

Paper Number: 4715

Ti-thermometry of magmatic quartz in evolved rocks from the Bushveld Complex, South Africa



Buthelezi, M.¹, Ashwal, L.D.¹ and Horvath, P.¹

¹ School of Geosciences, University of the Witwatersrand, WITS 2050, South Africa: Musawenkosi.buthelezi@students.wits.ac.za¹; lewis.ashwal@wits.ac.za¹; peter.horvath@wits.ac.za¹

The Bellevue core from the Northern limb of the Bushveld Complex [1] provides us the opportunity to study the thermal histories of layered mafic intrusions. Most geothermometers used in layered mafic intrusions have focused on constraining liquidus temperatures, using the equilibria existing between the combinations of feldspars, pyroxenes and Fe-rich olivines. We report concentration data for the trace element titanium hosted in quartz, in rocks such as olivine ferrodiorites, leucogabbroites, anorthosites and quartz anorthosites, obtained by electron microprobe to constrain the solidus temperatures for the rocks of the Bushveld Complex, using Ti-in-quartz geothermometers [2, 3] in eight samples from the Main and Upper Zones intersected in the Bellevue drillcore. Magmatic quartz occurs sporadically in these cumulate rocks and commonly occurs as intercumulus, triangular patches, typically between cumulate pyroxenes and feldspars, suggesting that it crystallized from trapped interstitial melts. Quartz grains in rutile-bearing samples (implying Ti activity = 1) have Ti concentration of 85 ± 14 ppm, and yield $T = 739 \pm 19$ °C for the calibration of [2] and 727 ± 19 °C for the calibration of [3]. These results imply a solidus temperature for Bushveld cumulate rocks of ~ 730 °C, which is consistent with $T = 670 - 940$ °C obtained for late-stage crystallization of zircon from Bushveld cumulate rocks, based on the Ti-in zircon thermometer [4]. Quartz grains in our non-rutile bearing samples yield Ti concentrations of 234 ± 63 ppm, implying spuriously high temperatures ($T = 856 \pm 46$ °C, calibration of ref. [2]; $T = 871 \pm 47$ °C, calibration of ref. [2]). This suggests a note of caution for geothermometry in non-rutile-bearing samples. Some of the quartz grains in our samples show weak zoning effects in cathodoluminescence (CL) images; we are exploring whether these correlate with Ti content, and hence temperature, or whether there are other trace elements unrelated to temperature effects that cause the CL patterns.

References:

- [1] Ashwal, L.D.; Webb, S.J., and Knoper, M.W. (2005). *South African Journal of Geology*, 108, 199-232.
- [2] Huang, R. and Aud´etat, A. (2012). *Geochim. Cosmochim. Ac.*, 84, 75– 89.
- [3] Wark, D.A. and Watson, E.B. (2006). *Contrib Mineral Petrol*, 152, 743–754.
- [4] Zeh, A., Ovtcharova, M., Wilson, A.H. and Schaltegger, U. (2015). *Earth and Planetary Science Letters* 418, 103–114.

