Fe isotope and trace element variations in Shilu iron deposit, Hainan province, China: an early Neoproterozoic iron formation

*Jian Sun[1], Xiang-kun Zhu[1], Zhi-hong Li[1]

1. Institute of Geology, Chinese Academy of Geological Sciences

The Shilu Fe ore deposit in Hainan province, China is known as the richest Fe-ore deposit in Asia, with proven ore reserves exceed 460 Mt of Fe-ore at an average grade of 51% FeO. It is dominated by high-grade hematite-type Fe ores, which are hosted in dolomite marble of Shilu Group. The constrained age of the ores is early Neoproterozoic, between ca. 0.8Ga and ca. 1.0Ga. The genesis of the deposit is still under debate due to its complicated geological characteristics. The proposed models include: 1) skarn type deposit; 2) magmatic-volcanic origin (erupted volcano); 3) exhalative sedimentary origin.

Here Fe isotopes and trace elements for iron ores and jasper from the main orebody (Beiyi Orebody) of Shilu deposit were systematically investigated based on carefully petrographic studies. It is observed under the microscope that fine-grained jasper is widely distributed in the Fe ores. The Fe isotopes and PAAS-normalized REE patterns vary regularly for iron ores from different layers. There are three layers of iron ores in Beiyi Orebody. The iron ores from the bottom (lower) layer have highly positive δ^{56}Fe values of ca. 1‰ ~ 1.5‰. Their PAAS-normalized REE patterns show remarkably positive Eu anomalies and negligible Y anomalies, indicating partly sourced from high-temperature hydrothermal fluids. On the other hand, the iron ores from the middle layer have slightly positive δ^{56}Fe values of ca. 0.2‰ ~ 0.4‰, whereas those from the upper layer have δ^{56}Fe values of ca. -0.2‰ ~ 0.2‰. Their PAAS-normalized REE patterns imply a mixed source from seawater and low-temperature fluids, with LREE depleted and HREE enriched, no or negligible Eu positive anomalies, and slightly positive Y anomalies.

The positive and variable Fe isotope compositions, and characters of REE patterns, as well as the fact that jasper is widely distributed in the iron ores, convincingly demonstrate that the Shilu Fe deposit is of chemical-sedimentary origin, or in other word, banded iron formation (BIF).

Shilu iron formation is not the only one of the early Neoproterozoic iron formations. Another one, the Aok iron formation in NW Canada, has also been previously reported. They likely deposited in a same period according to stratigraphic correlation. It seems that the early Neoproterozoic iron formations are not of local occurrence, but may be widely in globe, although their scale is not as large as that of Cryogenian iron formations. The origin and significance of occurrence of the early Neoproteorzoic iron formations are interesting issues worthy of further studies, but obviously they are not related to the “Snowball Earth”.

The Fe isotope and REE variation trend in Shilu iron deposit provide insights into the temporal evolution of iron deposition. The variation of REE patterns among different layers of ore deposit indicates that the degree of mixing of high temperature hydrothermal fluids is not constant during Fe precipitation. The correlation between Fe isotopes and REE patterns indicate that the Fe isotope variation may be affected by changes of physico-chemical conditions (such as pH, Eh and T) during Fe-oxide precipitation.

Keywords: iron deposit, iron isotopes, rare earth element, iron formation, early Neoproterozoic

