TRANSMISSION ELECTRON MICROSCOPY OF MINERALS AND ROCKS

CAMBRIDGE TOPICS IN MINERAL PHYSICS AND CHEMISTRY

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Transmission electron microscopy of minerals and rocks

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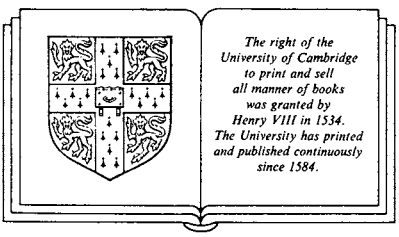

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Preface

Of the many techniques that have been applied to the study of crystal defects, probably no single technique has contributed more to our understanding of their nature, properties, and influence on the physical and chemical properties of crystalline materials than transmission electron microscopy (TEM). Although the importance of crystal defects and the use of TEM for their direct observation were recognized by physical metallurgists in the early 1950s, it was at least a decade later that earth scientists responded to many of the new ideas of the defect solid state and to the power of TEM. However, TEM is now used extensively for the direct observation of defect microstructures in minerals and rocks, and there appears to be an increasing number of earth scientists who want to use the technique or to become more familiar with the interpretation of TEM observations. This book is written for such people. However, it makes no attempt to be a practical manual of TEM or a definitive text, but rather an *introduction to the basic principles* of the technique and of the interpretation of electron micrographs and electron diffraction patterns. As such, I hope the book will also be useful to students of materials science.

The place of TEM in modern geological studies is considered in more detail in the Introduction, where I have expanded the description of the book's intent and content (usually to be found in the preface) to include a discussion of the history and role of TEM in mineralogical studies and the importance of mineralogy as one of the fundamental earth sciences.

It was Jim Boland who suggested I should write this book but, as the writing has kept me away from practical microscopy for so much of the past two years, I will not thank Jim for his suggestion – only for his contributions to our joint research and for his friendship. Other research students and colleagues with whom it has been a great pleasure to work and who have made substantial contributions to the book are too numerous to thank individually here. However, I should particularly like to name John Fitz Gerald, to whom I introduced TEM but who now teaches me;

Bruce Hobbs, John Christie, and the late Dave Griggs, who were so enthusiastic and supportive of our early TEM investigations of deformed minerals; John Hutchison for giving me my first direct experience of lattice resolution imaging; Robin Turner, who taught me most of the optics I know – his initial response to most of my questions was usually "But that is obvious to the meanest intelligence"; Dick Yund for exposing me to the complexities of exsolution in the feldspars; and Mervyn Paterson and Bruce Hyde, who made it possible to me to come to ANU. I also thank the following people whose outstanding TEM investigations of minerals I have particularly drawn on for the applications chapters: Dave Barber, Pam Champness, Jean Claude Doukhan, Martyn Drury, Brian Evans, Madeleine Gandais, Dave Kohlstedt, Gordon Lorimer, Wolfgang Müller, Dave Veblen, Rudi Wenk, and Christian Willaime.

I must admit that the examples I have chosen to illustrate the application of TEM to mineralogy and geology reflect my own particular interests and that many other excellent examples have not even been mentioned. I apologize to those scientists whose work I have apparently ignored but, at the same time, emphasize that the examples chosen cover most of the types of crystal defect to be found in a wide range of rock-forming minerals. Furthermore, I believe that the examples that are given more than adequately fulfill the very important purpose of reinforcing the basic message of the earlier chapters that the *images* formed in the transmission electron microscope must be correctly interpreted in terms of an appropriate theory of electron diffraction before they can provide any useful information about the nature of the *object*.

It is with great pleasure that I thank Clementine Kraysheck and Paul Brugman for their skills in preparing the line diagrams and photographs, and Denise Devir who, with some help from Maria Davern, typed the text with phenomenal accuracy, corrected my spelling, added missing words, and never complained about my frequent changes of mind. My wife Netta deserves thanks for help with proofreading and especially for putting up with months of persistent complaints about how all this writing was keeping me away from real work.

Alex C. McLaren

Canberra
28 November 1990

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