Springer Geochemistry/Mineralogy

CHAPTER · JANUARY 2013

DOI: 10.1007/978-3-642-25608-0_3

1 AUTHOR:

Soumyajit Mukherjee
Indian Institute of Technolog…

88 PUBLICATIONS **332** CITATIONS

SEE PROFILE

Springer Geochemistry / Mineralogy

Soumyajit Mukherjee

Deformation Microstructures in Rocks

Springer

Springer Geochemistry/Mineralogy

For further volumes:
http://www.springer.com/series/10171

Soumyajit Mukherjee

Deformation Microstructures in Rocks

Springer

Soumyajit Mukherjee
Department of Earth Sciences
Indian Institute of Technology Bombay
Mumbai
India

ISSN 2194-3176 ISSN 2194-3184 (electronic)
ISBN 978-3-642-25607-3 ISBN 978-3-642-25608-0 (eBook)
DOI 10.1007/978-3-642-25608-0
Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013936527

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Dedicated to my grandfather late
Mr. Sukhamoy Mukherjee who continues
to remain my role model

Preface

Study of microstructures is an indispensable component of understanding structural geology of any terrain. A number of 'new' microscopic structures, such as 'flanking microstructures', trapezoid-shaped mineral grains, micro-duplexes, reversal of ductile shear sense, migration of grain boundaries, pull-aparts of V- and parallel types, and new minerals nucleated inside host minerals have recently been described in individual papers. However, for the sake of brevity, these microstructural papers could not present numerous variations in their morphologies. *This book aims to highlight these structures selectively*. Nearly all these photomicrographs come from different western Himalayan shear zones. Ductile and brittle shear senses, where possible to interpret, have been referred in the captions. This book starts with photos of mineral fish that are perhaps the most common ductile shear sense indicators. Captions for photographs have intentionally been kept brief. For full-length discussion of these structures, kindly consult the 'References' section. Students and researchers of structural geology will find this book useful. Please send me comments and counter-arguments on interpretations of the presented microstructures at: soumyajitm@gmail.com

Acknowledgments

Editorial handling by Helen Rachner, Christian Witschel, Christian Bedall, Annett Büttner ('Earth Sciences & Geography' division, Springer), S.A. Shine David (Scientific Publishing Services (P) Ltd), and Nithiya Sivaraman (Production Editor, Springer). Mentored by Chris Talbot (retired from Uppsala University). Geology students of Indian Institute of Technology Roorkee whom I acted as a Teaching Assistant during 2002-2007 raised many unconventional questions on micro-structures. Discussions with Achyuta Ayan Misra and Rajkumar Ghosh (IIT Bombay) were fruitful. Roberto Weinberg (Monash University) provided thin sections from which two photos- Figs. 4.11 and 4.12- were taken. I am grateful to Bhim Bhatt and Ramesh Chand (IIT Roorkee), and Anil N Waghmare, Niranjan Panda, Narendra Vengurlekar, and Vasant Kashiram Dalvi (IIT Bombay) for preparing many thin-sections. Thanks to my wife Payel Mukherjee for bearing loneliness while I wrote this book.

Contents

Chapter 1
Mineral Fish and Ductile Shear Senses

Mineral fish are either single or aggregates of minerals that are ductile sheared (Figs. 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, 1.16, 1.17, 1.18, 1.19, 1.20, 1.21, 1.23, 1.24, 1.26, 1.29, 1.30, 1.31, 1.32, 1.33, 1.34, 1.35, 1.36, 1.37, 1.38, 1.40, 1.41, 1.42, 1.43, 1.44, 1.45, 1.46, 1.48, 1.49, 1.50, 1.51, 1.52, 1.53, 1.54, 1.55, 1.56, 1.57, 1.58, 1.59, 1.60, 1.62, 1.63, 1.64, 1.65, 1.66, 1.67, 1.68, 1.72, 1.73, 1.83, 1.85). Three common shapes of mineral fish are sigmoid, lenticular and parallelogram (ten Grotenhuis et al. 2003; Mukherjee 2011). These fish are bound by parallel (Figs. 1.3, 1.5, 1.9, 1.13, 1.15, 1.21, 1.23, 1.24, 1.37, 1.38, 1.49, 1.56, 1.59, 1.62), and rarely by non-parallel primary shear C-planes (Figs. 1.25, 1.26). Migration of quartzofeldspathic minerals and sometimes high-grade metamorphic index minerals towards them destruct their ideal morphologies. A top-to-S/SW ductile shear sense is revealed from these mineral fish from most of the Himalayan ductile shear zones. This indicates foreland vergent fore-thrusts of the northern portion of the Indian plate (Mukherjee et al. 2012; Mukherjee in press-1, 2). (Figs. 1.22, 1.27, 1.28, 1.39, 1.47, 1.69, 1.70, 1.71,. 1.74, 1.75, 1.76, 1.77, 1.78, 1.79, 1.80, 1.81, 1.82, and 1.84). How shear heat (Mukherjee and Mulchrone 2013), and reinterpreted ductile shear kinematics (Mukherjee 2012; Mukherjee and Biswas, submitted) affect shear fabric need to be studied further.

