LAB 1: VOLCANIC ROCKS (4 hours)

Take time to look at some of the thin sections on the microscopes. Each section has a 4x6 card summarizing the minerals and textures observable in the thin section.

I. Ocean Floor Basalts (MORB)

Ocean floor basalts form at spreading ridges, cover ~70% of the earth’s surface, and are commonly called MORBs (Mid Ocean Ridge Basalts). They are dominantly olivine tholeiites. [Tholeiite is the name given to basalts that contain normative hypersthene. Alkalic basalts contain normative nepheline and no normative hypersthene].

321-213 Basalt, Juan de Fuca Ridge, eastern Pacific Ocean.
This sample was dredged from the Juan de Fuca ridge off the Washington coast. It originally solidified at a water depth of 1-2 km. Take time to look at the thin section.

Questions: (1) Why is the outer surface of this sample glassy?

(2) Would you expect vesicles to be common in sea floor basalts? Why or why not?

II. Ocean Island Basalts (OIB)

OIBs are petrographically and chemically quite similar to MORBs. They are associated with thermal anomalies in the mantle (“hot spots”) and commonly form linear chains of volcanic islands, such as the Hawaiian Islands. Tholeiites and alkalic basalts occur in oceanic islands. Look at the thin section of the basalt from Mauna Loa.

202-ML-1 Olivine tholeiite, Mauna Loa volcano, Hawaii.
This sample contains abundant olivine phenocrysts in a fine-grained groundmass.

Questions: (1) Suggest a mechanism for the excessive enrichment of olivine crystals in a magma.

(2) What inferences can you draw about the cooling history of this rock?

(3) Why does this sample have so many vesicles?

Pele's tears, Mauna Loa, Hawaii (only one sample available--handle with care)
This is a type of **basaltic tephra**. It has the same chemical composition as the olivine tholeiite above. Note the different shapes of the glass beads.

**Question:** (1) What can you deduce from this sample about the style of eruption and the properties of the magma?

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**Reticulite, Kilauea, Hawaii** *(single sample—extremely fragile—do not handle)*

This unusual sample is a basaltic foam composed of films and filaments of basaltic glass separated by vesicles—a type of basaltic pumice if you like. It commonly forms during fire fountaining.

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**321-36: Vesicular rock** *(Basaltic scoria from a cinder cone)*

**Questions:** (1) Why is this rock red?

(2) What do you think was the composition of the gas that formed the vesicles?

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**III. Continental Flood Basalts**

Continental flood basalts form thick sequences of flows which cover thousands of square miles. Individual flows may extend up to 600 kilometers from their source vents, e.g., the Pomono Flow has been traced from a source vent in SW Idaho through the Columbia River Gorge to the Pacific Ocean. These basalts are usually **quartz tholeiites**. This term can be confusing because the basalts contain no **modal** quartz. However, when one calculates the analyses in terms of the normative minerals, the **norm** commonly contains quartz (and hypersthene)—hence the name quartz tholeiite. In general, flood basalts contain sparse phenocrysts, and are in large part erupted from fissure-like vents. Examples are the **Columbia River Basalts**, Deccan Traps in India, Siberian Traps in Russia, Karoo Basalts in South Africa, Paraná Basalts in Brazil, and the Ontong Java Plateau in the western Pacific Ocean. Historic fissure eruptions (on a smaller scale) occur in Iceland.

**321-34: Columbia River Basalt**

The Columbia River Basalt Group is made up of four formations. From oldest to youngest these are: **Picture Gorge Formation and Innaha Formations, Grande Ronde Formation, Wanapum Formation, and Saddle Mountains Formation**. Examine the thin sections of the ROSA flow which is the biggest of all the Columbia Plateau flows and is well exposed along old Highway 10 across the river from Vantage.

**Question:** What phenocrysts are present in this sample? They appear dark but are actually colorless.

**321-20: Steens Mountain Basalt, southeast Oregon.**

In many respects the Steens Mountain Basalt is similar to continental flood basalts but the volume of individual flows may be less. If you examine the thin section of the Abert Lake flow from Steens Mountain it will help to answer some of the questions.

**Questions:** (1) What is the light colored phenocryst mineral?

(2) Estimate a modal percent of this phenocryst mineral.
Estimate the chemical composition of this mineral (remember it’s a solid solution).

What do we mean by the term “zoning?” Look at the thin section and draw a sketch of a phenocrysts showing zoning…

**321-19: Snake River Plains Basalt, Idaho.**
Basaltic volcanism has been active in the Snake River Plain for approximately the past 10 million years. Recent activity is centered in the Craters-of-the-Moon area. It is believed that the same heat source is responsible for the SRP basalts and the Yellowstone silicic volcanics.

Questions: (1) What part of the flow might this sample be from? [Top, middle or bottom]. Why?

(2) What minerals can you identify?

**IV. Calc-Alkaline Volcanic Rocks associated with magmatic arcs**
The name “calc-alkaline” applied to this group of volcanic rock series is historical and based on the chemical composition of these rocks. More importantly for our purposes, this rock name has a geologic/tectonic connotation. Calc-alkaline volcanic rocks are found in modern and ancient **continental arcs and island arcs** that form above subduction zones. These volcanic rocks range in composition from basalts to rhyolites, although rocks of intermediate composition [andesites] are particularly abundant in some continental arcs, e.g., the Cascades. The Quaternary Cascade volcanoes are examples of arc volcanics.

