Fluid evolution and mineralogy during multi-stage hydrothermal alteration of quartz-depleted granites (episyenites)

REGINA FREIBERGER[1] & LUTZ HECHT[2]

[1] Institut für Mineralogie, Petrologie und Geochemie, Universität Freiburg, Albertstr. 23b, 79104 Freiburg, Germany
[2] Institut für Mineralogie, Museum für Naturkunde, Humboldt-Universität zu Berlin, Invalidenstr. 43, 10115 Berlin, Germany

Episyenites are quartz-depleted granitic rocks that have the chemical composition similar to syenites. Episyenites do not have a magmatic origin, but are formed through late-magmatic to subsolidus alteration. In the German Fichtelgebirge, episyenites are known from several localities, forming spatially restricted lensoid to pipe-shaped bodies within Hercynian granites. Frequently, quartz-depletion is associated with, or subsequently followed by polyphase alteration of different types (albite, chlorite, sericite, hematite, fluorite, pyrite, stilbite and secondary quartz). Episyenites may even be associated with U-, Au- or Sn-W-mineralization. Although dissolution of quartz produces a porous rock, former magmatic textures are generally well preserved. Cavities are filled with later formed minerals, including chlorite, quartz and calcite. Sharp contacts between the altered rock and the fresh granite are characteristic. Sometimes there is a small transition zone with corroded quartz. Outside the quartz-depleted zone, large alteration halos are developed (e.g. chloritization), in which no quartz dissolution is observed.

The geochemical mass transfer during episyenitization is mainly characterized by the depletion of Si, but almost all major and trace elements may show large mobility (including REE), depending on the associated and subsequent alteration type. Chlorite geochemistry shows decreasing Fe and Al^{IV} from early to late chlorite, which correlates with decreasing temperature. Fluid inclusion studies indicate that aqueous fluids causing quartz dissolution have relatively low salinities, but high homogenization temperatures (T_h) with a minimum T of 200 to 300°C. Fluids causing later alteration phenomena have higher salinities and lower T_h.

Discussion of quartz dissolution conditions must include changes in T, P, pH and fluid salinity, because silica solubility strongly depends on these parameters. A silica undersaturated fluid is necessary for quartz dissolution within granitic rocks. For most natural hydrothermal conditions, increasing pH, T, P and salinity leads to an increase in silica solubility. However, under low pressure, silica solubility increases slightly with decreasing temperature (above the critical point of water). The timing of quartz dissolution in relation to the emplacement of the host granitic rocks is still a matter of debate.

High precision U-series isotope measurements of East Scotia back-arc basalts using single-collector sector-field icp-ms

S. FRETZDORFF [1], C.-D. GARBE-SCHÖNBERG[1], J. FIETZKE[1], R.A. LIVERMORE[2] AND P. STOFFERS[1]

[1]Institute of Geosciences, University of Kiel, Olshausenstr. 40, 24118 Kiel, Germany (sf@gpi.uni-kiel.de)
[2]British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, UK

^{238}U-^{230}Th disequilibrium data are particulary useful to examine the process of recent (< 350 ka) fluid input from the subducting slab into the mantel source of arc lavas. Most island-arc lavas show ($^{238}U/^{230}Th$) > 1 which has been attributed to addition of an U-rich slab derived fluid to their mantle source. Very limited data exists for the U-series isotopic composition of back-arc magmas. Because of the transitional character of most of the back-arc basalts from MORB to arc-like it is not clear if recent fluid input will dominate to control the ^{238}U-^{230}Th disequilibrium in the melts.

Here we present high precision U-series isotope data of an active back-arc spreading center, the East Scotia Ridge, determined with a newly developed procedure using sector-field inductively coupled plasma mass spectrometry (ICP-SFMS, Micromass PlasmaTrace 2) coupled with a desolvating micro-nebulizer sample introduction system (Cetac MCN 6000 with PFA spraychamber). The procedure involves conventional ion-exchange column separation with ^{229}Th and ^{236}U spikes. In general, the abundance sensitivity is critical for accurate dterminations of $^{230}Th/^{232}Th$ ratios which are very low in rock samples (10^{-6}). The continously adjustable mass resolution of the PT2 instrument is advantageous for compromising abundance sensitivity (< 3 x 10^{-7} at 1100RP) with maximum transmission. Ionization efficiency (ions counted/ions introduced) is up to 1% (for U at 400RP) allowing precise measurements of $^{230}Th/^{232}Th$ with ± 2.5 (5) ‰ (2_) for 0.1 (0.01) pg ^{230}Th. Linear working-range of the detector and wash-out protocols had to be carefully optimized to avoid analytical bias. Results for international rock standards show good accuracy within the error of accepted values (($^{230}Th/^{232}Th$): TML 1.079 ± 0.008, JB-1 0.552 ± 0.006, AGV-1 0.921 ± 0.016).

The isotope ratios of the East Scotia Ridge lavas span a range in ($^{230}Th/^{232}Th$) and ($^{238}U/^{232}Th$) larger than reported of any other individual back-arc region. Most of the back-arc lavas have lower ($^{238}U/^{230}Th$) < 1 and are thus similar in composition to mid-ocean ridge basalts (MORB). Lavas from the centre and southern part of the back-arc have high ($^{238}U/^{230}Th$) ≥ 1, implying a recent addition of a U-rich slab-derived fluid.