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Alteration Products of Seafloor Massive Sulfides: A New Source of Copper?

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Deep-sea mineral deposits could make a major contribution to future global raw material supply. Requirements to reduce carbon emissions may result in deep-sea mining, as these deposits have increased ore grades, little to no overburden, and cause significantly less deforestation compared to terrigenous deposits.

Extinct seafloor massive sulfide (SMS) systems comprise the largest and only viable means of potentially mining these deposits. However, the fate of metals during seafloor weathering remains poorly constrained. It is uncertain if metals contained in sulphide minerals, such as Zn, Cu, and Au, are lost from the primary minerals during seafloor weathering forming barren systems, or are potentially stored in alteration products such as Fe-oxyhydroxides (FeOOH), forming supergene gossans.

Forty-two samples of FeOOHs and massive sulfide were collected at Semyenov hydrothermal field, an extinct, ultramafic-hosted SMS system at the Mid-Atlantic Ridge. The average Cu content of FeOOHs collected (excluding metal depleted chimneys) is 2.5 wt.% (n = 29), which lies at cut-off grade for Fe-Mn nodules of 2.5 wt.% Ni and Cu, illustrating the economic potential of FeOOHs. However, massive sulphides can contain up to 13.4 ppm Au and 10.6 wt.% Cu with an average of 4.8 wt.% Cu (n = 5), thus resulting in significant metal loss during oxidation.

Despite seafloor weathering resulting in metal loss from the sulphides, some of these metals remain within the Fe-oxyhydroxides, retaining a significant metal tenor. Furthermore, FeOOHs have the benefit of containing little to no sulphur, removing the need for energy-intensive smelting during processing and are thus more sustainable. Seafloor exploration at SMS deposits largely ignores FeOOHs; however, this research demonstrates the potential of Fe-oxyhydroxides for possible future exploitation. Further work will include acid leaching studies to determine the amount of recoverable Cu in FeOOHs.