Petrographic and isotopic features of the Ni- and Mo-sulfides extremely enriched black shales in the Lower Cambrian Niutitang Formation, Southwest China

YINGNAN ZHANG[1], YILIANG LI[2], LIPING QIN[1]

[1] CAS Key Laboratory of Crust-Mantle Materials and Environment, University of Science and Technology of China, Hefei, China (lpqin@ustc.edu.cn)

[2] Department of Earth Sciences, the University of Hong Kong, Hong Kong SAR, China

The black shale in the Lower Cambrian Niutitang Formation, Southwest China hosts extremely enriched polymetallic Ni- and Mo-sulfides. The abundances of Ni- and Mo-sulfides are as high as 3.8 and 7.7 wt%, respectively). The sulfide ore layer is composed of micro-meter sized sulfide spherules in the matrix of black shale. Being the richest sedimentary exhalative polymetallic ore ever reported, many works have attempted to uncover the formation mechanism of the metal enriched layer. However, to date the source of these metals still remians an open debate.

We observed the high-resolution structures of the sufide layers by electron microscopes and analyzed the Ni-Mo isotopic compositions of the sulfide spherules and matrix. Our results show that the Mo-sulfides make clusters as irregular spherules disseminated with numerous small pyrite framboids. Differently, Ni-sulfides made veins in the spherules or overgrowth as corona of the spherules. This indicates that the Mo-sulfide and the Ni-sulfides deposited at different stages of the shale formation. The Mo-isotopic compositions for the spherules are heavier than the matrix, which is consistent with the fact that the matrix hosts more Mo(VI) absorbed by Fe-Mn oxides. However there is no difference in Ni-isotopic compositions between the spherules and the matrix. Rather, they all sit on the mixing line between the seawater (low Ni/Mo and heavy Ni isotopes) and hydrothermal fluids (high Ni/Mo and light Ni isotopes). The different features of the Mo- and Ni-isotopic compositions suggest that Mo and Ni were derived from different sources. We suggest that Mo and a fraction of Ni were from the seawater that were reduced and deposited as sulfides. The hydrothermal fluids interacted with the sediments and the other fraction of Ni was brought by the fluid reduced by the TOC-enriched sediments and deposited around or within the the Mo sulfides.