Geophysical Research Abstracts
Vol. 18, EGU2016-15113, 2016
EGU General Assembly 2016

Iron isotope constraints on the mineralization processes of the Sandaowanzi telluride gold deposit, NE China

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Iron isotopes have been widely applied to interpret the fluid evolution, supergene alteration and the metallogenic material sources of the hydrothermal deposit. It may also have significant potentials on the research of the deposit. The Sandaowanzi telluride gold deposit, located in the Great Hinggan Range metallogenic Belt in NE China, is a large epithermal gold deposit of low-sulphidation type. It has a total reserve of $\geq$25t of Au and an average of 15 g/t. Gold-bearing quartz veins or gold lodes strike to the NW and dip 50-80°northeastward. Ore bodies, including low-grade ores along margins and high-grade ores in the central parts, principally occur in quartz veins. More than the 95 percent Au budgets are hosted in gold-silver tellurides. A six-stage paragenetic sequence of mineralization is revealed according to the compositions and microstructures of the mineral assemblages. Although sulfide minerals in the bonanza quartz veins are rare, pyrite are widespread in quartz veins and altered host rocks. Meanwhile there are always chalcopyrite veins within bonanza quartz veins.

Pyrite Fe isotope compositions from different levels (from +50m to +210m) of the main ore body of the Sandaowanzi gold ore deposit are investigated. There is an overall variation in δ57Fe values from -0.09 to +0.99 (av. 0.33). Among them, twenty three samples from different mining levels give positiveδ57Fe values, with the maximum positive value at the economic bonanza ores (level +130m). Four samples, however, possess negative values, one at level 170m, one at level 130m, and two at level 50m, respectively. The two negative values from the levels 170m and 130m are near the cores of the high grade ore body. The two negative values from the level 50m occur at one end of the lode ore body. The above data set shows that the δ57Fe values are not homogeneous at different levels of the ore body. On the other hand, a general trend for the positive values is that the highest δ57Fe value is located at level +130m, but decreases gradually towards deeper and shallower levels.

It is generally accepted that the isotopically light iron preferentially deposited early during the evolution process of mineralizing fluids and in the residues heavy Fe isotopes are enriched. Two stages of iron isotope fractionation are thus expected: enrichment of the isotopically light iron in the early stage at the level 170m and enrichment of the isotopically heavy iron in the later stage at the 130m. The results, therefore, suggest that mineralization first started at the level 170m and ended at the economic bonanza veins at level 130m. Meanwhile, the δ57Fe from levels 170m and 130m may suggest that mineralization started early near the core of the ore body, but the values from the level 50m may imply that mineralization started from one end of the ore lode.