Potassium Isotopic Constraints on Vaporisation and Volatile Element Evolution during Planet Formation

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The differentiated planetary bodies of the solar system such as the Earth, Moon, Mars, asteroid 4 Vesta and the Angrite Parent Body (APB) are depleted in moderately volatile elements (e.g., Na, Cl, K, Cu, Zn, and Rb) to various degrees compared with undifferentiated meteorites such as carbonaceous and ordinary chondrites. The reason for this moderately volatile element depletion in planetary materials is still under debate. Possible mechanisms include 1) incomplete condensation in the solar nebula; 2) partial evaporation during planetary accretion (e.g., via high-energy impacts); 3) magma ocean degassing, and 4) local volcanic outgassing. Understanding the causes of these depletions will provide new vital information on the origins of the terrestrial planets. In the past years, with the improvement of analytical precision, isotopes of the moderately volatile element K have been used as a novel tracer to distinguish these different mechanisms. Here we present the most comprehensive analysis of K isotope compositions of both primitive and differentiated planetary materials (see Figure) and discuss their implications on moderately volatile element evolution during terrestrial planet formation.