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BOOK REVIEWS

Rock properties

Schon, J. H. 1996. *Physical Properties of Rocks: Fundamentals and Principles of Petrophysics*, Vol. 18 of: Handbook of Geophysical Exploration, Seismic Exploration, Series editors K. Helbig and S. Treitel, Pergamon Press, 583 pp. Price Dfl 267, $170.

A book such as this is quite difficult to review, as handbooks of rock properties are not the sort of reading I curl up with at the end of the day, like readers of this journal might with a book on finite strain analysis of microstructures. Thus, I waited to use this book as a resource, amongst others, while teaching a class in mechanical processes in rock deformation, in order to evaluate it. This book is part of a 24 volume series of handbooks for seismic exploration, and the intended audience appears to be practitioners of the art of seismic exploration. The book consists of ten chapters which present an overview of terminology, theoretical relationships, and compilation of data on porosity and permeability, density, magnetic, electrical, and thermal properties of rocks, radioactivity, 'elastic properties', which in this book are really seismic velocity properties, seismic attenuation behavior, and a summary chapter on the relationships between the various properties. As its title, and the series title suggest, the data presented are for workers in applied geophysics, rather than the more global or research-oriented handbooks recently published by the American Geophysical Union (Aherns, 1995).

Although the book's title suggests an overview of petrophysics, the most useful and highest quality portions concentrate on seismic properties of rock. Approximately one-third of the book is devoted to seismic properties. For a seismic illiterate such as myself, the compilation of data and the theoretical relationships which form the basis of these data is well presented and informative. Readers of this journal will be disappointed that elastic properties presented are not the moduli, compressibility, etc. that are determined in rock derformation experiments. However, good comparative figures and tables are presented to show the velocities of dry rock, cracked rock, rocks moistened to different degrees and with different fluids, and the properties of different fluids. Also covered nicely are the mechanisms and implications of shear-wave splitting phenomena, with overviews of the possible mechanisms (such as the work of Crampin and co-workers). A separate chapter on seismic attenuation properties, and its possible mechanisms, is well presented, although too much emphasis is placed on linear elastic models for the attenuation.

Having defined the strengths of the book in the realm of seismic properties, I must point out a number of weaknesses. Despite the encompassing title, the chapters on topics other than seismic velocities and attenuation are not as well done. My current interests in transport properties of rock led me to focus on the chapter on porosity and permeability, which I found to cover the topic shallowly, and without a complete set of references. Little of the work on the topic of Brace or Byerlee and coworkers is included, for example, and the data presented are almost all from sedimentary rocks. In addition, there appears to be no mention of capillary entry pressure or minipermeameter tests, which have been used in the oil and gas industry for some time. The omission of other rock types is contrary to the stated intention of the book outlined in the introductory chapter, which points out that a wide range of applications now rely on sound knowledge of physical parameters. The chapters on electrical, thermal, magnetic, and radioactive properties are sound, but are limited to a brief overview of the physics, followed by a variety of results of studies.

This latter point focuses on what I feel is the biggest weakness of this book. Little or no background on the techniques used to determine rock properties is presented. Thus, those workers who cut their teeth on Carmichael (1989) or the classic work in Clark (1966) will be disappointed by the absence of an organized, clearly written overview of how various measurements are made. In my class, the most useful discussions on rock properties based on Carmichael (1989) or Clark (1966) center on the clear introductions of each chapter, by experts in the field, of the basics of how measurements are made, the limitations of each technique, and a large list of references for the techniques and the results. The single-authored attempt in the present book results in weakness in the depth of some of the material, a lack of any background on how the values are obtained, and what the limitations and errors are in the different measurement techniques.

Other problems with the book are that despite the lip service paid to emerging issues in shallow, geotechnical applications, little data are presented on low pressure, low temperature properties of rock (c.f. Afrouz, 1992); little data are given for the volumetrically small, but in some cases, locally important rock types (salf, tuff, basalts).

The book provides a valuable European perspective, as shown by the reference lists, but this is unfortunately at the expense of North American, Australian, and Japanese work, which in some of the fields is extensive, and critical to fill in some of the topics ostensibly covered in the book.

A significant concern is the cost—listed as US $170 when the book was received. Given that this is the cost of but one of 24 intended volumes, the price is very high; especially given the better priced comparative books (Aherns, 1995; Carmichael, 1989).

