Rapid and accurate determination of Cu isotope in copper bearing minerals using microdrilling and MC-ICP-MS

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The most important tool for Cu isotope analysis is using MC-ICP-MS which yields Cu isotope ratio with the precision of up to 0.04-0.06‰(Hou et al., 2016; Larner et al., 2011). However, isotopic determination using MC-ICP-MS requires chemical purification which is tedious and time consuming. In situ analysis using LA-MC-ICP-MS is more efficient, although most study suggest that LA-MC-ICP-MS suffered significant matrix effect even using femtosecond laser(Ikehata and Hirata, 2013; Ikehata et al., 2008).

In this study we present an accurate and precision in situ Cu isotopic determination process, which is sample, rapid, and achievable. 13 copper bearing minerals was analyzed, including native copper, seven cooper sulfides (chalcopyrite, chalcocite, digenite, covellite, cyanotrichite, tetrahedrite, bornite), two carbonates (azurite, malachite) and one cooper chloride (atacamite). Micro drills was used to sampling interesting positions, then the sample dust was divided into two parts. One part was directly added with 300 μL 4 mol/L nitric acid, sealed with a cover, and heated at 140 C° for 30 minutes. The other part was processed with chromatographic separation using macroporous anion-exchange resin AGMP-1M to verify the accuracy of this method. Then, these solutions were diluted to 1 μg g^{-1} with 2 % HNO_3 and analyzed on Nu plasma II MC-ICP-MS. All Cu isotope data was calibrated using SSB combine with NIST 994 pure Ga as internal standard. The effect of matrix elements in copper rich minerals was invested systematically. There has little influence on Cu isotope determination when matrix element/Cu ≤2. Results shows that the deviation of δ 65Cu between samples with and without chromatography is less than 0.04‰while δ 65Cu of cooper minerals analyzed in this work range from -1.25‰to +1.64‰.

Using micro drill in-situ micro area sampling improves the spatial resolution, avoid obtaining mixed results. Combining in situ sampling with MC-ICP-MS analysis in "wet" plasma mode, it is easy to acquire high-precision in-situ micro area Cu isotope composition with precision up to 0.05‰.