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Fluid evolution of low-sulfidation epithermal gold deposit

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Gold, As, Sb, and other contents in fluid inclusions and hydrothermal minerals such as quartz obtained from the Hishikari low-sulfidation epithermal gold deposits, SW Kyushu, Japan were investigated by Laser Ablation ICP-MS at ETH Zurich, Switzerland.
Two different veins were sampled from the underground mining area; high-grade (>40g/t Au) vein within the bonanza zone (+25mL) of the Sanjin vein system and low-grade (<4g/t Au) vein at the lowermost part (-20mL) of the Honko vein system. The veins show banding structure resulting from different mineral assemblages which are composed mainly of quartz and adularia. The highest gold part occurs near the most marginal (earliest) band in the both veins. In the high grade vein, the banding can be divided into 10 bands with saponite, calcite, and prehnite which is occasionally dominant. The low-grade vein is characterized by a marginal euhedral adularia and central (later) fine-grained quartz bands. The adularia grows on host rocks towards the center of the veins as the earliest stage of ore formation.
The early stage quartz crystals in high grade vein contain higher amounts gold with an average 0.53 ug/g as compared with the later ones showing less than 0.02 ug/g. The area possessing higher gold content is consistently located at the center of the grain and shows the brightest CL image. Gold nuggets are sporadically observable by SEM in the areas; indicating the core of the earlier quartz has a micron- to nano-size gold.
Fluid inclusions have a narrow variation in average homogenization temperatures ranging from 206℃ to 255℃ and salinity (<1.0 equiv. wt% NaCl) through the all bands. Fluid inclusions of the earliest quartz and adularia in low and high grade veins contain gold with a maximum concentration of several ug/g Au. Some fluid inclusions indicate several tens ug/gAu, which are probably caused by packed invisible nano-scale gold particles due to accidentally trapping after gold precipitation. Gold content in fluid inclusions as well as hydrothermal minerals gradually decrease from marginal (early stage) to central (later stage) parts of the veins. Besides, As and Sb contents in fluids become higher than those of the early ones, although those of quartz are more likely constant.
The accurate quantification of gold and other elements in fluid inclusions in the hydrothermal minerals by LA-ICP-MS can provide constraints for gold source: fluid inclusion and quartz are the most enriched in gold at the early stage, but deplete in the later stages, implying early "magmatic component dominant fluid" was enriched in gold, but meteoric water was depleted in Au. Arsenic and Sb in the early stage fluids are probably transported by a vapor-rich fluid ascending to more elevated part of the hydrothermal system such as paleo watertable, and recycled in the later stage due to a meteoric water circulation.

Keywords: Low-sulfidation epithermal gold deposit, LA-ICP-MS, Fluid inclusion, Quartz, Aduralia