"Inverse" Zn isotope fractionation discovered between chromian spinel and olivine

CHUN YANG\(^1,2\), SHENG-AO LIU\(^3\), LONG ZHANG\(^4\), ZE-ZHOU WANG\(^3\), PING-PING LIU\(^5\) AND SHU-GUANG LI\(^1\)

\(^1\)China University of Geosciences
\(^2\)University of Münster
\(^3\)China University of Geosciences, Beijing
\(^4\)Guangzhou Institute of Geochemistry, Chinese Academy of Sciences
\(^5\)School of Earth and Space Sciences, Peking University

Presenting Author: karlyang@cugb.edu.cn

The first zinc isotope data for chromian spinels (Cr-spinels) and coexisting olivines in oceanic peridotites are presented. All spinel-olivine pairs fall on the 1:1 fractionation line in the diagram of $\delta^{66}$Zn\(_{spinel}\) versus $\delta^{66}$Zn\(_{olivine}\), suggesting equilibrium isotope fractionation. Cr-spinels are always isotopically lighter than coexisting olivines, which is surprisingly opposite to the positive fractionation between Al-spinel and olivine in cratonic peridotites [1]. The “inverse” Zn isotope fractionation between Cr-spinel and olivine is unlikely to have been induced by olivine serpentinization and weathering. Instead, we suggest a “chemical effect” in which the Zn-O bond length (tetrahedral site) in spinel increases when Cr substitutes Al in octahedral site, which is corroborated by the striking negative correlation of $\delta^{66}$Zn with Cr\# in natural spinels.

During magma differentiation, zinc is moderately incompatible in silicate minerals (olivine and pyroxene) but highly compatible in Cr-spinels/chromites that have Zn contents tens of times higher than those of the melts [2]. Given its light Zn isotopic composition, chromite/Cr-spinel crystallization—if any—can evidently elevate $\delta^{66}$Zn and lower Zn contents of the residual melts. Lunar mare basalts are typically characterized by high $\delta^{66}$Zn and low Zn contents [3], which may have involved chromite crystallization during magmatic differentiation in addition to a major role of evaporation-induced isotope fractionation due to the giant impact. By contrast, the coupling of high $\delta^{66}$Zn and high Zn contents of global ocean island basalts (OIBs) and some intraplate alkali basalts, interpreted to reflect recycling of surface carbonates into the mantle [4], contradicts with a chromite crystallization model.