Ti zircon thermometry applied to metamorphic and igneous systems.

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Ti concentration within zircon is seemingly controlled by temperature [1]. This has the potential to yield valuable information as to the thermal evolution of metamorphic and igneous rocks. We present Ti zircon thermometry results for two Archean samples from southwest Greenland. Data was acquired on the SHRIMP II multi-collector at ANU by simultaneous measurement of ^{49}Ti and $^{28}Si^{16}O$. Referencing the minor Ti isotope to SiO rather than Zr allows the cross-calibration between NIST SRM glasses and SL13 zircon standard, without isobaric interference of ^{48}Ca on the major ^{48}Ti peak, or uncertainty caused by zircon Hf concentration.

G03-38 is a localized (<1 m^3) 'granitic' partial melt, segregated from an amphibolite unit during 2.7 Ga regional amphibolite facies metamorphism. Metamorphic zircons from the partial melt are in equilibrium with garnet, clinopyroxene and ilmenite in a confined system. Temperatures determined from the zircons (mean 677±12°C; n=11) lie within uncertainty of independent garnet - clinopyroxene thermometry.

In contrast, G97-18 is a 3.8 Ga, weakly deformed and homogeneous, large tonalitic intrusion. Oscillatory zoned igneous zircons are in equilibrium with titanite. Whole-rock geochemistry indicates Zr undersaturation (121 ppm) [2]. Ti in zircon temperatures (mean 681±29°C; n=34) probably underestimate that of the parental melt (800-900°C).

Composite analyses reveal complex Ti distributions within single zircon crystals, possibly related to magmatic evolution or trace element incorporation during growth. Variations in apparent crystallization temperatures between and within grains from G97-18 (range 151°C), can be compared with oscillatory zonation identified by cathodoluminescence. Extreme Ti enrichment at the zircon rims are identified as optically undetectable micro-inclusions (Ca-Ti phase) revealed by depth profiling with laser ablation ICPMS. Coeval crystallization of Ti buffering phases should be considered when interpreting these temperatures.

These results indicate the thermometer may used reliably in carefully selected applications.

References

[1] Watson E.B. and Harrison T.M. (2005) Science **308,** 841-844.

[2] Nutman A.P., Bennett V.C., Friend C.R.L. and Norman M.D. (1999) Contrib. Mineral. Petrol. **137,** 364-388.