UHT Metamorphism, the Lewisian, and the legacy of Mike O'Hara

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Ultrahigh-temperature, or UHT, metamorphism occurs where rocks of the continental crust are subjected to temperatures in excess of 900°C at pressures of 0.6-1.2 GPa, with peak-T dT/dz gradients of 30-50°C/km [1] [2]. UHT presents a challenge to thermomechanical models for orogenesis, requiring significant heat input either from the mantle or from the self-heating of crust enriched in radiogenic elements.

UHT metamorphism can now be established on the basis of a variety of major- and trace element themometers (e.g. Al in orthopyroxene, Ti in quartz and zircon, Zr in rutile), diagnostic mineral assemblages (e.g. Al-orthopyroxene + sillimanite + K-Feldspar + quartz and sapphirine + quartz in pelites; Fe-Mg pigeonites in metaironstones; ternary feldspars in pelites), and calculated phase diagrams for specific rock compositions. Examples of these approaches to characterising UHT are presented, focussing on the Napier Complex and Mather Supracrustals of Antarctica.

Amongst his many contributions to petrology and geoscience, Mike O'Hara must be recognised as one of the first proponents of what we now call UHT metamorphism [3]. In 1978 he proposed that the Scourian granulites of the Lewisian of NW Scotland experienced peak conditions of "ca. 1150±100°C; 15±3 kbar" based on his reintegration of pigeonites, ternary feldspars and lamellar intergrowths of pyroxenes,plagioclas and Fe-oxide. He also proposed that considerable partial melting occurred during this 'UHT' event – a scenario supported by recent work [4]. Whilst his temperature estimates were in detail too high, based on what are now outdated thermometers, the most recent P-T estimates based on thermodynamic modelling [5] yield conditions (8.5-11.5 kbar, 875-975°C) that at their upper end are compatible with O'Hara's implicit assignation of the Scourian as a UHT granulite belt.

[1] Harley (2008) *J. Met. Geol.* **26**, 125-154. [2] Brown (2006) *Geology* **34**, 961-964. [3] O'Hara & Yarwood (1978) *Phil. Trans. Roy. Soc. Lond. A* **288**, 441-456. [4] Johnson *et al.* (2013) *J. Geol. Soc. Lond.* **170**, 213-326. [5] Johnson & White (2011) *J. Geol. Soc. Lond.* **168**, 147-158.