# Hallmarks and physical effects of ultramafic melt metasomatism in mantle eclogite

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The mineralogy, chemical composition and physical properties of mantle eclogites with oceanic crustal protoliths can be modified by interaction with fluids and melts after emplacement into the cratonic lithosphere. We combine new and published data to isolate metasomatic signatures and evaluate their effects on eclogite physical properties. Modification by kimberlite-like ultramafic melts, probably intruded during lithosphere extension, is ubiquitous though not pervasive, and has affected ~20 and 40% of the eclogite population at various kimberlite localities investigated here. This is frequently concentrated at ~60 to 150 km depth, overlapping cratonic mid-lithospheric discontinuities. Hallmarks include lower jadeite component in clinopyroxene and grossular component in garnet, an increase in MgO and in part $SiO_2$, decrease in FeO and $Al_2O_3$ contents, LREE-enrichment accompanied by high Sr, Pb, Th, U ± Zr and Nb, and lower Li, Cu ± Zn. This is mediated by addition of a high-temperature pyroxene from an ultramafic melt, followed by redistribution into garnet and clinopyroxene. Clinopyroxene is the main carrier of the metasomatic signature due to the strong increase in apparent $^{clinopyroxne\text{-}garnet}$distribution coefficients with decreasing garnet grossular component. Depending on metasomatic intensity and degree of FeO reduction, these compositional changes generate high shearwave velocities and low densities at mid-lithospheric depths at some localities, and, if accompanied by $H_2O$ enrichment, will also enhance electrical conductivities and reduce eclogite viscosity compared to unenriched eclogites. Regional peculiarities include unusually high FeO contents, hence densities, in eclogites from the West African and northern Slave cratons, which could significantly contribute to regional gravity signals. High shearwave velocities of eclogites at mid-lithospheric depth beneath the western Kalahari craton mimic velocity profiles from tomographic models. On the other hand, diamond, which has high $V_S$, is destroyed during ultramafic melt metasomatism and cannot enhance $V_S$ signals in metasomatised eclogites.