Fe isotope variations in ferruginous sedimentary rocks above Kuroko deposits in the Hokuroku district, Northeast Japan

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The Hokuroku district in Northeast Japan hosts many large volcanogenic massive sulfide (VMS) deposits called Kuroko deposits, which were formed around 15 Ma by ancient submarine hydrothermal activity. Because they are composed of sulfide minerals that are stable in a reducing environment, redox environment on the seafloor during and after the formation of Kuroko deposit may play an important role in the preservation of the sulfide ores. Therefore, the objective of this study is to investigate the variation of Fe isotope compositions in the Fe-Mn-rich sedimentary rocks that are associated or are not associated with Kuroko deposits to understand the depositional environments and ancient sea-floor hydrothermal systems in the Hokuroku basin.

The samples show a large variation (-1.75–+2.02‰) in the δ^{56}Fe values. The samples that have large negative values also bear negative Ce anomalies. There is no correlation observed between the Fe isotope variation and the elemental Mn/Fe ratio, indicating Fe and Mn were decoupled during sedimentation processes. These signatures suggest that partial oxidation of dissolved ferrous iron occurred by mixing ferrous iron-bearing anoxic water with oxygen-bearing seawater, and therefore that the sea-floor of the Hokuroku basin was likely anoxic during and after the formation of Kuroko deposits. The samples that are not associated with Kuroko deposits show more negative δ^{56}Fe values (-1.75–+0.69‰) than the samples associated with Kuroko deposits (-0.80–+2.02‰). This may be due to a high influx of hydrothermal fluids and/or precipitation of isotopically lighter iron sulfide minerals during the formation of Kuroko deposits. The signatures in the Fe-Mn sedimentary rocks may be used as an exploration tool for VMS deposits.