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Exploring the Isotopic Variation of Germanium in Earth's mantle

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Quantifying Germanium (Ge) isotopic fractionation during Earth's formation requires an accurate estimation of the Ge isotope composition of silicate reservoirs, a challenge highlighted by previous studies[1–4]. Establishing a robust isotopic baseline for Earth's mantle necessitates a detailed investigation of mantle-derived melts and their source rocks. Garnet, a key Ge host, has a pressure-dependent partition coefficient that significantly influences Ge systematics in Mid-Ocean Ridge Basalts (MORBs) and Ocean Island Basalts (OIBs)[5,6]. This pressure dependence may lead to measurable Ge isotopic fractionation during mantle melting, affecting both melts and residues.

To better understand these effects, we have undertaken a large study (n > 60 samples) of different silicate reservoirs, significantly expanding upon the scarce mantle data reported so far[1–3]. We analyzed ultramafic mantle rocks, their mineral separates, and basalts from MORB and OIB settings. Germanium isotope ratios were measured using a Hydride Generation Introduction System coupled to the Neptune*Plus* MC-ICP-MS at CRPG Nancy. Mass bias is corrected by the sample-standard bracketing method to the standard NIST SRM 3120a, achieving a 2-sigma reproducibility better than 0.10 ‰ on $\delta^{74/70}$Ge with < 50 ng Ge consumed per triplicate analysis. Our new results explore potential variations in Ge isotope compositions, aiming to assess whether mantle lithology—particularly the presence of pyroxenites—plays a role in isotopic fractionation during mantle melting. By combining whole-rock and mineral-scale analyses, we evaluate how phase-specific partitioning may influence Ge isotope systematics, including whether residual garnet or other phases impart distinct isotopic signatures. These findings will refine our understanding of Ge behavior during mantle processes, improving our ability to assess Ge isotope variations in Earth's mantle.

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