Iron isotope fractionation during differentiation of mafic magma and its bearing on Fe mineralisation: A case study from the Panzhihua layered intrusion, China

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High-precision isotopic analyses have demonstrated that measurable Fe isotopic variations exist at both whole-rock and mineral scales. However, the mechanism causing these variations remans controversial. The Panzhihua layered intrusion in SW China is thought to be closely related to the late Permian mantle plume activity, and the rhythmic structures, which are considered as the result of crystallization differentiation of basaltic magma, are well developed. Thus, it provides an excellent opportunity to further investigate Fe isotope fractionation during magamatic differetiation.

Fe isotopic compositions of whole rocks and mineral separates (olivine, clinopyroxene, hornblende, magnetite) in the Panzhihua layered ore bearing intrusion were measured using a Nu Plasma HR MC-ICPMS. Overall variations in $\delta^{57}Fe_{IRMM-14}$ values from 0.02‰ to 0.25‰, and from -0.79 to 0.61‰ have been observed in whole rocks and mineral separates, respectively. The Fe isotope compositions show olivine < clinopyroxene < hornblende in $\delta^{57}Fe$ values. Negative correlation exists between oxygen fugacity and Fe isotope composition of the same mineral phase, indicating that Fe isotopic features observed in this study were not resulted from Fe isotopic exchange in sub-solidus diffusion process after crystallization, but mainly reflect isotopic mass fractionation during crystalisation. Besides, the Fe isotope features strongly indicate that the gravitational settling and sorting of crystals cannot be the main mechanism for the accumulation of the massive Fe-Ti oxide ore in the layered intrusion.

This study not only furthers our understanding in the behsvious of Fe isotopes during magmatic differentiation, but also sheds light on how to use Fe isotopes to tracing ore-forming processing.