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# Cu–Fe Isotope Study of the Jinchuan Magmatic Cu–Ni Sulfide Deposit

**SONG XUE** AND SHANGGUO SU

China University of Geosciences (Beijing)

Metal isotope systematics provide critical constraints on sulfide melt evolution in magmatic Ni–Cu systems. We investigated Cu isotopes in net-textured and disseminated sulfide ores from the Jinchuan Ni–Cu deposit to evaluate metal isotope fractionation during sulfide melt differentiation. Previous studies reported a negative $\delta^{65}$Cu–S correlation across different ore types, interpreted as evidence for early deep sulfide segregation that sequestered isotopically light metals in lower crustal magma chambers [1]. In contrast, our samples, restricted to net-textured and disseminated ores, define a clear positive correlation between $\delta^{65}$Cu and S content.

We interpret this relationship as reflecting progressive sulfide melt differentiation within the conduit system rather than deep magma chamber sequestration. Early crystallization of Fe-rich sulfide phases preferentially incorporated isotopically light Cu, driving the residual sulfide melt toward heavier $\delta^{65}$Cu values. Variable accumulation of sulfide crystallization products formed during sulfide melt evolution subsequently enriched the system in isotopically heavy Cu, generating the positive $\delta^{65}$Cu–S correlation.

To further constrain sulfide melt fractionation, we conducted in situ Fe isotope analyses of individual sulfide minerals in thin sections from disseminated and net-textured ores. The Fe isotopes show systematic inter-mineral fractionation, with pyrrhotite (Po) exhibiting the lightest $\delta^{56}$Fe, whereas pentlandite (Pn) and chalcopyrite (Ccp) display similarly heavier values (Po < Pn ≈ Ccp). This distribution is consistent with near-equilibrium fractionation during sulfide melt crystallization [2,3], in which early MSS crystallization preferentially incorporated light Fe isotopes, leaving the residual sulfide melt progressively enriched in heavy Fe and subsequently recorded by later Cu-rich melt–derived phases.

Together, the coupled Cu–Fe isotope systematics indicate that stage-dependent sulfide melt differentiation and variable accumulation of crystallization products during the conduit stage exert an important control on metal isotope signatures in the Jinchuan magmatic system.

[1] Zhao, Y., Wang, S.-J., Xue, C. & Brzozowski, M. J. (2024), Geology 53, 3-7. [2] Wang, P., Niu, Y., Sun, P., Wang, X., Guo, P., Gong, H., et al. (2021), Minerals 11, 464. [3] Brzozowski, M. J., Good, D. J., Wu, C. & Li, W. (2021), Chemical Geology 576, 120282.