Is the Zhaokalong Fe-Cu Polymetallic Deposit an IOCG Deposit?

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The Zhaokalong Fe-Cu-Au-Ag-Pb-Zn polymetallic deposit lies in the northwest part of Sanjiang ore belt, Qinghai Province, China. This deposit is mainly exposed in Triassic volcano-sedimentary rocks composed of andesite, limestone, argillite, carbonaceous slate, feldspathic-quartz sandstone, and dolomite as ore-bearing strata. The mineralization zone of the Zhaokalong deposit has a close relationship with the andesitic volcanic rocks, with a strike length of 2400 m, a horizontal width of 200–800 m, and a tilting extension of more than 700 m. These orebodies are mainly mineralized by Fe and Cu, with minor Au, Ag, Pb, and Zn. The Fe-Cu ores are characterized by massive brecciated structures, whereas the Pb-Zn ores have a mainly layered structure. Ore minerals are composed of iron-oxides and other metal sulfides, mainly including magnetite, hematite, siderite, limonite, chalcopyrite, galena, sphalerite, pyrite, tetrahedrite, bornite, etc. Gangue minerals are dominated by quartz, sericite, and ankerite, followed by chlorite, feldspar, calcite, biotite, muscovite, and barite. Regarding wall-rock alteration, silicification, chloritization, and baritization occur close to the mineralization, whereas Na-Ca alteration is located on the peripheries of the orebodies. Latest exploration revealed the metal reserves are of 965.91 Mt Fe @ 33.50%, 8.73 Mt Cu @ 0.70%, 7.04 Mt Pb @ 0.91%, 4.84 Mt Zn @ 0.71%, 182.83 t Ag @ 25.47 g/t, and 3.90 t Au @ 0.41 g/t in the Zhaokalong deposit.

Ore from the Zhaokalong deposit generally has high concentrations of Ba (1.66−16.86%), Mn (0.5−5%), As (0.01−0.26%), P (0.015−0.032%) and some Ni (0.2−169 ppm), Co (1.5−77 ppm) and Mo (0.88 −110 ppm). The REE patterns reveal an enrichment of the LREE compared to the HREE, with ΣREE ranging from 11.33 to 186.20 ppm. Compared to magnetite-hematite ores, sulfur-rich Pb-Zn ores are characterized by Eu positive anomalies, with higher REE concentrations. Aqueous and gaseous analysis for the fluid inclusions in these ores shows that the fluid is mainly composed of F^- (1.75−4.82 ppm), Cl^- (0.59−1.33 ppm), SO_4^{2-} (92.40−297.98 ppm), Ca^{2+} (2.10−15.32 ppm), Na^+ (2.40−5.86 ppm), and K^+ (1.15−4.50 ppm) in liquid phase and H_2O (477−1603 ppm), CO_2 (152.99−485.69 ppm), CH_4 (4.93−19.23 ppm) and H_2 (0.64−1.71 ppm) in gaseous phase, with weight ratios of Na/K ranging from 1.1−2.4. Thus, the mineralization fluid in the Zhaokalong deposit is an $SO4^{2-}$-F^--Cl^--Ca^{2+}-Na^+-K^+ type water, containing a high amount of CO_2 and some CH_4 and H_2. Homogenization temperatures in fluid inclusions mainly range from 150° to 250°C, with most salinity values ranging from 5 to 8 (wt % NaCl equiv).

The Zhaokalong deposit was classified as SEDEX-type deposit due to the relatively enriched sulfur in the ores, or characterized as a VHMS-type deposit because of its close relationship to volcanic rocks. However, the brecciated structures in massive Fe-Cu ores, the intense Na-Ca alteration in the periphery of orebodies, the associated Au-Ag mineralization, the high concentrations of Ba, Mn, As, P, Ni, and Co in the ores, and the high CO_2 contents and Na/K ratios of the fluid indicate that the Zhaokalong deposit could be an IOCG-type deposit.