

Geochemical and Sr-Os-B-Si isotope constraints on ore-forming process of modern sea-floor hydrothermal sulphide mineralization

JING-HONG YANG¹, SHAO-YONG JIANG^{1,2}, TAO YANG¹

¹ State Key Laboratory for Mineral Deposits Research, Department of Earth Sciences, Nanjing University, Nanjing 210093, China (yangjh@nju.edu.cn)

² State Key Laboratory of Geological Processes and Mineral Resources, Faculty of Earth Resources, China University of Geosciences, Wuhan 430074, China

Hydrothermal systems are widespread in modern and ancient seafloor, and may lead to formation of a number of economic significant polymetallic deposits. Among them, the massive sulphide deposits are the most important one in particular for Cu-Pb-Zn endowments. Seawater circulation, leaching of subsea-floor volcanic and sedimentary rocks and fluid mixing are suggested as the most important factors controlling the ore-forming process and ore deposition, and geochemical and isotopic tools have been treated as excellent fingerprints and indicators. Except for the use of conventional isotope systems such as oxygen, sulfur, lead, and strontium, new and recently developed isotope systems such as boron, silicon, and osmium isotopic compositions have also found their major applications in monitoring such hydrothermal processes. TAG hydrothermal mound is one of the largest known actively forming sulphide deposits at a sediment-free oceanic spreading center. Both sea-floor sulphide mounds and underlying sulphide stockworks (down to 125 mbsf) occur in this site. Os isotope analysis of the sulphides indicates fluid and ore-forming metal mixing processes between seawater and hydrothermal fluid. The highest ¹⁸⁷Os/¹⁸⁸Os ratios reach up to 1.07, which is similar to the seawater value and suggests a major seawater contribution, whereas the majority lower ¹⁸⁷Os/¹⁸⁸Os ratios (down to 0.56) indicate a dominantly hydrothermal component. Boron isotope data revealed a similar fluid-mixing scenario. The seafloor dispersed Fe-Mn oxide precipitation displays similar δ¹¹B value as seawater (~40‰), whereas the sulphides show lower δ¹¹B data from 12.0‰ to 24.6‰. Occurrence of anhydrite-rich lithology and Sr isotope data (0.7060 to 0.7089) similarly record the mixing process of seawater and black smoker fluids. Silicon isotope data of the siliceous precipitations in sulphide ores and wall rocks show negative δ³⁰Si values (-2.4 to -0.1‰), indicating a kinetic isotope fractionation between hydrothermal fluids and siliceous precipitations.