Hydrothermal Sub-solidus Reequilibration of Granites: An Inside View Using Multiple Feldspar Replacement Reactions

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The hydrothermal alteration of granites indicates considerable interaction between external fluid convection systems and crustal rocks as shown by oxygen isotope analysis (Taylor, 1977). Recent studies on granitic rocks frequently use magmatic processes to explain their mineralogy and geochemistry, but neglect to consider the effects of pervasive, large-scale fluid-rock interactions. We present work on granites from the Oskarshamn Region, Sweden with particular emphasis on multiple feldspar replacement reactions around shear zones, allowing an in depth understanding of sub-solidus reequilibriation of granitic rocks with hydrothermal fluids. Detailed scanning, transmission electron microscopy and Raman spectroscopy studies of plagioclase reveal a wide variety of replacement reactions. The most unaltered granite contains plagioclase crystals which are highly porous and include crystallographically continuous pristine microcline inclusions. The texture suggests that the plagioclase is already secondary and may be a replacement product of the microcline. Plagioclase is progressively replaced by albitic feldspar along polysynthetic twins and intergranular fractures. The chemical interface between plagioclase and albite is sharp on the nanometre scale, and the crystallographic orientations of plagioclase and albite are coincident within less than a degree. These characteristic features suggest an interface-coupled dissolution-reprecipitation replacement mechanism (Putnis & Putnis, 2007). Sericite is closely associated with the porosity in the albitised plagioclase. Transmission electron microscopy reveals a complex relationship between the albite and sericite. The phenomenon of reddening in the vicinity of fractures in the granite is contemporaneously related to the K-feldspatisation of sericite which is restricted to the altered plagioclase. Infiltration of heated K-bearing fluid is one possible mechanism for replacing sericite by orthoclase in a pseudomorphic manner. Furthermore, a lithostatic to hydrostatic pressure change, owing to fracturing, favours the feldspar reaction. Sub-micron size hematite precipitation within micropores in contact with the replacement front between the sericite and the product orthoclase results in the red coloration observed. The complex associations of a variety of feldspar-fluid reactions indicate that the replacement reactions may be due to multiple fluid infiltration events and that such granites are secondary, sub-solidus products of a parent rock with a different mineralogy. Therefore large-scale reequilibrations of granites through gigantic hydrothermal convection systems should be taken into account.

References

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