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Subducted carbonates, metasomatism of mantle wedges, and possible connections to diamond formation: An example from California

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ABSTRACT

We investigated calcite globules and veins in two spinel-garnet peridotite xenoliths from the sub-Sierra Nevada mantle. The studied xenoliths were entrained in a Miocene (11 Ma) volcanic plug. These carbonates are associated spatially with silicate glass inclusions, suggesting that they are primary inclusions—inclusions that formed at high temperature in the mantle and not at or close to the Earth's surface. The host peridotites represent samples of the lithospheric mantle wedge beneath the Mesozoic California magmatic arc, as indicated by radiogenic isotopic ratios measured on clinopyroxene separates [$^{87}Sr/^{86}Sr(11\ Ma) = 0.7058–0.7061$, $\varepsilon_{Nd}(11\ Ma) = –1.9$ to $–0.7$]. Mineral chemistry of the peridotite major phases is typical of a mantle section that was depleted of melt. The $\delta^{18}O$ values of olivine and orthopyroxene from the two samples are also typical of mantle rocks ($\delta^{18}O = 6–6.5‰$). In contrast, calcite veins have $\delta^{18}O$ of 18–20‰ and $\delta^{13}C$ of –14‰, arguing for a subducted sedimentary origin for these carbonates. Presumably, the carbonates were expelled from the downgoing slab and fluxed into the overlying mantle wedge as CO_2- or CO_2-H_2O-rich fluids or melts. The trace-element patterns of two analyzed calcite veins are typical of the arc signatures (e.g., depletions in high-field-strength elements) seen in calc-alkaline magmatic rocks worldwide. However, the cores of peridotite clinopyroxenes do not show that pattern, suggesting that the arc-like trace element signature was introduced via the recycled carbonate agent. A connection between mantle wedge carbonation and diamond formation in a subduction environment is proposed based on these observations.