EXERCISE 5C IGNEOUS ROCK IDENTIFICATION

PURPOSE: To learn the SYSTEMATIC PROCEDURE for igneous rock identification.

To learn to recognize the TEXTURE and MINERAL COMPOSITION of the igneous rocks.

To use the texture and mineral composition of igneous rocks to interpret the GEOLOGIC HISTORY of their formation.

DEFINITION:

Igneous rocks are rocks which CRYSTALLIZE from MOLTEN MATERIAL.
As the molten material cools, the elements combine to form minerals which group together to form rocks.

CLASSIFICATION:

All rocks are classified based on TEXTURE and MINERAL COMPOSITION. For the igneous Bowen's Reaction Series.

I. TEXTURE

A. SIZE

1. The size of the minerals in an igneous rock depends on the RATE OF COOLING of the molten material. The cooling process proceeds at different rates depending on the location of the molten material.

a. If molten material remains beneath the surface of the earth, it COOLS SLOWLY. During this slow cooling, LARGE CRYSTALS have a chance to form and a rock with COARSE-GRAINED texture is formed. The crystals are large enough to see with the naked eye. Coarse-grained igneous rocks are also referred to as INTRUSIVE because they cool "inside" the earth, or PLUTONIC, referring to Pluto, the Roman god of the underworld.

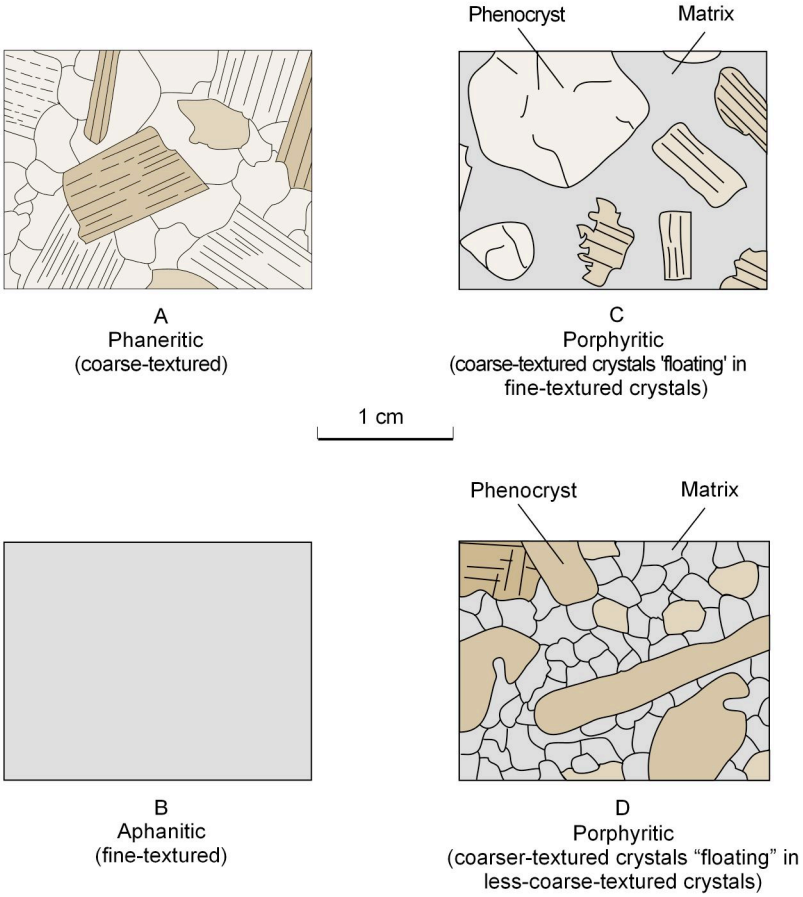
b. If the molten material comes out onto the surface of the earth, it COOLS RAPIDLY, and crystals do not have a chance to grow large. Igneous rocks with SMALL CRYSTALS have a FINE-GRAINED texture. In a fine-grained rock, most of the crystals are not large enough to be seen with the naked eye. They are also referred to as EXTRUSIVE because they form on the "exterior" of the earth, or VOLCANIC, because the molten material often comes out of a volcano. The word volcano is derived form Vulcan, the Roman god of fire.

