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A 3D reconstruction of plagioclase crystals in a synthetic basalt

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Abstract

The three-dimensional shapes of plagioclase crystals in an experimentally cooled basaltic liquid have been reconstructed, with the aim of (1) better understanding crystal growth processes and the diversity of crystal shapes produced during cooling, and (2) to assess the validity of crystal-size distributions (CSDs) derived from 2D sections. The experimental charge was cooled from above the liquidus (~1175 °C) at a rate of 0.2 °C/h. It contained ~40% crystals at the quenching temperature of ~1120 °C. To quantify the crystals in 3D, photographs of a series of 2D-polished sections were taken under an optical microscope using reflected light. Interpolation and 3D reconstruction of 261 individual crystals was performed using the gOcad geomodeling software, and their short (*S*), intermediate (*I*), and long (*L*) dimensions were measured. Plagioclase crystals are generally tabular, with a nearly constant *I*/*L* ratio. On the other hand, *S*/*I* and *S*/*L* shape factors are more variable, although both are found to be correlated with length of the *S* axis. These observations are believed to result either from crystal agglomeration and attachment, preferentially along (010) faces, or from varying thermodynamic or kinetic conditions during cooling. Growth rates along the *S*, *I*, and *L* axes have been calculated from the size of the largest crystals and vary from 1.5×10^{-10} to 5.1×10^{-10} and 7.2×10^{-10} m/s, respectively. The CSDs for the maximal length and short axes of 3D crystals are presented and compared with CSDs obtained from 2D sections. Published corrections for cutting effects are found to be generally very satisfactory.

Keywords: Crystal-size distribution, plagioclase, 3D reconstruction, crystal growth