Syncing TitaniQ: Towards reconciling experimental calibrations of the titanium-in-quartz geothermobarometer

M. D. ACOSTA[1]*, J. M. WATKINS[1] AND M. H. REED[1]

[1] Department of Earth Sciences, University of Oregon
(*macosta@ uoregon.edu)

The titanium-in-quartz geothermobarometer, TitaniQ, was developed by Wark and Watson [1] and Thomas et al. [2] to take advantage of the fact that quartz is common in crustal rocks and stable across a wide range of environments. However, the applicability of TitaniQ has been complicated by two issues: (1) two other groups [3, 4] used different methods and reported lower Ti concentrations in quartz, by a factor of 2-3 than TitaniQ, and (2) TitaniQ yields temperature estimates that are systematically lower, by about 100-150°C, from those of other thermobarometers applied to the same rocks.

We performed hydrothermal quartz growth experiments at 800°C and 1 kbar using methods hybridized from previous studies. An inner platinum capsule containing a Ti-free quartz seed crystal is placed within a gold capsule loaded with silica glass beads, 10 µL of water, and either powdered or crystalline rutile or anatase as the TiO_2 source. During an experiment, the seed crystal in the inner capsule develops an overgrowth, as in [3], and new quartz nucleates and grows in the outer capsule, as in [1, 2].

Our results span the range of previous calibrations. When rutile or an anatase crystal is used as a TiO_2 source, newly crystallized rutile is sparse, and Ti in quartz is low. These results are in general agreement with [3, 4] and indicate rutile is not effectively buffering titania activity in all experiments. In contrast, when powdered anatase is used as starting material, quartz co-precipitates with abundant rutile. This is the only type of experiment that produces high-Ti quartz, in agreement with [1, 2], but values from a single, well-buffered experiment span the range of previous calibrations [1-4]. We identify two reasons for the discrepancies between previous studies: (1) the type of TiO_2 source material matters, with powdered anatase yielding higher a_{TiO2} than powdered rutile, and (2) even when a_{TiO2} is fixed, variations in quartz surface roughness and growth rate can give rise to a wide range of values for Ti in quartz. Additional results will be presented, including quartz zonations, TiO_2 phase identification, and implications of our findings for recent temperature estimates based on TitaniQ.

[1] Watson, Wark, & Thomas (2006). *Contr. to Min. and Petr.* **151(4)**, 413. [2] Thomas, Watson, Spear, & Wark, (2015) *Contr. to Min. and Petr*. **169(3)**, 27. [3] Huang & Audétat (2012) *Geochim. et Cosmo. Acta* **84**, 75-89. [4] Nachlas & Hirth (2015) *J. of Geophys. Rsch.* **120(12)**, 8120-8137.