

In situ observation of crystal growth in a basaltic melt

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To understand the solidification processes of natural magma, we have carried out in situ observation of the crystallization of a basaltic melt cooling from $\sim 1240^{\circ}\text{C}$ in a moissanite cell. Olivine or clinopyroxene (cpx) appeared as the liquidus phase before the formation of plagioclase. During cooling at 100°C/hr , the morphology of olivine and cpx transitioned from tabular to hopper habit, and crystal growth rate (of the order of 1×10^{-8} m/s) is roughly proportional to crystal size. In one experiment dominated by olivine crystallization, the good image quality (Figure 1) allows the analysis of texture evolution. Nucleation of olivine occurred only in a narrow temperature and time interval below the liquidus. Two-dimensional length- and area-based crystal size distributions (CSDs) show counterclockwise rotation around axes of $8 \mu\text{m}$ and $100 \mu\text{m}^2$, which is attributed to the proportionate crystal growth. CSDs also indicate the dissolution of small crystals (Ostwald ripening). These data show that conventional analyses of crystal size distributions of igneous rocks may be in error – the slope of the CSD cannot be interpreted in terms of a uniform growth rate and the intercept with the vertical axis does not correspond to a nucleation density.

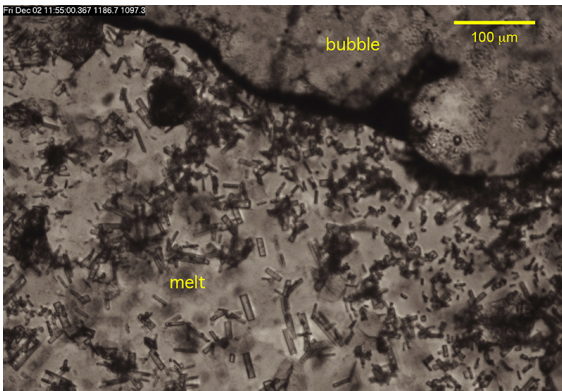


Figure 1: Real-time photomicrograph of olivine crystals in a basaltic melt cooling at 100°C/hr .