The North Australian Craton: A Palaeoproterozoic accretionary orogen

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The North Australian Craton (NAC) is 1,830,000Km^2, making up almost one quarter of Australia. The development of this system has a broad spatial and temporal organization such that sedimentation, magmatism and tectonism generally migrated southward over the interval ~2000 to 1700 Ma, and at least in the northern parts of the craton, appears to have a late Achaean substrate. In most regions, within 10-20 Ma, sedimentation was followed by deformation and granite-dominated magmatism associated with high thermal gradient metamorphism, pointing to a systematic pattern of crustal consolidation as the craton developed.

Detrital zircon spectra, maximum depositional of sediments, distribution of mafic intrusives and Hf isotopes over the NAC indicates a southerly migration of depositional activity from the Pine Creek Orogen in the north to the Arunta Orogen in the south, with two main phases of basin formation between 1880-1850 and 1830-1780 Ma. The sediments of these basins share common zircon detritus populations, particularly Neoarchean sources. A general trend toward more primitive Hf values with time is typical for retreating accretionary orogens. The Archean detrital populations recorded in sediments from all regions of the NAC, Hf isotopic data coupled with the systematic spatial and temporal pattern of magmatism and deformation/metamorphism is consistent with an Archean substrate that migrated southwards over a period of ~300 Ma. We can envisage such a migration as being controlled by a long-lived retreating margin, with distinct “pulses” of magmatism related to periods of accelerated extension. This scenario suggests that the NAC developed in an oceanic back arc setting, rather than in an intracratonic setting as has been recently proposed. The model implies that formation of Palaeoproterozoic continental lithosphere can be efficiently achieved in back arc settings, similar to the modern-day western Pacific.

Terrestrial temperature response during Early Eocene hyperthermals

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The Early Eocene is marked by a number of rapid global warming events called hyperthermals that are associated with negative carbon isotope excursions (CIE) in both marine and terrestrial records. Each theory to explain the connection of these hyperthermals with the CIEs predicts a different climatic response. Characterizing the timing, duration and magnitude of temperature change will help establish their cause and possibly establish whether or not they are driven by a single process. It is possible that all share a common underlying cause; if so, we might predict that the temperature change during each hyperthermal is proportional to the magnitude of its associated CIE (and perhaps exhibit other similarities, such as the relative amplitudes of marine and terrestrial temperature change). To our knowledge, the only hyperthermal for which we know the terrestrial temperature change is the Paleocene-Eocene Thermal Maximum (PETM).

Here we use carbonate clumped isotope (Δ_{47}) thermometry of paleosol carbonates from the Bighorn Basin (Wyoming, USA) to produce paleotemperature estimates at high temporal resolution for Early Eocene hyperthermals ETM2 and H2. Average baseline temperatures (which likely reflect near-peak summer ground temperatures) before and after the two hyperthermals are ~28°C and increase to ~38°C during the apex of each CIE; temperatures appear to recover close to baseline temperatures between ETM2 and H2. These data (combined with previous constraints on the PETM) suggest that both the absolute temperatures and the magnitudes of temperature change associated with the PETM, ETM2 and H2 are similar (within error); the magnitudes of temperature change (~10°C) also appear similar to/slightly greater than that found in arctic sediments [1]. In addition, our record shows a cooling interval within the peak of ETM2 that is similar in pattern to an event that is present in the arctic record [1]. These results suggest that the temperature change associated with the hyperthermals does not necessarily scale with the magnitude of the local CIEs from paleosol carbonate nodules (~6‰ for the PETM and ~4‰ for ETM2). For ETM2, the CIE appears to precede warming.

[1] Sluijs *et al*. (2009) *Nature Geoscience*. **2**, 777-780.

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