An exsolution origin for Archaean mantle garnet

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It is now well established that the cratonic sub-continental lithospheric mantle (SCLM) represents a residue of extensively melted fertile peridotite. The widespread occurrence of garnet in the Archaean SCLM remains a paradox because many experiments agree that garnet is exhausted beyond *c.* 20% melting. It has been suggested that garnet may have formed by exsolution from Al-rich orthopyroxene [1,2,3]. However, the few examples of putative garnet exsolution in cratonic samples remain exotic and have not afforded a link to garnet that occurs as distinct grains in granular harzburgite.

We present crystallographic (EBSD), petrographic and chemical (SEM-EDS and LA-ICP-MS) data for an exceptionally well-preserved orthopyroxene megacryst juxtaposed against granular harzburgite. Garnet lamellae within the megacryst show crystallographic continuity and have a strong fabric relative to the host orthopyroxene, strongly indicating that the megacryst formed by exsolution. Garnet lamellae are sub-calcic Cr-pyropes with sinusoidal rare earth element patterns, while the orthopyroxene host is high-Mg enstatite; the reconstructed precursor is clinoestatite. The megacryst shows evidence for disintegrating into granular peridotite, and garnet and orthopyroxene within the granular peridotite are texturally and chemically identical to equivalent phases in the megacryst. Collectively, this evidence supports a common origin for the granular and exsolved portions of the sample.

The compositions of the exsolved Cr pyrope and enstatite are typical of harzburgites and depleted lherzolites from the SCLM. Furthermore, garnet inclusions within orthopyroxene in several granular peridotites exhibit the same fabric as those in the exsolved megacryst. We hypothesise that clinoenstatite was a common phase in cratonic SCLM and that exsolution is the likely origin of many sub-calcic garnets in depleted peridotites.

[1] Cox. *et al.* (1987) in Nixon (ed.) *Mantle Xenoliths*, **537-550**. [2] Saltzer et al (2001) *J. Pet* **42**, 2215-2229. [3] Canil (1991) *EPSL* **106**, 64-72.