THE NATURAL Cu_5FeS_4–$Cu_{6.0}Fe_{0.5}S_4$–$Cu_7Fe_{0.3}S_4$–$Cu_9Fe_{0.5}Pb_{0.4}S_6$–Cu_2S SYSTEM, LUBIN COPPER DEPOSITS, POLAND

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Sulphide-calcite veins cutting black shale in Kupferschiefer deposits, Poland, contain Cu-Fe-Pb-S minerals showing unusual stoichiometry:

1) $Cu_9Pb_{0.5}Fe_{0.4}S_6$ forms isometric crystals intergrown with chalcocite, bornite, galena, "half" bornite, digenite and sphalerite. In reflected light $Cu_9Pb_{0.5}Fe_{0.4}S_6$ shows optical similarity to betekhtinite $Cu_{10}Fe_{0.6}Pb_{0.3}S_6$ (SCHÜLLER & WOHLMANN, 1955). The mineral contains (wt%, average of 8 microprobe measurements): S 21.36, Fe 2.40, Cu 62.87 and Pb 12.59. The Pb content is twice as high as that of betekhtinite. The mineral is pale cream, has weak bireflectance in air visible only at crystal boundaries changing from white-cream to pale cream, its reflectance at 550 nm is 30.40% in air, 15.75% in oil, so it is 2% lower than that of betekhtinite. Preliminary interpretation of XRD and electron diffraction data suggests that the mineral is either monoclinic a_0 = 7.30, b_0 = 8.70, c_0 = 7.86 and β = 97° or triclinic a_0 = 7.50, b_0 = 9.05, c_0 = 8.06, α = 88°, β = 97°, γ = 89°. The mineral discussed differs from betekhtinite by:

a) twice higher Pb content and consequently by its chemical formula,
b) isometric crystal habit,
c) XRD pattern and single crystal electron diffraction patterns.

2) "Half" bornite $Cu_6Fe_{0.5}S_4$ occurs in the same mineral assemblage as $Cu_9Pb_{0.5}Fe_{0.4}S_6$. It occurs as intermediate mineral between chalcocite and bornite or chalcocite and $Cu_9Pb_{0.5}Fe_{0.4}S_6$. Preliminary electron diffraction patterns suggest domain structure for "half" bornite. Basic diffraction spots are split into 3 or 6 nodes suggesting the existence of 3 similar unit cells with left and right twisted symmetry. The angle of twist is ±3°. Reflectivity of "half" bornite at 550 nm is 19.43% in air and 9.81% in oil, so it is darker than accompanying bornite, digenite and chalcocite. Reflectivity curve of "half" bornite is very different from that of bornite and is more similar to that of digenite.

3) "Quarter" bornite $Cu_7Fe_{0.3}S_4$ occurs as inclusions in chalcocite. Its reflectivity at 550 nm is 24.78% in air and 11.30% in oil, so it is distinctly lighter than bornite and digenite but darker than chalcocite. The dispersion reflectivity curve of "quarter" bornite is similar to that of chalcocite.

Electron diffraction patterns of the mineral are indexable according to the chalcocite cell although all basic diffraction spots are split into extra two modes accompanying basic chalcocite diffraction spots.

References

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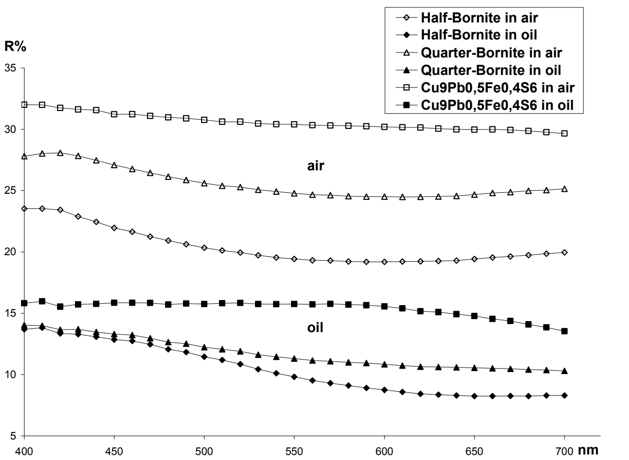

Fig. 1: Reflectivity curves of the minerals studied in air and oil.

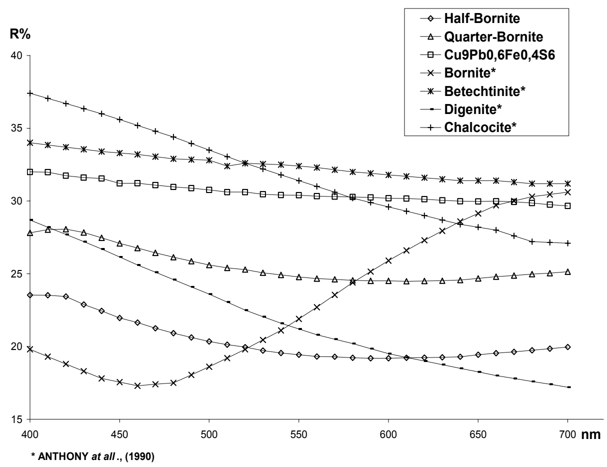

Fig. 2: Reflectivity curves of the minerals studied in air compared to bornite, betekhtinite, digenite and chalcocite standards.