GLG 333 -- IGNEOUS TEXTURES AND STRUCTURES

The following is a reorganization and amplification of Blatt, Tracy, and Owens, 2006, pages 29-35. (You may also want to refer to Barker, 1983, pages 106-120; Hyndman, 1985, pages 49-61; or Jackson, 1970, pages 255-273 and 317-323. You will also definitely want to look at MacKenzie et al., 1982, pages 4-73, to see what these igneous textures look like when viewed in thin-section under a petrographic microscope.)

I. SHAPE OF INDIVIDUAL CRYSTALS (indicates sequence of crystallization)

A. **Euhedral**. Crystal completely bounded by its own crystal faces. Indicates early crystallization from the magma, i.e. before enough other crystals were present to cause interference for space.

B. **Anhedral**. Crystal not bounded by any of its own crystal faces; rather, its form is imposed on it by the adjacent crystals. Indicates late crystallization from the magma, i.e. after most of the available space was already occupied by earlier-formed crystals.

C. **Subhedral**. Intermediate between euhedral and anhedral.

II. GENERAL ROCK TEXTURES

A. Based on Degree of Crystallinity

1. **Holohyaline**. Rock composed entirely of glass; no crystals visible even with magnification. Indicates cooling so rapid that no crystal growth could occur, i.e. quenching.

    a. **Obsidian** Massive volcanic glass.

    b. **Pumice** Frothy (micro-vesicular) volcanic glass.

2. **Hypocrystalline** (or **Hyalocrystalline**). Rock composed of both crystals and glass.

    a. **Pitchstone** Volcanic glass with a resinous luster or streaky appearance caused by microscopic crystallites.

    b. **Vitrophyre** Volcanic glass with macroscopic phenocrysts.

    c. **Perlite** Volcanic glass with a cloudy or milky appearance caused by devitrification. Often exfoliates in thin, concentric layers (i.e., onion-skin devitrification to produce "Apache tears")

3. **Holocrystalline**. Rock composed entirely of crystals (which may or may not be visible without magnification). Indicates cooling that was sufficiently slow to allow complete crystallization to occur.

B. Based on Crystal Size (obviously does not apply to holohyaline rocks)

1. **Equigranular**. All of the crystals are approximately the same size. Indicates that the entire rock crystallized under a single set of P-T (depth) conditions.

    a. **Aphanitic**. Uniformly fine-grained texture in which the individual crystals are too small to be seen easily without magnification. Indicates rapid cooling (but not quenching), i.e. volcanic extrusion.

        i. **Microcrystalline**. Individual crystals large enough to be seen easily with a petrographic microscope.

        ii. **Cryptocrystalline**. Individual crystals to small to be seen easily even with a petrographic microscope; but sufficiently crystalline to give a strong x-ray diffraction pattern.

    b. **Phaneritic**. Uniformly coarse-grained texture in which all the individual crystals are easily visible without magnification. Indicates slow cooling, i.e. intrusion.

        i. **Fine phaneritic**. Average crystal size < 1 mm. Indicates shallow intrusive cooling, i.e. hypabyssal intrusion (dikes and sills).

        ii. **Medium phaneritic**. Average crystal size 1-5 mm. The most common texture for common plutonic rocks (i.e. granites).

        iii. **Coarse phaneritic**. Average crystal size 5-10 mm. Indicates deep intrusive cooling, i.e. plutonic intrusion (batholiths).

        iv. **Pegmatitic**. Average crystal size > 10 mm. Indicates intrusive cooling of an abnormally gas-rich, silicic magma.

2. **Porphyritic**. Texture consisting of crystals of two distinctly different sizes. Indicates two distinctly different modes (episodes) of cooling. The larger crystals (usually of at most two or three different minerals) are called **phenocrysts** and are usually nearly euhedral. The material surrounding the phenocrysts is called the **matrix** or **groundmass**.

    a. **Porphyritic-hyaline** (or **Vitrophyric**). Phenocrysts surrounded by glassy groundmass. Indicates an initial period of slow (intrusive) crystallization followed by quenching of the remaining magma.

    b. **Porphyritic-aphanitic**. Phenocrysts surrounded by aphanitic groundmass. Indicates an initial period of slow (intrusive) crystallization followed by rapid (extrusive) crystallization of the remaining magma. The most common texture for common volcanic rocks (i.e. basalts).

    c. **Porphyritic-phaneritic**. Phenocrysts surrounded by phaneritic groundmass. Indicates two stages of slow crystallization, i.e. intrusion at two different levels.

