, usually mixed with steam and gas, it is called lava. Magma may or may not contain suspended solid (such as crystals and rock fragments) and/or gas phases.
- Ophitic -** A texture in which lath-shaped plagioclase grains are completely enclosed within a pyroxene grain. If the plagioclase is partially surrounded by pyroxene, the texture is subophitic. The term generally is applied to diabase. It is sometimes understood that ophitic refers to rocks in which the augite content exceeds the plagioclase content. The term diabassic may be applied to rocks in which plagioclase predominates.
- Pahoehoe -** A thick flow that contains a great deal of gas and is erupted at about 1,100° C. A flexible, glassy surficial skin forms, insulating the lava that lies beneath and keeping it molten for weeks or even years. Surface is typically smooth, billowy, or ropy. Varieties include corded, elephant-hide, entrail, festooned, filamented, sharkskin, shelly and slab pahoehoe. The term is Hawaiian.
- Phaneritic -** A texture in which most of the crystals are visible to the unaided eye. Subclassifications include:  
Fine - grains less than 1 mm in size  
Medium - grains between 1-5 mm  
Coarse - grains between 5 mm and 3 cm  
Very coarse - grains > 3 cm

- Phenocrysts -** A type of large grain found in igneous rocks. Generally large, conspicuous crystals in porphyritic rocks.
- Pillow (spilite) -** A structure found in certain extrusive igneous rocks which is characterized by discontinuous pillow-shaped masses ranging in size from a few centimeters to a meter or more in the largest dimension. The pillows are close fitting, with the concavities of one matching the convexities of the next. Grain sizes within the pillow usually increase toward the interior. Generally considered to be the result of subaqueous extrusion. Spaces between pillows are not common. When present, spaces are filled with scoriaceous material, with clastic sediments, or with material of the same composition as the pillows. The rock is usually basaltic or andesitic. Spilites are altered basalts which often occur as submarine lava flows exhibiting pillow structures. The feldspar is albitized and accompanied by chlorite, calcite, epidote, chalcedony, prehnite, or other low-temperature hydrous crystallization products.
- Porphyritic -** A texture in which large crystals are distributed in a finer matrix. The matrix may be glassy, microcrystalline, finely crystalline, or coarsely crystalline.
- Porphyry -** A rock with a porphyritic texture. Often preceded by an adjective, commonly a rock name used as an adjective, i.e. andesite porphyry.
- Pumice -** Gases in lava may be released slowly or even trapped as bubbles when the lava hardens. When the bubbles are tiny and closely packed, a lightweight stone called pumice is formed. Any kind of lava may turn into pumice, but most of it develops in rhyolites. Pumice is used commercially for cleaning and polishing wood, metal, and other surfaces. More recently it has found use in precast masonry, poured concrete, insulation, acoustical tile, and plaster. Rhyolite pumices are white. Andesite pumices are usually yellow or brown. Basaltic pumices are black.
- Pyroclast -** In the IUGS classification, an individual crystal, crystal fragment, glass fragment, or rock fragment generated by disruption as a direct result of volcanic action; shapes assumed by disruption or during subsequent transportation must not be altered by later redeposition processes.
- Pyroclastic -** An adjective describing rock material formed by volcanic explosion or aerial expulsion from a volcanic vent; also, pertaining to rock texture of explosive origin.

<b>Reticulite -</b>	Foamlike, brown to black basaltic glass in which the vesicles are enclosed by paper-thin walls. From the Latin <i>reticulum</i> , little net. Also called thread-lace scoria.
<b>Scoriaceous -</b>	The texture of a coarsely vesicular pyroclastic rock. The composition is usually basaltic or andesitic. The texture is coarser than a pumiceous rock. Vesicle walls may be smooth or jagged.
<b>Sill -</b>	A tabular intrusion that parallels the planar structure of the surrounding rock.
<b>Tuff -</b>	A general term for consolidated pyroclastic rock, especially those whose fragments are less than 2 mm across. From the French <i>tuf</i> , from Italian <i>tufo</i> , soft, sandy stone.
<b>Vesicle -</b>	A gas cavity (bubble) in a rock.
<b>Vesicular -</b>	A rock texture, especially of lava, characterized by abundant vesicles formed by the expansion of gases during the fluid stage of a lava.
<b>Welded Tuff -</b>	A glass-rich pyroclastic rock that has been indurated by the welding together of its glass shards under the combined action of the heat retained by particles, the weight of overlying material, and hot gases. It is generally composed of silicic pyroclastics and appears banded or streaky.

**Assignment:**

**Examine any two of rocks number 26, 27, 33, 37, or 38 in thin section (do not examine two of the same type or rock, e.g. 33 and 38). Prepare a labeled sketch of each selected thin section, being sure to label the sketch with magnification and either CN or PP. Identify the major minerals, and write a concise description of the petrography of the rock. A petrographic description includes a description of features seen in hand specimen, including mineral percentages, grain size, percent crystallinity vs. percent glass, and rock texture. This will be handed in at the beginning of the following lab.**

**Examine all of the rocks in hand specimen. The following rocks from Wards North American Rock Set are particularly good type examples. Be prepared for a lab midterm on the rock samples and the terminology in this laboratory after lab 8 is graded and returned.**

Number	Name
26	Dacite
27	Hornblende Andesite
33	Diabase
35	Amygdaloidal basalt
36	Basalt
37	Olivine basalt porphyry
38	Diabase porphyry

The following samples from other sources are also good examples. All are described in detail in the accompanying tables.

323	Andesite Porphyry
325	Diabase

Additional samples of various rocks, illustrating many of the terms described, are also available in the lab, and should be examined.

Brown andesite pyroclastics  
Welded dacite tuff  
Dacite welded tuff, altered  
Andesite welded tuff  
Andesite mudflow (lahar)  
Pahoehoe basalt  
Reticulite basalt  
Cellular basalt  
Spilite pillow basalt

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