c. Molten material beneath the earth's surface has gas dissolved in it. When the molten material is extruded onto the earth's surface, the gas can escape, causing the lava to froth or bubble. At the same time, the lava is solidifying around the escaping gas and holes are formed in the rock. This texture is called VESICULAR or CELLULAR. The GAS BUBBLES may be elongated and will resemble threads or fibers if the lava was flowing as it cooled. The bubbles will be more rounded if the lava as not flowing.

d. If molten material cools at two different rates, then two different sizes of crystals which have TWO DIFFERENT SIZES of crystals are said to be PORPHYRITIC.

e. If a lava cools super-fast minerals do not have time to form.
The lava solidifies without elements arranging themselves and a glass is formed. This texture is called GLASSY. A glassy rock sometimes looks shiny like glass.

f. Explosive volcanic eruptions blow gas, ash and sometimes large blocks into the air. When the ash and blocks settle to the ground they are often hot and weld together to form a rock with a FRAGMENTAL or PYROCLASTIC texture.



NOTE: Coarse-grained texture does not mean that the rock feels rough, it means that the minerals are visible to the naked eye.

Fine-grained texture does not mean that the rock feels smooth, it means that most (80%-90%) of the minerals are not visible to the naked eye.

Rocks with cellular texture are fine-grained or glassy, but the edges of the bubbles can feel extremely rough.

B. **SHAPE**

The shape of the minerals in an igneous rock is dependant on the physical properties of the minerals, especially cleavage and crystal form. For example, feldspars, pyroxene and amphibole are usually rectangular; quartz and olivine are equidimensional and biotite and muscovite are platy.

C. **ARRANGEMENT**

1. The minerals in an igneous rock usually have a RANDOM arrangement. This means that they are not parallel to one another or do not all face in the same direction, and that they are evenly distributed throughout the rock.
2. Igneous rocks are also said to have an INTERLOCKING arrangement of minerals because the crystals have grown together, leaving no spaces between them.

TEXTURE SUMMARY

LARGE CRYSTALS = COARSE-GRAINED = INTRUSIVE = PLUTONIC = SLOW COOLING

SMALL CRYSTALS = FINE-GRAINED = EXTRUSIVE = VOLCANIC = FAST COOLING

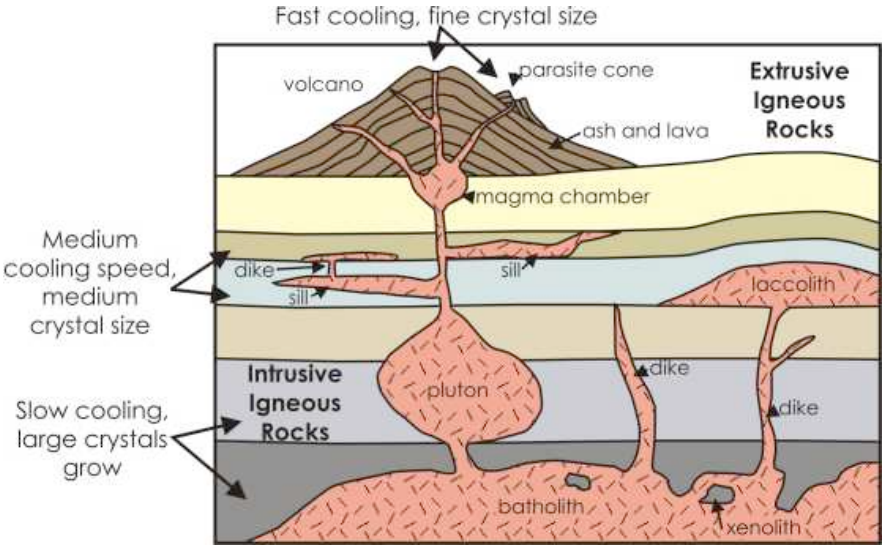
TWO DIFFERENT SIZES = PORPHYRITIC =TWO DIFFERENT RATES OF COOLING

FINE-GRAINED with GAS BUBBLES = VESICULAR = FAST COOLING WITH RELEASE OF GAS

NO CRYSTALS = GLASSY = QUENCHED (extremely rapid cooling)

