A Practical Guide to Rock Microstructure

Rock microstructures provide clues for the interpretation of rock history. A good understanding of the physical or structural relationships of minerals and rocks is essential for making the most of more detailed chemical and isotopic analyses of minerals.

Ron Vernon discusses the basic processes responsible for the wide variety of microstructures in igneous, sedimentary, metamorphic and deformed rocks, using high-quality colour illustrations. He discusses potential complications of interpretation, emphasizing pitfalls, and focussing on the latest techniques and approaches. Opaque minerals (sulphides and oxides) are referred to where appropriate. The comprehensive list of relevant references will be useful for advanced students wishing to delve more deeply into problems of rock microstructure.

Senior undergraduate and graduate students of mineralogy, petrology and structural geology will find this book essential reading, and it will also be of interest to students of materials science.

RON VERNON is Emeritus Professor of Geology at Macquarie University, Conjoint Professor of Geology at the University of Newcastle and Research Professor at the University of Southern California. He has taught undergraduate geology courses in Australia and Italy, as well as graduate courses and workshops in the USA, Italy, Germany, Finland and Mexico.

He has written two books, *Metamorphic Processes* (1976) and *Beneath Our Feet* (2000). The latter provides a clear and enthusiastic introduction to rocks for the non-geologist.

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For Katie

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Preface

Learning about rocks can give much pleasure to anyone interested in Earth and its development. I hope that readers of this book will share my enthusiasm for examining rocks with the microscope. I planned the book to be an introductory review of the main processes responsible for the microstructures of Earth rocks. However, I soon realized that if I did that, the book would be a collection of half-truths, with little scientific value. Though many rock microstructures are understood fairly well, the interpretation of many others involves considerable controversy, and new ideas are being published all the time. So, I have felt compelled to mention problems of interpretation and to present alternative views, where appropriate. Thus, the book has evolved into (1) a basic explanation of the main processes, (2) an introduction to more complex issues of interpretation and especially to the relevant literature, and (3) an outline of modern approaches and techniques, in order to emphasize the ongoing, dynamic nature of the study of rock microstructure. Because complicated problems cannot be discussed in detail in a book of this kind, I have tried to provide a sufficient number of references to enable the reader to delve more deeply.

I assume that the reader has a basic knowledge of geology, rock types and microscopic mineral identification. Thus, the book is aimed mainly at senior geoscience undergraduates and above. Emphasis is placed on higher-temperature processes, i.e. those that occur under igneous and metamorphic conditions, although the book begins with a brief discussion of sedimentary microstructures, as background for some of the metamorphic microstructures. The mineral abbreviations used follow those suggested by Kretz (1983), as extended by Bucher & Frey (1994), and are listed at the start of the book. There is an extensive glossary of microstructural terms at the end of the book.

I also hope that materials scientists may also gain some benefit and interest from the microstructures discussed and illustrated, because rocks are the 'materials' of Planet Earth, in the sense of 'materials science': the branch of science that links all solid materials, such as metals, ceramics, glass, organic polymers and, of course, rocks.

I took all the photographs, except where otherwise acknowledged. I am also responsible for most of the line drawings, with the assistance of Dean Oliver

(Figs. 5.11, 5.37) and Daleth Foster (Fig. 5.93). I thank David Durney, Dick Flood, Scott Johnson and Scott Paterson for critically reading parts of the typescript, Judy Davis for assistance with computer techniques, Geoff Clarke for access to specimens at the University of Sydney, Ross Both, John Fitz Gerald and Neil Mancktelow for providing images, and John Lusk, John Ridley, David Durney and Pat Conaghan for providing specimens of opaque minerals, deformed rocks/veins and sedimentary rocks at Macquarie University. People who kindly provided other samples or thin sections are acknowledged in the figure captions.

Mineral symbols used in this book

After Kretz (1983), extended by Bucher & Frey (1994).

Ab	albite
Act	actinolite
Alm	almandine
Als	aluminosilicate
Am	amphibole
An	anorthite
And	andalusite
Apy	arsenopyrite
Bt	biotite
Cal	calcite
Ccp	chalcopyrite
Chl	chlorite
Chr	chromite
Cld	chloritoid
Cpx	clinopyroxene
Crd	cordierite
Crn	corundum
Cv	covellite
Czo	clinozoisite
Dol	dolomite
Ep	epidote
Gln	glaucophane
Gn	galena
Gr	graphite
Grs	grossular
Grt	garnet
Hbl	hornblende
Ilm	ilmenite
Kfs	K-feldspar
Ky	kyanite

Lws	lawsonite
Mag	magnetite
Ms	muscovite
Ne	nepheline
Ol	olivine
Omp	omphacite
Opx	orthopyroxene
Or	orthoclase
Pgt	pigeonite
Phl	phlogopite
Pl	plagioclase
Prh	prehnite
Py	pyrite
Qtz	quartz
Rt	rutile
Scp	scapolite
Ser	sericite
Sil	sillimanite
Sp	sphalerite
Spl	spinel
Spr	sapphirine
Sps	spessartine
Srp	serpentine
St	staurolite
Stp	stilpnomelane
Tlc	talc
Toz	topaz
Tr	tremolite
Ttn	titanite (sphene)
Tur	tourmaline
Wo	wollastonite
Zo	zoisite
Zrn	zircon