



Silver and Co-Ni sulphoarsenides from the Kongsberg silver deposit, Norway

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The historical silver mines at Kongsberg, Norway, are world-famous for spectacular samples of thread silver exhibited at numerous mineralogical museums. More than 100 minerals have been reported from the deposit, including native elements (Ag, Au, As, Cu, S, C), sulphides, sulphosalts, selenides, arsenides, carbonates, sulphates, arsenates and halides, in addition to a range of silicate minerals (Neumann, 1944; Johnsen, 1986, 1987; Bancroft *et al.*, 2001). However, documentation of the minerals using state-of-the-art methods such as electron microprobe, with implications for the genesis of the deposit, is largely missing. In our contribution, we present new data on the compositional variations of silver and sulphoarsenides from the silver deposit.

Most of the ore minerals studied here occur in calcite veins in the hosting gneiss. For some samples, however, fluorite is the dominating vein mineral associated with the ore minerals. Mineral textures show that native silver formed during at least two separate stages. The earliest generation of native silver is typically represented by euhedral to subhedral crystals, up to 1 mm long. These crystals frequently contain rounded inclusions of acanthite, chalcopyrite and polybasite, and they are commonly rimmed by a zone consisting of Co-Ni-Fe bearing sulphoarsenides. The later generation of native silver occurs as fracture fillings, often enclosing the earlier Ag generation with its rim of sulphoarsenides.

Native silver shows significant variations in Hg, Au and Sb contents. Concentrations of up to 20 wt% Hg and up to 2.7 wt% Sb in silver have been measured during the present study. Dyscrasite and allargentum have also been observed in association with native silver. Neumann (1944) reported auriferous silver with up to 50 % Au. The sulphoarsenides rimming the crystals of the first silver generation vary in composition along the cobaltite-gersdorffite series with approximate limiting compositions $\text{Ni}_{0.8}\text{Fe}_{0.2}\text{AsS}$ and $\text{Co}_{0.51}\text{Ni}_{0.33}\text{Fe}_{0.16}\text{AsS}$.

Existing data indicate that the Kongsberg silver deposit formed in veins in the host gneisses during several stages of influx of external fluids carrying ore-bearing components. The presence of acanthite, chalcopyrite and polybasite as inclusions in the earliest generation of silver suggests that Cu, Ag, Sb and S were introduced during an early stage. This was followed by a stage of sulphide breakdown and formation of native silver. Subsequently, Co, Ni, and As bearing fluids were introduced, resulting in the growth of sulphoarsenide along the rims of the early euhedral crystals of silver. This stage was again followed by new growth of native silver. The presence of ore minerals in both calcite and fluorite filled veins suggests that both CO_3^{2-} and F^- -bearing fluids were important transporting agents for the ore forming elements.

References cited:

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