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Tin Isotope Fractionation during Magmatic Processes and the Isotope Composition of the Bulk Silicate Earth

Xueying Wang, Caroline Fitoussi, Bernard Bourdon*, Quentin Amet

Laboratoire de Géologie de Lyon (LGL-TPE), ENS Lyon, UCBL and CNRS, 46 Allée d'Italie, Lyon, 69364 Cedex 7, France.

Corresponding author: bernard.bourdon@ens-lyon.fr

Abstract

Tin is a moderately volatile element whose isotope composition can be used to investigate Earth and planet differentiation and the early history of the Solar System. Although the Sn stable isotope composition of several geological and archaeological samples has been reported, there is currently scarce information about the effect of igneous processes on Sn isotopes. In this study, high-precision Sn isotope measurements of peridotites and basalts were obtained by MC-ICP-MS with a double-spike technique. The basalt samples display small variations in $\delta^{124/116}\text{Sn}$ ranging from -0.01 ± 0.11 to $0.27\pm 0.11\%$ (2 s.d.) relative to NIST SRM 3161a standard solution, while peridotites have more dispersed and more negative $\delta^{124}\text{Sn}$ values ranging from -1.04 ± 0.11 to $-0.07\pm 0.11\%$ (2 s.d.). Overall, basalts are enriched in heavy Sn isotopes relative to peridotites. In addition, $\delta^{124}\text{Sn}$ in peridotites become more negative with increasing degrees of melt depletion. These results can be explained by different partitioning behavior of Sn^{4+} and Sn^{2+} during partial melting. Sn^{4+} is overall more incompatible than Sn^{2+} during partial melting, resulting in Sn^{4+} -rich silicate melt and Sn^{2+} -rich residue. As Sn^{4+} has been shown experimentally to be enriched in heavy isotopes relative to Sn^{2+} , the effect of melting is to enrich residual peridotites in relatively more compatible Sn^{2+} , which results in isotopically lighter peridotites and isotopically heavier mantle-derived melts. This picture can be disturbed partly by the effect of refertilization. Similarly, the presence of

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