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The cerium stable isotopic composition of mid-ocean ridge basalts

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Cerium (Ce) is a redox-sensitive element with four stable isotopes, ^{136}Ce, ^{138}Ce, ^{140}Ce and ^{142}Ce. High-precise and accurate Ce isotope data have been successfully reported using multiple-collector inductively coupled plasma mass spectrometry (MC-ICP-MS). The stable Ce isotope data can be expressed as $\delta^{142}Ce$ (‰) = $[(^{142}Ce/^{140}Ce)_{Sample} / (^{142}Ce/^{140}Ce)_{NIST\ SRM3110} - 1] \times 1000$. Recently, the Ce anomalies and Ce isotopes have been widely used to examine the redox state of paleo-environment, the oxygen fugacity of the magmas, etc. However, Ce isotope behavior during magmatic processes is still unknown. In this study, we report high precision Ce isotope composition of normal mid-ocean ridge basalts (N-MORB) from the Juan de Fuca Ridge, and depleted mid-ocean ridge basalts (D-MORB) from East Pacific Ridge and Ecuador Rift. $\delta^{142}Ce$ of these N-MORB samples showed a limited variation with an average of -0.004 ± 0.014 ‰ (2SD, N=8). For the D-MORB samples, they have $\delta^{142}Ce$ of 0.012 ± 0.015 ‰ (2SD, N=3). The consistent results between N-MORB and D-MORB can be probably attributed to limited isotopic fractionation during partial melting. Considering that Ce is a highly incompatible element, MORB can be assumed to represent the mantle's composition. One simple peritectic melt modelling suggests that >90% of Ce budget in both spine and garnet facies mantle will be extracted into melt after only 10% melting. Therefore, we suggest that the $\delta^{142}Ce$ of the MORB samples can be used to evaluate the average composition of the mantle.

Key Reference:

1. Liu, F., Ling, M. X., Zhang Z. F., Lu, W. N., Xu J. B., Li, X., Yang, D., Wu, J. J., Yang, H., 2023. Stable cerium isotope analysis of geological materials by MC-ICP-MS. Chemical Geology, 637, 121664.
2. Liu, F., Zhang, Z. F., Li, X., An, Y. J., Liu, Y. F., Chen, K. Y., Bao, Z. A., Li, C. H., 2021. Single-Stage Extraction Technique for Ce Stable Isotopes and Measurement by MC-ICP-MS. Analytical Chemistry, 93(37).