

The isotopic artifacts of enhanced crustal preservation in collisional orogenesis

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The generation of felsic crust at accretionary/collisional tectonic boundaries is considered globally to be in steady-state, although the rate of crustal production can vary locally.

U-Pb, Hf, and O isotopic analyses in detrital zircon are widely used to assess the timing and isotopic composition of crustal growth. The age distribution of global detrital zircon record is comprised of “peaks” and “troughs”.

This episodic temporal distribution of zircon crystallization ages has been argued to represent periods of global collisional orogenesis that isolated continental crust formed within accretionary settings within the interior of newly formed supercontinents. This is shown by comparing U-Pb, O, and Hf isotopes in detrital zircons derived from the accretionary, collisional, and post-rift stages of the assembly of the supercontinent of Rodinia based on data from Laurentia and Baltica.

Our results show that continental crust with highly negative ϵHf and high $\delta^{18}\text{O}$ values that formed during the accretionary stage is largely removed from the record preserved in collisional and post-rift stages, probably via sediment subduction, subduction erosion or tectonic delamination. These relations support the hypothesis that detrital zircon age peaks do not represent non-steady state felsic crust formation, but are an artifact of selective preservation during collisional orogenesis.

SCLM super-Si garnet traces the Archaean

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Sub-continental lithospheric mantle (SCLM) garnet that hosts oriented pyroxene lamellae, that exsolved from former super-Si garnet, have been reported only from the oldest parts of cratons including the Kalahari, Laurentia and Siberia composite cratons [1-5]. Direct implications are: the exsolution microstructure has (1) an Archaean affinity and (2) a global distribution. This study reviews reconstructed and normal garnet chemistries to evaluate proposed garnet origins and exsolution scenarios.

Proportions of pyroxene lamellae in garnet that were quantified using standard techniques range with 0.5-9.6vol.%. Re-integrated garnets have Si+Ti in the range of 2.992-3.086 (median 3.034) cations per 12 oxygen. Maximum values correspond to 7.9 GPa (median 6.4 GPa) [6] that favour a lithospheric origin of all garnet prior to exsolution. Garnet Si isopleths have negative slopes in P-T space [6] suggesting that the above P estimates are overestimated if pre-exsolved garnet formed at high T.

Ti-Na systematics shows a bimodal distribution. The larger fraction of pre-exsolved garnet (G1, G4, G5, G12) has $\text{TiO}_2 > 0.4$ wt.% and has a positive correlation between TiO_2 and Na_2O with $\text{TiO}_2/\text{Na}_2\text{O} > 10$. These features overlap those of lamellae-free garnet megacrysts [7], consistent with an origin from re-fertilising melts. The other, minor fraction of pre-exsolved garnet (G4, G5) has $\text{TiO}_2 < 0.4$ wt.% that correlates negatively with Na_2O at dominantly $\text{TiO}_2/\text{Na}_2\text{O} < 2$. Major elements suggest these pre-exsolved garnets to have a pyroxenite/websterite origin. Non-eclogitic lithospheric garnet diamond inclusions from the Siberia, Kaapvaal and Slave cratons include the negative, but not the positive correlation defined by the pre-exsolved garnet chemistry. Thus, low $\text{TiO}_2/\text{Na}_2\text{O}$ garnet (pyroxenitic/websteritic) formed part of Archaean SCLM prior to local lithospheric diamond formation.

In summary, (1) lamellae type pyroxene exsolution in garnet occurred at SCLM depth most likely by cooling and (2) appears to be a tracer of Archaean provinces, (3) high $\text{TiO}_2/\text{Na}_2\text{O}$ pre-exsolved garnet may have formed by infiltrating melts, (4) low $\text{TiO}_2/\text{Na}_2\text{O}$ pre-exsolved garnet is related to the origin of websterite/pyroxenite. Additional REE systematics will be presented to provide constraints on the latter.

[1] Haggerty & Sautter (1990) *Science* **248**, 993-996. [2] Roden *et al.* (2006) *Lithos* **90**, 77-91. [3] Spengler *et al.* (2006) *Nature* **440**, 913-917. [4] Bobrov *et al.* (2012) *Doklady* **444**, 574-578. [5] Alifirova *et al.* (2012) *Int. Geol. Rev.* **54**, 1071-1092. [6] Collerson *et al.* (2010) *GCA* **74**, 5939-5957. [7] Schulze (1997) *Expl. Min. Geol.* **6**, 349-366.