INDRANI MUKHERJEE

MEETING

Thursday 25th June 2026

TALK TITLE

Finding Ni-Mo deposits: Disentangling ore genesis models for metalliferous black shales

TEASER

Metalliferous black shales enriched in Ni, Mo, Co, and V are commonly attributed to seawater or hydrothermal processes. New mineralogical and geochemical data from black shales in China and Canada suggest a more nuanced model in which petroleum discharge played a critical role in upgrading metal concentrations. Evidence from sulphide textures, EPMA analyses, and synchrotron-based metal speciation studies provides new insights into the mechanisms responsible for extreme metal enrichment.

BIOGRAPHY

Indrani Mukherjee is a **senior lecturer and researcher in Earth Sciences at the University of New South Wales**. Indrani's research focuses on deep time geology. The approach involves a nuanced understanding of ancient marine environments, via novel and cutting-edge geochemical techniques. Her research questions key concepts, and explores links between early Earth evolution, the origin of complex life and formation of economic mineral deposits. Indrani did her BSc Honours and Masters in Geology at the University of Delhi. She completed her PhD at UTAS in 2018 where she worked as a lecturer and postdoctoral researcher in Earth Science until 2022. She then went on to pursue the Roger E Deane Fellowship at the University of Toronto. She was named as the Superstar of STEM (2022-2023) and is passionate about geoscience outreach.

COMPLETE ABSTRACT

Organic matter rich black shales enriched in transition metals such as Ni, Mo, Co, V, are often referred to as hyper-enriched or metalliferous black shales. Different causes may explain these enrichments: anoxia, high biological productivity, or hydrothermal activity. These processes may either aid in preservation of such metalliferous shales or be an additional source of metals. Two popular ore genesis models have been invoked for the formation of such types of metal enriched black shales – direct precipitation from seawater and hydrothermal origins. The sedimentary/seawater model suggests formation of such deposits initially occurred on the sea floor in a reducing environment where metals were sourced entirely from sea water and later

concentrated during diagenesis (for example, Coveney and Nansheng (1991), Orberger et al. (2007), Pi et al. (2013), Lehmann et al. (2016). Some models invoke low-T hydrothermal fluids, where submarine springs may act as source of metals along with seawater, in the above-mentioned sedimentary models Coveney and Nansheng (1991). Some research suggests high-T hydrothermal fluids possibly evolving from quartz-sulphide stockwork, may have been key along with seawater (Lott et al., 1999). While seawater and hydrothermal fluids remain popular fluid source types, ground water seeps (Steiner, 2001) and hydrocarbon seeps (petroleum discharge; Emsbo, 2005) have also been proposed.

The present contribution investigated the black shales from the Nuititang Formation in China (Daping & Ganziping in Hunan, Tianeshan in Guizhou) and Nick prospect in Yukon, Canada. The study proposes a nuanced ore genesis model for such deposits based on current observations. We advocate a model that is essentially a nuanced seawater model that takes into account the source of metals and the various chemical transformations that may have played a key role in concentrating the metals to higher grades. Given it is difficult to explain high grades of enrichment solely due to seawater, we prefer oil discharge (into the water column/sediments or both) as a key step in the mineralization upgrade process. The oil discharge would not just be a source of metals but also an important process that may have triggered a series of chemical reactions favoring mineralization. The presentation will discuss characteristic texture of the sulphides derived using reflected light microscopy and Scanning Electron Microscopy (SEM) in support of the model. Geochemical analyses (via Electron Microprobe Analyses or EPMA) along with speciation analyses (for Ni, Mo) collected via synchrotron-based absorption techniques will also be presented in support of the proposed model.