C. Based on Crystal Shape (used almost exclusively for holocrystalline, phaneritic rocks)

1. **Allotriomorphic** (or **Xenomorphic**). Rock composed almost entirely of anhedral crystals. Indicates simultaneous growth of all the various minerals present. A special type of allotriomorphic texture formed by the interpenetration of very large, crystallographically continuous crystals of quartz and alkali feldspar is known as **Graphic Intergrowth**.

2. **Hypidiomorphic**. Rock composed of intergrown euhedral and anhedral crystals. Indicates sequential growth of the various minerals present.

3. **Idiomorphic** (or **Panidiomorphic**). Rock composed almost entirely of euhedral crystals. This is the hypothetical opposite of allotriomorphic; it almost never occurs in nature.

III. SPECIAL TEXTURES AND STRUCTURES

A. Disequilibrium Textures (Indicate that early-formed crystals were unable to completely re-equilibrate with the evolving magma during the later stages of solidification.)

1. **Zoned Crystals** Concentric compositional variation within individual crystals. Indicates disequilibrium crystallization within a solid solution mineral series.
2. **Reaction Rims** Individual crystals of one mineral each completely surrounded by one or more crystals of a different mineral. Indicates disequilibrium crystallization involving two members of a discontinuous reaction series.
3. **Coronas** Compositional variation (reflected by color variation) in the matrix surrounding individual phenocrysts. Indicates disequilibrium within the melt phase.
4. **Embayed** or **Corroded Phenocrysts** Indicates that the early-formed crystals were being re-absorbed by the magma at the time that solidification was completed.

B. Contact Relationships

1. **Gradational Contacts** Indicates intrusion of magma into warm and/or low-melting-point country rock.
2. **Sharp Contacts** (**Chill Zones** or **Chilled Margins**) Indicates intrusion of magma into cold and/or high-melting-point country rock.

C. Wall-rock Inclusions

1. **Xenoliths** Rock fragment inclusions.
2. **Xenocrysts** Inclusions of individual crystals of wall-rock material. Indicate that the wall rock soft enough to be easily disaggregated (i.e. still hot). Often difficult to distinguish from phenocrysts unless of "anomalous" composition.

D. Pyroclastic (Fragmental) Textures

1. **Volcanic Breccia** Angular to rounded fragments of extrusive igneous rocks embedded in a matrix of compacted volcanic ash.
2. **Crystal Tuff** Individual crystals and/or clusters of crystals embedded in a matrix of compacted volcanic ash.
3. **Crystal-Lithic Tuff** Roughly equal proportions of individual crystals and fragments of volcanic rock embedded in a matrix of compacted volcanic ash.
4. **Vitric Tuff** Compacted volcanic ash with little or no embedded crystals or fragments of volcanic rock.

E. Volatile-escape Textures. Gas bubble holes (**vesicles**) indicate that gas was being liberated from the magma at the time that solidification was being completed.

1. **Vesicular Texture** Aphanitic rock containing isolated vesicles (<50% of the total)
2. **Amygdules** Vesicles filled by precipitation from aqueous solutions.
3. **Scoriaceous Texture** Aphanitic rock containing abundant (>50% of the total)
4. **Pumiceous Texture** Glassy material containing vesicles.
5. **Miarolitic Texture** Phaneritic rock containing angular gas holes.

F. Flow Textures and Structures

1. **Aligned Crystals** (**Trachytoid** or **Trachytic Texture**)
2. **Elongated Vesicles**
3. **Elongated Xenoliths**
4. **Schlieren Structure** Compositional layering or banding (“flow banding”)