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Testing the Limits of Ti-in-Quartz Thermometry and Diffusion Modelling on the Fish Canyon Tuff

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How are silicic magmas stored in the upper crust? Answering this question is key to understanding how these systems form and erupt. While some studies posit storage in an eruptible state at low viscosity (>750°C) (*warm storage*), others suggest storage in a rigid state (>50% crystals) at temperatures near their solidus (*cold storage*). Storage temperature and time near the solidus are constrained by mineral thermometry and diffusion modelling, respectively. Since quartz is abundant over a range of compositions and temperatures, a Ti-in-Quartz thermometer has been calibrated and Ti diffusion coefficients (D_{Ti}) were determined. However, simply applying this thermometer or D_{Ti} to quartz is burdened by an ongoing debate regarding their experimental calibration. This debate centers around three thermometers by [1], [2], [3] and three D_{Ti} by [4], [5], [6] each of which when applied to igneous systems favors either *warm* or *cold storage*. Thus, we estimate the limitations of the different thermometers and D_{Ti} in determining the pre-eruptive conditions of magmatic systems by applying them to quartz from the Fish Canyon Tuff (FCT, USA). This tuff is an optimal location, since it is a prime example of *cold storage* with multiple studies providing constraints on its storage conditions. The thermometer by [2] suggests 737±16°C, which is consistent with other FCT temperature estimates. Residence times at this temperature are determined using the three D_{Ti} and by comparing results to timescales from Ba-in-Sanidine diffusion, as well as the total storage time of the mush (from zircon U-Pb ages and eruption history). Timescales using D_{Ti} by [6] exceed the total storage time of the mush unless storage temperatures were higher, which would be inconsistent with *cold storage* of FCT. Timescales determined using [5] and [6] are consistent with FCT. Those using [5] suggest long-term storage near 737°C, whereas [6] suggest storage below 737°C.

[1] Huang & Audétat (2012), *GCA*, 84, 75-89. [2] Zhang *et al.* (2020), *EPSL*, 538, 116213. [3] Osborne *et al.* (2022), *CoMP*, 177(3), 31. [4] Cherniak *et al.* (2007), *Chem. Geol.*, 236(1-2), 65-74. [5] Jollands *et al.* (2020), *Geology*, 48(7), 654-657. [6] Audétat *et al.* (2021), *EPSL*, 561, 116847.