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Correlation of stable isotope thermometry and "classical" geothermometers applied on selected ore mineralizations of the Eastern Alps

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Geothermometers are widely applied for estimating the formation (crystallization) temperature of mineralizations. This study is aimed to compare individual methods applied to selected historical important ore deposits of the Eastern Alps: Upper Austroalpine crystalline basement units: Ni-Co-Bi deposit Zinkwand/Schladming/Styria; Pb-Zn deposit Tösens/Tyrol. Upper Austroalpine Greywacke zone: Cu deposits Mühlbach/Salzburg and Radmer/Styria. Penninic nappe system: Pb-Ag deposit Erzwies-Silberpfennig/Salzburg.

All these vein systems comprise mainly carbonate gangue (calcite, ankerite and siderite) and minor quartz. They were selected due to their large vertical extent (up to 300 m) to assure a wide range in crystallization temperatures of ore minerals and gangue.

Determination of δ^{13}C and δ^{18}O ratios is a well established method for characterizing mineralizing fluids due to their origin (meteoric, magmatic or metamorphogenous) and temperature. The δ^{18}O ratio is controlled by the involved fluid and the crystallization temperature. The main prerequisite is equilibrium between precipitate and dissolution. Two different options exist for estimating temperature: (1) Calculation with a known δ^{18}O ratio of the fluid and a measured ratio of coexisting minerals, (2) calculation with two measured δ^{18}O ratios of carbonate and coexisting quartz.

Depending on the mineral paragenesis of the deposits the following “classical” geothermometers are applied: Na-K, K-Mg, Na-Li cation exchange thermometers for gangue minerals (calcite, ankerite, siderite and quartz), arsenopyrite thermometry, FeAsS-NiAsS-CoAsS solid solution temperatures, Cd-exchange thermometer of galena and sphalerite, the occurrence of native metals (e.g. Bi) and exsolution textures in ore minerals. In addition microthermometric determination of homogenisation temperatures of fluid inclusions in carbonate and quartz and sulphur isotope thermometry of suitable mineral pairs are done.

First results of the Zinkwand deposit are as followed: 365–400 °C (arsenopyrite thermometer), 340-410 °C (Na-Li thermometer, calcite gangue), 300-500 °C (FeAsS-NiAsS-CoAsS solid solution temperatures) and the occurrence of native bismuth (< 273 °C). Due to the paragenetic sequence the primary ores phases (gersdorffite, arsenopyrite, loellingite, nickelite) have formed under conditions around more than 400°C and the carbonate gangue well below 350 °C. Lastly native bismuth has been formed below 273 °C. The δ^{18}O-value (VSMOW) of the involved fluid has to be around +8 to +10 ‰ to cope with the temperatures of metamorphic waters. These preliminary results have to be refined with δ^{18}O of quartz measurements, sulphur isotope temperatures of cogenetic mineral pairs and fluid inclusion data.

The variable tectonic position and differences in formation ages, metamorphic history and host rocks provide ideal conditions to study pros and cons of the individual geothermometers and their sensitivity.