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Metasomatism-driven redox state of the Wajrakarur SCLM revealed by $Fe^{+3}/\Sigma Fe$ measurements in peridotitic garnet xenocrysts

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The scarcity of mantle-derived xenoliths in Indian kimberlites has hampered exploration of the subcontinental lithospheric mantle (SCLM). From our small inventory, here we present $Fe^{3+}/\Sigma Fe$ measurements, using the EPMA flank method, for 15 peridotitic garnet xenocrysts from P9 and P10 intrusions of the Wajrakarur kimberlite field (WKF) located in the Eastern Dharwar craton in southern India. We provide the first estimates on the oxygen fugacity (fO_2) of the SCLM below Wajrakarur. The measured $Fe^{3+}/\Sigma Fe$ ratios for garnet xenocrysts range from 0.02-0.10 (±0.01). Using the modelled Mg# for olivine and orthopyroxene coupled with Ni-in-garnet thermometry (Canil, 1999) and applying the algorithm of Stagno et al. (2013), we obtained $\log fO_2$ values ranging from FMQ-2.4 to FMQ-4.5 (±0.5). The wide range of $\log fO_2$ values in garnets correlates well with metasomatic enrichment in Ti, Y, and HREE, implying metasomatism-driven oxidation of the mantle column below Wajrakarur at the mid-lithospheric level. Furthermore, garnets with 'normal' rare earth element (REE) patterns, which dominate the deeper lithosphere, have a narrower range of $\log fO_2$ values. However, garnets with 'sinusoidal' REE-patterns that dominate at the shallower level, exhibit a wider range of $\log fO_2$ values that extends towards the carbonate stability field. The wide range of $\log fO_2$ values for Wajrakarur SCLM could have implications for the unique spatial and temporal association of kimberlites, orangeites, lamproites, and ultramafic lamprophyres in the region.

References: *Canil D (1999) The Ni-in-garnet geothermometer: Calibration at natural abundances. Contributions to Mineralogy and Petrology 136(3):240–246; Stagno V, Ojwang DO, McCammon CA, Frost DJ (2013) The oxidation state of the mantle and the extraction of carbon from Earth's interior. Nature 493:84-88.*