Styles of eclogite melt and peridotite reaction in the lithospheric mantle: An experimental study

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Interaction between eclogite-derived melt and peridotite has played an important role in modifying the cratonic lithospheric mantle and generating high-Mg igneous rocks. To better understand the peridotite physical state on melt-peridotite interaction, we conducted reaction experiments of lherzolite with two basaltic andesites and a ferro-basalt at 1300°C, 1375°C, and 1425°C and 2 GPa using the reaction couple method. At 1300°C, when lherzolite is subsolidus, the lherzolite has a very small dissolution rate, and is mineralogically and texturally unchanged. Garnet and clinopyroxene precipitate at the melt-rock interface. The low-temperature reactions enrich the melt with SiO_2 and Na_2O, and deplete the melt with Al_2O_3, FeO, and CaO. At 1375°C and 1425°C, when the lherzolite is partially molten, the dissolution and equilibration rates are faster due to grain-scale process that involves dissolution, precipitation, and reprecipitation. Dissolution of olivine and precipitation of orthopyroxene produce a melt-bearing orthopyroxene-rich lithology at the melt-rock interface followed by a melt-bearing harzburgite and a melt-bearing lherzolite. The lithology near the interface can be an orthopyroxene-rich harzburgite or an orthopyroxenite depending on the reacting melt composition. The reaction produces melt with increased MgO, FeO, CaO, and Mg#, and decreased SiO_2, Al_2O_3, and Na_2O. The dissolution rate obtained from the experiments is used to assess the survival of mantle xenoliths high-Mg diorites. The experimental results provide insight into the styles of eclogite-derived melt and peridotite reaction in the lithospheric mantle beneath the North China Craton (NCC). At the lithosphere-asthenosphere boundary, the reaction is dominated by the high-temperature regime, which produces orthopyroxene-rich lithologies such as orthopyroxene-rich harzburgite and orthopyroxenite-veined peridotite. At a shallower depth of the lithospheric mantle, the reaction is characterized by the low-temperature regime, which produces garnet-bearing lithologies such as garnet pyroxenite and high-Mg granulite. Interactions between eclogite-derived melts in both regimes are responsible for the geochemical features of the early Cretaceous high-Mg igneous from the NCC.