MICROSTRUCTURAL EVOLUTION
IN CRYSTAL-MELT SYSTEMS

by

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A Dissertation

Submitted to the University at Albany, State University of New York

in Partial Fulfillment of

the Requirements for the Degree of

Doctor of Philosophy

College of Arts and Sciences

Department of Geological Sciences

1994

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.

ACKNOWLEDGMENTS

I wish to thank Dr. W.D. Means for making this dissertation possible. The thesis project was conceived by Dr. Means, and he also developed the experimental techniques with his very hard work during the earlier stage of this project. Most of the ideas presented in my thesis are the results of continuous discussions with Dr. Means. I thank him for his patience with my slowness and English when we had discussions. I will be always grateful all these nice considerations given to me by Dr. Means.

I would like to thank the members of the thesis committee, Drs. W.D. Means, J.W. Delano, M.B. Bayly, and E.B. Watson for taking the time to read my thesis, and discussions with them helped to improve the content of my thesis. Dr. Delano provided the lab equipment and material for the coarsening experiments, and he also taught me what hard work is by showing himself working harder than most of graduate students. I thank him for the valuable lesson.

I am also indebted to many people who helped me directly or indirectly to finish the work. I thank Dr. W.S.F. Kidd for his considerations, Dr. G.D. Harper for his continuous encouragement and interest in the thesis work, Dr. Hauser of the chemistry department for the suggestion of the experimental material, Dr. Buckingham for helping to identify the blue phase crystals, and Diana Paton for pleasant humors and helping me whenever I had administrative troubles. I thank Ben Hanson for being such a nice friend especially when I was depressed, and for setting up and doing the coarsening experiments. Jin-Han Ree is appreciated for taking time to help me in many ways and bring me into the very interesting discussions; without him I would not have met my advisor Dr. Means. Discussions with the people who participated in the seminar series of igneous petrology were beneficial. They are Dr. Means, Dr. Harper, Angela Coulton, Charlie Stuart, Mike Edwards, Taohong Li, Bruno Ciscato, and Stefan

Kosanke. Many graduate students are thanked for their friendship, encourgement, and helpful discussions. They are Christoph Arz, Rolf Herrmann, Jin-Han Ree, Yun Pan, Rob Alexander, Ben Hanson, Steve Schimmirich, Steve Tice, Wolfram von Kiparski, John Waechter, Volker Brüchert, Bok-Nam Ree, Angela Coulton, Nancy Griesau, Young-Joon Lee, Andreas Plesch, Susi Vogel, Chris Achong, Mike Edwards, Michael Haschke, Albert Hiller, Bruno Ciscato, Steffi Dannenmann and Stefan Kosanke. There are also many people whose names were not mentioned, although their help was greatly appreciated. They are Dr. Putman, Dr. Delong, Dr. Spear, Brian Taylor, Mark Jessell, Paul Bons, Mary Roden, Mary Lou Hill, Dr. Myer, Dr. Goodwin, Vinny Grassi, Rick and David Valentino, and Barbara Bloomfield.

Lastly, but not leastly, I wish to thank my wife and all the family members for their love and continuous support.

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