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Stable neodymium isotopic fractionation during chemical weathering

JIANGHAO BAI, JINLONG MA AND GANGJIAN WEI

Guangzhou Institute of Geochemistry, Chinese Academy of Sciences

Presenting Author: baijianghao@gig.ac.cn

Stable Nd isotope ratio is a potentially useful tool to provide new constraints on the geological reservoir formation processes, complementing information from the radiogenic Nd isotope system. Here we present for the first time the behavior of stable Nd isotopes in low-temperature geochemistry via a well-studied basalt weathering profile on Hainan Island, South China. The results showed that the $\delta^{146/144}$Nd values spanned a range of approximately 0.21‰, from +0.06‰ in the lower profile to -0.15‰ in the upper profiles, while the $\tau_{Th,Nd}$ (%) values decreased from +387.7% to -68.2%, indicating that significant fractionation of stable Nd isotopes and migration of Nd elements occurs during chemical weathering. The sequential extraction results suggest that the majority of Nd in this profile was hosted in the exchangeable and residual phases. The exchangeable phase was enriched with the heavy Nd isotope (^{146}Nd) due to the adsorption of Nd onto gibbsite, which was supported by the positive correlation between the abundance of gibbsite and the proportion of Nd in the exchangeable phase, as well as the $\delta^{146/144}$Nd values. The desorption of Nd from clay minerals may cause the light Nd isotopic compositions of the residual phase. Evidence of desorption was based on the negative correlation between $\delta^{146/144}$Nd values and the abundance of halloysite as well as kaolinite. These findings elucidate the mechanisms affecting stable Nd isotopic fractionation in low-temperature geochemistry, and prove the premise that ^{146}Nd/^{144}Nd = 0.7219 ($\delta^{146/144}$Nd = 0‰) in radiogenic ^{143}Nd/^{144}Nd ratio studies did not hold. Our study shows that the stable Nd isotope ratio is a highly useful indicator for chemical weathering, and combined with the radiogenic ^{143}Nd/^{144}Nd ratio will be a powerful geochemical tracer for understanding global Nd cycles.