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Experimental study of plagioclase growth, nucleation rates, and shape evolution during cooling of an anhydrous basaltic andesite.

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Crystal textures are commonly used to assess the physical and chemical state of pre and syn-eruptive magmatic processes. Plagioclase nucleation and growth rates have been investigated in a range of composition [1,2], but basaltic andesite is underrepresented in the experimental dataset. In this study, a series of experiments were performed at 1 atm on an anhydrous natural basaltic andesite from Osorno volcano (Central Southern Volcanic Zone, Chile) at NNO to determine its nucleation and growth rates and to constrain the role of the cooling rate, isothermal dwells, and initial superheating on the plagioclase habit. Three series of cooling-driven experiments were conducted: (A) initial equilibration at 1190°C, above the liquidus (1180 ± 5 °C), during 24h followed by different cooling rates (1°C/h, 3°C/h, 9°C/h); (B) same as in (A) followed by several isothermal dwells; (C) initial heating at 1450°C followed by a 1°C/h cooling rate. All runs were quenched at different temperatures (1165°C, 1140°C, 1120°C, 1100°C). We used different methods to calculate the growth and nucleation rates: batch method (image analyses), maximum size (l_{max}) and Crystal Size Distribution (CSD). They range from 1.05 x 10^{-7} to 3.6 x 10^{-6} $mm.s^{-1}$ and from 3.17 x 10^{-2} to 2.8 $mm^{-3}.s^{-1}$, respectively. These results and especially the growth rates are comparable with those of [2] (10^{-7} to 10^{-6} $mm.s^{-1}$) who performed hydrous experiments on a basaltic andesite. With decreasing temperature, there is a general trend in plagioclase shape to evolve from elongate to prismatic/bladed as observed by [2]. However, we observe a large variability of shape for each undercooling value (3D modeling with ShapeCalc [3]). The proportion of the largest and small crystals respectively increases and decreases at constant crystallinity and with increasing dwell time suggesting Ostwald ripening. Finally, the superheating step removes potential nuclei/germs (more anorthitic residual cores) and induces the crystallization of larger crystals at temperatures significantly lower than the liquidus.

[1] Pupier, E. et al. (2008). *Contributions to Mineralogy and Petrology* 155, 555. [2] Shea T., Hammer J. E. (2013). *Journal of Volcanology and Geothermal Research* 260, 127. [3] Mangler, M.F. et al. (2022). *Contributions to Mineralogy and Petrology* 177, 64.