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REVIEWS

Geochronology: Linking the isotopic record with Petrology and Textures

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In determining the age of minerals and rocks it is often possible to derive a precise number that can be interpreted as a date, it is another matter to accurately interpret the number in terms of the timing of a discrete geological event or process. This is the challenge addressed by the contributors to an edited volume in the Geological Society Special Publication series entitled Geochronology: Linking the isotopic record with petrology and textures. The volume consists of fourteen papers derived from a special symposium held at the 2002 Goldschmidt Conference in Davos, Switzerland.

Advances in analytical capabilities over the past 10-15 years allow geochronological studies to be carried out at a scale similar to petrological observation and within the realm of mineral processes. A variety of techniques is now available for high spatial resolution isotopic analyses (ion probe, laser ablation; microsampling). For example, reduction in sample size using careful grain selection or in situ methods permit isotopic analysis at the sub-50 μm scale. The power of these technical advances, and the importance of understanding the context in which they are applied, is highlighted by the papers in this volume.

The topic is very broad and this is reflected in the range of papers from detailed technical notes on analytical methods to a review paper on metamorphic reaction rates. As a single collection, the book is not a definitive representation of the current state of knowledge within any one area as only a handful of papers are of a review nature. This is alleviated somewhat by a very useful introductory chapter by the editors that outlines the current state of knowledge, ties the disparate papers together, and provides a solid reference list.

The volume is divided into four sections of unequal length: 1) Improving the link between accessory phase chronometers and petrological information; 2) Advances in the chronometry of major minerals – prograde histories; 3) Texturally controlled ('in situ') chronometry; and 4) Understanding transport processes in rocks.

The three papers in the first section focus on petrological observations combined with trace element and isotopic data of accessory minerals to link their formation with major mineral phases, and ultimately to the pressure-temperature-time path of metamorphic rocks. The paper by Foster and Parrish on metamorphic monazite is a useful review that also contains some new ideas on establishing monazite within a quantitative metamorphic framework. Papers by Whitehouse, and Moller et al. are good examples of the type of information that can be extracted through integrated trace element and isotopic analyses of zircon

The second section contains four papers on dating major rock forming minerals. The paper by Anczkiewicz and Thirlwall is a technical paper dealing with improved analytical methods for preparing garnet for Sm-Nd analyses. The paper by Stowell and Tinkham provides a case study integrating geobarometric data with Sm-Nd garnet age dating in the Cordillera of western USA. Zheng et al. use stable isotope data to demonstrate the importance of evaluating chemical and isotopic equilibrium in the interpretation of isotopic mineral isochrons. Romer and Rotzler demonstrate the importance of understanding the reaction history of metamorphic rocks for accurate interpretation of U-Pb data in metamorphic titanite.

Cliff and Meffan-Main's paper in the section on texturally controlled 'in situ' chronometry further highlights the importance of considering isotopic disequilibrium. Careful in situ microsampling of petrologically defined domains is used to isolate material that attained equilibrium at different times. VanHaecke et al.'s paper on using ICP-MS for Rb-Sr analyses, although an interesting technical investigation, seems at odds with the overall theme of increasing accuracy through increased analytical and contextual precision.

The last section includes five papers focused on transport processes in rocks and their role in interpreting geochronological data. As the editors point out, our generally poor understanding of these processes remains a major impediment. Baxter presents a useful review of natural metamorphic reaction rates and suggests the discrepancy between lab based and natural estimates for regional metamorphic reactions reflects the very important role fluids play in rock reactions. Kriegsman and Nystrom present a review of melt segregation rates in migmatites along with a companion paper outlining a detailed case study. Papers by Wartho and Kelly and Kramar deal with in situ argon geochronology and the interpretation of diffusion profiles. The important role of fluids and deformation to the interpretation of thermal histories of minerals is highlighted.

In general, the papers in this volume are well presented and illustrated.

The index is particularly useful. The volume will be of general interest to geochronologists and metamorphic petrologists. Its message of employing multiple analytical techniques to fully interpret geochronological data within petrological context represents the current benchmark for accurate geochronological calibration of polymetamorphosed rocks in orogenic belts.