FRAGMENTS = FRAGMENTAL = PYROCLASTIC = EXPLOSIVE VOLCANIC ERUPTION

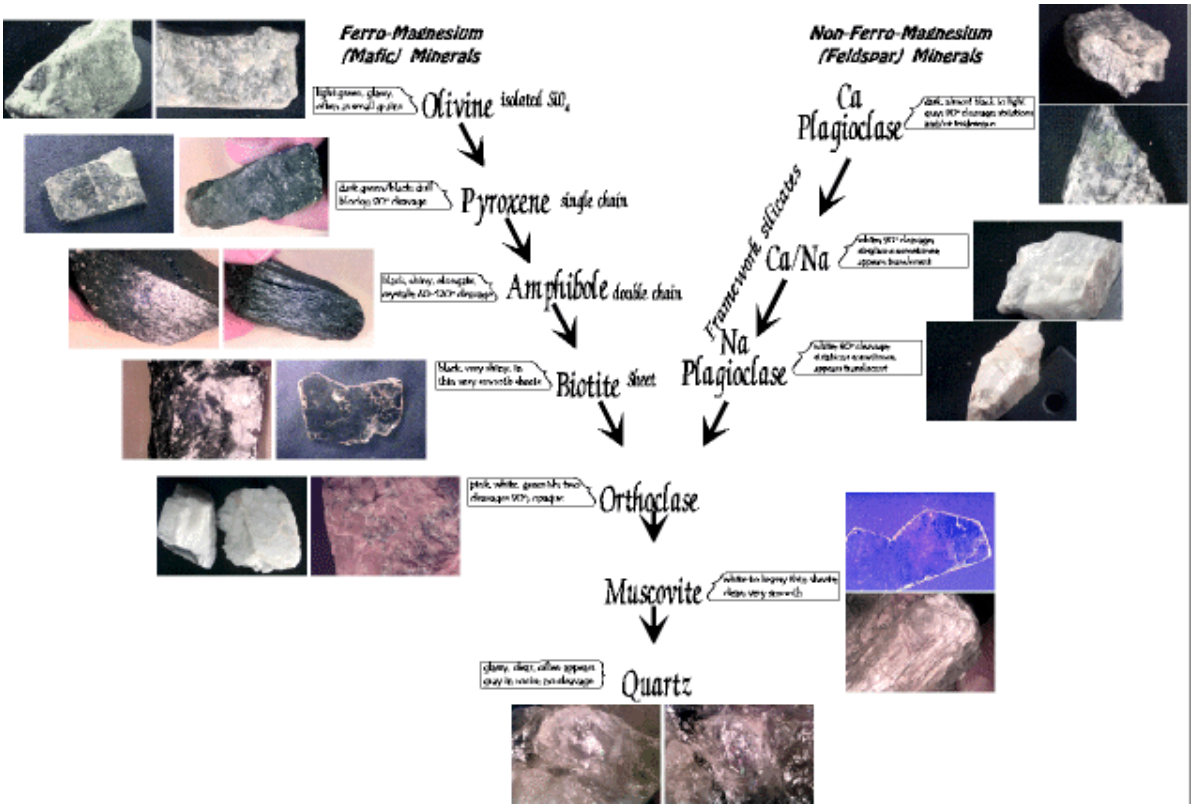
RANDOM, INTERLOCKING arrangement



II. **COMPOSITION**

A. There are primarily 9 minerals which can be found in igneous rocks. These 9 minerals crystallize at different temperature during the formation of igneous rocks.

