Geophysical Research Abstracts
Vol. 14, EGU2012-4063, 2012
EGU General Assembly 2012

Application of the TITANIQ geothermometer to ultrabasic rocks

J.J. Esteban (1), J.M. Tubía (1), J. Cuevas (1), and J.I. Gil Ibarguchi (2)

(1) Departamento de Geodinámica, Facultad de Ciencia y Tecnología, Universidad del País Vasco, apartado 644, 48080 Bilbao, Spain (jj.esteban@ehu.es), (2) Departamento de Mineralogía y Petrología, Facultad de Ciencia y Tecnología, Universidad del País Vasco, apartado 644, 48080 Bilbao, Spain

The titanium-in-quartz geothermometer (TitaniQ), based on the equilibrium partitioning of Ti between rutile and quartz at P < 1 GPa (Wark and Watson, 2006), is being nowadays successfully applied to quartz-bearing crustal rocks (Liu and Santosh, 2010), mineral deposits (Focke et al., 2009) or even to quartz mylonites (Grujic et al., 2011; Baker et al., 2011). However, the strong nonlinear dependence of the Ti-in-quartz solubility upon higher pressures (> 1.5 GPa) makes necessary an independent pressure constraint to obtain accurate temperatures (Thomas et al., 2010). In order to test the TitaniQ geothermometer in ultrabasic rocks, we have analysed by electron microprobe Ti concentration of quartz inclusions within garnets from a garnet-pyroxenite of the Sierra Bermeja massif (Ronda peridotites, Betic Cordilleras). The results obtained are compared with those provided by conventional geothermobarometers.

The pyroxenite shows granoblastic texture consisting of partially kelyphitized garnet and clinopyroxene. Plagioclase is present along the grain boundaries of clinopyroxene, in late veins or included within garnet. Other minor matrix minerals are rutile and quartz. Garnet compositions cover the range Py58-54Alm28-22Gro21-15And3-1Uva1-0. Garnets have inclusions of plagioclase (andesine An30-50), clinopyroxene (Ens46-42Wo52-45 Fs8-5; XJd:18-12), rutile and quartz. Clinopyroxene shows chemical variations that attest changing recrystallization conditions. Cores are closer in composition to garnet-included pyroxenes and show decrease in $Al2O_3$ and Na2O contents and increase in CaO and MgO towards the rims.

Clinopyroxene and plagioclase inclusions in garnet allow calculating the equilibrium conditions of a first Grt-Cpx-Pl assemblage. P-T were calculated iteratively using coupled thermo-barometric formulations as follows: (1) Eckert et al. (1991) and Nimis and Taylor (2000), and (2) Eckert et al. (1991) and Krogh-Ravna (2000). Although, these are one of the most reliable formulations for P-T estimation in ultramafic rocks, the results show significant differences in T: 1025 ºC-1.7 GPa and 825 ºC-1.5 GPa, respectively.

From our data, the average Ti content of quartz inclusions is 178 $\pm$ 21 ppm. This corresponds to quartz crystallization temperatures of 994 $\pm$ 17 ºC (at 1.7 GPa; Thomas et al., 2010) and 821 $\pm$ 16 ºC (at 1 GPa; Wark and Watson, 2006), assuming in both cases that $aTiO_2$ = 1 since rutile is present as needle inclusions in garnet.

Quartz is far from being a main mineral in mantle rocks. However, according to thse new data and the concordance within the limits from the conventional geothermobarometers for ultramafic rocks, we propose that the Ti-in-quartz composition can be used to precise crystallization temperatures and therefore, it could be consider a useful geothermometer in quartz-bearing pyroxenites.

References:
Barker et al. (2011). Geology, 38, 379-382.
Eckert et al. (1991). Amer. Mineral., 76, 148-160.
Focke et al. (2009). J. Geochem. Exploration, 101, 93.
Grujic et al. (2011). Geochemistry, Geophysics, Geosystems (G3), 12, Q06012.
Liu and Santosh (2010). Contrib. Mineral. Petrol., 159, 225-235.
Nimis and Taylor (2000). Contrib. Mineral. Petrol., 139, 541-554.
Thomas et al. (2010). Contrib. Mineral. Petrol., 160, 743-759.
Wark and Watson (2006). Contrib. Mineral. Petrol., 152, 743-754.