

NANOSCOPIC APPROACHES IN EARTH AND PLANETARY SCIENCES²

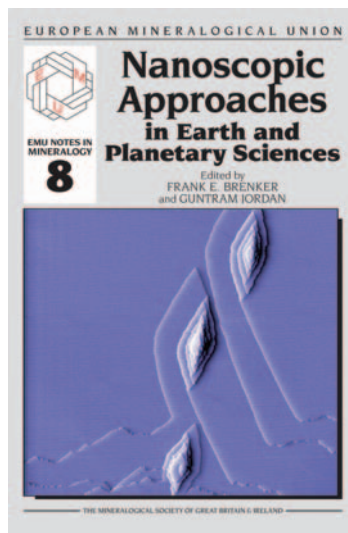
Published by the European Mineralogical Union and the Mineralogical Society of Great Britain and Ireland, this volume follows the 9th EMU School entitled “Nanoscopic Approaches in Earth and Planetary Sciences,” held in Munich in 2007. This seems like a long delay before publication of the book, especially since methodological developments usually go fast. However, the content of the book is clearly not outdated. Some chapters even contain bibliographic references published as recently as 2010. As noted in the preface, this book aims to provide a thorough introduction to nanoscale techniques and related results and developments in the Earth and planetary sciences. In my opinion, this goal was achieved. In a book dealing with methodological considerations, it is always difficult to find a balance between technical information and scientific applications. Some of the chapters achieve that balance perfectly, and I definitely recommend their reading to students and colleagues who need to use these techniques or process recently acquired data.

In chapter 1, Wirth gives the basics of focused ion beam (FIB) milling techniques. Considering the wealth of geoscience studies he has accomplished using FIB, he is the perfect author for this chapter. The chapter will be of great interest to those who are about to start using FIB for the preparation of ultrathin samples, getting 3-D textural and/or chemical information at the nanoscale, or performing micromachining. Indeed, in addition to providing basic facts about the instruments and ion-solid interactions, the chapter gives many practical tips that are usually difficult to find in the literature.

Chapter 2 by Brenker, about the nanopetrology of pyroxenes, shows how a TEM study of the nanostructures in pyroxenes can provide useful information on the thermal history of rocks. Chapter 3, by Gollaschindler and van Aken, is on the use of electron energy loss spectroscopy for nanoscale determination of Fe³⁺/ΣFe ratios and valence state mapping. It is definitely a must-read for everyone (and they are numerous) who wants to learn how to determine the redox state of Fe with this technique. After providing some details on the technique (scattering geometry, excitation process, shape of the ionization edges, data corrections, etc.), the authors review the different approaches that can be taken and then assess their validity and limits. These reviews read almost like simple recipes, giving you the feeling that you will be able to carry out the operations easily.

Chapter 4 by Lyon and Henkel, on time-of-flight secondary ion mass spectrometry (TOF-SIMS), and chapter 5 by Sinha and Hoppe, on ion microprobe analysis, are complementary and give a detailed overview of ion microprobe measurements. Like chapter 3, these chapters achieve a perfect balance between a detailed commentary on basic principles, ion sources, detectors, and mass analyzers on the one hand and geoscience applications on the other. These are, again in my opinion, must-read chapters.

Chapter 6, by Vincze, Silversmit, Vekemans, Terzano, and Brenker, deals with synchrotron radiation micro- and nanospectroscopy. It is restricted to hard X-ray microprobes that allow performing X-ray fluorescence (XRF) and X-ray absorption spectroscopy (XANES and EXAFS) measurements. After presenting the instrumentation, including the light source, the chapter focuses on the advantage of coupling XRF measurements with Monte Carlo simulations to achieve precise quantitative measurements of elemental concentrations at the trace level in solids. Three-dimensional micro-XRF methods as well as XANES and EXAFS spectroscopic analysis (with a short practical course on how to process EXAFS data) are also presented. One regrets the absence of a chapter



on soft X-ray nanospectroscopic analysis (e.g. scanning transmission X-ray microscopy, or STXM), which allows measuring the speciation of light elements such as carbon, nitrogen, and oxygen as well as heavier elements such as the transition elements at the 25 nm scale. This technique is indeed increasingly applied in the geosciences, and it would have complemented nicely chapter 6.

In chapter 7, Pina and Jordan provide an exquisite review of the kinetics and mechanisms of growth and dissolution of mineral surfaces at the nanoscale. The chapter starts with a short section on the principles of the scanning probe microscope and in particular the atomic force microscope (AFM). Then it details applications on the growth of mineral surfaces and explains clearly what we can learn about mineral-growth mechanisms, how such growth is influenced by supersaturation, the different kinetic models, the role of defects, and the influence of organic and inorganic impurities. This is followed by a much shorter but still very interesting section on mineral dissolution.

Finally, chapter 8 by Becker, Reich, and Biswas, on nanoparticle interactions in natural systems, includes results from TEM and STM analysis. The reader interested in nanoparticles may want to read this chapter to understand how atomistic calculations, including at the quantum mechanical and empirical levels, can complement information provided by nanoscale analyses. Noteworthy, one section provides results from atomistic calculations on a calcite biomineralization template by peptides.

If you are interested in EELS, Fe redox state measurements, SIMS, synchrotron-based micro- or nano-XRF, molecular dynamics simulations, nanoparticles, AFM analyses, or mineral dissolution and growth mechanisms, you will definitely be glad to have this book on your shelves for learning and teaching purposes.

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² Brenker FE, Jordan G (eds) (2010) *Nanoscopic Approaches in Earth and Planetary Sciences*. EMU Notes in Mineralogy 8. European Mineralogical Union and the Mineralogical Society of Great Britain & Ireland, 382 pp, ISBN: 978-0-903056-25-0, £40 (£25.50 for individuals)