Isotope anomalies produced by extremely small isotope fractionations: A process-driven amplification effect?

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According to the classic isotope fractionation theory developed by Urey and Bigeleisen [1,2], isotope anomalies (e.g., $\Delta^{17}O$, $\mu^{142}Nd$ and $\mu^{182}W$) observed in mantle-derived samples are generally attributed to radioactive decay or nucleosynthetic rather than fractionations [3,4]. However, the discovery of the nuclear field shift effect (NFSE) shed new light on the orgin of such mass-independent isotope anomalies [5,6]. At the same time, because of the small magnitudes of such anomalies, it is quite necessary to check how such NFSE-caused fractionation changes during the formation of mantel-derived samples.

Inspired by previous works [7,8], here we devloped a multi-stage closed-system melting and crystallization evolution model (MC2-model) and conduct Monte Carlo simulations to trace the changes of NFSE-caused fractionations. A high-temperature approximation developed by [6] and exponential law were used to calculate the isotope fractionation factors and final measured isotope anomalies, respectively.

Our simulation work [9] show that there exists an amplification effect for such NFSE-caused fractionations during such multi-stage processes. Such effect scales linearly with the stage number *N*, the total times of melting and crystallization. Combined with statistical analysis, our results indicate that some ppm-level isotope anomalies observed may just extremely small NFSE-caused fractionations magnified after multi-stage high-temperature processes.

[1] Urey, H. C., *J. Chem. Soc*., 1947, 562-581. [2] Bigeleisen, J., *J. Chem. Phys*., 1947, **15**, 261-267. [3] Rizo, H., et al., *Geochem. Cosmochim. Acta*, 2016, **175**, 319-336. [4] Boyet, M., et al., *Earth Planet. Sci. Lett.*, 2018, **488**, 68-78. [5] Bigeleisen, J., *J. Am. Chem. Soc.*, 1996, **118**, 3676-3680. [6] Fujii, T., et al., *Earth Planet. Sci. Lett.*, 2006, **247**, 1-9. [7] Liang, Y and Liu, B., *Geochem. Cosmochim. Acta*, 2016, **173**, 181-197. [8] Liu, B and Liang Y., *Geochem. Cosmochim. Acta*, 2017, **203**, 216-234. [9] Zhang, Y and Liu Y., *under Review*.