

MICROSTRUCTURAL EVOLUTION  
IN CRYSTAL-MELT SYSTEMS

by

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## ABSTRACT

Microstructural development in a rock analog crystal-melt system is focused on in this study, using an experimental technique in which microstructural changes can be observed *in situ* and processes can be inferred from the microstructural changes. The aim of the work has been to contribute to the basis for understanding the origin and significance of textural features of rocks that have passed through a melt-present interval in their history.

During isothermal deformation experiments, microstructures indicating crystal plasticity and dynamic recrystallization are observed at fast strain rates. At slow strain rates, a pressure solution-like process, contact melting/redeposition, is active, resulting in optically strain-free crystals. Grain boundary sliding is also active during slow strain rate deformation, with concurrent accommodation process of contact melting/redeposition and assisting process of grain boundary migration.

Textural metamorphism such as dendrite segmentation and coarsening, and grain and phase boundary migration is observed to start in the analog system even at supersolidus conditions. Stimulated by observations of coarsening in the analog system, some physical and numerical experiments were carried out to discover the rates of coarsening in silicate crystal-melt systems. Results from experiment and simulation suggest that the kinetics of forsterite coarsening is fast enough to remove small crystals in a short period of time compared to the time required for complete solidification of a magma. These processes may introduce complications when attempting to infer the rates of processes in rocks such as crystal growth and nucleation, and the order of crystallization.

The validity of this type of analog experiment is checked using scale modelling. It is found that non-steady state structures in the experiment can be identical to that in the

natural system only when the experimental relative rates of processes at an instant are identical to those in the natural system. Given these complications, the experimental results from the analog system may not have any parallels in natural conditions. However, this type of experiment, even if unscaled, can provide some building blocks for the later more thorough models which can better link processes and microstructural changes.

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