ESS103A Name_____
Igneous Petrology, Spring 2006 **Due: June 9, 2006**

Homework 6
TERNARY PHASE DIAGRAMS / ISOTOPE CHEMISTRY OF THE COLUMBIA RIVER BASALTS

1. Ternary Phase Diagrams

Finish questions 10-15 on the Di-An-Fo ternary diagram worksheet we partially completed in class on Friday, May 26. Turn these questions in with this homework.

2. Rb-Sr and Sm-Nd isotopic systematics

Read p. 277-281 of Winter to learn about the geologic environment of continental flood basalts, and the tectonic setting of the Columbia River Basalts. This should help you understand the geology-related question in this section.

A) Using the partition coefficients (D) in Table 9-1 on p. 157 in Winter, determine the bulk partition coefficients for Sm and Nd in a garnet lherzolite with 60 wt% olivine, 15% opx, 15% cpx, and 10% garnet.

B) Is Sm incompatible or compatible in garnet lherzolite? Is Nd incompatible or compatible in garnet lherzolite? Which one is the most compatible in garnet lherzolite?

C) Write down the relevant radiogenic decay equations for the Sm-Nd system and the Rb-Sr system (see p. 175). Which is more incompatible, Rb or Sr (we did this in a class handout…)? Describe the difference between the Sm-Nd system and the Rb-Sr system in terms of the relative incompatibility of parent and daughter isotopes.

D) Now assume the mantle source material produces a small amount of partial melt. Describe what will happen to the $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ ratios of both the partial melt (and rocks derived from multiple episodes of partial melting) and the depleted source material over long periods of time as radioactive decay progresses.

E) Keeping in mind your answer to part D), match the following components to their numbered positions in the isotope diagram of Figure 1. Components 3 and 4 are located off the diagram in the general directions shown.

Bulk silicate earth/ enriched mantle
Old lower continental crust
Young upper crustal granites
Depleted mantle

Hint: very old rocks have had more time to grow in ^{143}Nd, and Sm-Nd isotope systematics are not as easily reset as Rb-Sr.

F) The eruptive sequence of the Columbia River Basalts is given in Table 15-2, and the extrusion rate vs. time is shown in Figure 15-5 (p.280-281). Using these diagrams and Figure 1, produce a

plausible explanation of the magmatic sources and components for the Columbia River Basalts, and describe how the amount each source contributed may have changed over time.

Figure 1.