

Tracing hydrothermal fluids in porphyry systems using K and Mg isotopes

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Here we report the first integrated investigation on behaviors of Mg and K isotopes during water-rock interaction at high temperature conditions. High precision K and Mg isotope measurements of bulk altered rocks from the Dexing porphyry Cu deposit in China reveal a large variation K and Mg isotope compositions in both altered porphyry intrusion and surrounding wall rocks, where hydrothermally altered rocks have a $\delta^{41}\text{K}$ range of -1.02‰ and +0.38‰, $\delta^{26}\text{Mg}$ values range between -0.49‰ and 0.32‰. Generally speaking, the altered samples tend to enrich heavy K and Mg isotopes relative to unaltered igneous rocks, which are interpreted to reflect preferential incorporation of heavy K and Mg isotopes in alteration products of phyllosilicates. However, a small proportion of altered samples show anomalously low $\delta^{41}\text{K}$ and $\delta^{26}\text{Mg}$ values. The K and Mg isotope variability of altered samples is not correlated with elemental mobility or mineralogy of the alteration product. We argue that the variations in $\delta^{41}\text{K}$ and $\delta^{26}\text{Mg}$ values in altered rocks were produced by activities of different fluids that were either associated with different K and Mg isotope fractionation factors due to different physical-chemical properties, or with very evolved isotopic compositions by Rayleigh processes. Therefore, K and Mg isotopes of altered rocks could be used as a novel tracer for fingerprinting different fluids in complex hydrothermal systems.

