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# Ferric iron budget of Kaapvaal cratonic mantle peridotite

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Oxidation fugacity plays an important role in many geochemical processes, such as partial melting and melt-rock interaction. How mantle peridotite responds during such processes is dependent on the amount of $Fe_2O_3$ present, since it occurs in much smaller quantities than $Fe^{2+}$ and affects buffering capacity. This is particularly the case since redox reactions have been directly implicated in the rejuvenation and eventual breakup of cratons (e.g. Foley 2008, 2011). In addition, oxygen fugacity also influences the incorporation of OH in nominally anhydrous minerals, which can affect the mechanical integrity of cratonic blocks (Peslier et al. 2010). These issues are important for understanding the evolution of the upper mantle beneath the Kaapvaal craton. Canil and coworkers (1994, 1996) reported bulk ferric iron contents for 11 peridotites (10 garnet-bearing and 1 spinel-bearing) from the Kaapvaal. The purpose of this study is to build on their pioneering work to better assess the ferric iron budget of Kaapvaal cratonic mantle and to improve our understanding of how ferric iron is distributed within the peridotitic assemblage. Our data set includes more than 30 additional samples, predominantly garnet peridoites, from 7 localities in South Africa and Lesotho.

Bulk $Fe_2O_3$ contents were determined by combining measured $Fe^{3+}$ contents of individual minerals (by Mössbauer spectroscopy) with their respective modal proportion in each sample. $Fe^{3+}$ contents of garnet and clinopyroxene reported in Woodland & Koch (2003), Lazarov et al. (2009) and Woodland (2009) were combined with new data for orthopyroxene (opx) and modal mineralogy to make this assessment. Opx has $Fe^{3+}/Fe_{tot}$ of 0.04-0.1 and $Fe^{3+}$ contents are comparable between Opx and coexisting Cpx.

Calculated whole rock $Fe_2O_3$ contents range from 0.02 to 0.29 wt % with contents systematically decreasing with increasing degrees of depletion (as indicated by increasing MgO and decreasing $Al_2O_3$ content). For a given MgO content spinel peridotites from younger mantle tend to have even lower $Fe_2O_3$ contents (Woodland et al. 2006), suggesting that the cratonic mantle has been somewhat re-enriched in $Fe^{3+}$ through subsequent metasomatic processes. Variable degrees of metasomatism are probably also responsible for the observed scatter in the current data set. Opx contains 40-80% of the total $Fe_2O_3$, making it the dominant contributor. This is a higher proportion than usually observed in non-cratonic spinel peridotites (Woodland et al. 2006) and can be related to the generally higher modal amounts of Opx in the Kaapvaal mantle. Garnet is the second most important carrier of $Fe^{3+}$.

Although Cpx has the highest $Fe^{3+}/Fe_{tot}$ of all phases, its low total Fe content and low modal proportion means that it makes a relatively small contribution to the overall $Fe_2O_3$ budget. No correlation between whole rock $Fe_2O_3$ content and calculated oxygen fugacity is apparent, due to variations in modal mineralogy between the samples.

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