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Oxygen isotope evidence for input of magmatic fluids and precipitation of Au-Ag-tellurides in an otherwise ordinary adularia-sericite epithermal system in NE China

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Abstract

Tellurium-rich (Te) adularia-sericite epithermal Au-Ag deposits are an important current and future source of precious and critical metals. However, the source and evolution of ore-forming fluids in these deposits are masked by traditional bulk analysis of quartz oxygen isotope ratios that homogenize fine-scale textures and growth zones. To advance understanding of the source of Te and precious metals, herein, we use petrographic and cathodoluminescence (CL) images of such textures and growth zones to guide high spatial resolution secondary ion mass spectroscopy (SIMS) oxygen isotope analyses (10 μm spot) and spatially correlated fluid inclusion microthermometric measurements on successive quartz bands in contemporary Te-rich and Te-poor adularia-sericite (-quartz) epithermal Au-Ag vein deposits in northeastern China. The results show that large positive oxygen isotope shifts from –7.1 to +7.7‰ in quartz rims are followed by precipitation of Au-Ag telluride minerals in the Te-rich deposit, whereas small oxygen isotope shifts of only 4‰ (–2.2 to +1.6‰) were detected in quartz associated with Au-Ag minerals in the Te-poor deposits. Moreover, fluid-inclusion homogenization temperatures are higher in comb quartz rims (avg. 266.4 to 277.5 °C) followed by Au-Ag telluride minerals than in previous stages (~250 °C) in the Te-rich deposit. The Te-poor deposit has a consistent temperature (~245 °C) in quartz that pre- and postdates Au-Ag minerals. Together, the coupled increase in oxygen isotope ratios and homogenization temperatures followed by precipitation of Au-Ag tellurides strongly supports that inputs of magmatic fluid containing Au, Ag, and Te into barren meteoric water-dominated flow systems are critical to the formation of Te-rich adularia-sericite epithermal Au-Ag deposits. In contrast, Te-poor adularia-sericite epithermal Au-Ag deposits show little or no oxygen isotope or fluid-inclusion evidence for inputs of magmatic fluid.

Keywords: Quartz, SIMS, oxygen isotopes, fluid inclusions, magmatic fluid, Te, epithermal Au-Ag deposits