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An experimental study of metal extraction from continental red-bed sandstones

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Understanding the extraction and transport of metals in sedimentary basins is important because basin-hosted copper deposits host more than 23 % of the world's discovered copper as well as other metals such as vanadium and cobalt. These critical metals are key for the ongoing clean energy transition.

Red bed sandstones have been identified as potential metal sources for sedimentary basin-hosted copper deposits because they are a characteristic facies in the mineral system and their iron oxide coatings can adsorb metals (*Figure 1*). The dissolution of these coatings could lead to the formation of an ore fluid. However, previous experiments to understand the extraction and mobility of copper and other trace elements have not considered flow effects, elevated temperatures, or the effects of natural variations in brine chemistry.

Hence, we report new experiments to quantify the release of metals from red bed sandstones while in contact with: (i) aqua regia; and (ii) a variety of natural brines over a range of temperatures. Experiments with aqua regia are used to determine the total leachable metal content of the rocks whereas brine experiments represent conditions more relevant to metal mobilisation in sedimentary basins. Leaching under aqua regia revealed a significant variability of trace element concentration from the red bed sandstones, with ore-bearing basins displaying higher trace metal concentrations. We found the highest concentrations of copper and cobalt in samples from the Neuquén Basin (Argentina) and Katangan Basin (Zambia). Furthermore, acid leaching produces a positive correlation between iron and some trace metals including vanadium, chromium, nickel and titanium, suggesting these metals are also incorporated in oxide grain coatings. Preliminary results from the brine leaching experiments show that sandstones have a highly variable ability to exchange protons and therefore buffer pH; some experiments show little pH change whereas others show a decrease to pH 3 over several months. Experiments are ongoing to understand the proton exchange mechanism(s) and the potential impact of natural low pH on metal extraction.

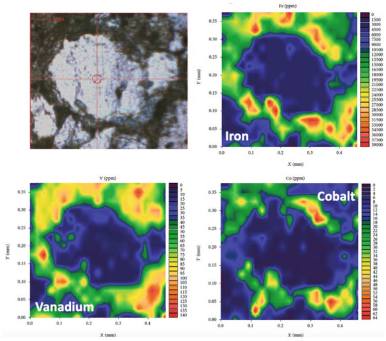

Figure 1. LA-ICP MS maps of Fe, V, and Co for grain coatings in red bed sandstones (Parnell et al., 2021)