The sequence in which these minerals form in known as **BOWEN'S REACTION SERIES**

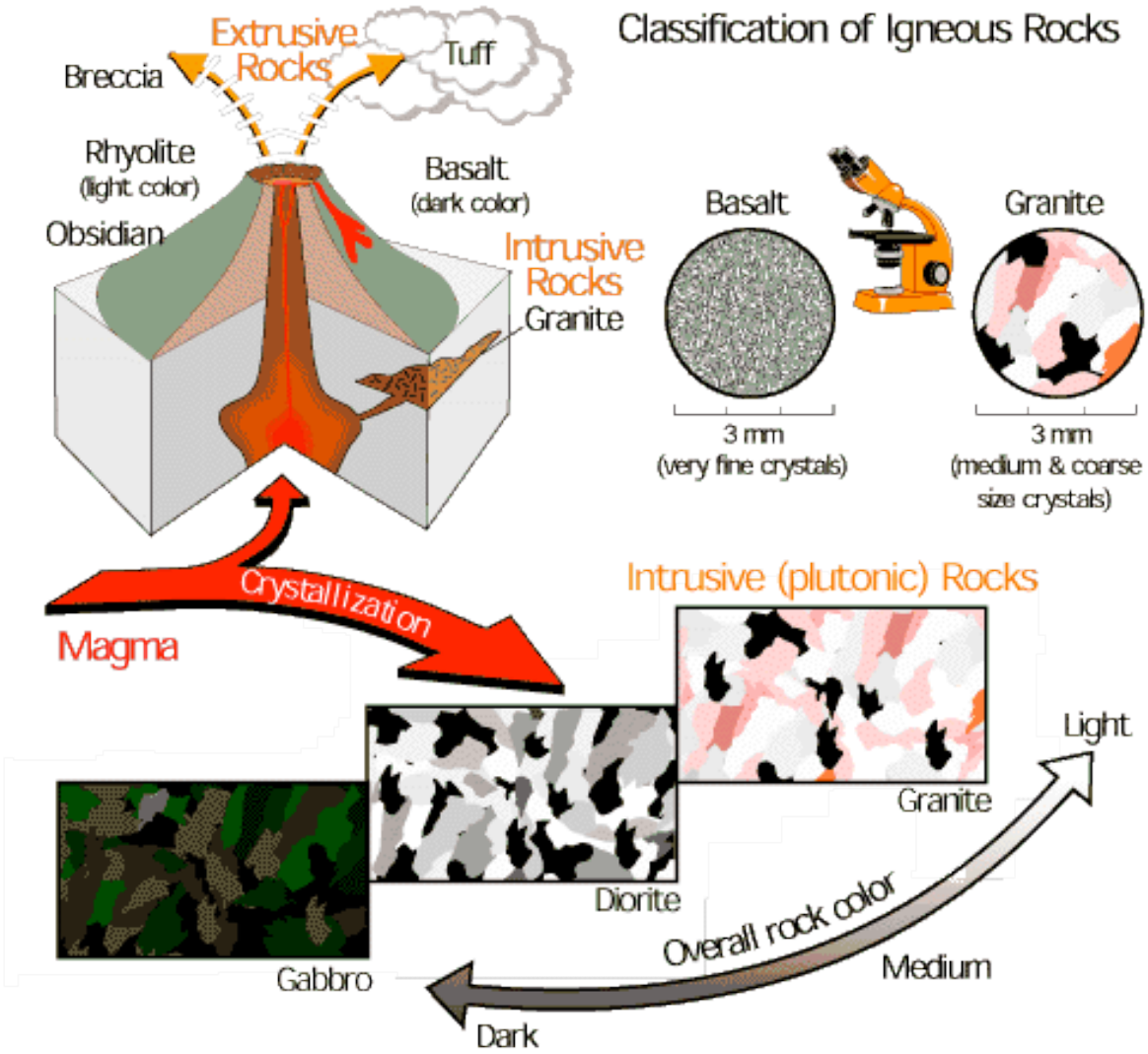


1. These minerals are all SILICATES, meaning they contain silicon (Si) and oxygen (O). The silicate minerals are divided into two groups: mafic and sialic.

   a. Olivine, pyroxene, amphibole and biotite are MAFIC minerals meaning they contain magnesium(Mg) or iron (Fe). Mafic minerals are usually dark colored.

   b. Ca- and Na-plagioclase feldspar, Orthoclase feldspar, muscovite and quartz are SIALIC minerals, and contain no magnesium (Mg) or iron (Fe). They do contain silicon (Si) and all but quartz contain aluminum (Al). Except for Ca-plagioclase, sialic minerals are usually light- colored.

