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The chemical evolution of a magmatic-hydrothermal system related to a Sn-W mineralisation

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Introduction

The chemical evolution from late-stage pegmatitic to early hydrothermal stages was studied on silicate melt and aqueous fluid inclusions in quartz from granite pegmatites related to the important tin-tungsten mineralisation of the Variscian Ehrenfriedersdorf Complex. Two different types of silicate melt inclusions exist namely type A and B melt inclusions [1] as well as a suite of coexisting and later-stage aqueous fluids [2]. The melt inclusions are interpreted as two coexisting melts which were trapped simultaneously on both sides of a two melt solvus. Aqueous fluids display boiling features. Major and trace element compositions were obtained by SR XRF analysis which allows non-destructive simultaneous analysis of elements with Z between 20 and 92 of unopened fluid and melt inclusions in the ppm to wt% range to trace the element enrichment processes during phase separation and fractional crystallisation.

Melt inclusions

Both melt inclusion types display a positive correlation of Cs and Rb with Nb, Ta and Sn. Cs and Rb contents range between 10 and 2000 ppm and 10 and 7000 ppm, respectively with highest values in the type B melt inclusions. Maximum Sn concentrations (range: 10 – 1550 ppm) were found in type A melts. Nb and Ta concentrations and variations are by an order of magnitude lower with Nb/Ta ratios below 0.25. REE are always absent documenting the high grade of differentiation of the granitic melts.

Fluid inclusions

The important metals are already enriched in fluids of the pegmatite stage. Cu is the element most efficiently extracted from the pegmatitic melts. Ore-forming processes take place at the hydrothermal stage: fluids of the initial hydrothermal stage transported mainly Cu and Sn (up to 2700 ppm) as economically important elements, along with As and some Nb (concentrations below 700 and 50 ppm, respectively). Hydrothermal brines transported mainly Zn (up to 6250 ppm) along with Fe and Mn (up to 10500 and 2750 ppm, respectively), with only minor amounts of Cu and Sn (below 240 ppm).

References

- [1] Thomas, R., Webster, J.D. and Heinrich, W. (2000) *CMP* **139**, 394-401.
 [2] Thomas, R., Förster, H.-J. and Heinrich, W. (2003) *CMP* **144**, 457-472.

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Is there a genetic link between iron oxide-apatite and Cu deposits, Norbotten, Sweden?

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Introduction

The iron oxide-apatite and spatially related copper deposits of Norbotten, Sweden have been suggested to have linked genetic mechanisms, and form part of the iron oxide-copper-gold class (IOCG). Recent developments in the bulk analysis of fluid inclusions for cation and anion chemistry and Cl isotope ratios provide an ideal route for investigating fluid source in this environment. We report the results of an investigation of quartz veins from Fe-oxide bodies and Cu deposits in the Norbotten region, carried out as part of the EU-RDFs Georange program.

Fluid inclusions

All the samples studied contain hypersaline brine inclusions, with a salinity range of 32 to 38wt. % NaCl eq. in Fe-oxide bodies, and of 38 to 47wt % NaCl eq. in Cu deposits. These are typically accompanied by CO₂-rich inclusions. The inclusion assemblage from the Aitik deposit is considerably more complex, with coexisting hypersaline and CO₂-rich aqueous inclusions. Pressure estimates for the trapping of the fluids range from 2-3kbars.

Halogen and major cation fluid inclusion geochemistry

A bulk crush leach study was carried out on samples from both deposit deposits. Overall the analyses suggest that the mineralizing fluids in the Fe-oxide and Cu deposits are NaCl-CaCl₂-H₂O-CO₂ hypersaline brines. The Br/Cl elemental compositions for the bulk of the samples range from 0.0004 and 0.0016 and are broadly consistent with a magmatic origin for the fluids. However, two samples, including the sample from Aitik, are more Br enriched (or Cl depleted) than typical magmatic-hydrothermal fluids and may suggest a component of metamorphic fluids in the mineralising system.

Overall, there is no systematic variation in the halogen and most of the cation elemental ratios between the Fe-oxide deposits and the Cu deposits. However, the Fe-oxide mineralizing fluids do appear to have lower Fe/Mn and Ca/Ba ratios than the Cu deposits. Preliminary work suggests evolution from late stage fluids associated with Fe-oxide deposits to more saline fluids associated with Cu-deposits. The Aitik deposit, and possibly other shear zone hosted deposits in the area, formed from distinct fluid types, although aqueous-carbonic immiscibility still appears to be a major process.