A Practical Guide to Rock Microstructure

Second Edition

A clear understanding of the processes responsible for observed rock microstructures is essential for making reliable petrogenetic interpretations, including inferences made from chemical and isotopic analyses of minerals. This volume presents a comprehensive survey of rock microstructures, emphasizing basic concepts and the latest methods, while highlighting potential pitfalls in the interpretation of the origin of rock microstructure. Richly illustrated with over 250 colour photographs, including more than 10 per cent new photomicrographs and several mesoscopic images, this book demonstrates the basic processes responsible for the wide variety of microstructures in igneous, metamorphic and sedimentary rocks. This second edition includes extensive updates to the coverage of igneous rocks, as well as recent ideas on physical processes in migmatites and partial melting of metasedimentary rocks. This practical guide will continue to be an invaluable resource to advanced students and early-career researchers of mineralogy, petrology and structural geology, as well as professional geologists and materials scientists.

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For Katie

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Preface to the Second Edition

The invitation from Cambridge University Press to prepare a second edition of *A Practical Guide to Rock Microstructure* gives me the opportunity to bring the text up to date by referring to more recently published material, as well as adding new images and replacing some images with better ones. Unfortunately, many petrologists minimize the value of microstructural investigations, and some crush rocks for chemical/isotopic studies without looking at them; to them a rock is a grey powder in a labelled vial. However, the structures of rocks contain a great deal of useful information, and, in the long run, any chemically based interpretation has to be at least consistent with the structural evidence. So, I continue to urge students to examine the microstructure, because it will help to understand the origin of the rocks being investigated.

Preface to the First Edition

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., at igneous and metamorphic conditions, though the book begins with a brief discussion of sedimentary microstructures as background for some of the metamorphic microstructures. Many terms defined in the glossary are in italics where first encountered in the text. The mineral abbreviations used follow those suggested by Kretz (1983), as extended by Bucher & Frey (1994), and are listed after this Preface.

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 thank David Durney, Scott Johnson and Scott Paterson for critically reading parts of the typescript; Geoff Clarke for access to specimens at the University of Sydney; Ross Both and John Fitz Gerald for providing images; and John Ridley, David Durney and Pat Conaghan for providing specimens of opaque minerals, deformed rocks/veins and sedimentary rocks, respectively. People who kindly provided other samples or thin sections are acknowledged in the figure captions.

Mineral Abbreviations

Alm	almandine
Am	amphibole
Ab	albite
Act	actinolite
Als	aluminosilicate
And	andalusite
An	anorthite
Bt	biotite
Cal	calcite
Chl	chlorite
Cld	chloritoid
Cpx	clinopyroxene
Crd	cordierite
Crn	corundum
Czo	clinozoisite
Dol	dolomite
Ep	epidote
Gln	glaucophane
Gr	graphite
Grs	grossular
Grt	garnet
Hbl	hornblende
Ilm	ilmenite
Kfs	K-feldspar
Ky	kyanite
Lws	lawsonite
Mag	magnetite
Ms	muscovite
Ol	olivine
Ne	nepheline
Omp	omphacite
Opx	orthopyroxene
Or	orthoclase
Pgt	Pigeonite
Phl	phlogopite
Pl	plagioclase
Prh	prehnite
Qtz	quartz
Scp	scapolite
Ser	sericite
Sil	sillimanite
Spl	spinel
Spr	sapphirine
Rt	rutile
Sps	spessartine
Srp	serpentine
St	staurolite
Stp	stilpnomelane
Tlc	talc
Tr	tremolite
Toz	topaz
Ttn	titanite (sphene)
Tur	tourmaline
Wo	wollastonite
Zo	zoisite
Zrn	zircon
Apy	arsenopyrite
Ccp	chalcopyrite
Chr	chromite
Cv	covellite
Gn	galena
Py	pyrite
Sp	sphalerite