A new Titanium excess phase saturation thermometer for silicate melts with implications for conditions of Archean crust formation

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We calibrate a new Titanium excess phase (rutile, ilmenite) saturation thermometer with an extensive experimental literature database (375 experiments) via regression. Based on statistical analysis we find temperature and melt polymerisation, expressed as NBO/T significant for the solubility of Ti in a silicate melt. Additional parameters such as pressure, H_2O and oxygen fugacity are insignificant for Ti solubility below the liquidus. The thermometer is calibrated on mafic to felsic compositions for temperatures between 675 and 1450°C. The calculated temperature is the liquidus temperature at which a composition is saturated with a Ti excess phase.

The processes that formed continental crust in the Archean remain a matter of discussion and geologic evidence of that period is often ambiguous. Therefore, we apply the Ti excess phase saturation thermometer on TTGs (tonalite-trondhjemite-granodiorite), which are the characteristic granitoids of Archean cratons. Temperature conditions of TTG formation should help to constrain different genetic models. By comparing TTG compositions with Ti excess phase saturated experimental melts, we can distinguish between Ti excess phase saturated and undersaturated TTGs. Less evolved compositions are commonly undersaturated. Saturation temperatures of those compositions that are saturated with a Ti excess phase are between 750 and 900 °C. TTG compositions that are at the liquidus in this temperature range, require to be hydrous melts with 10 to 15 wt% dissolved H_2O. Such high water contents are either due to low degree melting, fluid presence during melting, and/or crystal fractionation. Undersaturated TTGs most likely formed from higher degree melting, at higher temperatures (>900 °C).