Iron isotope features of the Chagangnuoer iron deposit, western Tianshan, NW China

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The stable isotopes of transition metals have drawn much attention as possible tools to monitor geochemical processes. Especially, the iron isotopes have been widely applied to studying different deposits and large iron isotope fractionation can occur during metallogenic processes. We investigated the iron isotope compositions of ferrobasalt and major iron-bearing mineral separates from the Chagangnuoer iron deposit, western Tianshan, China. The main purpose of this work is: (1) to investigate the extent of iron isotope fractionation in magmatic hydrothermal deposits; (2) to understand the redox control on iron isotopic fractionation during fluid exsolution and subsequent mineralization; (3) to examine the feasibility of using iron isotopes to trace the metal source.

The iron isotope (δ^{56}Fe) compositions of the ferrobasalt, magnetite, garnet, pyrite and chalcopyrite display a total range from –0.572‰ to +0.210‰. The iron isotope values of the magnetite (0.00‰ to +0.210‰) and garnet (-0.030‰ to +0.099‰) are higher than those of the ferrobasalt and sulfide. The iron isotope values of the ferrobasalt (-0.401‰ to -0.165‰) are higher than those of chalcopyrite (-0.527‰ to -0.464‰) but lower than those of pyrite (-0.389‰ to -0.046‰). To better understand the redox state of different types of samples, the $Fe^{3+}/\sum Fe$ ratios of them were obtained using titration methods. The ferrobasalt samples show low $Fe^{3+}/\sum Fe$ ratios from 0.157 to 0.284, implying the iron in the ferrobasalt are mosly ferrous. The garnet and magnetite samples have $Fe^{3+}/\sum Fe$ ratios from 0.907 to 0.931 and from 0.671 to 0.684, respectively. The pyrite and chalcopyrite samples exhibit extremely low $Fe^{3+}/\sum Fe$ ratios.

The result suggests that the iron for the Chagangnuoer deposit was predominantly from a single source and magma-derived. The iron isotopes fractionated during fluid exsolution from the ferrobasaltic magma since the iron contribution from the other sources is insignificant. Iron isotope composition of the fluid during subsequent precipitation matches well with the prediction of equilibrium mass fractionation.