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Sulfur isotope insights into sulfur biological and geochemical process in metal-sulfide mine tailings

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Sulfur biogeochemical processes in metal-sulfide mine tailings affect the release and migration of heavy metals, which is related to the downstream environment and human health. To better understand the source, composition and transformation of sulfur, we collected tailing samples from two sediment profiles (CDK and S0) of a typical metal-sulfide mine located in north of Guangdong, south China. A modified method to extract elemental sulfur (ES), acid volatile sulfide (AVS), chromium reducible sulfur (CRS) successively was developed, and sulfate was divided into water soluble sulfate (WSS), exchangeable sulfate (ExS), and acid soluble sulfate (ASS) after rinsing using different solution, so as to characterize the distribution of sulfur species and its isotope composition.

Results showed sulfate was the main existence in CDK and S0, and sulfur isotope ratio between sulfate and original ore was similar, indicating sulfate originated from the oxidation of sulfide mineral. However, sulfate species were different in both sites. About 55% sulfate were WSS in CDK, while 68% were ASS in S0. Besides, ASS in S0 depleted more ^{32}S than CDK, implying the formation of sulfate mineral was more active in S0. Moreover, reduced sulfur species were more abundant in S0, and sulfur isotope fractionations between AVS and CRS ($\Delta^{34}S_{AVS-CRS}$) of up to -29.8‰ in S0, indicating intense bacterial disproportionation and sulfide oxidation. Specially, $\delta^{34}S_{CRS}$ homogeneously ranged in -0.9‰ ~ 0.1‰ when CRS was more than 250 mg/kg, while low CRS content was corresponding to more negatively $\delta^{34}S_{CRS}$ values, implying there existed a conversion from FeS to FeS_2. The findings of this study provide insights into the sulfur biogeochemical process in metal-sulfide mine tailings.