Probing the evolution of the lower crust with trace element geochemistry and U-Pb geochronology of lower crustal xenoliths from Queensland, Australia

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The thermal evolution of the lower continental crust is poorly understood, primarily due to sample scarcity. Lower crustal xenoliths, brought to the surface by rapidly rising magmas, provide direct evidence of the composition and evolution of this enigmatic part of the crust.

The widespread xenolith-bearing Cenozoic volcanism of eastern Queensland, Australia, provides a valuable resource to study the lower crust. The majority of the xenoliths are mafic granulites, although minor felsic rock types are also present. The xenoliths are inferred to be derived from a range of tectonic settings. Here, we combine petrology, major and trace element mineral chemistry and U-Pb geochronology of accessory phases (zircon, rutile, apatite and titanite) of these xenoliths to explore the temporal and thermal evolution of the lower continental crust in eastern Australia.

Preliminary U-Pb zircon and titanite dates from the xenoliths are dominantly Paleozoic and likely relate to extensional events during the Permian-Triassic Hunter-Bowen Orogeny, a time of significant heat flow in the region. Some zircon grains record Proterozoic age trends, which suggest at least parts of the lower crust in Australia are relatively ancient. Apatite, rutile and some titanite rims have young dates that reflect rapid cooling and closure upon eruption of the basalts. The young dates provide an age constraint for intraplate volcanism in eastern Australia, for which age data are locally lacking or unreliable. These thermochronometers also further constrain the temporal thermal evolution of the lower crust across the different tectonic terrains sampled.