Molybdenum and chromium molecular geochemistry: Advancing the paleo-redox proxies

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To reconstruct the Earth's oxygenation or study past oceanic anoxic events, we rely on paleo-redox proxies. Usually, these proxies are trace metals showing contrasting redox behavior depending either on the presence of oxygen or sulfide (e.g. Fe, Mo, Cr). The current approach consists mainly of examining trace metal bulk geochemistry by measuring their concentrations and isotopic signatures in sedimentary records, despite the lack of a complete understanding of the mechanisms involved during their burial and post-depositional remobilization. Without doubt, this approach has produced successful outcomes, but as we constantly move towards a refined interpretation of environmental archives, we have to improve our characterization of reactions involving paleo-redox proxies. By disregarding how geochemical controls govern burial and diagenetic processes that can alter the original paleo-redox proxy signal, we run the risk of misinterpreting sedimentary records.

By combining the current approach (trace metal concentrations and isotopes) with molecular geochemistry, we can significantly improve our identification of ancient redox regimes in paleoceanography. Molecular geochemistry (i.e. speciation analysis) aims to identify and quantify the predominant geochemical species present in the studied system. To determine the redox proxy speciation, we can use either chromatographic techniques coupled to inductively coupled plasma mass spectrometry (IC-ICP-MS) for water samples and/or beam focused X-ray absorption fine structure (μXAFS) spectroscopy for sediment and rock samples.

I will demonstrate the importance of considering trace metal molecular geochemistry, if we hope to refine our interpretation of sedimentary records, by presenting new insights gained from on-going research focusing on the speciation analysis of Mo and Cr in modern and ancient settings.