Fluid evolution associated with the early Proterozoic Rauhala Zn-Cu-Pb sulphide deposit in Ylivieska, Western Finland

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Abstract: The results of a fluid inclusion study of massive and disseminated ores from the Rauhala deposit, western Finland, show three different fluid inclusion types: (1) CO\textsubscript{2}-CH\textsubscript{4} (≤22 mol% CH\textsubscript{4}), (2) CH\textsubscript{4}, (3) H\textsubscript{2}O (0.4–21 eq.wt.% NaCl), and an additional type-E ("empty") inclusion. Fluid inclusion geothermobarometry shows that the ores were remobilized between 2.7–1.2 kb and 460–300 °C in a fluid environment varying from a saline (15–21 eq.wt.% NaCl) aqueous solution to a retrograde CH\textsubscript{4} fluid. Evolution of gaseous fluids is mainly attributed to metamorphic and deformational processes.

Key-words: fluid inclusions, sulphide deposit, P-T conditions, Rauhala, Finland.

Introduction

The stratiform Rauhala Zn-Cu-Pb deposit is located in the northwestern part of the main sulphide ore belt (Kahma, 1978), which forms a boundary between the Archean and Proterozoic rocks in eastern Finland (Fig. 1). The deposit is hosted by an early Proterozoic metaturbidite sequence intruded by a subvolcanic quartz diorite and narrow tholeiitic dykes (Västi, 1989). The estimated ore reserve of the deposit is 1.2 Mt ore with an average grade of 6.7 % Zn, 1.6 % Cu and 1.2 % Pb based on a cutoff of 2 % Cu equivalent. The origin of the deposit has been attributed to either volcanic-exhalative (Västi, 1989; Rasilainen & Västi, 1989) or magmatic processes (Vaa­sjoki, 1989) on the basis of geological/geochemical and lead isotopic characteristics, respectively. The fluid inclusion study was initiated in an attempt to impose further constraints on the origin of the deposit on the basis of fluid evolution.

Geological setting

The Rauhala sulphide deposit is a slightly bent concordant sheet, which is about 590 m long, 350 m wide and 2.1 m thick. The deposit consists of massive and disseminated ores. Generally, the disseminated ore, which is hosted by a sericite schist, occurs below the massive ore (Fig. 1). No stringer ore zone has been found. The wall rocks are metasediments, which include graded metaturbidites and mica schists with black schist, metagreywacke, quartz-feldspar schist, tuffaceous hornblende schist and cordierite gneiss intercalations (Västi, 1989). The metasediments overlying the ore are cut by a quartz diorite intrusion. Narrow tholeiitic dykes crosscut both the metasediments, the ore and the quartz diorite. In the metasediments and in the quartz diorite carbonate occurs either as crosscutting veins or as a common accessory mineral. The rocks in the Rauhala area have undergone metamorphism under amphibolite facies conditions.

Pyrhotite, sphalerite, chalcopyrite, galena, pyrite and arsenopyrite are the main constituents of the ore. A number of accessory minerals have been described by Kojonen et al. (1989). Pyrhotite is the most abundant mineral in the massive ore. According to Kojonen et al. (op. cit) the peak of the metamorphism took place at P-T conditions of about 5.5 kb and 540 °C and the formation of the mineralization at 1.5 kb (minimum) and 350–540 °C. These data are derived from arsenopyrite-sphalerite thermobarometry. The main sulphide minerals have been re-equilibrated.