Relationship of Bi- and Ag-bearing sulphosalts and Au-Ag-Hg minerals in polymetallic ores of the Siegerland District, Rhenish Massif

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Chalcopyrite marks the transition between the invisible Au-bearing Fe-Co-(Ni)-As-Cu dominated and the visible Au-bearing subsequent Zn-Pb-Cu dominated mineralization in the Siegerland District of the Rhenish Massif.

The precipitation of visible Au and Bi is undoubtely related to the precipitation of early chalcopyrite-1, sphalerite, tetrahedrite, late chalcopyrite-2 and galena. However, Bi does not act as a liquid Au-collector due to the low forming temperature which ranges between 150°C-250°C [1].

While early precipitated Au is Ag-rich (< 20 mass-% Ag) [2], the later formed Au is even more enriched in Ag and Hg as well.

The native, Ag-bearing gold acts as a nucleus for the overgrowing silver-mercury-bearing mineralization, which forms the alloys (mercury-)electrum and amalgam (up to 23 mass-% Hg) as well as rare native silver ($Ag_{0.88}Sb_{0.03}Au_{0.05}Hg_{0.04}$), the fluid is depleted in Cu due to chalcopyrite-1 precipitation that additionally leads to formation of euhedral matildite.

Besides, the Ag-bearing and Pb-enriched sulphosalts like gustavite and ourayite get first replaced by Ag-Cu-Pb-sulphosalts of the pavonite-series (pavonit, mummeite, berryite, neyite and an unnamed mineral) as a result of increasing Cu-activity and later by Ag-depleted sulphosalts like hammarite, krupkaite, cuproneyite, aikinite and friedrichite.

In a next step, this mineralization is replaced by euhedral bismuthinite ($Bi_{2.07}(S_{2.97},Se_{0.03})Cu_{0.04}Fe_{0.07}$), minerals of the ikunolite-laitakarite-series (atomic ratio S/Se >1) as well as anhedral native bismuth. All sulphosalts contain certain concentrations of Se (Te is absent) with a maximum of 10 mass-% in ikunolite ($Bi_{4.48}(S_{1.57}Se_{1.43})$ that indicates a reduced S-activity and thus high Se- and Bi-activities. After the depletion of Bi, consecutively sphalerite, chalcopyrite-2 and As- and Sb-bearing fahlores precipitate which lastly, like the sulphosalts, are overgrown by mozgovaite, galenobismuthite and Ag and Bi enriched galena that partly adopt element contents of the replaced sulphosalts.

[1] Erlinghagen, K-P. (1989), *N.Jb. Min. Mh.* ***1989****, 557-567.*
[2] Hellmann, A. (2011), *MinPet* ***2011****, Referate Band, 123.*