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Study on magnesium isotopes of the Mariana forearc mantle wedge serpentinite

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The serpentinized mantle wedge is critical for the geochemical cycling of water, volatiles, and fluid-mobile elements in the subduction zone. It is also a major reservoir of magnesium (Mg) in subduction zones, but its Mg isotopic compositions are not well constrained. To investigate Mg isotopic fractionation during mantle wedge serpentinization, and better understand Mg isotopes of the mantle wedge, we studied Mg isotopes of mantle wedge serpentinites/serpentinized peridotites exhumed by Mariana forearc serpentinite mud volcanoes. Whole-rock δ^{26}Mg values of these samples variably range from -0.29 to -0.03‰. Some serpentinite/serpentinized peridotite samples have significantly elevated δ^{26}Mg values up to -0.03‰, which is caused by seafloor weathering after their exhumation by the mud volcanoes. In contrast, the unweathered partially serpentinized peridotites have homogeneous δ^{26}Mg values of -0.29 to -0.27‰ (mean δ^{26}Mg = -0.28 ± 0.01‰, 2SD, n=3), which represent the primary Mg isotopes of the Mariana forearc mantle wedge peridotite. However, the unweathered mature serpentinites (i.e., completely serpentinized) have slightly heavier Mg isotopes (δ^{26}Mg= -0.29 to -0.21‰, mean δ^{26}Mg = -0.24 ± 0.05‰, 2SD, n=16) than the serpentinized peridotites, indicating that Mg isotopes are fractionated during the late-stage mantle wedge serpentinization. It is probably due to the leach of isotopically light Mg by the infiltrating slab fluids after the complete consumption of olivine.

By compiling Mg isotope data of mantle wedge and oceanic mantle peridotites, we found that the Mg isotopes of mantle wedge peridotites are more uniform and lighter than those of oceanic mantle peridotites. The Mg isotope difference between them is most probably caused by manlte heterogeneities, not by different degrees of early partial melting as indicated by the incremental batch melting modeling.