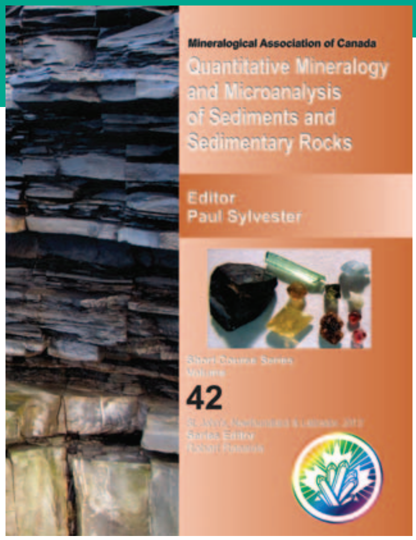
QUANTITATIVE MINERALOGY AND MICROANALYSIS OF SEDIMENTS AND SEDIMENTARY ROCKS*



Mineral liberation analysis (MLA), combined FIB-SEM-TEM techniques, synchrotron and light stable isotope microanalysis, hot and cold cathodoluminescence, X-ray-computed tomography, reflectance and imaging spectroscopy, high-resolution heavy-mineral analysis, computer-controlled scanning electron microscopy (CCSEM), U–Pb and fission-track geochronology of zircon and apatite, Hf and Pb isotope geochemistry of zircon and feldspar—this is the impressive menu of the novel, exciting techniques currently applied in the study of sedimentary deposits and illustrated in full detail in the relatively slim volume *Quantitative Mineralogy and Microanalysis of Sediments and Sedimentary Rocks*.

This useful book, resulting from a two-day short course held at Memorial University in St. John's, Newfoundland, in May 2012, compiles the major recent advances made in the field and testifies to the terrific impact that rapid technological development has had on the Earth sciences in the last few decades. Perhaps enough impact to make some people think that the stereotypical field geologist in mud-covered boots and armed with a hammer and compass is a throwback to the last millennium, forever replaced by the technological scientist dressed in a clean, white labcoat and standing in front of his pet machine. However, as Editor Paul Sylvester aptly states in the first line of his preface, "Good geology starts with careful field observations." Not dissimilar is the opening statement in the classic textbook *Origin of Sedimentary Rocks*, by Blatt, Middleton and Murray: "Field work forms the basis for the study of sedimentary deposits. To make best use of the limited time and resources available, the geologist must first consider how he will select his observations and specimens for further study in the laboratory." In other words, we still need the field geologist if we want to make full, effective use of our vast spectrum of glittering new weapons. We still need our dear old microscope to carefully select our target and to decide where and how to shoot. No matter how glamorous and powerful, instruments and techniques are means, not ends. Nonetheless, there is no doubt that the declining interest in sedimentary petrology during the late 1980s and early 1990s (the glorious *Journal of Sedimentary Petrology* changed its name and then was discontinued in 1993) was briskly reversed in subsequent years by the welcome appearance and exponential utilization of new methods and machines for performing provenance analysis. For those with the means to access costly instruments routinely, this technological renaissance has indeed brought a gust of fresh air.

Several of the 14 chapters of the book emphasize the increasing role that technology-intensive methods, most of which were originally devised and introduced for industrial needs, have played in the solution of a wide range of problems of scientific or economic interest. The hardware and software of the MLA, QEMSCAN, and CCSEM systems, whose principles are carefully explained in three different chapters by P. Sylvester, by N. Keulen, D. Frei, P. Riisager, and C. Knudsen, and by D. H. C. Wilton and L. S. Winter, were first developed to assess the potential of mineral resources and were initially focused mainly on applied mineralogy and metallurgical processing. But they were soon used to tackle a variety of practical and scientific issues, including the study of synthetic crystals for superconductors and catalysts and of dust particles and fibers in the lung tissue of mine workers. Synchrotron microanalysis, described by H. Jamieson and A. Gault, is another powerful, nondestructive technique for the analysis of soils, dust, and mine tailings. Light stable isotopes and cathodoluminescence provide invaluable tools for the investigation of fluid migration and diagenetic processess, as shown by L. B. Williams, N. Clauer, and R. L. Herving, and by L. Gonzales-Acebròn and J. Götse.

The book also thoroughly describes how the new analytical techniques can be and are currently used in hydrocarbon exploration. The study of shale gas as a potential future energy resource led to the development of integrated FIB-SEM-TEM methods, as outlined by R. Wirth and L. Morales. A. Morton demonstrates how heavy-mineral analysis may represent the most effective and occasionally sole way to correlate productive horizons and to monitor stratigraphy during drilling. G. Pe-Piper and D. J. W. Piper describe a regional study conducted for petroleum exploration, in which mineralogical, geochemical, and geochronological methods are integrated. The rationale and methods used in single-grain isotopic and geochronological tracing of detrital minerals, such as zircon, apatite, and feldspar, are dealt with in detail in three comprehensive review chapters, by J. Košler, by D. M. Chew and R. A. Donelick, and by S. Tyrrell, P. D. W. Haughton, J. S. Daly, and P. M. Shannon. Among the new techniques applied to the quantitative study of sedimentary deposits, however, there is at least one noticeable absence: Raman spectroscopy, one of the most flexible, promising, and cost-effective methods for the mineralogical study of sand-sized to silt-sized sediments. Although the main emphasis is, for understandable reasons, on new sophisticated techniques, often applied to single accessory minerals, it would have been useful to recall that research cannot benefit from these in full when traditional approaches, such as classic bulk-sample petrography, are largely forgotten. Extracting previously inaccessible geochemical and geochronological information about a rare component represents a great added value when it complements, rather than replaces, the rich general information potentially obtained from the main components. One valuable statement in this sense is the recommendation contained at the end of A. Morton's chapter: "*These methods should be used to complement traditional petrographic data, which provide varietal and textural information that the newer methods cannot as yet resolve*." Petrographic observation allows us to collect information on the whole spectrum of detrital grains. Conversely, geochronological analysis of detrital zircon focuses on about 0.02% of total sediment; forgetting the remaining 99.98% hardly makes sense.

Sedimentary deposits not only retain the complete record of geological and climatic processes that have modeled the Earth's surface in the past, they also contain the mineral and energy resources essential for the economic well-being of mankind. The quantitative study of the petrographic, mineralogical, and geochemical composition of sedimentary deposits is thus essential for improving our capability to exploit natural resources and to understand and manage complex problems, such as climate change and environmental pollution. This exhaustive and detailed update edited by Paul Sylvester is timely and will be of invaluable help to students and researchers trying to keep pace with the ever-increasing speed of technological progress.

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