Ultrahigh-temperature crustal metamorphism

DAVID E KELSEY

Continental Evolution Research Group, School of Earth and Environmental Sciences, University of Adelaide, Australia, 5005 (David.Kelsey@adelaide.edu.au)

Ultrahigh-temperature (UHT) metamorphism, characterized by crustal temperatures exceeding 900 °C, is now accepted as a widespread and important style of regional granulite-facies metamorphism. UHT metamorphism occurs in excess of the solidus of most crustal rocks and is typically recognised on the basis of unusual mineral assemblages in Mg-Al-rich rocks, including sapphirine + quartz, osumilite and orthopyroxene + sillimanite. The generation and maintenance of UHT metamorphic conditions is a conundrum in Earth Sciences as it requires the revision of tectonic models and has implications for the mechanical and rheological behaviour of the lithopshere.

Two approaches are required in order to understand UHT metamorphism. First is to assess the mineralogical and temporal record of UHT terranes, by deciphering the thermal and physical (i.e. *P-T*) conditions, and to constrain timescales, for their evolution. The retrieval of *P-T* conditions and the meaning of geochronological data is hampered somewhat since the extreme temperatures typically exceed the closure temperatures of most isotopic and elemental closure systems. Nevertheless, developments in mineral equilibria modeling and *P-T* retrieval techniques have allowed for *P-T* evolution histories to be tightly constrained. Similarly, the timing of zircon growth is becoming better understood through studies investigating REE patterns in minerals coexisting with zircon and through constraints provided by zircon dissolution.

Armed with *P-T-t* and field/geochemical information, the second approach involves investigation of the tectonic setting(s) of UHT metamorphism. The generation of granulites, including UHT granulites, remains in dispute, with extensional (arc accretion) as well as collisional settings proposed. All models invoke the role of either lithospheric mantle or asthenosphere in generating high temperatures in the deep crust. However, this notion must be questioned in the general absence of voluminous syn-metamorphic mantle-derived rocks in UHT terranes. The future direction of studies on UHT metamorphism must be towards improving our understanding of the geodynamic and tectonic implications of UHT terranes.