2. It is possible for the igneous minerals to cool SLOWLY to form a COARSE-GRAINED igneous rock or to cool QUICKLY to form a FINE-GRAINED igneous rock. Thus, two rocks may have the same composition, but different textures and therefore, are given different rock names.



B. The igneous rocks are divided into three FAMILIES.
Each member of a family has the same composition, but different textures, depending on the rate of cooling of mode of cooling of the molten material.

1. MAFIC family contains primarily mafic minerals	High temperature minerals: Olivine, Pyroxene, and Ca-plagioclase. Dark-colored minerals= **Dark-colored rock.**
2. INTERMEDIATE family mafic and sialic minerals	Intermediate temperature minerals: Dark- and Light-colored minerals= **Dark- and Light-colored rock.**
3. SIALIC (FELSIC) family contains primarily sialic minerals	Low temperature minerals: primarily Orthoclase feldspar and Quartz (and a few dark minerals such as biotite). Light-colored minerals=**Light-colored rock**.

4. The main distinction between the three families of igneous rocks is the kind of feldspar each contains:

FAMILY	FELDSPAR	COLOR
a. MAFIC	Ca-Plagioclase Feldspar	Blue-black to blue-gray
b. INTERMEDIATE	Na-Plagioclase Feldspar	Blue-grey to white
c. SIALIC	Orthoclase Feldspar	White to pink

5. If the feldspar is difficult to identify, then the amount of quartz should be determined:

FAMILY	QUARTZ
a. MAFIC	None
b. INTERMEDIATE	Very little or none (<5%)
c. FELSIC	Abundant (30%)

6. A further distinction can be made by identifying the dark-colored minerals.

FAMILY	DARK MINERALS	DISTINGUISHING CHARACTERISTICS
a. MAFIC	Olivine	no cleavage, greenish
	Pyroxene	cleavage, greenish-black
	Ca-Plagioclase	cleavage, blue-black, striations
b. INTERMEDIATE	Pyroxene	not distinguishable from amphibole in hand sample
	Amphibole	Long thin cleavage faces Diamond-shaped cross-section
c. SIALIC	Biotite	More round or irregular cleavage faces Flat, platy cross-sections Biotite in these rocks will be 5-15%

D. The majority of the igneous minerals are harder than glass, so igneous rocks are harder Than glass.

E. The majority of the igneous minerals have cleavage, so the individual minerals in a coarse-grained igneous rock will show flat, shiny cleavage faces.

PROCEDURE FOR IGNEOUS ROCK IDENTIFICATION

Step 1. Classify the ROCKS by overall color as a clue to their composition. Separate them into a Dark pile and a Light pile.*

*NOTE: Despite their dark color, rocks with a glassy texture have a sialic composition and belong to the SIALIC Family. Place the green rock with the dark colors.

Have this checked before you go on.

2. Determine the TEXTURE of each igneous rock. Choose from the list below. Write this on the table provided.
   a. COARSE
   b. FINE
   c. PORPHYRITIC – fine
   d. PORPHYRITIC - coarse
   e. VESICULAR
   f. GLASSY

3. Write the general COMPOSITIONAL CATEGORY on the table provided.
   SIALIC (FELSIC) rocks are light in color,
   MAFIC rocks are dark in color.
   *NOTE: Despite their dark color, rocks with a glassy texture have a sialic composition and belong to the SIALIC (FELSIC) Family.
   ULTRAMAFIC rocks are green

