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The Effect of Volatiles in Lithosphere-Asthenosphere Boundary at 2.5, 4.5, and 10 GPa.

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This study examines experimentally interactions between the hydrated subcontinental lithosphere and an eclogite-rich asthenosphere at high pressure (2.5, 4.5, and 10 GPa) and high temperatures (900 -1500 °C). The resulting mineral assemblages included olivine, orthopyroxene, clinopyroxene, pyrope, amphibole, phlogopite, and magnesite. At 2.5–4.5 GPa and moderate temperatures, reaction textures indicate alkali element mobility, CO_2 release, and partial H_2O retention, forming orthopyroxene- and amphibole-rich zones. Phlogopite is stable up to 1100°C at 2.5 GPa. At higher temperatures, intercalated olivine and clinopyroxene were observed. Melt compositions evolved from basanitic at low melt fractions to trachy-andesitic and andesitic at higher temperatures.

At 10 GPa, CO_2 retention in minerals and melt increases, while H_2O release is enhanced. Orthopyroxene, garnet, and magnesite remain stable, whereas clinopyroxene stability decreases, and amphibole is absent. Partial melts at 10 GPa show higher CO_2 and MgO and lower Al_2O_3 and SiO_2 concentration than those at 2.5–4.5 GPa.

The experiments shed new light on metasomatic processes at the lithosphere-asthenosphere boundary (LAB) across different pressure-temperature conditions, constraining the role of volatiles in partial melting as a function of lithospheric thickness. Additionally, this study provides insights into the reactions driving lithospheric rejuvenation and their influence on Earth's volatile cycles in Phanerozoic and cratonic lithospheres.