**321-21: Basaltic andesite, Mount Baker.**
This rock contains two pyroxenes: clinopyroxene (augite) and orthopyroxene. You can verify this by looking at the thin section of the Mount Baker sample.

Question: (1) Identify the phenocrysts and describe the texture of this rock.

**321-33: Porphyritic andesite, Mount Adams.**
Questions: (1) What is the major mafic mineral in this sample?

(2) Is this a lava flow or pyroclastic flow deposit? Why?

**321-191: Dacite airfall pumice, Mount St. Helens, May 18, 1980.**
These samples were collected 15 miles northwest of the volcano and were associated with the cataclysmic eruption. Notice that they are disk-shaped rather than spherical. Verify that the phenocrysts are plagioclase, hypersthene, and hornblende. This rock has been classified as dacite based on its bulk SiO₂ content (64 wt.%). [Dacite has >63 wt.% SiO₂. Andesite has <63% SiO₂].

Question: What mineralogical feature distinguishes andesite from dacite?

321-197: *Mount St. Helens dacite from the dome.*

Dacite from the lava dome that formed during February 1981 activity. Note the small xenoliths present. Compare this sample with sample 321-191. The two samples have essentially the same bulk chemical composition and illustrate the possible variations in appearance of volcanic products from a single type of magma at a single volcano.

321-12: *Rhyolite airfall pumice, Newberry Caldera, Oregon.*

Compare this sample with the pumice from Mount St. Helens.

Question: (1) What is the main constituent of this sample?

321-25: Obsidian showing [spherulitic](#) texture, i.e., very fine intergrowths of alkali feldspar and tridymite/cristobalite formed by [devitrification](#). Note the radial pattern within these spherulites. Note the conchoidal fracture which is characteristic of volcanic glass. The rock is virtually holohyaline.

Questions: (1) Why do some volcanic rocks solidify as glass?

(2) What do we mean by the term “devitrification”?

V. Continental volcanic rocks not all of which are obviously related to magmatic arcs

321-132: *Porphyritic alkali rhyolite (Papoose Rhyolite), Idaho.*

Questions: (1) What are the phenocrysts?

(2) What kind of feldspar(s) are present (look for twinning)?


This sample was collected from a dike.

Questions: (1) Identify the phenocrysts in this rock (there is one which you haven't seen before in this week's lab).
321-16, 321-17, large display sample: Bishop Tuff (high silica rhyolite)
These two samples are from the 700,000 year old Bishop Tuff in eastern California. You should also look at the big display sample. The Bishop Tuff is a pyroclastic rock with a high SiO₂ content (~75%). Eruption of this enormous ash flow resulted in the formation of the Long Valley caldera, which has shown renewed activity recently. Note the flattened pumice fragments (fiamme) which form a distinctive texture (eutaxitic) in 321-17. The texture of the Bishop tuff varies from top to bottom. The fragmental nature of the tuff is clearly visible in thin section.

Question: (1) What are the constituent clasts?

(2) Which of the two specimens is welded?

(3) How might you determine that 321-16 and 321-17 formed as pyroclastic flows and not as lava flows?

(4) Would you predict that the sample which is welded came from near the bottom or the top of the ash flow?

321-241 Rhyolite (locality unknown) (single display sample)
Note the flow folds in this sample. Rhyolite magma has a very high viscosity which prevents magma mixing and preserves structures which developed during flow.

321-247 Basalt agglutinate (locality unknown) (single display sample)
This rock was collected from a mound of basalt known as a spatter cone formed by the accumulation of molten bombs and ropes and chunks of basaltic lava ejected from a small vent. The constituent bombs, being molten, tend to adopt a bulbous form in flight.

321-325 Komatiite (Western Australia) (single display sample)
Komatiites are ultramafic lava flows, in some cases containing over 30 weight percent MgO (most basalts contain less than 10% MgO). It has been determined that the liquidus temperature of komatiite is ~1600°C and that a high degree of mantle melting (~50%) is required to produce komatiite magmas. Almost all komatiites are Precambrian in age, indicating that the mantle in Precambrian times was significantly hotter than the present day mantle. Higher temperatures in the Precambrian mantle made it possible to get higher degrees of partial melting. The distinctive feature of komatiites in hand specimen is the presence of large acicular or tabular olivine crystals (best observed on the weathered surfaces). This characteristic feature is termed spinifex texture.
It is so named because it looks remarkably like a type of spiky grass that grows in Western Australia.

Questions: (1) Why was the Precambrian mantle hotter than the present mantle?

(2) What conditions are required to form acicular olivine?

Questions: (1) What phenocryst in addition to hornblende is present in this sample.

(2) Why is the matrix reddish?

202-HM-1: Dike rock from Highwood Mountains, MT

Question: What is the phenocryst mineral in this sample? Why is this unusual?

202-MB-1 Sulfur Creek Flow, Mount Baker, WA

WRITE OUT A COMPLETE DESCRIPTION OF THIS ROCK