Fluid induced transition from banded kyanite- to bimineralic eclogite and implications for the evolution of cratons

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Heterogeneous, modally banded kyanite-bearing and bimineralic eclogites from the lithospheric mantle, collected at the Roberts Victor Diamond mine (South Africa), show a reaction texture where kyanite is consumed. Geothermobarometric calculations using measured mineral compositions in Perple_X allowed the construction of a P-T path showing a steep, cool prograde metamorphic gradient of 2°C/km raising to peak conditions of 5.8 GPa and 890˚C for the kyanite eclogite. The kyanite-out reaction formed a bimineralic eclogites and is probably an integral part of the mineralogical evolution of most archetypal bimineralic eclogites at Roberts Victor and potentially elsewhere. The kyanite-out reaction occured at close to peak pressure (5.3 GPa) and was associated with a rise in temperature to 1380˚C. The δ18O values of garnets are consistently higher than normal mantle values. Differences in garnet trace element signatures between differing lithologies in the eclogites are significant. Grossular-rich garnets coexisting with kyanite have strong positive Eu-anomalies. The kyanite-out reaction was most likely triggered by a heating event in the subcratonic lithosphere. The steep (high-P low-T) prograde P-T path defining rapid compression at low heating rates is atypical for subduction transport of eclogites into the lithospheric mantle. Such a trajectory is best explained in a model where strong lateral compression forces eclogites downward to higher pressures, supporting models of cratonic lithosphere formation by lateral collision and compression.