Investigation of metal associations in the metal- rich black shales of the Niutitang Formation in the context of the Cambrian explosion

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A transition from oxygen-deficient to oxygenated oceans triggered the evolution of complex multicellular life at the Precambrian-Cambrian boundary, 542 million years ago. At this time, both the evolution of metazoan radiation and the genesis of sub-economic Ni, Mo, Rare Earth Elements (REE) and Platinum Group Element (PGE) deposits were triggered in shallow marine environments, including on the Yangtze platform in China. This is one of the most enigmatic examples of a sediment-hosted base and precious metal deposit showing an association of ore-grade metals with organic matter (OM). The genesis of this and other strata-bound deposits is poorly understood.

This study aims to investigate in detail the fine-scale distribution of Ni, Mo, Au, Ag, Se, V, Zn, U and PGEs in this rare ore layer, providing further insights into the genesis of this metal accumulation. A multi-proxy approach was used with total organic carbon (TOC), X-ray diffraction (XRD), whole rock geochemistry and $\delta^{13}C_{kerogen}$ analysis to investigate bulk compositions. To get further insight into metal associations and spatial distributions, microbeam XRF mapping, scanning electron microscopy (SEM), Synchrotron XRF mapping, electron probe micro-analyser (EPMA) and laser-ablation ICP-MS on sulfides were applied on samples from the mineralised horizon and the surrounding black shales. This bulk and fine-scale study of metals, organic-rich matrix and phosphorite nodules allows a greater understanding of metal associations in this unique, highly anoxic and sulfidic (euxinic) marine system, in the context of the Cambrian bioradiation of metazoans.