ESS103A Name_____
Igneous Petrology, Spring 2006

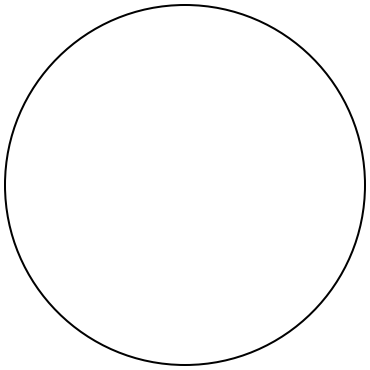
LAB 8
MANTLE XENOLITHS

The primary source of magmas on Earth is the mantle. In this lab exercise, you will examine rocks representative of the mantle. They reach the surface as xenoliths entrained in magmas.

1. Study sample L-122-230 (thin section and hand sample).
    a) List the major minerals (there are two of them) that are present in this rock in order of abundance.

    b) Suggest a rock name based on the relative proportion of the minerals using the IUGS classification scheme for ultramafic rocks.

    c) Provide an illustration of strained (kink banded) pyroxene in this rock:



    d) Strained minerals are diagnostic of igneous or metamorphic rocks?

    e) Is this rock protogranular, porphyroclastic, or equigranular?

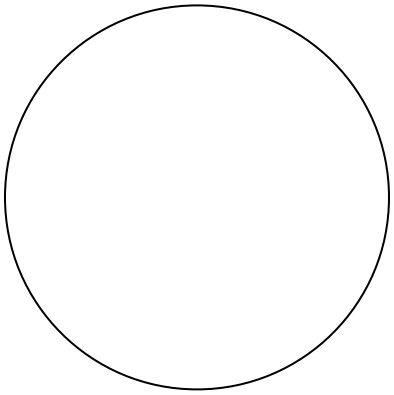
2. Study sample L-218-20 (thin section and hand sample).
    a) What's the purple mineral in the hand sample?

    b) What's the emerald green mineral in the hand sample?

    c) List the major minerals that are present in this rock in order of abundance.

d) Suggest a rock name based on the relative proportion of the minerals using the IUGS classification scheme for ultramafic rocks.

e) Find evidence of 120^{o} grain boundaries and provide an illustration.



f) Are 120^{o} grain boundaries diagnostic of igneous or metamorphic rocks?

3. Study sample L-175-23 (hand sample).

a) Provide IUGS name or names for the xenolith portion(s) of this rock, a field name for the rest of this rock, and identify whether each portion is intrusive or extrusive and volcanic or plutonic.

	Name	Intrusive or extrusive	Plutonic or volcanic
Xenolith 1	IUGS:		
Xenolith 2	IUGS:		
Rest of rock	Field:		

b) What do these xenoliths tell us about the composition of the mantle?

c) How are the individual crystals entrained in the "rest of the rock" similar to and different from the mineral grains in the xenoliths? Do you think these individual crystals formed from the "rest of the rock" or came from the same source as the xenoliths?

4. Study sample L-215-33 (hand sample).
    a) Identify all five minerals in this rock by color or by distinguishing feature and list in order of abundance.

Mineral	Color or distinguishing feature

    b) Suggest a rock name based on the relative proportion of the minerals using the IUGS classification scheme for ultramafic rocks.

5. Examine the phase diagram illustrating the pressure and temperature dependence of lherzolite mineralogy.

    a) Balance the reaction for the transition from spinel peridotite to garnet peridotite:

    __ $MgAl_2O_4$ (spinel) + __ $MgSiO_3$ (enstatite) =

    __ $Mg_3Al_2Si_3O_{12}$ (garnet) + __Mg_2SiO_4 (olivine)

    (similar reactions exist for conversion of plagioclase-bearing to spinel-bearing assemblages at lower pressure)

    b) Will the mantle be more olivine- or orthopyroxene-rich at higher pressure?

    c) What is the aluminous phase at higher pressure?

    d) Which sample equilibrated at higher pressure, or **1) L-122-230** or **2) L-218-20**?

    e) The continental crust tends to be >30 km thick which is equivalent to pressures of at least 1 GPa at its base. Why would you expect xenoliths of plagioclase peridotites to be relatively rare?

