Copper nanoparticles along fluid inclusion trails in hematite

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Interaction between minerals and hydrothermal fluids can lead to pseudomorphic replacement if the dissolution and precipitation rates are coupled to one another (CDRR). Such reactions are mediated by a reaction interface along which transient porosity occurs and within which mineral inclusions can precipitate as products of fluid-mineral interaction [1]. Hydrothermal hematite (Hm) from granite-hosted, iron-oxide copper gold (IOCG) deposits such as Olympic Dam (OD), South Australia, display a prominent geochemical signature comprising U-Pb-W-Sn-Mo (granitophile elements; GS) [2]. Such a signature can change within grains that show partial pseudomorphic replacement of Hm resulting in newly-formed Hm that features either pores, and/or inclusion-attached pores. The geochemical signature of the new-formed Hm is always distinct from that of the precursor Hm [2].

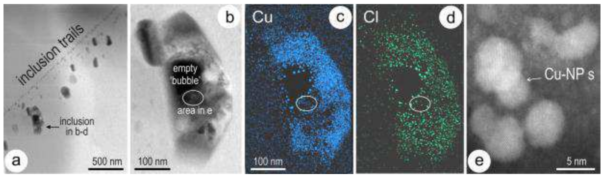

Fig. 1. HAADF-STEM images (a, b, e) and EDX maps (c, d) showing inclusion trails, their morphology and selected composition. Cu-NPs are shown in (e). Images and maps obtained at 200 kV.

FIB-prepared TEM foils cut across unusual Cu-As-rich zones in one such GS-bearing Hm from OD were analysed by HAADF-STEM imaging and EDX-STEM mapping. Results show the presence of nm- to µm-scale composite inclusions along trails parallel to crystal zoning (Fig. 1a). Coarser inclusions contain empty 'bubbles', and display elements typical of fluid inclusions (e.g., Cl, Na, K, C; Fig. 1b-d). Metal-bearing (Cu, As, Mo, W, Sn) nanoparticles (NPs) are identified within such inclusions. The presence of Cu-NPs (Fig. 1e) is concordant with the sulphide-poor environment for the analysed Hm. We suggest these metal-bearing NPs formed during CDRR-driven replacement of GS-bearing Hm.

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