No evidence for stable Cr isotope fractionation during planetary differentiation

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Approximately 58 % of chromium has been incorporated into Earth's core during its metal-silicate differentiation, assuming a chondritic bulk Earth composition (~4300ppm Cr) and no volatility loss of Cr during the accretionary phase of our planet. The compatible behaviour of chromium during partial melting of the mantle (~2700ppm Cr) leads to low-Cr basaltic crust (~200-300ppm Cr). Crystal fractionation further depletes Cr in highly evolved igneous reservoirs such as continental granitoids (usually <100ppm Cr). Chromium is usually present in its trivalent oxidation state in magmatic minerals and rocks, but significant amounts of Cr^{2+} can form in silicate melts depending on the prevailing oxygen fugacity [1]. This study investigates potential stable Cr isotopic fractionation during planetary differentiation where the size of isotopic fractionation may yield information about the differentiation conditions (i.e. f_{O2}, temperature, pressure).

Average δ^{53}Cr values of 11 ordinary and 7 carbonaceous chondrites determined by double spike MC-ICP-MS are -0.113 ± 0.044‰ (2SD) and -0.128 ± 0.043‰, respectively, indistinguishable from the δ^{53}Cr value of igneous silicate Earth reservoirs of -0.124 ± 0.101‰ [2]. Our data disagree with earlier findings of much lighter δ^{53}Cr values for undifferentiated chondrites [3,4] and indicate that Earth's core formation did not lead to measurable stable Cr isotopic fractionation. The average δ^{53}Cr values of 13 MOR basalts of -0.118 ± 0.111‰ and 24 highly evolved continental granitoids of -0.137 ± 0.093‰ reproduce well within uncertainties and are indistinguishable from the average δ^{53}Cr value of 9 mantle peridotites of -0.137 ± 0.093‰, indicating that partial mantle melting and crystal fractionation within Earth's crust do not induce measurable Cr isotopic fractionation. This finding is supported by the lack of any correlations between δ^{53}Cr and major element concentrations in MOR basalts and granitoids.

[1] Berry et al. (2006) *AmMineral* **91**, 1901ff. [2] Schoenberg et al. *ChemGeol* **249**, 294ff. [3] Moynier et al. (2011) *Science* **331**, 1417ff. [4] Schiller et al. (2014) *JAAS* **29**, 1406ff.