References

Afrouz, A. A. (1992) Practical handbook of rock mass classification systems and modes of ground failure, CRC Press, Boca Raton, Florida, 195 p.

Aherns, T. (1995) editor, Handbooks of Constants, American Geophysical Union Reference shelf series, 3 volumes.

Carmichael, R. S. (1989) Practical handbook of physical properties of rocks and mineral, CRC Press, Boca Raton, Florida, 741 pp.

Clark, S. P., Jr. (1966) Handbook of physical constants, Geological Society of America Memoir 97, 587 pp.

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Ocean margins

Banda, E., Torne, M. and Talwani, M., 1995. *Rifted Continent–Ocean Boundaries*. Kluwer. Price Dfl 260 US$185, £117.

This volume of 20 papers was published as part of the NATO ASI series and comprised the proceedings of a workshop held in Mallorca, Spain in 1994. The volume covers virtually all aspects of ocean–continent boundaries (OCB) including: volcanic margin processes; numerical models of rift propagation and melt generation; discussion of the sources of extensional stresses that might cause continental break-up; a set of papers on Atlantic margins, including transform margins; and papers on the Mediterranean and the Japanese Sea. This is a useful, well-written and well-edited series of review papers. Although biased towards the Atlantic margins, it is an important volume for all those interested in ocean–continent boundaries and the break-up process.

The first series of papers deal with OCB processes. A review of volcanic margins is presented by Eldholm *et al.*, which they define as those margins that possess clear seaward dipping reflectors. The OCB on such margins has extensive extrusive cover and a lower crustal high velocity body. Such margins are associated with an asthenosphere which has a high melt potential before, during and after break-up. Such margins are often, but not exclusively, associated with hot spots. Keen and Boutilier present an early stage review of finite element models to solve the Navier–Stokes equations for incompressible mantle flow associated with continental rifting. These models suggest that the development of significant small-scale convection in the asthenosphere and lower lithosphere below a rifted solid upper lithosphere is more dependent upon rift geometry that rate of rifting. Such convection affects the subsidence history and the volume of melt produced from the decompression of the upwelling mantle material. This conclusion differs from that of Bown and White, who give a very clear review of the relationship between rifting, melting and subsidence. They argue for four controls: Beta factor; potential temperature; initial lithospheric thickness and duration of rifting. Subsidence is affected by the volume of melt produced because the combination of igneous rock produced plus the depleted mantle residue is less dense than the initial mantle source rocks.

These models assume pure shear and agree well with both non-volcanic (Galacia Bank) and volcanic (Rockall Plateau) margins in the north Atlantic region. Bott presents an analysis of the tensile stresses associated with rifting. He demostrates that such stresses are due to the thermal anomaly beneath rifts and to subduction on opposite sides of the plates. More subdued extensional stresses can originate from the abrupt weakening of the lithosphere at the newly formed plate boundary. Watts and Marr estimate the strength of margins using the gravity anomaly associated with sediment loading. "Strong" margins exhibit a long wavelength, single edge effect anomaly, whilst "weak" margins show a shorter wavelength, double edge effect anomaly whose symmetry is affected by the strength of the oceanic lithosphere. This model applied to the east coast of the USA argues for a weak continental margin which is not related to hot-spot activity, whilst weak African margins are probably influenced by proximity to hot-spots.

The next papers discuss north Atlantic margins of Norway (1 paper), Greenland (2 papers), USA (1 paper) and Iberia (5 papers) and the structure of the Atlantic crust (1 paper). Svrivastava and Roest argue that the SW Greenland margin is bounded by thin crust that is of problematic nature. Seismic evidence has suggested that it is continental, but the magnetic signatures suggests oceanic crust formed before Chron 30. Carbonell *et al.* use seismic anisotropy to estimate the mineralogy of the deep crust and identify a zone of magnetic underplating above the Moho in SW Greenland. New deep seismic data from the Norwegian margin presented by Skogseid and Eldholm support a late Cretaceous–early Palaeocene rifting event associated with voluminous vulcanism and melt emplacement.