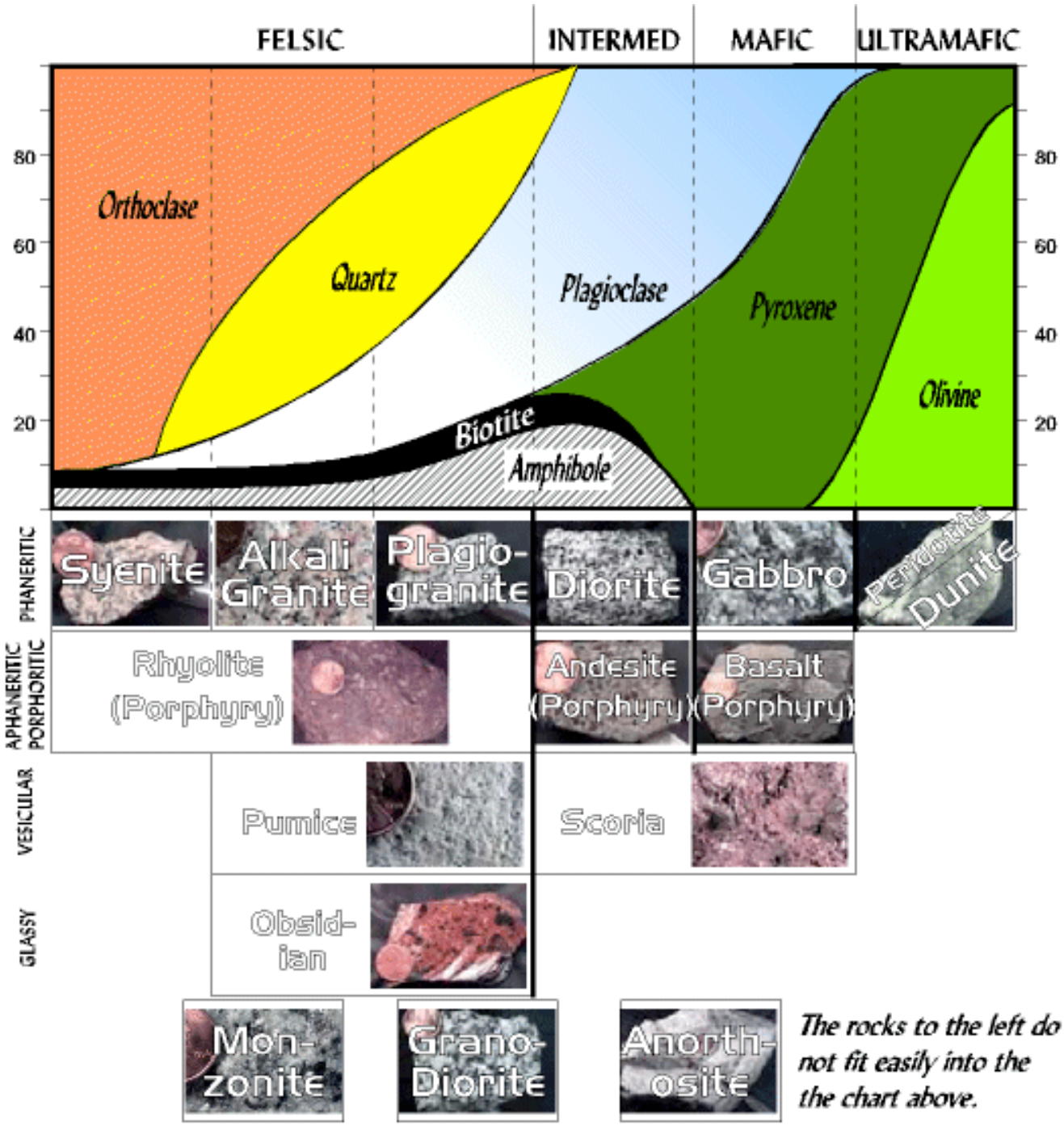
4. Use the chart on p. 8 to indicate two to three of the minerals MOST LIKELY to be found in the rock. Write these on the table provided. Find these minerals in your COARSE-GRAINED samples

5. Place the sample to the right of the description.

6. Use the classification chart on page 8 to determine the rock name. (There may be more than one example of some rocks.)

7. Indicate whether the rock is VOLCANIC (fast cooling at the surface) or PLUTONIC (slow cooling below the surface)

8. Have lab instructor check your identifications.



The rocks to the left do not fit easily into the the chart above.

Texture	Compositional Category	The two most likely minerals	Name	Volcanic or Plutonic?	Cooling rate: Fast or Slow?