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Calcium stable isotopes of Tonga and Mariana arc lavas: Implications for slab fluid-mediated carbonate transfer in cold subduction zones

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Carbonation of oceanic lithosphere occurs widely during seawater alteration, and subducted carbonated oceanic lithosphere may play a key role in carbon recycling in subduction zones. Here we investigate the Ca isotopic composition of arc lavas from the Tonga rear arc and Mariana arc, western Pacific, to explore the effect of fluid-mediated carbonate transfer in subduction zones. Fresh basalts (0.84 ± 0.01‰, 2sd, n = 3) and dacites (0.84 ± 0.10‰, 2sd, n = 9) from the Tonga rear arc show indistinguishable $\delta^{44/40}$Ca, reflecting negligible Ca isotopic fractionation during differentiation of hydrous arc magmas. More importantly, arc lavas from both the Tonga rear arc (0.84 ± 0.09‰, 2sd, n = 12) and Mariana arc (0.79 ± 0.12‰, 2sd, n = 9) display MORB-like $\delta^{44/40}$Ca values. The MORB-like $\delta^{44/40}$Ca of arc lavas indicates that the carbonates released from altered oceanic lithosphere (AOL) do not significantly modify the Ca isotopic composition of the mantle wedge, although extensive volcanic CO_2 degassing at both arcs suggests that slab fluids might introduce abundant carbonate into the depleted mantle wedge. These results could be attributed to a limited Ca budget in the slab fluids added to the mantle wedge and/or homogeneization effect of variable $\delta^{44/40}$Ca for the slab fluids. At cold subduction zones, a fraction of carbonates from the AOL may survive during slab dehydration and recycle into the deep mantle.