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Partial Melting Experiments in Carbonated Secondary Pyroxenite at 3 GPa and Origin of Primary Arc Magmas

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Introduction
Subduction of oceanic lithosphere fluxes the mantle wedge with carbonate and hydrous fluids, thus commencing the crustal recycling process, which results in mantle heterogeneity. The melting of the subducted slab and the mantle wedge generates arc magmas. Arc magmas are enriched in incompatible trace elements relative to MORB, reflecting contributions from subducted slab-derived fluids and melts. Geochemistry of arc magmas suggests influence of olivine-poor mafic lithologies, such as pyroxenites in the source mantle wedge, which are produced from the reaction between the subducting slab and the ambient mantle peridotite. Here, we report new partial melting experiments of carbonated secondary pyroxenite, performed at 3 GPa and 900-1425 ℃ to investigate the role of pyroxenite in the generation of arc melts. A silica-deficient secondary pyroxenite with Mg# of 0.85 and Ca# of 0.26 was used as a starting material, fluxed with 2.5 wt.% CO2. All experiments were performed in a 0.5-inch Talc-Pyrex assembly in a piston cylinder apparatus at IIT Kharagpur. Starting material was loaded in a graphite-lined Pt capsule and welded shut to prevent loss of volatiles. This procedure minimized Fe-loss and kept the oxygen fugacity in the vicinity of the CCO buffer.

Results
Near-solidus runs consist of clinopyroxene (Cpx), orthopyroxene (Opx), garnet (Grt), and quartz (Qz), along with carbonatitic melt. The low-degree carbonatitic melt changes to carbonated silicate melt with increasing degree of melting (>15%) after exhaustion of Qz. Modal abundance of Opx sharply increases and starts to segregate from Cpx with the dissolution of Grt (melt fraction >25%). Cpx exhausts at melt fraction > 50%, leaving out Opx as the liquidus phase. The partial melt compositions (volatile-free basis) formed near and after the garnet exhaustion are basaltic-andesite to basalt (SiO2 56.8 - 51.7 wt.%, CaO 10.4 - 12.6 wt.%). The volatile-free major element compositions of carbonated-silicate melts after Grt exhaustion show Al2O3 (16.2–13.6 wt.%), MgO (8.5–15.4 wt.%), and CaO/Al2O3 ratios of 0.64–0.90. These compositions suggest that CO_2-fluxed melting of slab-derived secondary pyroxenite can produce melts similar to primary melts of tholeiitic basalts from Izu-Bonin and Japan arcs.

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