Highlights and Breakthroughs:

AN EXAMINATION OF THE TI-IN-QUARTZ THERMOBAROMETER IN ROCKS THAT CONTAIN DYNAMICALLY RECRYSTALLIZED QUARTZ: RE-EQUILIBRATION OF [TI] DURING RECRYSTALLIZATION

JOHN M. HUGHES

Department of Geology, University of Vermont, Burlington, VT 05405, U.S.A.

Abstract: As metamorphic petrologists attempt to understand the pressure – temperature – time – deformational history of metamorphic rocks, numerous thermobarometers have been developed that help recreate that history. As these thermobarometers are developed, they invariably mature as they are tested on a variety of metamorphic assemblages. In the work entitled *Ti resetting in quartz during dynamic recrystallization: Mechanisms and significance,* the authors demonstrate that the metamorphic process of dynamic recrystallization of quartz lowers the [Ti] in quartz as recrystallizing quartz crystals re-equilibrate in equilibrium with the composition of the intergranular medium, which is typically undersaturated in Ti. The authors conclude that analyses using the TitaniQ thermobarometer in rocks that contain dynamically recrystallized quartz cannot be meaningfully interpreted until methods are developed that can account quantitatively for the reduction of [Ti] resulting from crystal plastic flow. The paper is essential reading for all who use thermobarometers that use quartz as one of the reacting phases.

Keywords: Titanium, quartz, dynamic recrystallization, TitaniQ

Reconstructing the pressure – temperature – time – deformation history (P – T – t – D) of metamorphic rocks has received considerable attention over the past several decades. Combinations of field observations, detailed laboratory analyses, and thermodynamic data in numerous mineral systems have been used to recreate metamorphic history, and metamorphic petrologists have sought and proposed many such thermobarometers. One such thermobarometer that was recently proposed is the Ti-in-quartz thermobarometer ("TitaniQ"), a thermobarometer that was initially calibrated by Wark and Watson (2006). The thermobarometer is of particular usefulness because of the ubiquitous nature of quartz in metamorphic rocks and its involvement in many metamorphic processes.

Virtually all thermobarometers undergo revision as they are tested on rocks from a wide variety of field settings, and the TitaniQ thermobarometer is no exception. As noted by Ashley et al. (2013), *applied to pelitic schists metamorphosed at mid-crustal depths, the TitaniQ thermobarometer has been shown to be an effective monitor of Si-flux resulting from: (i)*

metamorphic reactions, (ii) strain-induced solution transfer, and (iii) Si-charged fluid influx.

In their current work, Ashley *et al*. (this volume) report the use of the TitaniQ thermobarometer in rocks that contain dynamically recrystallized quartz. Those authors note that the quartz in such rocks is variable with respect to [Ti]; subgrains that display evidence of dynamic recrystallization display a *lower* [Ti] than undeformed porphyroblasts in the same rock, suggesting a loss of Ti in dynamically recrystallized quartz. They evaluate that disparity, and conclude that localized re-equilibration of [Ti] is promoted at subgrain boundaries and defects that migrate through recrystallizing quartz crystals. This re-equilibration is thermodynamically regulated by the composition of the intergranular medium, which is typically *undersaturated* in Ti. They note that analyses from dynamically recrystallized quartz cannot be meaningfully interpreted until methods are developed that can account quantitatively for the reduction of Ti resulting from crystal plastic flow. Their observations refine the use of the TitaniQ thermobarometer, and suggest further research that is necessary before the method is used in rocks that contain dynamically recrystallized quartz. This paper is essential reading for anyone who plans to use this thermobarometer, or indeed any thermobarometer that uses quartz in its reactions, and will undoubtedly be widely cited in the future.

REFERENCES

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