The end of the Hadean: The world turns over

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Context and Results

A U-Pb/Hf-isotope study of >16,000 zircons from sources worldwide has demonstrated that at least 70% of Earth's continental crust probably formed in Archean time [1], and much probably is >3 Ga old. The model-age (T_{RD} and T_{MA}) distributions of ca 500 low-Re sulfides in mantle-derived peridotite xenoliths, mainly from the Kaapvaal, Siberian and Slave cratons, peak between 2.5-3.0 or 3.0-3.5 Ga, depending on locality. In detail, at each locality the oldest T_{MA} model ages from the mantle sulfides correlate well with the oldest U-Pb ages and Hf model ages from crustal zircons. Younger T_{MA} peaks commonly coincide with later major crustal events.

The sulfides in mantle xenoliths are secondary phases, and Os model ages probably are biased toward young ages. Most of the studied sulfides are from garnet-bearing peridotites, and garnet is generally a secondary phase in these rocks [2]. In Siberian xenoliths, model ages of sulfides included in garnet are younger on average than those of sulfides included in olivine. However, detailed searches of the most depleted peridotites available have thus far revealed very few sulfides with model ages >3.5 Ga, just as the oldest widespread crustal ages are around 3.5 Ga.

Conclusions

These data suggest that the oldest crust and the oldest, highly depleted SCLM are broadly coeval, and are interpreted as forming during massive mantle overturns that produced the residual Archean SCLM, providing buoyant "life rafts" that ever since have supported and preserved the continental crust. The 3.5 Ga overturn event changed Earth's fundamental tectonic behaviour, and truly marks the end of the Hadean period

[1] Belousova *et al*. (2010) *Lithos* **119**, 457-466. [2] Malkovets *et al*. (2007) Geology 35, 339-342.

Investigating controls on calcium isotope ratios in marine carbonates and barite across the Paleocene-Eocene Thermal Maximum

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The stable calcium isotopic composition of seawater can be controlled over million-year time scales by the relative fluxes of Ca into and out of the ocean, given knowledge of the isotopic compositions of these fluxes. Ocean acidification, such as occurred at the Paleocene-Eocene Thermal Maximum (PETM), should perturb the riverine input of Ca relative to Ca output as pelagic $CaCO_3$. We therefore expect coincident variability in the Ca (and C) cycles that should be evident in the Ca isotope record. Yet environmental and post-depositional factors can affect the isotopic composition of a recording phase resulting in values inconsistent with changes in seawater Ca isotopic composition. This study measures Ca isotopes in marine barite and bulk carbonates over the PETM in order to evaluate their use as recorders of seawater δ^{44}Ca.

This study reports high temporal resolution (~25 ka) Ca isotopic compositions (δ^{44}Ca, relative to Bulk Earth) of bulk marine carbonates and coeval marine pelagic barite from ODP Leg 199 Site 1221C (Equatorial Pacific) and bulk carbonates from ODP Leg 198, Site 1212B (Shatsky Rise). The study also reports $CaCO_3$ content and bulk carbonate δ^{13}C and δ^{18}O for 1221C and 1212B. The marine barite Ca isotope record decreases by 0.3‰ after the benthic extinction event (BEE), increases to a maximum (-0.7‰) as $CaCO_3$ accumulation rates peak, and returns to values near modern day (-1.3‰) <100 ka after the BEE. Interestingly, bulk carbonate δ^{44}Ca values are distinct from the barite record. At Site 1221C, carbonate δ^{44}Ca increases just after the barite δ^{44}Ca drop and stays high (~0.4‰) until the barite record returns to near modern δ^{44}Ca values. Sediments at 1221C decrease to near zero $CaCO_3$ accumulation at the BEE, strongly suggesting that dissolution occurred. By comparison, the 1212B core has high $CaCO_3$ content (80-98%) over this interval and exhibits trends that are similar to the 1221C marine barite record but vary in absolute magnitude.

One hypothesis to explain the observed differences is that post-depositional diagenetic reactions (dissolution/recrystallilzation) in the sedimentary column influence the measured δ^{44}Ca. Alternately, it is possible that variations in local Ca cycling can explain the differences in the carbonate and barite records. We will explore both hypothesis using numerical models and various data.