# An oxygen fugacity profile of the lithospheric mantle beneath the Adelaide Fold Belt, Australia

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Evidence from xenoliths have identified a stratigraphy of oxygen fugacity ($fO_2$) in the sub-cratonic lithospheric mantle, whereby a horizon of unusually oxidised mantle overprints the ambient trend of decreasing $fO_2$ with depth [e.g. 1]. This has been attributed to the effects of metasomatism in the mantle. Observations have so far, however, been restricted to a small number of cratons (Kaapvaal, Slave, and Diavik).

The recent discovery of a kimberlite in the Adelaide Fold Belt of Australia, containing a suite of well-preserved garnet-bearing xenoliths [2], provides the first opportunity to profile the $fO_2$ beneath the Australian craton. The xenoliths contain garnet-cpx-opx±chromite±amphibole, but no olivine, and span an estimated pressure range between 1.8 and 4.5 GPa.

$Fe^{3+}/\sum Fe$ for garnet was determined by Fe K-edge XANES spectroscopy from the intensity of the *post-edge minimum*. $Fe^{3+}/\sum Fe$ ranged between 0.040 and 0.136 with concomitant estimates of $fO_2$ ($\Delta \log fO_2$) ranging between -2.3 and 1.3. The data define a trend of decreasing $fO_2$ with increasing depth with a gradient that is consistent with the results from other cratons (~1 log-unit per GPa). This represents the first $fO_2$-depth profile of the upper mantle beneath the Australian continent.

The trace element compositions of all phases were determined by LA-ICP-MS. The $REE_N$ profiles of garnet in most samples are normal to depleted. Where present, sinusoidal profiles coexist with enrichment of Ti, Zr and Y, consistent with established manifestations of metasomatism. There is no apparent correlation between metasomatism and $fO_2$.

No unusually oxidised samples were observed. This is consistent with results from other cratons where oxidation associated with metasomatism occurs in a spatially restricted horizon at greater depths (~ 150 km) than those at which these samples equilibrated.

[1] Woodland and Koch (2003), EPSL 214, 295-310
[2] Tappert et al. (2011), J. Pet. 52, 1965–1986