Chromium stable isotope composition of meteorites and its cosmochemical and geochemical significance

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There has been increasing interest recently in the use of metal stable isotopic composition variations for fingerprinting the material from which Earth accreted and for tracing various planetary processes [1-5]. A recent study showed that chondrites have systematically lower $\delta^{53}Cr$ values (up to 0.4 ‰) than the bulk silicate Earth [6]. This was interpreted to reflect incorporation of isotopically light Cr into the core at relatively low temperatures and high oxygen fugacities. However sequestration of a significant amount of Cr into the core could be limited at high oxygen fugacities [6]. Furthermore, such a large offset in the $^{50}Cr/^{52}Cr$ ratio (up to 0.8 ‰) may affect the accuracy of non-mass dependent Cr isotope anomaly measurements as mass fractionation in nature often does not obey the exponential law that is typically used to correct mass fractionation in both nature and in the mass spectrometer [7].

Our new high-precision Cr stable isotope data obtained by using a combination of the ^{50}Cr-^{54}Cr double-spike technique and thermal ionization mass spectrometry (TIMS) for terrestrial rocks fall in a similar range with previous studies [e.g.8]. However, our measurements of chondrites show no resolvable difference from the terrestrial samples. This suggests that either only limited amounts of Cr partitioned into the core or that at the P and T conditions of mantle-core differentiation, no Cr isotope fractionation took place between the two reservoirs. With the available data, the silicate Earth and chondrites have very similar stable isotope compositions in Mg, Fe and Cr, but different Si, Ni, Cu and Zn isotopic compositions. Any evolutional model for Earth needs to accommodate these distinct stable isotope features.

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