Seminar 4 (to follow Lecture 8)

"Grain boundaries as reservoirs of incompatible elements in the Earth's Mantle", by Hiraga et al., in Nature, 427, 699-703, 2004, and "Chemistry of grain boundaries in mantle rocks" by Hiraga et al., Amer. Min. 88, 1015-1019, 2003.

These papers use scanning transmission electron microscopy (STEM) to show that Ca, Al, Ti and Cr have higher concentrations at the surface of olivine grains relative to the olivine interiors. A partition coefficient is defined as $D = C_{GB}/C_{GM}$ where GB – grain boundary and GM = grain matrix. As with mineral/melt partition coefficients, the D's involving grain boundary concentrations are functions of ionic radius, ionic charge and temperature. The authors conclude that migrating melts within the mantle, especially at low melt fraction, could be strongly affected by the concentrations of elements on grain surfaces.

In a study of D_{REE}^{ol} and $D_{REE}^{opx/cpx}$ in peridotite, Lee et al. "Extension of lattice strain energy theory to mineral/mineral rare-earth element partitioning: an approach for assessing disequilibrium and developing internally consistent partition coefficients between olivine, orthopyroxene, clinopyroxene and basaltic melt" (GCA, 71, 481-496, 2008) conclude that grain boundary enrichments are not the major process controlling REE partitioning between these minerals (see their Fig. 4).

A new contribution by Hiraga et al. "Equilibrium interface segregation in the diopside-forsterite system II: Application of interface enrichment to mantle geochemistry", (GCA, 71, 1281-1284, 2007) shows that Cs, Rb and Ba are most strongly incorporated on mineral interfaces.