

**EXPERIMENTAL GROWTH OF FIBERS AND FIBROUS VEINS**

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 & Sciences**

**Department of Earth & Atmospheric Sciences**

**2000**

## Abstract

Experiments on growth of fibers and fibrous veins using analog materials demonstrated that fibers can develop by a distinctive process of growth, called *Taber growth*, which is characterized by accretionary growth of vein-like bodies of fibrous crystals in confined space at the fiber-wall interface, by drawing nutrient from pore solutions in the "wall-rock" on one hand and pushing apart the enclosing walls on the other, through the action of a "force of crystallization". Taber growth differs markedly from the crack-seal model of Ramsay, in that no long-range, wall-parallel cracking is involved, and the growth itself plays an active role in opening a vein. It differs from all models of vein development that involve passive growth of crystals following and keeping pace with externally imposed vein dilation, or involve delivery of solute along a fluid-filled vein crack or fissure, rather than through the wall rocks. Based on extensive experimental observations the detailed characteristics of Taber growth were documented and its essential growth conditions were studied. It was found that the ambient humidity, the pore fluid pressure and the grain or pore size are the principal controlling factors that determine the morphologies of fibers and whether fibrous or non-fibrous blocky crystals grow. Detailed examination of experimental Taber fibers revealed microstructural features that are reminiscent of similar features in natural fibrous veins.

Fibrous veins with various types of fiber curvature patterns were produced under different growth conditions. Examination of the tracking behavior of some typical experimental veins showed that fibers in Taber growth generally track the instantaneous displacement as long as the growth interface remains cohesive and there is no internal deformation within the fiber aggregate. The concept of tracking was criticized and re-evaluated in light of the experimental observations, and a method was developed by which vein displacement histories can be reconstructed using fibers that are known to track the wall-vein displacements.

The displacive characteristic of Taber growth was specially investigated through experiments on growth of fibrous veins under large compressive loading conditions. It was demonstrated that fibrous veins could grow against virtually any pressures or stresses externally imposed on the wall blocks as long as the pressure was not so large as to cause the failure of the blocks and fibers couldn't grow at any other sites against smaller pressures. The crystallization force in Taber growth was analyzed from a point of view of thermodynamics, and it was interpreted as reflecting a *crystallization pressure*, which is defined as the difference between the fluid pressure and the theoretical maximum independent pressure that a crystal can grow against without dissolving under the given supersaturation conditions. Theoretical analysis suggests that the crystallization pressure in Taber growth can attain values of about the same order as geologically realistic values as long as a high supersaturation level can be maintained and growth occurs in confined spaces in a fine porous medium. Further analysis of the surface energy effects on crystallization in a fine-grained medium suggests that the conspicuous displacive crystallization of Taber growth is due to the distinctive process of crystal growth in fine porous media. Solution confined in such a porous medium can become highly supersaturated without much crystallization in the pores, thus producing a large crystallization pressure that is capable of forcing or pushing open a "vein" in the "wallrock" wherever its strength is weakest.

Taber Growth affords significant implications for some natural veins. Fibrous veins formed by Taber growth could be *non-tectonic* as well as synkinematic. Taber growth readily explains why the instantaneous direction of new fiber segments should parallel the instantaneous direction in which older segments of the same fibers are moving away from the vein wall. The possible role of the displacive crystallization of Taber growth in formation of fibrous veins further suggests that some natural fibrous veins may have been forced open by displacive growth.

## **Acknowledgments**

I am deeply indebted to my supervisor Win Means for all these years of his guidance and support, and for his consistent encouragement and inspiration throughout the course of this work. I learnt a great deal from him not only as an inspiring scientist but also as a great teacher who encouraged independence as well as provided direction with his thoughtful comments and challenging questions and set an excellent example of what a professional teacher is. I would also like to thank my examiners for reading this thesis. I am particularly thankful to Brian Bayly for very helpful and constructive criticism on Chapter 5 and for pointing out several important points that greatly clarified some of my ideas about Taber growth. I thank Greg Harper for the thorough, careful reading of my thesis, and for many helpful comments and suggestions. Bill Kidd is thanked for reading my thesis and leaving questions despite his busy schedule.

Many other people have also assisted me in the course of this work. In particular, I am thankful to Youngdo Park and Ben Hanson for their advice and help at the beginning of this research. I thank Weiguo Liu, Caiping He, Xiaohua Liu for introducing me to, and providing samples of, the various types of porous filter membranes that could be used as alternative materials in the experiments. I thank Ed Stander for many useful discussions on fiber growth and for the clever design and implementation of new Taber growth experiments.

Most importantly, I would like to thank all the Geological Sciences faculty and students of the Department of Earth & Atmospheric Sciences, who have not only tolerated me attaching myself to the Department but have been extremely welcoming to me from the outset and have helped me in innumerable ways through my (long) graduate career. I'm particularly grateful to John Delano for his concern and encouragement and for his many clearly-stated, thought-provoking questions and comments at the Graduate Student Seminars. I thank Greg Harper for numerous stimulating discussions on fibers. I thank Bill

Kidd, Brad Linsley, John Arnason and Stephen Howe for the helpful questions at the Student Seminars. Thanks also to my fellow graduate students whose questions helped a lot in clarifying my thought. In particular, I thank Stefan Kosanke, Steffi Dannenmann, Mike Edwards, Soumava Adhya, and Nick Hayman. I am particularly thankful for the great opportunities in the Geological Sciences Department to present and discuss my research at the Graduate Student Seminar in each semester, from which I benefited a great deal over the years.

My thanks also to the staff of the Department of Earth & Atmospheric Sciences for all the work they have done for me. In particular, I am grateful to Diana Paton for being the one I could always turn to for help during the years I stayed there and for her cheerful response to each and every request that I made.

In addition, I have been lucky enough to have the support of many good friends who helped me get through these years of graduate school. I thank Wei Wang, Yong Zhang and Xing Zhang for those unforgettable days we spent together. I also thank Weiguo Liu and Xiangyang Ye for putting up with me as I struggled in my writing. I am specially indebted to Lei Ren, my best friend for all these years, for being the one to share everything with and for helping me through these important years of my life. Thanks very much, Lei, for the many days and nights we worked together, and for the help with the endless printing of figures for my thesis. I am also indebted to Bin Zhu for inviting me to stay with his family during the final stage of my thesis preparation. Their generosity is greatly appreciated.

Financial support for this work was provided by National Science Foundation grants EAR-9404872 and EAR-9705701 to Win Means.

Finally, I thank my wife Keli and my daughter Cindy for their understanding, patience and encouragement; without their support the completion of this work would have been impossible.

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