ELECTRON MICROPROBE ANALYSIS AND SCANNING ELECTRON MICROSCOPY IN GEOLOGY

This book describes electron microprobe analysis (EMPA) and scanning electron microscopy (SEM) specifically from a geological viewpoint. No prior knowledge is assumed and unnecessary technical detail is avoided, in order to keep the book easily accessible to new users of these techniques.

The principles of electron–specimen interactions and instrumentation are covered in the first part of the book. The mechanisms involved in SEM (secondary and backscattered electron) image formation are then explained, with full consideration of digital imaging techniques. The operating principles of energy- and wavelength-dispersive X-ray spectrometers are described, as well as ancillary techniques including cathodoluminescence (CL) and electron backscatter diffraction (EBSD). Procedures for qualitative and quantitative X-ray analysis (using either electron microprobe or SEM instruments) are described in detail. The production of X-ray 'maps' showing element distributions is also described, with examples. Finally the subject of specimen preparation is discussed. There is an emphasis throughout on specifically geological aspects not covered in books aimed at a more general readership.

This updated version of the first (1996) edition takes full account of recent developments and is intended for geological graduate students and postdoctoral workers, as well as those in commercial laboratories. It is also an invaluable accompaniment to courses for geological EMPA and SEM users.

DR REED is affiliated to the Department of Earth Sciences at the University of Cambridge. He has spent over forty years practising and researching electron microprobe analysis. After studying physics at Southampton University, he gained a Ph.D. from the University of Cambridge in 1964 for research in using EMPA to analyse iron meteorites. He went on to be a Scientific Officer at the Natural History Museum, London from 1965 until 1970 before his appointment as Senior Research Fellow at the Australian

National University, Canberra in 1970, where he implemented a new system for quantitative ED analysis. From 1974 until his retirement in 2002, Dr Reed was at the Department of Earth Sciences, University of Cambridge with research interests including ion and electron microprobe analysis and developing simulation software. In 1981 he was awarded the Microbeam Analysis Society Presidential Award for his outstanding scientific contribution to the theory and practice of microbeam analysis, followed in 1984 by honorary life membership. He has written, and contributed to, several books on the subject, including *Electron Microprobe Analysis* (Cambridge University Press, first edn 1975, second edn 1993).

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Preface

The favourable reception given to the first (1996) edition of this book suggests that the joint treatment of electron microprobe analysis (EMPA) and scanning electron microscopy (SEM) with a specifically geological slant has been found to serve a useful purpose. It was therefore decided to proceed with this second, revised and updated, edition. The inclusion of both EMPA and SEM can be justified on the grounds that the instruments share much in common and their functions overlap: SEMs fitted with X-ray spectrometers are often used in analytical mode, while EMP instruments, though designed primarily for analysis, also have imaging functions similar to those of the SEM.

The capabilities of the computers used both for instrument control and for data processing have increased greatly since the first edition. Whilst this allows more sophisticated software functions, it does not diminish the need to understand both the operating principles of the instruments and the factors controlling the results, the explanation of which is the main purpose of this book. Digital rather than analogue imaging is now the norm, with concomitant advantages provided by image processing and image analysis techniques. The increasing use of 'false' colour images in various forms is reflected in an expanded colour section in this edition. Significant instrumental developments include the increasing adoption of field emission electron sources, which are especially beneficial for high-resolution SEM applications. Also, variable-pressure or environmental SEMs are more commonly used. In addition, interest in ancillary techniques such as cathodoluminescence and electron backscatter diffraction has grown.

As before, no prior knowledge is expected of the reader and technical detail is limited to that needed for a sound understanding of operating principles and interpretation of results. It is hoped that the book will be particularly useful to

postgraduate students and postdoctoral researchers in university geology departments, where it may serve as an accompaniment to courses for SEM and EMPA users.

Inevitably a book reflects the bias of the author and for this I ask the reader's indulgence, as well as for any errors or omissions.

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