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Concentration of metals in ore-forming fluid responsible for hypothermal vein-type tungsten deposit: insight from quantitative analysis of fluid inclusions by synchrotron X-ray fluorescence

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Introduction

Hypothermal vein-type deposits are major source of W and Sn. This type mineralization is believed to have associated with deep-seated S-type magma, and is formed from weakly acidic, reduced hydrothermal solutions close to equilibrium with their host rocks. The waters are moderately saline (<10 wt.% NaCl equiv.) and are largely magmatic origin. However, chemical compositions of ore-forming fluid especially heavy metal contents are poorly known. In this study, we clarified metal concentrations of ore-forming fluid and its temporal change during mineralization of the W-Sn veins at the Takatori deposit.

Samples

Veins of the Takatori deposit are characterized by the mineralization of early wolframite-topaz-fluorite-muscovite stage, middle sulfides-fluorite stage, late cassiterite stage, and final rhodochrosite-calcite-clay mineral stage. Quartz is the dominant gangue mineral and accompanied through all stages. Fluid inclusions trapped in quartz are two-phase (liquid and vapor) type. Based on the examination for cutting and crossing relationship among trails of pseudosecondary inclusions, temporal generation of fluid inclusion was determined.

Analytical method

These inclusions were analyzed for their metal contents. Doubly polished section of quartz containing fluid inclusions was radiated by synchrotron X-ray at BL-4A, Photon factory, KEK. Intensities of fluorescent X-ray were applied to the theoretically obtained correction equation [1] which gives relationship among concentration of metal in fluid inclusion, intensities of X-ray fluorescence, depth of fluid inclusion from the surface of quartz crystal and pass length of X-ray in inclusion fluid. Concentrations of metals such as W, Fe, Mn, Cu and Zn were successfully determined.

Results

Photomicrograph and X-ray images of W, Fe and Mn for early stage fluid inclusion are shown in Fig. 1. Early stage fluids are characteristic for very high metal concentration; 3700-1300 ppm W, 6200-4100 ppm Fe, 1800-1000 ppm Mn, 3000-1500 ppm Cu and 2900-1800 ppm Zn. However, the metal concentration suddenly dropped to 580-50 ppm Fe, 280-50 ppm Mn, 130-50 ppm Cu and 150-50 ppm Zn in middle to late stages. Tungsten was not detected in fluids of this stage. Late stage fluids contain only Mn of 230-50 ppm.

Our results indicate that the ore-forming fluid at the early stage was higher in heavy metal concentration than those of later stages. Mineralization of wolframite, the main ore mineral in this deposit, has been restricted within the early stage, which was controlled by metal contents in ore-forming fluids.

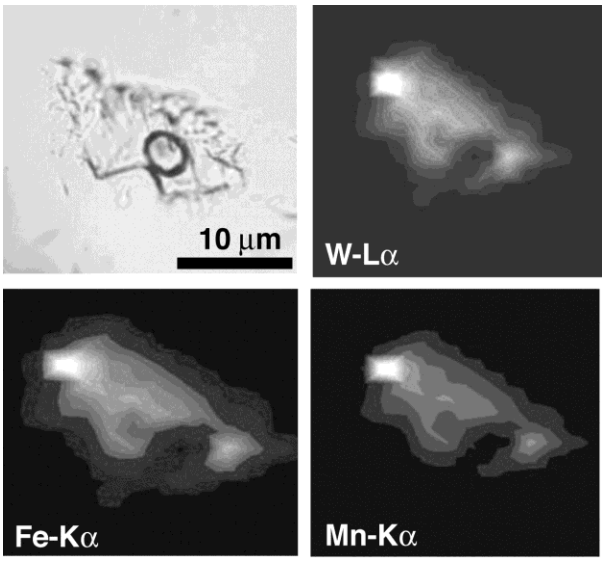

Figure 1. Photomicrograph and SXRF images of early stage fluid inclusion.

Reference

[1] H. Nagaseki et al., Eur. Jour. Mineral., 18, 309 (2006)

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