Thermal fluctuations beneath continents

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The Central Atlantic Magmatic Province (200Ma): plume evidence?

- No hotspot track
- Region elongated over 8000km
- Low rate of magma supply (100-200m)
- No uplift
- No radial pattern

Coltice et al. (2009)
Same for the Karoo (180Ma)

Coltice et al. (2009)
Hypothesis
Boundary layer theory:
continental insulation + longer wavelength of convection
Theory and experiments: temperature increases with continental size.
2 small continents

1 big continents

Phillips & Coltice (2010)
Zhong et al. (2007)
Zhong et al. (2007)
3D spherical convection with plate-like behavior and continental rafts

$t^* = 0.17792$

$t = -24 \text{ Ma}$

Rolf, Coltice & Tackley (2012)
Average subcontinental temperature vs. continental connectivity

\[ T(\bar{\alpha}_{\text{norm}}) = 1792 \, \text{K} - 101 \, \text{K} \cdot \bar{\alpha}_{\text{norm}} \]
(a)

Temperature $T$ in 1000 K as a function of time $t$ in Ga.

$t_{-2}$, $t_{-1}$, $t_B$, and $t_{+1}$ are marked on the graph.

$t_{+1} \approx 3.81$ Ga.
(a) The graph shows the temperature in K for different time points (t_{-2}, t_{-1}, t_B, t_{+1}, t_{+2}). The shaded area indicates the time period t_{+2} ≈ 4.08 Ga.
Whittaker et al. (2008)
Atlantic and Indian MORB: rel. frequency (%)

\[ T_{\text{pot}}(\text{Na}, \text{°C}) \]

\[ T_{\text{pot}}(\text{Fe}, \text{°C}) \]

Median

\(1\sigma\)

\[ \delta\text{Age (Myr)} \]

Red Sea, N-CIR, S-CIR, SWIR

Brandl et al. (2013)
With continents

Without continents