## First In-situ Observation of the Crystallization of Basalts

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The quantitative analysis of igneous textures has been proved to be a powerful tool to investigate the solidification history of magmas in plutonic and volcanic systems. It is commonly carried out by measuring the crystal size distributions (CSDs) of natural samples in post-mortem investigations or artificial samples obtained from laboratory experiments and computer simulations. The reliability of textural interpretations relies on both the knowledge of mechanisms driving magma crystallization such as crystal nucleation, crystal growth and Ostwald ripening, and the ability of CSD patterns to clearly return the whole cooling history of rocks. Nevertheless, recent studies have showed that quantitative interpretation of natural rock textures and CSDs is in some cases difficult. Moreover, cooling rates and other parameters of the thermal history usually cannot be obtained from conventional analyses.

We approached to this matter by developing a new high-temperature experimental device which applies the moissanite (SiC) anvil cell to optical in-situ observation of textural evolution of melts undergoing cooling and heating stages. Because of the extreme mechanical and chemical resistance of moissanite, the technique allows to maintain high temperatures, up to the maximum temperature of 1400°C, for many days. Experiments are performed on chips (diameter of ˜1.8mm, thickness $\leq 100\mu$m) of natural or synthetic glass. Textural analysis of samples is performed using time-lapse movies recorded during experiments. The method allows the in-situ observation of various processes in magmas, including bubble formation, fractional crystallization and Ostwald ripening.

An experiment performed on a supercooled basaltic melt at constant temperature of 900°C showed the nucleation and growth of plagioclase crystals and produced textures resembling those of natural rocks. In a time span of about 45 minutes, the crystallinity increased from 6% to 42%, the number density of crystals decreased by a factor 1.7, the mean grain size increased by ˜1.6% and crystal shapes changed from prismatic to tabular. The recovered CSDs depart from simple log-linear correlations, but show a downturn at small values of length, which suggests Ostwald ripening mechanisms, and a fan-like shape related to textural coarsening. Growth rates, directly determined on selected crystals, are estimated in the range 0.85 - 1.3 x $10^{-8}$m/s. For comparison, plagioclase growth rates obtained from experiments on shoshonitic basalt, heated near its liquidus temperature (>1250 °C) and cooled down with different cooling rates (5 °C/min, 1 °C/min, 0.1 °C/min), vary between 0.5 x $10^{-8}$ m/s and 7 x $10^{-8}$m/s.

In conclusion, this experimental approach using the moissanite anvil cell can provide important constraints on the kinetics of magma crystallization and the way they affect CSD patterns, making it possible to simulate magmatic processes occurring in natural (closed) systems.

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