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Research on the mechanism of Rb-Sr dating with dilute acid leaching

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Rb-Sr dating of sphalerites has been shown as a promising and effective technique for the direct dating of Pb-Zn deposits. However, this technique is still questioned by some scholars due to the divergent opinions about the occurrence of Rb and Sr and the dating mechanism. Therefore, this study analyzed the contents of Rb, Sr, Pb, Zn, Fe, Ca, and Mg in hand-picked sphalerite grains, diluted acid leachates, and sulfide residues. The analytical data shows that Rb, Pb, Zn, and Fe are mainly distributed in the sulfide residues and the concentrations of Rb displays a positive correlation with those of Fe, which indicates that the ion pair of Rb^{+} and Fe^{3+} possibly substitutes for Zn^{2+} in the crystal lattice of sphalerite according to the ion substitution formula of $2Zn^{2+}=Rb^{+}+M^{3+}$. In addition, the analytical data show that Sr, Ca, and Mg are predominantly concentrated in the diluted acid leachates, and there is a positive correlation between the concentrations of Sr and those of Ca and Mg, which indicates that the diluted acid leaching removes not only the secondary fluid inclusions but also carbonate inclusions in the hand-picked sphalerite grains. Because the Sr^{2+} can easily enter into the crystal lattice of carbonates (e.g., calcite, dolomite) because of the similarity of the radius of Sr^{2+}(1.13Å) and Ca^{2+} (0.99Å), the carbonate inclusions documented by Electron Microprobe analysis have high common Sr that can mask the radioactive Sr in minerals. Thus through the dilute acid leaching, the common Sr in carbonate inclusions can be eliminated. Subsequently the Rb/Sr ratios and their variation range become larger, which is of great significance for the successful Rb-Sr dating of sphalerite. To confirm whether the common Sr in the carbonate inclusions can be removed thoroughly by the dilute acid leaching, several experiments were carried out to examine the effects of varying acid concentration and leaching times. First, the sphalerite grains were dissolved in acid solutions of different concentrations for the same amount of time. Second, the sphalerite samples were dissolved with one concentration of acid solution for different times. Then the Rb-Sr isotope compositions were analyzed for the acid leachates and sulfide residues. The analytical results show all data points are distributed along the same Rb-Sr isochron, which indicates the common Sr in the carbonate inclusions can be removed thoroughly no matter what the acid concentration or time of leaching. Therefore, the Rb-Sr isochron age is reliable.