Magmatism

Steam-bath Earth (*July 2017*)

The Earth's mantle probably contained a significant amount of water from the start. Its earliest history was one of intense bombardment, including the impact that formed the Moon. Together with the conversion of gravitational potential energy to heat while the core was settling out from the mantle, impacts would have kept its overall temperature high enough to prevent water vapour from condensing on the surface until such heat input ceased and heat loss by radiation allowed the surface rapidly to cool. The atmosphere would have been rich in water vapour. Evidence from zircons that are the earliest tangible materials yet recovered hint at the formation of Zr-rich magmas – probably granitic in the broad sense – about 100 Ma after the Moon-forming event (see *Zircons' window on the Hadean* July 2001). Yet no trace of substantial granitic rocks that old have ever been found.

Don Baker and Kassandra Sofonio of McGill University in Montreal, Canada have considered processes other than partial melting or fractional crystallisation that may have been possible during the earliest Hadean. In particular they have looked at one thought once to be a contender in the genesis of granite and latterly sidelined (Baker, D.R. & Sofonio, K. 2017. A metasomatic mechanism for the formation of Earth's earliest evolved crust. *Earth and Planetary Science Letters*, v. **463**, p. 48-55; DOI: 10.1016/j.epsl.2017.01.022). They heated powdered artificial samples that chemically resembled the Earth's original silicate mantle in sealed double capsules – an inner part containing the silicate powder and an outer one containing water. The capsules were held at around 727°C for a time and then quenched. The outer part of each capsule was found to be a glass of roughly granite composition. The experimental design ensured that superheated water diffused across the inner-outer capsule wall. So the 'granite' must have formed by a metasomatic process – essentially preferential solution of its component elements in supercritical water – the experimental temperature being insufficient to partially melt the ultramafic charge in the inner capsule.

Baker and Sofonio conclude that degassing of this metasomatic fluid – silicate-rich 'steam' – may have produced substantial masses of sialic crust on the Earth's surface. Removal of material produced in such a manner would also have extracted trace elements with an affinity for granite from the early mantle – so-called incompatible elements. The subsequent recycling of such granitic blobs back into the mantle may explain geochemical signs in >500 Ma younger Archaean crust – produced by 'normal' igneous processes – of incompatible-element enriched reservoirs in the Early mantle.