Geophysical Research Abstracts
Vol. 12, EGU2010-7097, 2010
EGU General Assembly 2010

Tracking intercumulus crystallisation at the Skaergaard intrusion using immobile trace elements: Evidence for liquid immiscibility

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A key target in the study of a layered intrusion is to constrain the liquid line of descent of the magma. However, the liquid line of descent of the intercumulus liquid is rarely considered, and is often assumed to be equivalent to that of the bulk magma. If the bulk liquid and interstitial liquids follow the same liquid line of descent, then intercumulus zoning profiles should be similar to the cryptic compositional variations seen with stratigraphic height. Because of extensive sub-solidus and diffusional changes that occur in slowly cooled rocks, clues to the composition of the intercumulus liquid can only be obtained using very slowly diffusing trace elements and components; the anorthite content of plagioclase and its Ti concentration are ideal in this respect.

For the Skaergaard Intrusion, east Greenland, anorthite content (XAn) decreases monotonically as temperature decreases and the liquid becomes more evolved. The Ti content decreases in both cumulus and intercumulus plagioclase, as a result of falling liquid Ti after Fe-Ti oxides start to crystallise. However, Ti-XAn zoning in intercumulus plagioclase does not match the cryptic variations observed with increasing stratigraphic height, which demonstrates that the cumulus and intercumulus liquid lines of descent are not equivalent. In the intercumulus plagioclase, different trends develop adjacent to fine-grained, mafic and felsic interstitial pockets, which represent the crystallised products of trapped, late-stage immiscible liquids. The zoning trends vary systematically as a function of stratigraphic height and spatial location within the intrusion. The distribution and composition of the reversed plagioclase are used to infer the spatial distribution and differential movement of interstitial immiscible liquids throughout the Layered Series, and processes affecting the intercumulus liquid.