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Nucleation delay in felsic systems

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Nucleation delay is the time required to establish the steady state nucleation rate. The duration of the nucleation delay depends upon the degree of supersaturation and the composition of the melt, as well as the the composition of the nucleating phase. Nucleation delay times in felsic systems vary between a few minutes and several weeks. Nucleation delay can change depending on the pressure and temperature conditions and cooling path. This term can influence the order of crystalization and textures that can be observed in the crystalization end-product – the igneous rock.

Experiments were conducted to study nucleation delay in granitic composition melts. The starting material was prepared by crushing and grinding rhyolitic obsidian (LCO) from Lake County, Oregon, USA with addition of 0.25 wt. % B_2O_3 (LCOB). Experiments in melts with 3.5 wt. % H_2O were conducted in piston cylinder apparatus at 500 MPa for 1, 2, 4 and 8 weeks at 500 ° C, for 1 and 4 weeks at 400 ° C, and for 1 week at 600 ° C In all LCOB + water experiments oxide crystals (predominantly magnetite) are present, which are also present in zero time runs. At 500 ° C silicate crystals first appear in 2-week long experiment. The crystallization takes the form of spherulites composed mostly of K-rich alkali feldspar with lesser amounts of intergrown quartz. In longer experiments the amount of quartz becomes progresively more pronounced, the melt is depleted in potassium, and the growing feldspars become sodium rich near their terminations. Experiments for 1 and 4 weeks at at 400 ° C and for 1 week at at 600 ° C failed to nucleate any silicate crystals. Experiments were complemented by estimation of nucleation delay times using the equations of Fokin et al. (2006, [1]), thermodynamic data calculated by MELTS as implemented in PhasePlot, the activation energy for Al-Si interdiffusion in silica rich melts [2], and the interfacial energies for nucleating phases from Hammer (2004, [3]).

The modelled nucleation delay times and the order of nucleation agree within a few hours of experimental observations., These results encourage us to apply our results to quantitatively describe nucleation kinetics in natural systems.

[1] Fokin, V.M., Zanotto, E.D., Yuritsyn, N.S., Schmelzer, J.W.P. (2006). *Journal of Non-Crystalline Solids,* 352, 2681-2714. [2] Baker, D.R. (1990). *Contributions to Mineralogy and Petrology,* 4, 407-423. [3] Hammer, J.E. (2004) *American Mineralogist*, 89, 1673-1679.