

Redox state of deeply subducted ancient oceanic crust

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Some compositional heterogeneities of the convecting mantle are due to recycling of crustal material with an average age of ~2 Ga [1] and thus may have involved ancient oceanic crust (OC), as sampled through mantle eclogite xenoliths. We present new $\text{Fe}^{3+}/\text{Fe}_{\text{total}}$ obtained by Mössbauer in eclogite garnet ± clinopyroxene from Orapa (Kapaavaal craton) and Koidu (West African craton), from which we calculate f_{O_2} relative to the fayalite-magnetite-quartz buffer ($\Delta\log f_{\text{O}_2}$) [2]. Combined with nascent published data-sets, results are used to unravel the effects of secondary metasomatic overprint during residence in the cratonic mantle and identify primary signatures related to formation of their igneous protoliths and metamorphism during deep recycling. Preliminary results indicate that coupled LREE- and MgO-enrichment during oxidative metasomatism by kimberlite-like melt leads to an ill-defined increase in $\text{Fe}^{3+}/\Sigma\text{Fe}$. Surprisingly, some mantle eclogite suites retain a broad negative correlation of $\text{Fe}^{3+}/\Sigma\text{Fe}$ with Eu^* , as expected for incompatible behaviour of Fe^{3+} in igneous cumulates. This testifies to some robustness of Fe speciation in mantle eclogites despite their Archaean to Palaeoproterozoic ages. The highly reduced nature of Archaean OC [3], followed by further reduction upon pressure increase [4,5] suggests that refractory graphite/diamond will be the stable carbon species. Thus, deep subduction of Archaean OC provides no oxidising power, and carbonatites, from which diamond could crystallise through redox freezing in the transition zone [6], are not expected to form. Instead, evidence for deep carbonatite-peridotite interaction may point to recycling of carbonate sediments which can avoid early and complete reduction. Conversely, there may be a role for CH_4 -rich fluids in subducted OC, which could facilitate “hydrous redox melting” ($\text{CH}_4 + \text{O}_2 = \text{H}_2\text{O} + \text{C}$) rather than “carbonated redox melting” or freezing [7].

[1] Andersen et al. (2015) *Nature* **517**; [2] Vasilyev (2016) PhD Thesis, Australian Nat Univ; [3] Aulbach & Stagno (2016) *Geology* **44**; [4] Stagno et al. (2015) *CMP* **169**; [5] Aulbach et al. (2017) *EPSL* **474** [6] Thomsen et al. (2016) *Nature* **529**; [7] Foley (2011) *JPet* **52**