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Establishing Cu isotopes as a tracer for seafloor mineral deposit formation using hydrothermal experiments

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The demand for copper (Cu) shows no sign of diminishing in the future, and improving the understanding of the formation of Cu-bearing deposits is therefore necessary. An intriguing target for investigations are seafloor hydrothermal mineral deposits, but it is unknown what causes deposit size and metal content to vary between different seafloor hydrothermal systems. The application of novel tracers of geochemical processes can potentially fill this knowledge gap. Empirical data suggest that Cu isotope ratios measured in hydrothermal deposits and fluids can provide insights into sub-seafloor processes leading to the formation of Cu-bearing deposits. However, the behaviour of Cu isotopes under hydrothermal conditions (up to 400°C and 400 bar) is not yet well known.

Here, we present the first results of a systematic study that aims to determine Cu isotope fractionation under hydrothermal conditions. This study includes natural fluid and sulfide samples from seafloor hydrothermal systems in three distinct geologic settings, the Arctic Mid-Ocean Ridge (ultraslow spreading), the Mid-Atlantic Ridge at 12-15°N (slow spreading), and the Manus Basin (back-arc basin). Cu isotope ratios of natural samples will be compared to hydrothermal fluids that are experimentally produced in heated, pressurized batch reactors in the hydrothermal laboratory at the University of Bergen. Our experimental set-up enables us to simulate different sets of temperature and pressure conditions over flexible time periods, producing realistic, controlled hydrothermal fluids. This way we can identify isotope signatures of ore-forming processes responsible for the supply, transport, and deposition of Cu in seafloor hydrothermal systems.

Results from this study will provide a solid framework for the interpretation of Cu isotope ratios measured in hydrothermal deposits and enhance the understanding of sub-seafloor processes leading to the formation of hydrothermal Cu deposits.