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# An Extreme (1200°C) Test of Zircon-Rutile Thermometers

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Natural tests of Ti-in-zircon and Zr-in-rutile thermometers to ultrahigh temperature conditions are important for validating the extrapolation of experimental calibrations to real rocks. Here we report Ti contents in zircons and Zr concentrations in rutiles that formed during extreme sanidinite facies metamorphism and partial melting of a highly magnesian sapphirine-enstatite-spinel granulite xenolith hosted within a 2240 Ma norite complex that intruded end-Archaean (2520-2480 Ma) basement gneisses of the Vestfold Hills, Antarctica. Phase equilibria modelling and calculations on both the xenolith and host norite constrain xenolith partial melting and consequent zircon, rutile, Ti-sapphirine and enstatite crystallisation to 1170-1200°C at 2.5 kbar [1].

The Ti contents of zircons formed on crystallisation of the sanidinite facies partial melts have been determined by SIMS and high beam current EPMA. Both confirm that the zircons have extreme Ti contents, 260-380 ppm, that are the highest recorded from any natural terrestrial zircons. The calculated Ti-in-zircon temperatures [2] of 1173±38°C derived from these Ti data overlap with independent estimates and hence support the experimental calibration of this thermometer in rutile-saturated systems. Rutiles, which are exsolved or decomposed into intricate two-phase intergrowths comprising micron-scale zircon granules and lamellae in host rutile host, yield re-integrated Zr contents of 2.71 ± 0.90 wt%. These data require *minimum* temperatures [3] of 1168±80°C at 2.5 kbar. Silica activities ($aSiO_2$) calculated using sapphirine-spinel-$SiO_2$ equilibria lie in the range 0.8-0.85 and lead to $aSiO_2$-corrected Ti-in-zircon [2] and Zr-in-rutile [3] temperatures in the range 1180-1210°C. The observation that the temperatures derived from the Ti and Zr data overlap, are mutually consistent, and compatible with previous estimates, confirm the applicability of pressure-corrected zircon-Ti and rutile-Zr thermometry to metamorphism under extreme temperature conditions (dT/dz = 200 in this example).

[1] Harley & Christy (1995) *Eur. J. Min*. **7**, 637-653; [2] Ferry & Watson (2007) *Contrib. Min. Pet.* 154, 429-437; [3] Tomkins, Powell & Ellis (2007) *J. Met. Geol*. **25**, 703-713.