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Late metallogenetic processes in the Suurikuusikko gold deposit, Kittilä mine, Finland

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The Suurikuusikko orogenic gold deposit at Kittilä is located in the ca. 2.0 Ga Kittilä Group of the Central Lappland greenstone belt. The mineralization occurs within the Kiistala shear zone and is made up of pyrite and arsenopyrite, with subordinate tetrahedrite, chalcopyrite, gudmundite, gersdorffite, pyrrhotite, jamesonite, chalcocite, sphalerite, bornite, galena, and rutile. The mineralizing fluids induced the formation of albite and carbonate in the host rocks comprising mafic tuffs, graphitic metasediments, black chert, and banded iron formations. Post-mineralization faulting produced zones of crushed rock within the mineralization. These zones contain fractured sulfide grains, locally recrystallized. Gold occurs largely as atoms trapped in the lattice of arsenopyrite (73%) and pyrite (23%). The rest of the gold (approx. 4%) occurs in metallic state, as inclusions of Au-Ag-Hg alloys in pyrite and arsenopyrite.

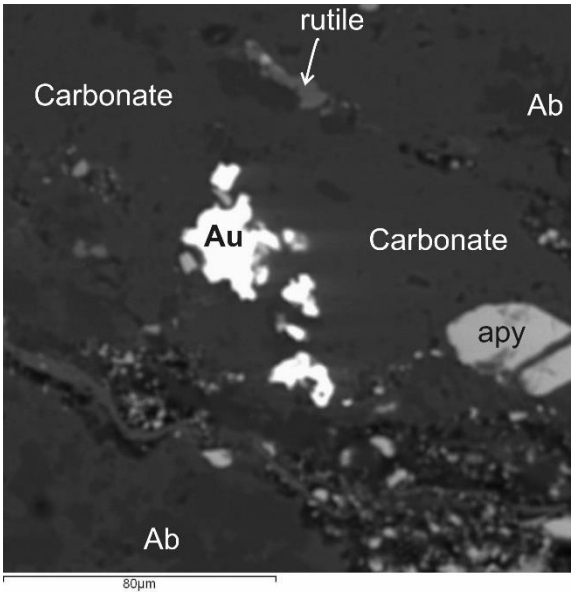

Figure 1. Hg-rich electrum grains (38%Au, 46%Ag, 16%Hg) in a carbonate veinlet. Back-scattered electron image. Ab = albite; apy = arsenopyrite.

Several ore samples from the Suurikuusikko Mine have been studied for gold distribution and paragenesis. The optical microscope and electron microscope study was combined with energy-dispersive spectroscopy and wavelength-dispersive spectroscopy to determine mineral composition.

The investigations showed a relatively high abundance of gudmundite (FeSbS), commonly as euhedral crystal clusters, often with arsenopyrite inclusions. However, gudmundite inclusions occur in both pyrite and arsenopyrite. Tiny grains (<20 µm in size) of ullmannite (NiSbS) and another Ni mineral showing compositions that correspond to the formula Ni_2Sb_2S have also been found. Metallic gold commonly occurs in zones where the ore was brecciated. Here, arsenopyrite grains are relatively large (up to > 100 µm) ± equant ± rounded, sometimes cracked, as opposed to the arsenopyrite from the main mineralization type, which is acicular, euhedral (rhombic in cross-section), and fine-grained (ca. 10-20 µm across). Gold occurs as inclusions in pyrite and arsenopyrite but also fills the cracks of the fractured arsenopyrite crystals. All Au grains contain large amounts of Ag and variable Hg (from less than detection limit to > 20% Hg). The Hg-rich electrum is also found in carbonate (ferroan dolomite), associated with rutile and arsenopyrite (Fig. 1). The investigated samples suggest Sb

enrichment of the mineralizing solutions. The recrystallization and size increase of the sulfide grains in the brecciated ore suggests mobilization of the elements from the crushed material. Conceivably, Au migrated from the crushed sulfides and precipitated as native metal. Nevertheless, the association of metallic Au with Ag and Hg, unlike the gold from the main mineralization type, suggests the late circulation of fluids that transported and precipitated the three metals or, at least, triggered Au extraction from the sulfidic material.

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