Crystallisation kinetics of alkali feldspar in a peralkaline melt of pantelleritic composition

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Single step cooling experiments were performed in order to investigate crystsallisation kinetics of alkali feldspar in peralkaline melts. The crystallisation process was investigated as a function of undercooling (ΔT), water content and time. The starting material is a synthetic composition analogue of a pantellerite (PAN 0113), which belongs to the Fastuca pumice fall eruptive unit. PAN 0113 presents a peralkalinity higher than 1 and a silica content of 68 wt %, and as in all the pantellerites the FeOtot content is relatevely high (7 wt %). Experiments were performed at pressures between 25 and 100 MPa and temperature of 720 °C, under anhydrous and hydrous conditions. Non-equilibrium experiments were conducted at fO_2 ranging from NNO+1 to NNO-1 (meaning one log unit above or below the fO_2 controlled by the nickel-nickel oxide buffer), where the most reduced conditions represent the most reliable and closest conditions to the natural pantelleritic system.

Measured nucleation rates (I_m) vary between 10^1 and 10^2 $cm^{-3}s^{-1}$, whereas growth rates (G_L) vary from 10^{-7} and 10^{-8} cm/s. Under non-equilibrium conditions, the time of crystallization in volcanic systems is of great importance because the quantification of the crystallization kinetics of a silicate melt is strictly related to the timescales of its eruptions, and, hence, helps to understand and quantify the related volcanic procceses. Furthermore, the presence of Aenigmatite in the most reduced experiments allows us to better control its field of stability that is still not well constrained.

This work provides new relevant data of disequilibrium crystallisation kinetics in pantelleritic compositions, which have not sistematically studied yet. Since crystallization mechanisms can be related to the occurrence and behavior of some geochemical and geophysical eruption precursors, the investigations of magma residence time during eruptive processes can have important implications in terms of evaluation of volcanic hazard and risk.