Unraveling cryptic high-temperature polymetamorphism: An Alpine example

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Distinguishing between mineral phases which record evidence of distinct metamorphic events in high-grade polymetamorphosed rocks is one of the most difficult tasks facing metamorphic petrologists. This is particularly challenging when attempted on rocks that have experienced partial melting in at least one of these events. Resetting of mineral equilibrium compopsitions during metamorphic overprinting and an evolving bulk-rock composition during partial melting or late-stage fluid fluxing mean that both conventional thermobarometry and quantitative *P-T* modeling can be ineffective or easily misinterpreted. Here, we aim to elucidate the nature of potentially polymetamorphic granulites from the Gruf Complex, Central Alps, through integration of trace element thermometry, *in-situ* geochronology, and pressure-temperature (*P-T*) pseudosection modeling of carefully chosen textural domains. The Gruf Complex contains ultrahigh temperature (UHT) granulites and remains one of the most enigmatic features within the Alpine orogenic belt. Some studies suggest that UHT conditions record peak *T* during the Eocene Alpine orogen [1], whilst others invoke UHT conditions during Permian rifting overprinted by upper amphibolite facies migmatisation during Alpine orogenesis [2, 3].

Zr in rutile (rtl) and Ti in quartz (qtz) thermometry on grains in several textural domains of a single hand sample help to resolve ambiguity regarding the phases and textures that record different stages of the rock's history. Results suggest the presence of two distinct generations of biotite (bt), recording dramatically different *T*. Rtl grains within highly resorbed, high-Ti bt yield 710–780 °C. Textural association with high-*T* opx + grt ± sill assemblages suggests that they may record prograde heating leading to incomplete bt dehydration melting, and resultant formation of porphyroblastic opx with rtl inclusions that yield 810–880 °C. Rtl grains in texturally equilibrated, low-Ti bt or in matrix cordierite clearly record a later stage, low *T* recrystalization. Qtz and rtl grains in grt yield *T* of 800-850 °C, suggesting possible grt growth coeval with opx.

[1] Möller *et al*. (2012) *IGC, Abstracts* **34**, 3161. [2] Galli *et al*. (2011), *Lithos* **124**, 17-45. [3] Galli *et al*. (2012), *Contrib. to Mineralogy and Petrology,* **163**, 353-378.

Reconstruction of nutrient redox cycling in the Early Neoproterozoic

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A significant body of evidence suggests that the deep ocean remained anoxic until the terminal Neoproterozoic. Recent studies on mid-Proterozoic [1] and later Neoproterozoic [2,3] (<750 Ma) marine sediments indicate that water masses beneath the oxic surface ocean were dominantly ferruginous, with sulphidic conditions restricted to the continental margins. However, in contrast to the Mesoproterozoic, sulphidic continental margin conditions appear to be particularly sparse in the later Neoproterozoic, while little is known about the nature of ocean chemistry in the early Neoproterozoic. This is particularly significant since the bioavailability and the redox cycling of nutrients are prone to change dramatically when shifting from sulphidic to ferruginous conditions. Thus, the biogeochemistry of the ocean preceeding the onset of the first Neoproterozoic glaciation is poorly constrained. Here, we reconstruct the evolution of coupled redox-nutrient cycling throughout a succession capturing pre- (>800 Ma) to syn-glacial sediments. Our focus is on a succession of deeper and shallower marine deposits from the Huainan region, northern China. The transect constitutes a potential archive of the biogeochemical response to linked changes in ocean redox conditions and nutrient feedbacks during the run-up to extreme climate change. Our data document the links between phosphorous cycling and ferruginous waters, under conditions characterised by low sulphate and apparent low productivity.

[1] Poulton *et al*. (2010) *Nat. Geosci*. **3**, 486-490. [2] Canfield *et al*. (2008) *Science* **32**, 949-952. [3] Johnston *et al*. (2010) *EPSL* **290**, 64-73.

DOI:10.1180/minmag.2013.077.5.7