6. Use the Fo-Di-Qz phase diagram to answer the following questions about the effect of partial melting on the mineralogy of the residue:

   a) To help with the following questions, if you were to cool liquid with the composition of point A, what would the crystallization sequence be?

   b) What is the name you would give to a rock whose composition is given by point A?

   c) Locate the invariant point on the diagram that shows where olivine, diopside, and enstatite can coexist with a liquid. The composition of that point is the composition of the first liquid to coexist with these minerals when melting begins. Is this point a eutectic or peritectic (note: a peritectic will lie outside the triangle containing the minerals with which it is associated)?

   d) Assume that liquid of the appropriate invariant point composition is extracted from a rock whose composition is given by point A. Will the sample become depleted in Di, Fo, or En?

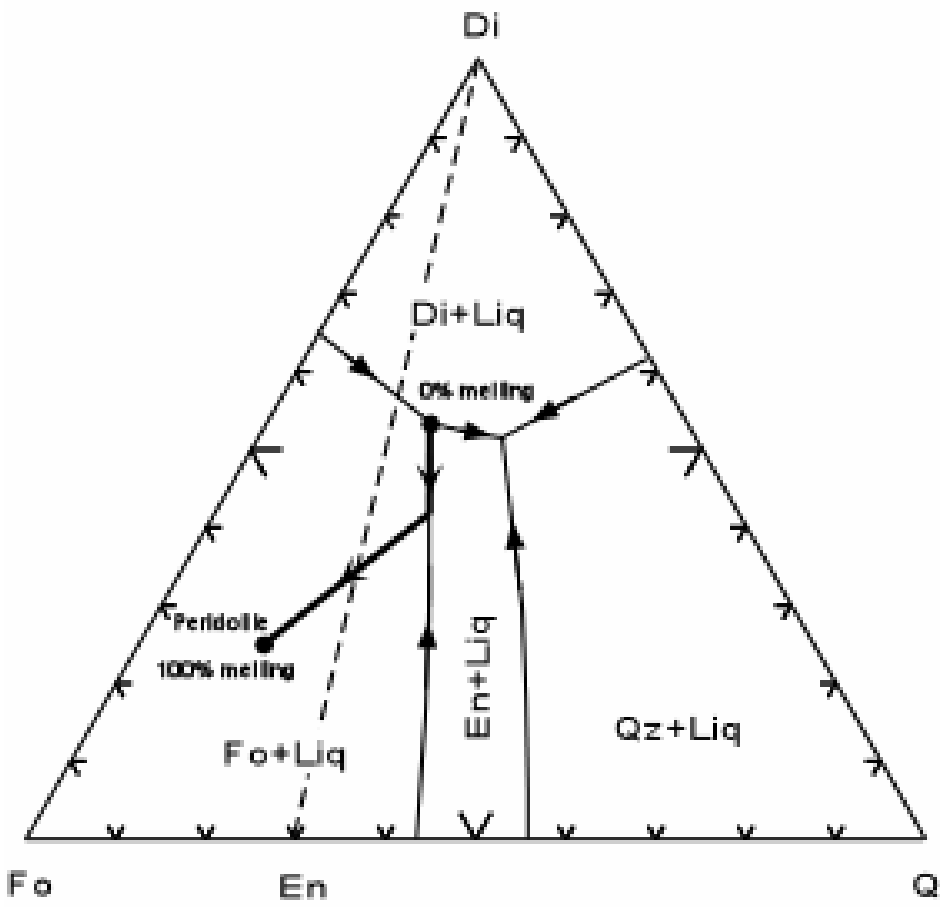
   e) What rock name would you give point A once one of the minerals has been depleted by melting?

   f) Find the join connecting the compositions of the remaining two minerals (the two-mineral solid must lie somewhere along this join). Also, find the boundary curve where liquid can coexist with the remaining two minerals. If further melting of point A were to occur, which of the two minerals would you expect to be the last one present?

   g) What name would you give this monomineralic sample?

   h) Summarize the names of the ultramafic rocks found in question 6 in order of increasing depletion.

   i) Summarize rocks **2) L-122-230**, **3) L-175-23**, **L-215-33** in order of increasing depletion.


Di
Di+Liq
0% melting
Peridotite
100% melting
En+Liq
Fo+Liq
Qz+Liq
Fo
En
Q