CHAPTER 6

CONCLUSIONS AND FUTURE WORK

Conclusions

Work done on the Eyjafjöll Volcanic System has produced the following conclusions:

1) Simple fractional crystallization of parent material Ey-49 can produce most of the observed compositions in Eyjafjöll. Application of higher pressure crystallization where clinopyroxene is the first liquidus phase is indicated by the variations seen in CaO and petrographic data from Eyjafjöll rocks. It is further supported by the high Al:Ti ratios of the clinopyroxene phenocrysts. Presence of water during crystallization is indicated by the difference between the real data and the modeled data for the Al_2O_3 diagrams which can be explained by lower crystallization temperatures for plagioclase. Further support for hydrous conditions comes from comparison with surrounding systems, all with moderate to high water contents. Observed scatter on all diagrams can be explained by two processes. The first process is accumulation in varying amounts of phenocrysts of olivine, clinopyroxene, plagioclase and titanomagnetite. The second process is mixing of magmas which are at different stages of evolution. Chemical (increased Al_2O_3 and Sr) and petrologic evidence (multiple populations and textures for plagioclase phenocrysts) suggests plagioclase accumulation is an important process for most of the Eyjafjöll samples.

2) High helium isotope data (18 to 19 x atmospheric) shows a hotspot component dominates the source for this system. This is corroborated by the uniformly LREE-enriched patterns for all the samples analyzed. The uniformity of the helium ratios relative to age of the rocks suggests no change

in source composition through time. The similarity of the values for alkalic and tholeiites suggest that crustal assimilation is not the mechanism which provides the alkalic character to this system.

3) Gaps in ages can be explained by removal of material during transgressive glacial events (which have been dated elsewhere in Iceland as occurring at approximately 160 and 400 Ma) and by change in climate (becoming colder with more ice) prior to and during the ice ages, when hyaloclastites (not sampled) dominate the eruptive material.

4) FeO and MgO variations compared with models of mantle melts at varying pressures suggests that primary melt segregation occurs at 12-15 Kbar (36 to 45 km depth) from a spinel lherzolite (as described by Kushiro et al., 1968) source composition. Melt is probably small, around 3%. This is corroborated by geophysical evidence which shows melts below Eyjafjöll starting at 15 km depth and the intersection of the geothermal gradient with the mantle solidus at approximately this same depth and pressure. The REE trends also indicate a spinel lherzolite source melting at small degrees, with minor amounts of a phase with which HREE are compatible (most likely garnet) creating the LREE enriched slopes.

5) The description of the SEVZ as a propagating rift tip holds true in regards to Eyjafjöll data, fitting all the criteria employed by Christie and Sinton, (1981) in their description of the Galapagos propagator. The only major difference is the length of ridge over which the propagator extends (greater for the SEVZ). This suggests that changes in cooling rate (decreasing from tip) and magma supply (increasing from tip) occur over larger regions than in the Galapagos. This is possible because of the slow spreading rate of Iceland (decreased magma supply) and the presence of a large and wide

transform zone (South Iceland Seismic Zone) intersecting the tip of the SEVZ propagator and increasing cooling rate.

6) Eyjafjöll lies right behind the tip of the propagator, and has a low magma supply and rapid cooling rate. This has evolved over time, however. In the earliest history of this system, compositions were limited to alkali basaltic material with little fractional crystallization. In more recent times, however, the compositions have become more varied, with flows representing nearly every level of crystal fractionation, from 0 to 75%. This suggests a decrease in cooling rate and/or increase in magma supply during the evolution of Eyjafjöll and the consequent formation of more stable magma chambers. (Further increasing the supply and decreasing the cooling rate should create a more steady-state magma chamber system with constant recharge and therefore minimal differentiation.) There is also evidence (alkalic character and little fractionation) that in its earliest history, Eyjafjöll was most likely near the tip of the propagator.

7) The SEVZ is propagating southward at a rate approximately equal to 0.8 ± 0.3 cm/yr. This is a very rough estimate averaged over the lifetime of the Eyjafjöll Volcanic System and assuming that it originally was the tip of the propagator. This propagation is accompanied by changes in cooling rates (decrease) and magma supply (increase) and consequently eruptive phenomena and compositional data.

Future Work

Future work that would increase the understanding of the Eyjafjöll Volcanic System and perhaps answer some of the questions brought up in this thesis includes:

A) Determination of water content for plagioclase phenocryst-rich rocks of the Eyjafjöll Volcanic System will help in calculations of whether or not these crystals will float in the magmas. As well it will help quantify the effects of plagioclase liquidus temperature suppression, and better determine the crystallization sequence. Perhaps it might be useful in determining how the system has changed over time as well, if it is discovered that water content decreases or increases with time. This determination could come best through analysis of hyaloclastites (fresh glass).

B) Further microprobe work on some of the inclusions could help support the idea of high pressure fractionation .

C) Better mapping of the system should be done, most particularly regarding presence of lava flows on the northern side of the system which has been mapped primarily as hyaloclastites. Once properly mapped, these flows should then be sampled.

D) Sampling and analysis of hyaloclastites would be of further help in determination of compositional changes of the system through time. The hyaloclastites might be even more useful than the whole rocks for comparison with the modeled trends, as they contain no crystals. Dating of these rocks is impossible by K-Ar methods, but if other methods exist it would be quite beneficial to discover if these rocks can account for the gaps in activity seen by the flows. (This could also help constrain the dates of past ice ages in Iceland).

E) Further isotope work should be done, most specifically $\partial^{18}O$ and Sr ratios in order to better constrain the source material composition and how much, if any, is contributed by undepleted mantle. It would also be instructive to see how these change through time, and with alkalinity. Finally this might help determine whether any small amounts of crustal assimilation are occurring.

F) Dating of Vestmannæyar drill cores, especially at the base of the present Vestmannæyar Volcanic System alkalic material would better constrain rates of propagation. Also, any dates for corresponding geochemical trends for any of the other volcanic systems of the SEVZ would also help better define the propagating rate.

G) More precise ilmenite-magnetite equilibrium determinations should be done in order to discover with more certainty what the oxygen fugacity conditions are for this system, especially as NNO seems to be what present data indicates, and yet this value has never before been attached to oceanic basalts.