Identifying the granitic composition water-saturated solidus

The granitic water-saturated solidus (G-WSS) is the lower temperature limit of magmatic mineral crystallization. The accepted water-saturated solidus for granitic compositions was largely determined >60 years ago[1]. More recent advances in experimental petrology, improved analytical techniques, and recent observations that granitic systems can remain active or spend a significant proportion of their lives at conditions below the traditional G-WSS[2–5] necessitate a careful experimental investigation of the near-solidus regions of granitic systems.

Natural and synthetic starting materials were melted at 10 kbar and 900°C with 4–8 wt% H_2O to produce hydrous glasses for subsequent experiments at lower P–T conditions used to locate the G-WSS. We performed *crystallization experiments* and *melting experiments* at temperatures ranging from 575 to 800°C and 1, 6, 8, and 10 kbar on 12 granitoid compositions. First, we ran a series of isothermal crystallization experiments along each isobar at progressively lower temperatures until runs completely crystallized to identify apparent solidus temperatures. Geochemical analyses of quenched glass compositions demonstrate that progressive crystallization drives all starting compositions towards silica-rich, water-saturated rhyolitic/granitic melts (e.g., ~75–78 wt% SiO_2).

After identifying the apparent solidus temperatures at which the various compositions crystallized, we then ran series of reversal-type *melting experiments*. With the goal of producing rocks with hydrous equilibrium microstructures, we crystallized compositions at temperatures ~10°C below the apparent solidus identified in crystallization experiments, and then heated isobarically to conditions that produced ~20% melt during the crystallization experiments. Importantly, crystallization experiments and heating experiments at the same P–T conditions produced similar proportions of melt, crystals, and vapor. A time-series of experiments 2–30 days at P–T conditions previously identified to produce ~10% to 20% melt did not reveal any kinetic effects on melt crystallization.

Experiments at 6 to 10 kbar crystallized/melted at temperatures close to the published G-WSS. However, at lower pressures where the published G-WSS is strongly curved in P–T space, all compositions investigated contained melt to temperatures ~75 to 100°C below the accepted G-WSS. The similarity of crystallization temperatures for the higher-pressure experiments to previously published results, similar phase proportions in melting and crystallization experiments, and the lack of kinetic effects on crystallization collectively suggest that our lower pressure constraints on the G-WSS are accurate. The new experimental results demonstrating that the lower-pressure G-WSS is significantly lower than unanimously accepted estimates will help us to better understand the storage conditions, evolution, and potential for eruption in mid- to upper-crustal silicic magmatic systems.

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