Thermometry of the intrusion-associated late Permian Pb-Cu-Zn deposit from the Pfunderer Berg near Klausen (South Tyrol, Italy)

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The minig district Pfunderer Berg to the west of Klausen in South Tyrol (Italy) is located in the contact area between Permian magmatic bodies, associated with the Brixen granodiorite, and the Southalpine basement of the Brixen Quarzphyllite.

During the Permian extensionional event several dioritic dykes and small plutons intruded into the Variscan metamorphic basement near Klausen. This Permian magmatic event led to a strong (ca. 650°C and 0.2 – 0.3 GPa) contact metamorphic overprint of the surrounding quartzphyllites as well as the contemporaneous formation of Cu-ore deposits in the contact zone and hence ore mineralization occurs in the magmatic rocks as well as the contact metamorphic basement rocks. Due to the fact that the geological position of the mining area is in the south of the SAM (southern limit of Alpine metamorphism) these rocks were not affected by the Alpine metamorphic overprint and thus allow to provide *P-T* constraints on the pre-Alpine metamorphic evolution of this area. The Alpine orogeny only resulted in brittle faulting and occasional remobilization of the ore mineralization.

The ore mineral assemblage consists mainly of sphalerite, chalcopyrite, galena and fahlore. Most of the galena grains show abundant inclusions of fahlore and acanthite (Ag_2S). In one sample we found chalcopyrite grains surrounded by gustavite ($PbAgBi_3S_6$) and cosalit ($Pb_2Bi_2S_5$). Fahlore occurs texturally in two generations, as inclusions in galena and as well as in the matrix. The matrix fahlores are almost pure tetrahedrite with Sb contents ranging from 3.64 to 4.00 a.p.f.u. The Zn content in the fahlores ranges from X_{Zn} = 0.43 to 1. The Ag substitution for Cu is also strongly variable and ranges from 0.22 to 1.94 a.p.f.u. The composition of fahlore inclusions in galena differs from the fahlore composition in the matrix. Although they are almost pure tetrahedrite in composition, the Ag content is much higher (X_{Ag} = 0.57-0.86) and the Zn content is lower (X_{Zn} = 0.18-0.25). The Fe content of sphalerite ranges from 0.04 to 0.17 a.p.f.u with high Cu contents in Fe poor sphalerites.

The high temperature of formation of this ore deposit is confirmed by characteristic granular chalcopyrite exsolution textures in sphalerite as well as sphalerite star-shaped exsolutions in chalcopyrite. Chalcopyrite also shows $\alpha\beta$ transformation lamellae, which indicate minimal temperaturs of 500°C. The Cd-exchange thermometer between galena and sphalerite inclusions yields still higher temperatures of approximately 700°C which is consistent with the phase relations in the Cu-Fe-(Zn)-S system in the *T*-fS_2 space at high *T*.

In the context of the SFB HiMAT project (historical mining activities in Tyrol and adjacent regions) this mining area is important to understand historical mining and smelting activities therefore additional petrological, mineralogical and metallurgical investigations are planed.

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