for structural geologists who often are faced with questions such as "Are there fractures at depth? Can fractures stay open in reservoirs and aquifers? How do you separate tectonic fractures from surfacial ones in outcrops and road cuts?" And so on.

The weakness of the book, in my opinion, is generally organizational. The first three sections in the Appendix including fracture definition; surface morphology of opening fractures and its kinematic implications are the backbone of the book and should have been incorporated into Chapter 2. The last section in the Appendix on stress fields associated with drilling and coring operations belongs to Chapter 3. However, this section is ineffective because it neglects the stress concentration associated with drilling and coring. Fractures around the well bore, for example well bore breakouts, provide crucial information about the stress field that can be used in the interpretation of both natural and induced fractures in oriented and unoriented core samples. Finally, the field of natural fractures in rock and their flow properties is a complex broad topic, an adequate coverage of which is outside the scope of this book. The reader may want to supplement the book with several recent research articles on these topics.

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Fluids in the crust

National Research Council (1990) *The Role of Fluids in Crustal Processes.* National Academy Press, Washington, DC, U.S.A. Price $24.50 (cloth; ISBN 0-309-04037).

This book is a collection of papers dealing with the effects of fluids on endogenic geological processes, and aims to give an assessment of the emerging topic of fluid research. In 11 chapters, diverse aspects of fluid involvement in endogenic processes are discussed, and illustrated by case studies. Most chapters represent independent overviews of a particular sub-discipline, and have been written by a different author or combination of authors. In an introductory note, an overview of the subject is presented in which the diverse topics are discussed, and a "Recommended Research" paragraph is given. In Chapter 1, Bredehoeft and Norton discuss the basic equations of the pertinent processes: flow, advection, heat, stress and strain as well as mineral–fluid reactions, and the significance of these processes is illustrated by examples. Chapter 2 is a more specialized derivation by Norton of the equations of fluid–rock interaction near magma chambers. From Chapter 3 onwards, the style of the book changes, and more conceptual models are presented, and various techniques and results are given: e.g. joint development near batholiths (Titley); fluid dynamics and metamorphism and magmatism (Walther, Wickam and Taylor); the use and principles of stable isotope studies (Taylor); the signature of fluids in deep seismics (Oliver) and the effects of fluid on tectonics (Engelder, Nur and Walder).

Due to the diversity of authors and subjects, it is hardly possible to give a review of the entire book, as all the chapters should be evaluated separately. Therefore, I will limit myself to those aspects of the book which deal with structural geologic or tectonic processes.

Oliver (Chapter 8) presents one of the most intriguing models, relating far reaching horizontal fluid migration (e.g. hydrocarbons) to plate tectonics. The geographic distribution of oil and gas fields is related to the large scale crustal tectonic history. Although his model is speculative and debatable, it is interesting because it is a new idea, worthy of evaluation. Other chapters of the book which have a structural geologic bearing discuss the effects of high pore pressures on fault and joint dynamics. In this respect, the book offers a good overview of the subject, but not many new points of view are presented.

A fundamental omission of the book is that it lacks one or more chapters on the role of fluids in ductile deformation and recrystallization. This is very strange, as it is one of the most fundamental effects of fluids in crustal deformation. Furthermore, a book like this should include a chapter of the results of deep drilling experiments, as this gives more than anything else an account of direct sampling of the fluid phase at a depth deeper than superficial. Nevertheless, the book offers insight in many different aspects of fluid studies, the techniques and their limitations, and is a worthwhile purchase.

I can recommend this book to anyone who is interested in the topic, especially considering the price is $29.50 (export), which is moderately cheap for a hard cover copy.

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Granites

Brown, P. E. and Chappell, B. W. (editors). 1992. *Second Hutton Symposium on The Origin of Granites and Related Rocks. Transactions of the Royal Society of Edinburgh, Earth Sciences* 83. *Parts* 1 and 2. Royal Society of Edinburgh, U.K. 508 pp. Price £55.00.

The Second Hutton Symposium on the Origin of Granites and Related Rocks was held in Canberra in September 1991 and it is a great tribute to the editors that the Proceedings have become available in such a short time. The volume contains 43 papers and 70 abstracts and is therefore an almost complete record of the papers presented. Of the published papers, about a third are major review articles, whilst the remainder are more detailed case studies. The volume has two biases, one towards Australian geology, which is understandable given the location of the conference. The other bias towards petrology perhaps reflects the concentration of current effort in this field of granite studies.

This volume presents an up-to-date snapshot of what we know about the origin of granites. Major themes include the source of granite magmas and the relative roles of crustal and mantle contributions; the mechanisms and physical conditions of melting; the nature of the heat sources responsible for granite generation; the mechanisms of granite emplacement and the extent to which granite chemistry can be related to tectonic setting.

One of the most important questions about the source of granite magmas concerns the extent to which granite compositions mirror that of their source. It has been argued that many granite magmas contain significant amounts of crystals which did not precipitate from the melt. These crystals are residual (restite) and inherited from the source during partial melting. They remain in the melt because of the viscosity of the magma and the difficulty of separating the melt from unmelted residue. Three lines of evidence, presented by a number of different authors, offer strong support for the restite model. First, there is the direct observation of restite material in felsic igneous rocks. Two very clear examples are given, both from Spain, of a granite and a dacite, both rich in enclaves of sedimentary material. Second, a thermodynamic study of selected Australian granites showed that observed compositional variations are the result of restite unmixing and that some samples contain up to 65% restite, a view corroborated by an independent experimental study of plagioclase compositions. The third argument comes from observations made using the SHRIMP ion microprobe in which old zircons are identified in the core of some magmatic zircons crystals. These are thought to be inherited from and characteristic of the source of the granitic magma. These studies also show that in a single granite, inherited zircons may have a wide range of ages and challenge previous interpretations of discordia plots for granites containing inherited zircons.

The restite model is the underlying assumption of the S- and I-type granite classification, first proposed for the granites of the Lachlan fold belt in eastern Australia. S(edimentary) and I(gneous) type granites are recently redefined as S(upracrustal) and I(nfracrustal) granites to distinguish between sources which have been exposed to supracrustal weathering processes and those which are in the deep crust and formed by underplating. It is apparent, however, that many workers regard the S- and I-concept as one which does not export well and interpret S- and I-type granites as crust and mantle end-members in what is more normally a continuum. This is the premise in a Nd-isotope study which calculates the relative crustal component in a given granite magma. Mafic enclaves can also indicate the involvement of mantle processes although their relative volume in granite melts (*ca* 2%) is in conflict with volumes estimated from isotope data which suggest up to 70% mantle component. Further evidence for a mantle contribution to granite magmas comes from a number of regional studies. One very detailed experimental study of a garnet-bearing dacite from New Zealand concluded that the magma can only have originated at mantle depths.

If the restite debate has been current for several years a newer area of investigation for granite petrologists is the question of heat sources. A consensus is emerging that granites are produced as water undersaturated melts at relatively high temperatures (850–950°C) by vapour-absent melting of lower continental crust. What is the heat source for such a process? Many authors consider the mantle as the primary heat source, reflecting the predominantly petrological approach to granite genesis in this volume. Questions addressed concern the mode of heat transport from mantle to crust. Is it by emplacement of mantle-derived