



## Constraining Major Element Fractionation in an Alkali Gabbroic Sill using Mass Balance Modelling.

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The Ringkallen hill gabbro (RHG) is an  $\sim$ 225m thick layered alkali gabbroic sill in central Sweden. It is a part of the much larger  $\sim$ 1.26 Ga Ulvö Gabbro complex, a series of 200-300m thick saucer-shaped alkali gabbroic intrusions with diameters of 30-80km. The anorthite (An.) content of plagioclase decrease gradually from  $\sim$ 70% at the margins to  $\sim$ 45% at the Sandwich Horizon, and the bulk composition of the RHG calculated from whole-rock analyses closely resembles the chilled margin composition, suggesting that the intrusion crystallised from a single pulse of magma in a closed system. Mass balance calculations were used to calculate the evolution of the supernatant liquid to the point where 90% of the intrusion had crystallised. The results show a successive decrease in the concentration of  $\text{Al}_2\text{O}_3$  and  $\text{MgO}$ , an increase in  $\text{MnO}$ ,  $\text{TiO}_2$ ,  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$ , while the concentrations of  $\text{SiO}_2$  and  $\text{CaO}$  remain stable. The major element variations of the calculated supernatant liquid were used to constrain the proportion between cumulus phases and crystallising liquid fraction (CLF). By iteratively changing the bulk partition coefficient by varying the proportion between the cumulus phases and the CLF for a given interval, the best estimate was found using root mean square method. The results indicate that the intrusion crystallised with a CLF of  $\sim$ 0.8 for the first 50% of crystallisation, and the next 30% had an estimated CLF of  $\sim$ 0.6 and the final 10% had  $\sim$ 0.8 CLF. At the point where 90% of the intrusion had crystallised, the stratigraphy contained only  $\sim$ 25% cumulus minerals. In strong contrast, simulation of the stratigraphic decrease in An. content of plagioclase by thermodynamic modelling suggests more than 70% fractional crystallisation. The strong stratigraphic decrease of plagioclase An. content is inconsistent with the modest change of the An. content of the calculated liquid. This suggests that the linear partitioning in the binary plagioclase system for these alkali gabbroic intrusions may be different from experimental results.