Fluid inclusion study of a sediment-hosted copper ore deposit in the Lubin area (Poland)

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The sediment-hosted copper ore deposit in the Fore-Sudetic Monocline (Lubin area, SW Poland) is one of the largest in the world. Copper mineralization (Cu and Cu-Fe sulphides) follows a redox front (*Rote Fäule*) and occurs close to the contact between the uppermost Lower Permian terrestrial sandstones (*Rotliegendes*), and Upper Permian (*Zechstein*) marine deposits (including siliciclastics, shales, dolomites, and evaporates). Mineralization is characteristically vertically zoned, and the sulphide type is unrelated to the host-rock lithology. This deposit is believed to be an equivalent to the German *Kupferschiefer* copper ore formation.

Processes leading to the ore formation in the Lubin region can be better understood with a modern fluid inclusion study, combining of classical microthermometry with LA-ICP-MS analysis. This provides valuable data on temperature, pressure and chemical composition (including concentrations of major and trace elements in individual fluid inclusions) of the hydrothermal fluids.

Samples collected from the three deep mines (Lubin, Rudna and Polkowice-Sieroszowiec) represent a variety of rock types (from both oxidized and reduced zones). Fluid inclusions were found in various rock types, but the most abundant are calcite veins and calcite infills of cavities in dolomites. Fluid inclusions are generally very small (<10μm), but diameters range up to 20-50 μm. Three main fluid inclusion types were identified: (1) aqueous two-phase primary fluid inclusions of irregular shapes, with small vapor bubble sizes (5-10 vol.%); (2) square single-phase aqueous fluid inclusions, distributed in the outer parts of the crystals; and, (3) very small secondary aqueous fluid inclusions with medium vapor bubble sizes (30 vol.%), present in late cracks.

Our combined microthermometry and LA-ICP-MS analysis provides the first data on the origin and geochemical evolution of low-temperature hydrothermal fluids in the Polish *Kupferschiefer* ore formation.

# Extreme pressure dependence of sulphur solubility in silicate melts (experimental data)

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Physicochemical conditions of sulphur concentration within fluid-bearing magmas in the upper mantle and the earth crust during sulphide-silicate immiscibility are very important for understanding of origin of magmatic sulphide deposits. Influence of pressure on solubility of sulphur is still controversial [1-3].

We studied influence of pressure on the SCSS (sulphur concentration at sulphide saturation) in H_2O and H_2O+CO_2-bearing silicate melts. We used Pt-peridotite ampoules filled with powder of olivine basalt and synthetic sulphide $Fe_{30}Ni_{30}Cu_{30}S_{10}$ as starting compositions. The highest concentrations of sulphur were 0.88-1.01 and 0.2 wt.% in H_2O-and H_2O+CO_2-bearing silicate melts respectively at 1.5-2.0 GPa (Fig. 1). The minimum concentrations were 0.1-0.2 wt.% both at low (0.1-0.8 GPa) and high (2.5-4.0 GPa) pressure.
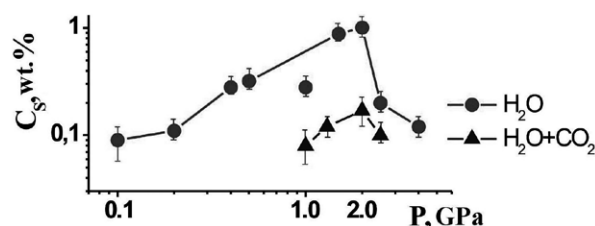
Figure 1: Relationships between pressure and SCSS in H_2O- and H_2O+CO_2-bearing silicate melts.

Inversion of relationships between pressure and SCSS in H_2O- and H_2O+CO_2-bearing silicate melts at P=1.5-2.0 GPa can be related to the inversion of volume effect of reactions and speciation of C, O, H and S in basalt melts at different pressure. Such inversion can play an important role in transport of sulphide sulphur and ore elements from the deep magmatic centres to the upper levels of the Earth crust where most of known sulphide ore deposits were discovered.

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