Cycle of metals during hydrothermal alteration of the oceanic crust: Experimental study of sulfide leaching by hydrothermal fluids

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Understanding source-deposit relationships in VMS systems is crucial for mining exploration and knowledge of oceanic hydrothermal processes. Studies of modern mid-ocean ridges and ancient ophiolitic systems have shown that the formation of these ore deposits is the result of the convective circulation of seawater within the oceanic crust, which leads to an intensive alteration of the sheeted dyke complex. It has been proposed that metal-depleted epidosites commonly found at the base of the sheeted dyke complex are the source rocks of metals in VMS deposits. However, some aspects of metal mobilization and transfer processes are still poorly understood. Although it is generally accepted that metals are released through leaching of magmatic sulfides present in the sheeted dyke complex, recent studies suggest that some metals (Zn, Co and Ni) are rather released by destabilization of secondary silicate minerals such as chlorite and amphibole. The purpose of this project is to experimentally test if the leaching of magmatic sulfides on its own allows to explain the amount of metals presents in VMS, or if it is necessary to involve silicate minerals as well. Thus, synthetic sulfides doped with various metals (Cu, Mn, Ni, Co, Zn, Pb, Mo, Au, Ag) together with natural samples of fresh MORB were reacted with an aqueous NaCl (0.5 m) solution at 400°C and 400 bars in a hydrothermal pressure vessel for one month. A pyrite-pyrrhotite-magnetite buffer assemblage was used to constrain fO_2 and fS_2, and the hydrothermal fluid was regularly sampled during the experiment and analyzed by ICP-MS. Preliminary results suggest an efficient dissolution of metal-bearing sulfides and a delayed alteration of the MORB samples, in accordance with the starting hypothesis. In addition, the present study allowed to determine metal solubility and partitioning between hydrothermal fluid and mineral phases (sulfides and silicates) in conditions favourable to the epidotization of the oceanic crust.