Encyclopedia of Sediments and Sedimentary Rocks

Edited by Gerard V. Middleton
Kluwer Academic Publishers
P.O. Box 17, 3300 AA Dordrecht, The Netherlands
2003, 928 p., US$390.00, hardbound
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Encyclopedias occupy an uncertain position on the intellectual landscape. Embattled teachers may revile them as purveyors of superficial information, much favoured by students seeking to complete term papers with minimal research. And yet, a well-prepared, rigourous encyclopedia is an invaluable learning resource and reference compendium that can command immense loyalty from its users. So enamoured was Aldous Huxley of *Encyclopedia Britannica* that he seldom travelled without at least one volume, and his entire set once accompanied him on a world cruise. Now, Gerry Middleton has edited a new encyclopedia devoted to sediments and sedimentary rocks, a Herculean volume that runs to 821 pages of main text (including index), divided among more than 250 subject entries. Reviewing so massive a distillation of sedimentological information would daunt even the most enthusiastic polymath, and so we six scientists who have contributed to this review have divided our labour. Each of us has read a number of entries, some in our areas of specialty, some not. Although we have not tried to read every entry in the volume, we have studied enough of it to form a group consensus regarding its many merits, tempered by the recognition of some problems that are probably unavoidable in any book of this scale. We are unanimous that this volume is user-friendly, broadly summarizes an immense body of knowledge, and should become the intellectual travelling companion of any student or professional of the field of sedimentary geology.

The encyclopedia has benefitted from an army of top-notch workers, helmed as it is by Professor Middleton and four associate editors (Michael Church, Mario Coniglio, Lawrence Hardie, and Frederick Longstaffe) and anchored by an impressive roster of authors, the names of many of whom will bring nods of agreement at the propriety of their having been chosen to contribute. Thanks to the good efforts of so many people, many things about the book deserve unalloyed praise. It provides an entry point into numerous topics through entries that are, on the whole, up to date and of high quality. At their best, the sections in the encyclopedia provide adequate background data, sufficient illustrations to support their written explanations, and appropriate references for the interested reader wishing to delve into more specialized aspects. Indexing is thorough and the editors provide a very powerful tool by cross-referencing related topics. Treatment of topics is relatively basic and thus accessible to the broadest range of users, and coverage of historical developments is balanced with current thinking. A specialist may not learn much that is new about her or his field but will find much new and interesting information when reviewing entries from unfamiliar fields. The book is attractively and durably bound, the paper, typeface, and page layouts are easy on the eyes, and line drawings are generally clear and reproduced at an appropriate size.

It is probably inevitable that any volume of this size and scope, written by one-hundred and ninety-three contributors, will suffer from some unevenness in tone and level of treatment. Editors must make decisions about how material is to be partitioned and not everyone will agree with an editor's choices. Editors must also impose standards as to writing style and level of treatment, but not all authors will faithfully follow an editor's instructions. It is also probably inevitable that six geologists will not stay unanimous for very long. Thus, our opinions diverge on the question of how consistent the book is in its overall treatment of its subjects. Four of us, in particular, were struck by some unevenness, wondering if the editors had wielded sufficient control on the format, length, and general level of treatment of various subjects. Although variability in these matters does not detract excessively from the encyclopedia's overall usefulness, it does mean that some entries are more helpful than others.

An example of this variability is provided by significant variations in depth of treatment. In some cases this reflects the relative significance of topics. Yet in other instances the handling of subjects is genuinely uneven. Some contributors seem to have written their articles with an encyclopedic format very much in mind. Such articles concisely but thoroughly cover the history of a concept, as well as its modern context. Those topics presented with a methodical approach are fine examples of how the encyclopedic format should work, e.g. the treatments of alluvial fans and of fluid inclusions. Some other entries are all right as far as they go but are marked by odd omissions or curious redundancies. For example, the rather terse section on storm deposits deals at moderate length with the formation of hummocky cross-stratification, a subject dealt with at length in a separate entry. It also briefly discusses currents and suspended sediment, but it essentially ignores carbonate and mixed carbonate-siliciclastic storm deposits. Similarly, the section on debris flows is almost entirely devoted to subaerial examples. There are entries that ably document a concept's history but say little about the state of the art (see, for example, "Sedimentary Structures as Way-up Indicators"); others present only a summary of the latest research. Neither approach is necessarily invalid, but the emphasis in some entries seems to depend more on authorial enthusiasms than on editorial oversight. Of course, it may just as well be to the credit of the editor and associate editors that the book is as uniform in style, content, and breadth as it is!