Resolving the Syn-Genetic Age of the King Metamorphosed VHMS Deposit, Yilgarn Craton, Western Australia

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The exploration of VMS deposits in high-grade metamorphic terranes can be quite challenging due to intensive deformation and metal remobilization. Metamorphism can also cause isotopic redistribution, obscuring the syn-genetic age of VMS mineralization and leading to misinterpretations of regional metallogenic models. In this study, we employed multiple geochronological approaches to constrain the temporal evolution of the King metamorphosed VMS deposit in the Eastern Goldfields Superterrane, Yilgarn Craton.

The peak metamorphism age, constrained by Lu-Hf garnet geochronology, yielded an isochron age of ca. 2680 ± 27 Ma. This age is consistent with the M2 regional-contact metamorphism associated with the emplacement of Ca-rich granitoid intrusions. On the other hand, the footwall felsic unit, which is the host rock of massive sulfide mineralization, yielded a weighted mean age of 2725 ± 10 Ma.

Detailed petrographic observations revealed that pyrrhotite was formed by the desulfidation reaction of pyrite during metamorphism. Consequently, pyrrhotite is expected to record the metamorphism age, whereas pyrite would preserve the syn-genetic mineralization age. Systematic Re-Os geochronology revealed that recrystallized pyrite grains yielded a Re-Os isochron age of 2729 ± 34 Ma, consistent with the felsic footwall. Meanwhile, pyrrhotite yielded an isochron age of 2654 ± 39 Ma, consistent with the metamorphism age. Additionally, we analyzed molybdenite hosted by late granitoid intrusions, which yielded a weighted mean age of 2648 ± 16 Ma. Molybdenite occurring along the foliation of footwall biotite-quartz schist also consistently yielded a weighted mean age of 2658 ± 23 Ma.

In the Eastern Goldfields Superterrane, significant VMS mineralization is typically restricted to the Kurnalpi Terrane between approximately 2705 and 2680 Ma. However, this study demonstrates that an older period of VMS mineralization also occurred in the Eastern Goldfields Superterrane, coeval with the youngest period of VMS mineralization in the Youanmi Terrane, Western Yilgarn (ca. 2725 Ma).