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An orogenic peridotite-hosted pyroxenitic system records melt-rock interaction within the initially subducted continental slab front

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Subduction zones are key places for energy exchange and material circulation between Earth's spheres. The onset of continental subduction generally needs the drag of the earlier-subducting oceanic slab. During the continental subduction initiation, dynamic processes and material cycling styles in the subduction factory will be significantly changed. This poorly-known continental subduction initiation and relevant intra-slab interaction will be rapidly masked when the following continent collides with the other continent, generating a Himalayan-type orogen. Here, we present a systematic petrochemical and geochronological study of a rarely-preserved zoned pyroxenite vein system crosscutting the Svartberget crustal-type garnet peridotite in Norway to reveal a poorly known process of the supracrustal materials interact with the ultramafic lowermost crust within the slab during continental subduction initiation.

The vein includes inner garnet-clinopyroxenites (locally as garnetites) and outer MgO-richer pyroxenites, showing compositional zoning produced by interaction between felsic melts and Proterozoic peridotitic cumulates that formed within the Baltica continental lower crust. Complex U-Pb ages, trace elements and Hf-O isotopic compositions of zircons from the garnet-clinopyroxenite zone as well as elevated initial $^{87}Sr/^{86}Sr$ (0.7325-0.7559, calculated for 438 Ma) of the whole vein system suggest that the felsic melts originated from supracrustal materials (likely granitic sediments) overlying the continental slab front. Pressure-temperature estimations and zircon U-Pb dating show that such a reaction occurred within the fragmented ultramafic lowermost crust of the Baltica slab front (~50-60 km in depth) at ~438 Ma, related to the continental subduction initiation in the early Caledonian orogeny. The vein system in the Svartberget peridotite was further subducted to ultrahigh-pressure conditions (~807-852 ℃, ~3.2-3.5 GPa) at ~407 Ma during the Baltica-Laurentia collision. This study thus provides new insights into the transition of convergent dynamics and material interaction styles from initial to deep subduction of a continental slab.

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