Microanalytical characterisation of hydrothermal fluid interaction with feldspar phenocrysts, Alta andesite, Comstock Lode region, Nevada

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The Ag-Au Comstock and related lodes are hosted mainly within the Miocene Alta andesite, and are associated with Miocene hydrothermal fluids dominated by a meteoric water component (Taylor, 1976). A whole-rock $\delta^{18}O$ study of country rock samples from the extensive 1880s collection of G.F. Becker and F.R. Reade (Becker, 1882) has produced a three dimensional picture of the paleo-hydrothermal convective fluid flow regime (Criss et al., 2000). A sub-suite of samples from the Sutro Tunnel adit documents progressive alteration, with whole rock $\delta^{18}O$ values ranging from +6 permil in distal, relatively fresh andesite to –0.2 permil within 400m of the Coryell Lode (Criss and Champion, 1991). Igneous feldspar phenocrysts show systematic alteration and replacement textures with decreasing whole rock $\delta^{18}O$ along the adit.

Progressive hydrothermal alteration of the feldspars from the Sutro Tunnel adit is well illustrated by a combination of backscattered electron, cathodoluminescence and Time of Flight Secondary Ionisation Mass Spectrometry imaging. Alteration of igneous zoned feldspars (An_{35-55}) progressed via increasingly complex reaction rims, cross-cutting calcite ± quartz veins, and recrystallisation of feldspar associated with cracks filled with fluid inclusions. Within 400m of the Coryell Lode, feldspar phenocrysts have been recrystallised to albite, labradorite, calcite, sericite and quartz. Ion microprobe $\delta^{18}O$ data for feldspar show no evidence for O diffusion from the hydrothermal fluid within zoned igneous phenocrysts. By contrast, the replacement feldspar phases carry the lighter $\delta^{18}O$ values of the hydrothermal fluid.

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Decoupling of ^{226}Ra and Si in surface waters of the Atlantic Sector of the Southern Ocean

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^{226}Ra (half-life 1600 years) has been used as a tracer for ocean circulation and is rated a bio-intermediate element due to its participation in the biogeochemical cycle. Based on the similarity of vertical water column profiles of ^{226}Ra and Si, it has been hypothezised that siliceous tests act as a main carrier phase for ^{226}Ra (e.g. Ku et al. 1970). However, direct evidence for incorporation of ^{226}Ra by silicate-forming plankton is very scanty. Measurements on different plankton species as well as controlled tank experiments yield ambiguous results.

Here we present a high-resolution N-S-transect for ^{226}Ra and Si in surface waters of the Antarctic Circumpolar Current (ACC) and the Weddell Gyre (WG) at 20° E. Both elements show a general increase from north to south with the highest values in the region where upwelling Circumpolar Deep Water enters the WG. ^{226}Ra approximately doubles from 8 dpm/100kg to 17 dpm/100kg. Si concentrations reach maximum values of 70 µmol/l south of the Polar Front (PF). The relationship between both parameters is rather weak. The high resolution sampling shows that local variations in the Si concentrations are not mirrored by changes in the ^{226}Ra activity. Particulate uptake of ^{226}Ra continues north of the PF after the near depletion of Si, indicating a decoupling between diatom productivity and the ^{226}Ra distribution in the Southern Ocean.

We propose that acantharians, $SrSO_4$-forming radiolarians, might act as a major carrier phase for radium in the upper ocean. They have recently been attributed an important role in the biogeochemistry of Ba (Bernstein et al. 1998). Based on the above observations and the geochemical similarities of Ra and Ba, it seems likely that the biogeochemistry of radium in the upper ocean is equally affected by acantharians as Ba is. For the open ACC, acantharian abundances can reach 30 000 individuals per m^3. The continuing depletion of ^{226}Ra after the exhaustion of Si north of the PF could indeed be linked to the increasing importance acantharians gain in the marine productivity cycle in subantarcic and subtropical waters.

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