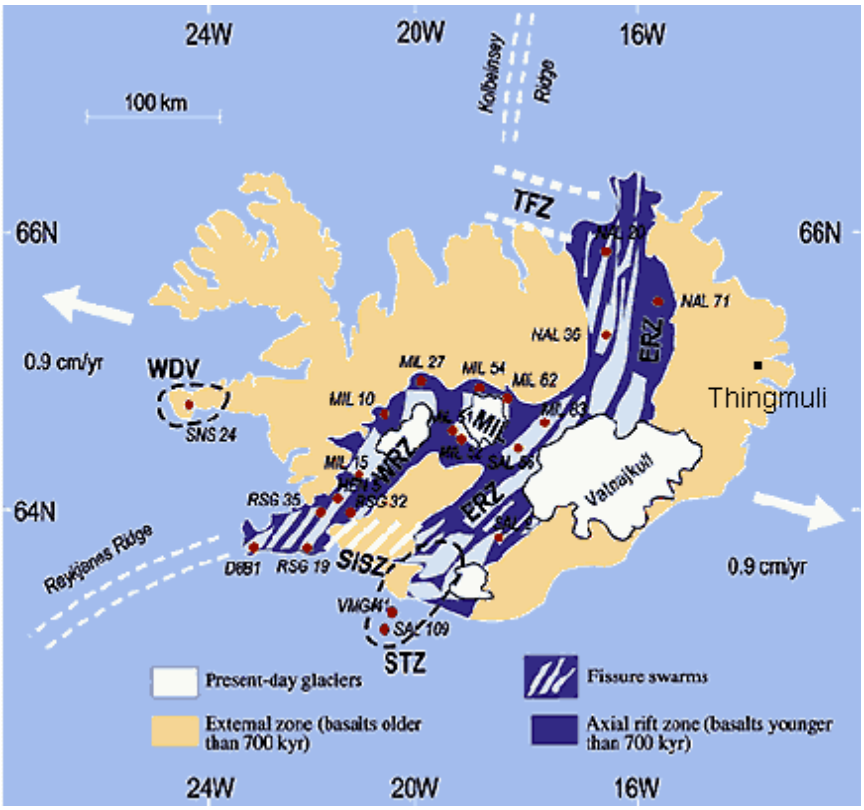
GEOL 306 **Spring 2005**

Major Element Variation Diagrams

Motivation: This assignment provides an introduction to some of the ways in which major element data can be applied to the interpretation of igneous rocks. It introduces you to a 'classic' petrological locality, and provides practice in ensuring that you are making your plots convey information to other scientists.

Geologic Context: The data in this exercise come from analyses of volcanic rocks collected at Thingmuli, a volcanic center in eastern Iceland (Fig. 1). Although much of Iceland is made up almost exclusively of basalts, Thingmuli is famous for the wide range of rocks types found there, including basalts, andesites, and rhyolites. Many of the rocks are aphanitic, but those that are porphyritic contain phenocrysts of plagioclase, olivine, augite, magnetite, ilmenite, and apatite. The major question you are seeking to answer in this exercise is "how are these different rocks related to one another?" In particular, you will use variation diagrams to determine whether this range of rock types can be related by fractional crystallization or magma mixing. The completed assignment includes four Harker plots and the answers to the questions.



What To Do:

1. Your have been given a spreadsheet containing the chemical data for rock samples from Thingmuli, and some minerals. You have also been given graph paper.

2. Create silica variation diagrams (Harker plots) of the following: (a) MgO versus SiO_2, (b) CaO versus SiO_2, (c) Na_2O versus SiO_2, and (d) K_2O versus SiO_2. Include the minerals (oliv, cpx, plag) on your plots with a different symbol (i.e., make them a different data series from the rock analyses). Make certain the axes of each plot are labeled correctly, and that they are scaled appropriately.

3. Based on: (1) your knowledge of mineralogy and igneous petrology (i.e., that different minerals crystallize at different temperatures as a magma cools), (2) the geologic background data you are given about Thingmuli (i.e., the phenocrysts that are present), and (3) the trends you see on your Harker plots, answer the following questions. This will be easiest to do if you make all of the plots before you start thinking about the questions.

Questions:

1. Look at your Harker diagrams for MgO and CaO. What mineral(s) are responsible for the chemical trends shown by these elements as silica increases?

2. What type of trend would an incompatible element have on a Harker diagram? Do any of the elements you plotted display incompatible behavior? If so, which one(s)?

3. Sodium and potassium are both alkali elements, but they have different trends on these plots. Describe how the trends of these elements differ in appearance. Why does this difference occur?

4. In what order (from first to last) did the minerals plag, oliv, cpx in this magma begin to crystallize? Explain how you can tell from a Harker diagram when a mineral begins to crystallize.

5. *Bonus Question.* It is rare in nature to find primary magmas that contain more than about 15 weight percent MgO, and MgO decreases during fractional crystallization. Yet somehow sample 25 from Thingmuli contains over 20% MgO. Looking at your CaO and MgO diagrams, how might you explain the unusually high MgO concentration in this sample?

6. *Bonus Question*. Name each rock sample.