Deciphering the sources and melt generation mechanisms of Cenozoic intraplate volcanism in central Mongolia

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One of the largest regions of Cenozoic intra-plate volcanism stretches across central Asia from the Baikal Rift in Siberia, through central Mongolia to China. In Mongolia this is expressed as numerous small-volume alkali-basaltic cones and lavas, erupted since *ca.* 30 Ma. Currently, accepted models of melt generation for intraplate magmatism, such as mantle plumes, lithospheric extension and convective removal of the lithosphere, are difficult to reconcile with some aspects of volcanism and tectonics in this region.

A suite of basalts erupted across an area of Cenozoic uplift in central Mongolia, known as the Hangai Dome, has been analysed for major and trace elements and Sr-Pb isotopes. Based on Sr-Nd-Pb-Hf isotopes, Barry *et al.* [1] suggested the involvement of both lithospheric and asthenospheric source regions in the genesis of the Hangai basalts. We present new rare earth element (REE) data to constrain the depth and degree of partial melting beneath this region, which is best modelled using chondrite-normalised Dy/Yb and La/Yb ratios. This modelling implies a small degree (1-4%) of partial melting in widespread areas across the dome. Additionally, an enriched light REE/ heavy REE signature indicates deep (~100km) garnet-facies melting which fluctuates to shallower (~70km) spinel-facies melting through time. Ar-Ar dating implies melting has persisted for at least the last 5.9 Ma [1].

When trace element results are combined with both published and new isotopic data, a shift in mantle source with melting depth is implied. Although current results do not uniquely define a melt generation model, further study will assess the relative importance of lithospheric and asthenospheric melting in the genesis of these basalts, and contribute to understanding this enigmatic volcanic region.

[1] Barry, T. L., Saunders, A. D., Kempton, P. D., Windley, B.F., Pringle, M.S., Dorjnamjaa, D. & Saander, S. (2003) *J. Petrol.* **44** 55-91.

Temperature and timing of diagenesis from carbonate clumped isotope thermometry and thermochronology

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Temperatures of diagenesis in sedimentary basins are commonly inferred from tools that can constrain rock thermal histories or peak temperatures, but not the timing or temperature of crystal growth for major diagenetic phases. We demonstrate a technique to resolve both the temperature and timing of growth for distinct cementation, re-crystallization, and replacement phases using 'clumped isotope' paleothermometry–a new tool based on measurement of the ^{13}C-^{18}O bond enrichment in carbonates.

This paleothermometer can resist resetting due to reheating and late-stage fluid circulation, enabling the temperatures of multiple diagenetic events to be interrogated using a single sample. Temperature estimates are independent of the isotopic composition of phases with which carbonate underwent exchange, making it possible to determine changes in the $\delta^{18}O$ of diagenetic fluids that accompany changes in temperature. Such data can reveal water-rock ratios and in some cases discriminate between open and closed system behavior and between cooling and heating sequences. When combined with constraints on a sample's thermal history, clumped isotope thermometry also enables the timing of diagenetic events to be estimated.

Growth temperatures for three generations of carbonate in an Eocene lacustrine limestone sample from the Colorado Plateau provide a detailed record of calcite replacement and precipitation at temperatures of 24-75ºC in a closed, rock-buffered system. The sample experienced a significant thermal pulse associated with the extrusion of an overlying Miocene basalt, the thermal effects of which are constrained by previous $^{40}Ar/^{39}Ar$ and (U-Th)/He data. Combined with petrographic and oxygen isotopic analysis, these data present an ideal opportunity to reconstruct the sample's post-depositional history in unusual quantitative detail.

When applied to other samples, this approach could provide a valuable means to understand sedimentary basin evolution, fluid-rock interactions, hydrocarbon genesis, dolomitization, and canonical models relating carbonate textures to the timing of precipitation.