Thermodynamic Modeling, One of the Most Significant Method to Reveale Physico-chemical Conditions of Mineralization Process: an Example from Weilasituo Zn-Cu-Ag Deposit, Inner Mongolia, China

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Abstract: Traditionally, the value of $\delta S^{34}(\Sigma S)$ can be used to infer the S source of the ore-forming hydrothermal fluid. In most case, $\delta S^{34}(\Sigma S)$ is represented by peak value of sulfur isotope data of metal sulfide, however if metals precipitate at medium(or high) oxygen fugacity and pH conditions, this method will be imprecise. The constructing of the $\log fO_2$-pH diagram of δS^{34} contours with the stability fields of significant minerals and the $\log fS_2$-T diagram can effectively calculate value of $\delta S^{34}(\Sigma S)$, explain the transformation of sulfur isotope data in different mineralization stage and restore the physico-chemical conditions of mineralization process. The Weilasituo Zn-Cu-Ag deposit is a typical hydrothermal vein deposit in the south of the Great Hinggan Range, which was hosted in the Hercynian quartz diorite and Paleozoic gneiss. The mineralization sequence was divided into four stages: stage 1, quartz-pyrite-arsenopyrite (generally most abundant minerals listed first); stage 2, quartz-sphalerite-chalcopyrite-pyrite- pyrrhotite; stage 3, quartz-calcite-galena-chalcopyrite-pyrite; stage 4, quartz-poor sulphide. The δS^{34} values of the stage 2 and 3 metal minerals, from -1.6 to 2 and from -4.4 to 1.7, respectively. The $\delta S^{34}(H_2S)$ which can be calculated from the δS^{34} values of metal minerals, range from -1.7 to1.9 in the stage 2 and from -4.7 to 1.4 in the stage 3. Based on thermodynamic Model , the pH range from 5.2 to 7.7 and the $\log fO2$ range from -40.8 to -35.8 in the stage 2, and the pH range from 5.8 to 7.7 and the $\log fO2$ range from -37.5 to -34.8 in the stage 3. And $\delta S^{34}(\Sigma S)$ is more accurately estimated to be -2 which represents the sulfur is sourced from magma. Obviously, an significant factor affecting the mineral precipitation in Weilasituo deposit is the transition from low to high oxygen fugacity, while the pH may remain in a stable range. The accompanying trend is the conversion of low sulphur fugacity ($\log fS_2 \approx -12$) to medium sulphur fugacity ($\log fS_2 \approx -10$). These changes in the ore-forming environment are considered to be the key to the decline of the $\delta S^{34}(H_2S)$. Here, a distinct transition of physico-chemical conditions were recognized and Thermodynamic modeling, one of the most significant method are showed.

Key word: thermodynamic modeling, physico-chemical conditions, S isotope, Weilasituo deposit

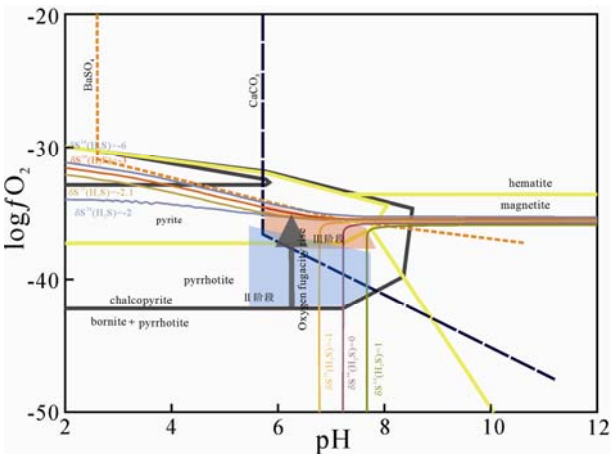

Fig. 1. $\log fO_2$-PH diagram showing solubility and stability relationships of minerals during the main mineraliation stage and illustrating the effects of $fO2$-pH changes on the sulfur isotopic compositions of minerals

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