Chromium isotopes of basalts from the Ontong Java Plateau and Samoan Ocean Islands: Implications for the core-mantle interaction

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Introduction: Basaltic rocks from large igneous provinces (LIPs) and from ocean islands (OIBs) are thought to be derived from the deep-rooted mantle upwelling. Recent studies have shown that some of these rocks, including OIBs from Samoa and Hawaii, are characterized by ^{182}W deficits that are well resolved from the ambient upper mantle [1, 2]. This negative ^{182}W signature has recently been proposed to originate from the outer core which has a μ^{182}W of −220 [3-5]. If so, the ^{182}W anomaly may be accompanied by deficits of ^{53}Cr, a decay product of a short-lived radionuclide ^{53}Mn, because Cr is more siderophile than Mn at high temperature [6, 7]. However, the Cr isotope variations of LIPs and OIBs are still poorly known. Here, we report the mass independent Cr isotopic data for basaltic rocks from the Ontong Java plateau (OJP) and Samoan OIBs, to further examine the core-mantle interaction that can cause the systematic isotopic variability between LIPs and OIBs.

Results & Discussion: We prepared OJP drill core samples provided by the Ocean Drilling Program and basalt samples from the Samoan Island of Tutuila. The chemical separation and purification of Cr from the samples were made following the procedure described by [8]. The recoveries of Cr were 90-100% for all samples. We have measured Cr stable isotope compositions of the samples processed through the separation scheme by thermal ionization mass spectrometry (TIMS). The external reproducibilities achieved here were ±5 ppm and ±11 ppm for ^{53}Cr and ^{54}Cr, which are markedly smaller than isotope variation among planetary materials (^{53}Cr ~1 ε ; ^{54}Cr ~2 ε). The Cr isotope analyses so far yielded ε^{53}Cr = 0.03 ±0.05, ε^{54}Cr = 0.02 ±0.10 (2SE) for the OJP basalts, and ε^{53}Cr = 0.03 ±0.05, ε^{54}Cr = −0.03 ±0.11 ~ 0.05 ±0.11 for the Samoan basalts. The results for both the OJP and Samoan basalts reveal that there is no resolvable $^{53, 54}$Cr excess or deficit in their source. Our results suggest that there' s no systematical contribution to Cr isotope signatures in the source of OJP and Samoan islands from the material with the anomalous Cr isotope compositions. Therefore, the chemical interaction between the core and the LIPs and OIBs sources is not detectable in terms of the Cr isotopes. This implies that, unlike W, the difference in the Cr concentrations of the core and the mantle might not be so large, or that Cr in the core does not necessarily diffuse in the mantle.

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