# Archean lithospheric mantle: The fount of all ores?

*SUZANNE Y. O'REILLY[1], W.L. GRIFFIN[1], G.C. BEGG[1,2], N.J. PEARSON[1] AND J.M.A. HRONSKY[1,3].

[1]CCFS/GEMOC, Macquarie University, Sydney, Australia (*correspondence: sue.oreilly@mq.edu.au)
[2]Minerals Targeting Intl., 17 Prowse St., W. Perth, Australia
[3]Western Mining Services (Aust.) Pty Ltd, 17 Prowse Street, W. Perth, WA 6005, Australia

Magma-related ore systems form economic deposits that underpin our human civilisation. The magmas related to metallic element redistribution derive from the asthenosphere, then traverse and interact to varying degrees with the subcontinental lithospheric mantle (SCLM). Convergent geochronology datasets of Hf isotopic model ages for zircons and Re-Os model ages for mantle sulfides, reinforced by other geochemical and tectonic criteria, indicate that over 70% of the SCLM and its overlying crust (now mostly lower crust) formed at about 3.5 Ga, probably in a global overturn event that marked a change in Earth's fundamental geodynamic behaviour. This primitive SCLM, the roots of the Archean cratons, was geochemically highly depleted, and subsequently played a major role in crustal metallogeny for many ore types. *Firstly*, the high degree of buoyancy of this ancient SCLM relative to the asthenosphere, due to the Mg-rich and Fe-poor composition, results in persistence today of low-density, rheologically coherent Archean domains (including relict blobs in rifted ocean basins [1]) and commonly, preservation of old crustal domains (the "life-raft" model). *Secondly*, the enduring (and volumetrically dominating) Archean lithospheric mantle domains represent a reservoir for metasomatic enrichment over their 3.5 billion year history, creating a potentially metallogenically fertile mantle impregnated with critical elements (including Au, Cu, Ni? and platinum group elements [2]). *Thirdly*, the formation of Archean cratons provide an architectural lithospheric mantle-scape of regions with contrasting rheology, composition and depth penetration. The cohesive Archean domains control magma and fluid pathways around their margins, and may act as both sinks and sources for ore-forming elements depending on the geodynamic evolutionary stage. *Fourthly*, if this first stabilisation of lithospheric mantle at 3.5 Ga signalled the end of an overturn regime (either uniquely, or intermittent with subduction), then long-lived tectonic regimes conducive to mineralising systems (e.g. back-arc basins, passive margins, cratonic boundaries) became available.

[1] O'Reilly *et al.* ( 2009), Lithos, 112, 2, 1043-1054. [2] Zhang *et al.* (2008), E. Sci Rev 86, 145-174.

# P-T modeling reveals juxtaposition of units within the Gruf Complex (Central Alps) during orogenesis.

J. OALMANN[1], A. MÖLLER[2] AND R. BOUSQUET[3]

[1,2]Department of Geology, University of Kansas, USA, (joalmann@ku.edu, amoller@ku.edu)
[3]Institute of Geosciences, Christian-Albrechts-Universität zu Kiel, Germany, (bousquet@min.uni-kiel.de)

Equilibrium assemblage diagrams calculated with Theriak-Domino are used to constrain peak P–T conditions of sapphirine granulites and migmatitic paragneisses. Residual orthopyroxene + garnet + sapphirine + sillimanite granulites record peak conditions of 900–960°C at 8–10 kbar. Subsequent UHT decompression to <8 kbar produced cordierite coronae around peak minerals. Complex compositional zoning patterns in garnet porphyroblasts suggest no diffusional equilibration at peak conditions and thus a short-lived UHT event. Muscovite-bearing and muscovite-free paragneisses reached peak conditions of 650–700°C and 700–750°C, respectively, at ≤7.5 kbar. The paragneisses contain no evidence for UHT metamorphism. The different peak conditions suggest that peak metamorphism of the granulites and paragneisses occurred at different crustal levels. The granulites and associated charnockites were subsequently juxtaposed against the paragneisses and associated orthogneisses along mylonitic shear zones.

Ages of zircon rims in granulites suggest they underwent UHT metamorphism at ≥32.7±0.5 Ma (Liati & Gebauer, 2003, *SMPM*). Variably deformed aplite and pegmatite dikes crosscut all other rock types and are deformed within the mylonitic contacts between the granulite–charnockite and paragneiss–orthogneiss units (Galli, 2010, PhD thesis, ETH Zürich). The dikes crystallized at ≤30 Ma, suggesting juxtaposition occurred between 33 and 30 Ma, coeval with crystallization of the Bergell tonalite–granodiorite. By c.24 Ma, the granulites and thus the entire Gruf Complex cooled below the U-Pb closure temperature of rutile (Oalmann *et al.*, 2011, Goldschmidt abstract), coinciding with crystallization of the Novate S-type leucogranite and the latest, undeformed dikes.

UHT metamorphism coincides with the transition from (U)HP to Barrovian metamorphism in the Central Alps. Therefore, heat for UHT metamorphism likely resulted from asthenospheric upwelling after slab breakoff. Exhumation and juxtapostion of units within the Gruf Complex was likely related to the emplacement of the Bergell intrusion.


DOI:10.1180/minmag.2013.077.5.15