Tracing the source and evolution of the Osborne IOCG ore fluids

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Quartz samples selected from the Osborne IOCG deposit, 155 km south of Cloncurry, in the Mt Isa Inlier of NW Queensland, host complex assemblages of fluid inclusions in which a fluid evolution with at least two distinct compositional groups can be identified.

Primary multi-solid >500^{o}C fluid inclusions (MS) with ultra-high salinity (<64 wt% NaCl equiv.), are correlated with iron-oxide precipitation. Secondary >350^{o}C liquid-vapour ± halite fluid inclusions (LVD) with high salinity (20-40wt% NaCl equiv.), lie on trails that emanate from chalcopyrite and under CL are shown to be hosted by a second generation of quartz. They are interpreted to relate to Cu mineralisation.

PIXE and LA-ICP-MS measurements indicate high concentrations of Fe and Zn in both MS and LVD fluid inclusions (<1 wt % and <0.2 wt % respectively). However, the Fe/Zn ratio is highest in MS inclusions, with the secondary fluid inclusions being enriched in Zn and Ca. Both fluids have Cu concentrations of <3000 ppm.

Semi-selective thermal decrepitation, allows simultaneous determination of Cl, Br, I and noble gas isotopes via noble gas mass spectrometry of irradiated samples (Ar-Ar methodology). This technique documents a spread in molar Br/Cl ($0.3\text{-}2.4\times10^{-3}$) and I/Cl ($3\text{-}26\times10^{-6}$) that define a trend indicative of halite dissolution by either crustal bittern brines or magmatic fluids.

The ^{40}Ar/^{36}Ar values of MS and LVD inclusions are uniformly low with a single analysis at 2,200 and the majority at values of <1,000. These values are most similar to those determined in sedimentary bittern brines and provide strong evidence for a crustal fluid origin. Pegmatitic veins include primary MS inclusions with a maximum ^{40}Ar/^{36}Ar value of 17,000 this is well above that of the ore fluids and models invoking magmatic ore fluid sources are not supported.

Late-stage veins are dominated by LVD fluid inclusions that exhibit a shift in Br/Cl and I/Cl values towards seawater-like compositions, relative to the earlier assemblages. They are interpreted to be later than the secondary fluid inclusions in main-stage samples and may represent the involvement of a third fluid. The temporal decrease in salinity may indicate that dilution/fluid mixing was an important process for ore precipitation.