Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.24305

Raman- and X-ray fluorescence micro-spectroscopy analysis of deep-sea ferromanganese nodules in Pacific Ocean

MARIA DITTRICH[1] AND ANDREAS VOEGELIN[2]

[1]University of Toronto

[2]Eawag, Swiss Federal Institute of Aquatic Science and Technology

Presenting Author: m.dittrich@utoronto.ca

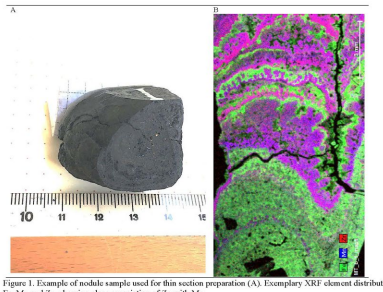

Figure 1. Example of nodule sample used for thin section preparation (A). Exemplary XRF element distribution map of Fe, Mn and Zn, showing close association of Zn with Mn.

Recently, a great interest in deep-ocean resources has been turned again to iron-manganese nodules as a source of rare earth (REE) Elements, which become one of the most limiting metal industrial sources. The marine ferromanganese nodules are the most abundant mineral deposits in the deep ocean [1]. In this study we investigated the nodules of the Clarion-Clipperton zone (Pacific Ocean) which are composed of 7 Å phyllomanganates, and δ-MnO_2. The Mn-micronodules are built of fine concentric growth layers with different Mn/Fe ratio. The concentric layers also include copper, nickel, cobalt, molybdenum, lithium, and titanium. More detailed studies on the mineralogical composition revealed the minerals' disordered properties and low crystallinity. The formation mechanisms of nodules are still debated, especially the role of microbes. Combining Raman microscopy, X-ray fluorescence (XRF) spectroscopy, and scanning electron microscopy with electron energy dispersive X-ray spectroscopy (SEM-EDS) techniques allows us to shed light on the mineralogical and microbial signatures of iron-manganese nodules. The spatial distributions of minerals and trace in the natural ferromanganese nodules has been studied with Raman, XRF, SEM -EDX mapping. The Raman spectroscopy effectively allows identification the specific mineral phases in the ferromanganese nodule with diverse structures including todorokite and birnessite (i.e., layered structure). Further Raman mapping analysis showed the spatial distribution of cobalt (Co) and nickel (Ni) association with Mn oxides.

References

1. Hein J.R., Koschinsky A. (2014) Deep-ocean ferromanganese crusts and nodules. In: Holland HD, Turekian KK, Treatise on Geochemistry. (2nd edn), Oxford Elsevier, USA, 273.