S. Mukherjee, *Deformation Microstructures in Rocks*,
Springer Geochemistry/Mineralogy, DOI: 10.1007/978-3-642-25608-0_1,

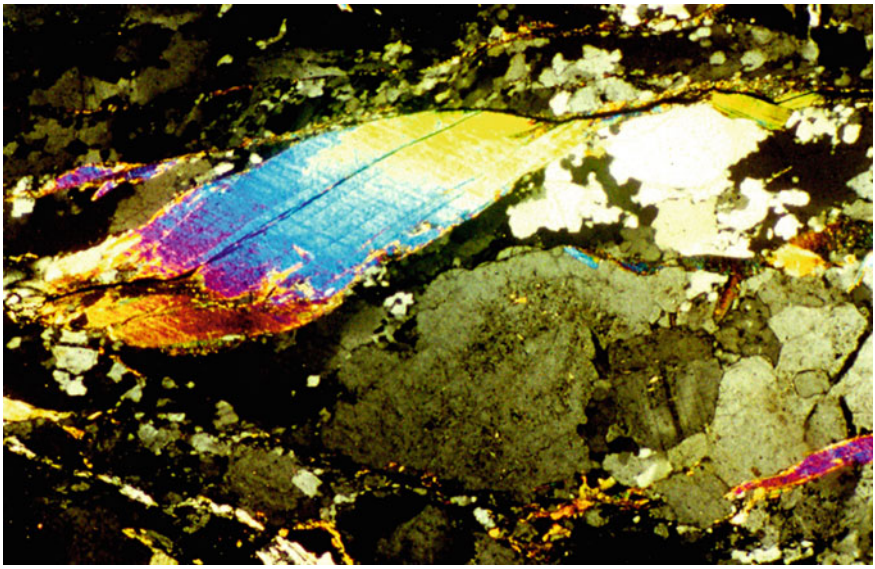

Fig. 1.1 A sigmoid mica fish. *Top-to-right* shear. Recrystallized and sheared quartzofeldspathic minerals in the matrix, above the fish, shows the same shear sense within a *narrower zone*. The primary shear C-plane is characterized by fine grained micas. Reproduced from Fig. 1.3b of Mukherjee (2011). Cross-polarized light. *Location* Karakoram Shear Zone (India). Mukherjee (2012) presented a reinterpretation of ductile (simple) shear. *Width of view* 2 mm

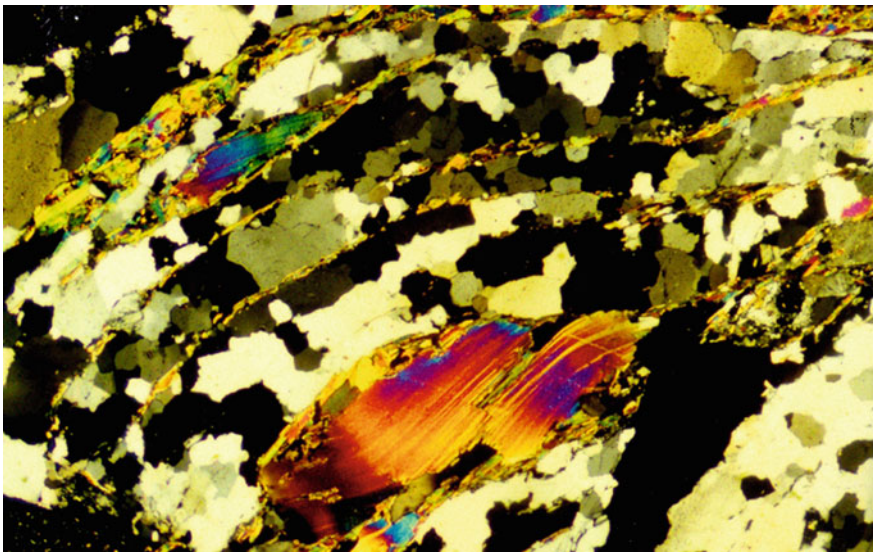

Fig. 1.2 Two adjacent sigmoid mica fish. *Top-to-right* shear. Trails of micas bound sigmoid quartzofeldspathic domains of same shear sense. Reproduced from Fig. 1.3a of Mukherjee (2011). Cross-polarized light. *Location* Karakoram Shear Zone (India). *Width of view* 2 mm