LAB # 6: ULTRAMAFIC ROCKS

This week's lab contains thin sections (and hand specimens) of most of the common types of ultramafic rocks (rocks with a color index > 90.) They come from a variety of occurrences including ultramafic mantle xenoliths from alkali basalts, komatiites (ultramafic lavas), alpine peridotites, ophiolites, deep crustal metamorphic rocks, and ultramafic cumulates from layered intrusions. You will find that all of these rocks have fairly simple mineral assemblages, being composed of varying proportions of olivine, orthopyroxene, and clinopyroxene, along with lesser amounts of plagioclase, Mg-Al spinel, garnet, hornblende, biotite, Cr-Fe spinel, etc. However, ultramafic rocks are very susceptible to alteration so you should also describe the secondary minerals. Please be careful when handling these sections as we only have one each of a number of them.

In examining and describing these thin sections and hand samples you should:

(1) **Identify and describe the primary minerals.** On the rock description sheets, list the optical properties that are of diagnostic importance (i.e., that enable you to determine compositions or distinguish otherwise similar minerals). You will find in some sections that olivine and orthopyroxene have parallel extinction and very similar values of 2V, so you will need to pay close attention to relief, crystal form, color/pleochroism, cleavage, exsolution, and birefringence to tell them apart. A complete description should also include discussion of any internal features of the minerals that might have petrogenetic significance such as zoning, inclusions, twinning, exsolution, or deformational features such as kink bands. Where possible, try to determine the crystallographic orientation of twinning and exsolution lamellae. Many ultramafic rocks show the effects of alteration (veins and zones of serpentine, talc, iron oxides, etc.). It is important to describe such alteration and to try to determine the secondary mineral assemblages as this may provide clues (a) to the original mineral assemblage, and (b) to later events, e.g., low grade metamorphism which might have affected the samples.

(2) **Describe the textures.** Although the mineral assemblages of ultramafic rocks may show only limited variation, many different types of textures may be observed. Textural descriptions should include such things as grain size, grain shape and crystal habit (you should consult the textures handout for the appropriate terms). Also note any evidence for reactions or recrystallization and try to distinguish primary features from secondary ones. In describing cumulate ultramafic rocks, such as those from the Stillwater Complex, it is important to distinguish cumulus minerals from intercumulus minerals. The latter may occur as (a) overgrowths on cumulus minerals, (b) replacements of cumulus minerals, or (c) interstitial space fillings.

(3) **Estimate the mode of the rock and name the rock.** In naming the rock you should follow the IUGS classification scheme (classification scheme for Ultramafic rocks is appended) where possible (obviously it cannot be applied to the komatiite). However,
when naming the Stillwater samples (or any cumulate rocks) it is common practice to name the rock on the basis of its cumulus minerals -- a rock containing cumulus olivine (but no other cumulus phases) would be termed an olivine cumulate (oC), one with cumulus olivine and bronzite would be called a harzburgite (obC), etc. The shorthand terminology can sometimes be confusing and even misleading and we will review it in the lab.

(4) Discuss any petrogenetic inferences you can draw from your observations -- crystallization sequences, deformational episodes, etc. [see attached sheets on "Writing a Complete Petrographic Description"]

THIN SECTIONS

Ultramafic rocks from alpine peridotites and/or ophiolites

Twin Sisters  [sample from Twin Sisters, WA--most likely the Twin Sisters massif represents part of a dismembered ophiolite]
CA-1-B  [These three samples are from the Pt. Sal ophiolite, CA. They are all similar so concentrate on one of the three. CA-2E-C is more altered than the other samples]
CA-2E-A
CA-2E-C

Ultramafic mantle xenoliths

BSQ-35  [This sample is from Baja California, Mexico. It occurs as a xenolith in an alkali basalt of Quaternary age]
KH-1  [This sample is from Kilbourne Hole, New Mexico. It occurs as a xenolith in a Holocene basanite flow]
HB-2-2  [This sample is from Hawaii. It occurs as a xenolith in nephelinitic tuffs of the Honolulu Volcanic series, Oahu. This is an example of a composite xenolith, i.e., it is composed of two parts with different mineral assemblages, textures, and modes.]
San Carlos  [This sample is a xenolith from a maar in New Mexico. Enclosing basalt forms part of the thin section]

Komatiite

A-3  [Munro township, Ontario, Canada. This area contains a sequence of tholeiitic basalts and komatiites of Archean age. Some of the olivine in this sample is still fresh but a substantial proportion of the olivine has altered to serpentine. Also, the groundmass is largely altered. Note the fan-shaped “sheaves” of pyroxene. Komatiites are essentially restricted to the Archean.]

**Ultramafic cumulates from Stillwater Complex**

**M-10---SC-B14---704 or 663 or 936**

The M-10 [lower]—SC-B14[middle]—704 or 663 or 936[upper] samples represent the three members of a cyclic unit from the Ultramafic series in the Archean Stillwater Complex. A complete cyclic unit is composed of a lower member in which the cumulus minerals are olivine +/- chrome spinel and the postcumulus minerals are orthopyroxene, clinopyroxene, plagioclase +/- biotite +/- rare amphibole. In many samples, the primary minerals have been partially altered to serpentine and talc. The middle member of a cyclic unit is a harzburgite containing cumulus olivine + cumulus orthopyroxene [+- small amounts of cumulus chrome spinel] with intercumulus clinopyroxene and plagioclase. The upper member of the cyclic unit is a bronzitite containing cumulus orthopyroxene and postcumulus clinopyroxene + plagioclase. Note the large clinopyroxene oikocryst in 704.

**Garnet peridotite**

This sample of garnet peridotite is actually a deep crustal sample from Norway. Note the rims on the garnet—commonly refered to as kelyphitic rims. Identify all the mafic minerals in this sample.

**HAND IN A COMPLETE DESCRIPTION OF THE SAMPLE LABELED "SC-936" [Multiple sections plus one polished section are available]**

In addition to the detailed description you should keep good and accurate notes on all the other samples in your notebook.