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A critical comment on Thy et al. (2009b): Liquidus temperatures of the Skaergaard magma

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Abstract

The study by Thy, Tegner, and Lesher (Thy et al. 2009b) is based on whole-rock compositions in batch-melting experiments at one atmosphere that have a very large temperature variation for a very small plagioclase compositional variation. Their steep *T-X* slopes of up to 14 °C/An% contrast with the overall regression for the intrusion of <4 °C/An%. This paradox can be evaluated by using separate tests for equilibrium in temperature and composition. The issue of temperature is clouded by the presence of low-temperature components in the beginning of melting experiments. Compositions of plagioclase and liquid are too close to each other compared to expectations from other experiments at 1 atm and at pressure. A ruling hypothesis is perceived here to the effect that every *T-X* pair represents a valid equilibrium between a liquidus composition and a solidus composition. Therefore, by inversion, each solidus composition defines a valid temperature. Its corollary is that all such pairs receive equal weight and can therefore be legitimately regressed together. The Thy et al. (2009b) regression is passed through the center of gravity of the data rather than through the extrapolated maximum liquidus points. If the ruling hypothesis is falsified, these approaches lose their validity; upon testing, it is falsified. In temperature, testing leads to consequences known to be false. In composition, a test for reproducibility in results also fails, thereby falsifying the principle of stable equilibrium. The falsifications are repeated in at least three ways. The study results cannot furnish a valid thermal path for the fractional crystallization of Skaergaard magma. A selection of the highest-temperature results comes closer to a realistic result based on comparison with earlier experiments that melted out the trapped liquid component of the Skaergaard cumulates. New experimental approaches at the liquidus are needed to help define temperatures and fractionation progress in the Skaergaard intrusion.

Keywords: Batch melting, ruling hypothesis, magma temperatures, metastability, plagioclase, melt, equilibrium, Skaergaard intrusion