A review of the EDGE experiment along the eastern US seaboard by Talwani *et al.* suggests that basaltic seaward dipping reflectors cause the East Coast Magnetic Anomaly. The single polarity of these mafic rocks suggest rapid sub-aerial spreading associated with a very high rate of magma production. A model is presented of an intially sub-aerial spreading ridge that subsequently subsided. The Atlantic is traversed with a discussion by Danobieta *et al.* of the similar seismic characteristics of ocean floor developed on either side of the Mid Atlantic Ridge Chron 16, a time when the spreading rate halved. There then follows a substantial section on the Galatian margin including papers by Sibuet *et al.*, Boillot *et al.*, Krawczyk and Reston, and Torne *et al.* Oceanic crust occurs west of the Peridotite Ridge, whilst thinned continental crust exists to the east. The 'S' reflector, at about 12–8 km depth within this thinned crust may represent a major shear detachment where, at least immediately east of the Peridotite Ridge, the upper plate continental crust has detached from its basement and during break-up been emplaced onto an oceanic basement. Numerical modelling of this margin suggests that here the OCB is 115 km wide.

The final part of the book covers a variety of subjects. Vegas *et al.* report on the structure of the South Scotia Ridge, comprising crustal fragments transported eastwards from the South America–Antarctica isthmus and the Bramsfield Trough, a half graben behind the South Shetland arc. The Moho underlying the Valentia Trough along the Mediterranean Iberian margin is mapped by Vidal *et al.* using stacked wide-angle seismic sections. Ergun *et al.* attribute the Marmara Sea basin to strike-slip pull apart associated with post-Eocene movements on the Anatolian fault system. A detailed account is given by Mascle *et al.* of the Côte D'Ivoire–Ghana transform margin where the ocean–continent transition occurs over just 5 km juxataposing 20 km thick continental crust against 5 km thick oceanic crust. The Pacific margins are only represented in the final two papers by Kinoshita and Hirata and Kurashima which discuss the Japan Sea Basin. The opening of this back-arc basic in the Miocene may have been associated with ophiolite emplacement and it is presently underlain by thinned continental crust in the south and oceanic crust in the north.

Many of the articles in this book are well written and often contain concise and informative reviews of the topic discussed. It is a must for any researchers concerned with ocean–continent boundary process, and oil company geologists, especially in view of the new interest in deeper water basins. It is also valuable for those geologists who study ancient continental margins. Although the book tends to concentrate on the Atlantic, the variety of margin types described provide a salutary lession to those, like myself, who try to reconstruct ancient margins using a simple template. This is a good book; I enjoyed it.

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Asian tectonics

Yin, A. and Harrison, T. M. (editors) 1996. *The Tectonic Evolution of Asia*, Cambridge University Press. 666 + xii pages. Price £125 (US$200). ISBN 0-521-48049-3

This volume is a compilation of presentations made at a conference (Rubey Colloquium) held at UCLA in February 1994. An eclectic range of topics on the general theme of the conference title are included in the 21 papers by 67 authors. A particular distinction, and one of the most valuable aspects of the volume, are reviews and synthesis of existing data and ideas, well-presented, and giving a good idea of current understanding, and containing excellent sources of references to the original papers. However, there are plenty of new, original data and ideas in this volume too. All papers were reviewed externally, and the volume shows other clear signs of careful editing; specifically that the figures are reproduced at adequately large size, that labels on them are all explained, and that there is an amazing rarity of typographical errors in the text.

The book is divided into several sections, starting with geodynamic models of the Cenozoic deformation. This section contains one of the usual suspects, a good review of the thin viscous sheet model for collisional lithospheric thickening, including some geometric modifications. The other paper in this section, by Kong and Bird, which uses a thin shell finite element model containing the major faults, is a new, and ambitious development. Structural geologists may be interested among other things in a firm conclusion predicted by the model that the (numerous) large faults all must be very weak.

The second section is on Seismotectonics. This contains two papers with new data based on highly precise earthquake locations and their first motions. One covers the western Sunda/Burma Arc, the other includes, among other far-distant parts of Asia, discussion of earthquakes in the Indian continent, including a possible nascent thrust indicated by a deep earthquake in the upper mantle beneath the present position of the Main Boundary Thrust. A third paper in this section reviews results from seismic tomographic techniques on mantle structure beneath Asia.

Part 3 contains four papers on the geological development of the Himalaya and Karakorum. Here, in particular, are papers that are of value as up-to-date reviews. One by Patrick Le Fort covers the mountain system as a whole, and gives a good up-to-date overview by a single author who has worked in the chain for many years and who has seen close-up most of what he is talking about. There is also a wide-ranging compilation of isotopic age and metamorphic P–T–t data for Himalaya–Karakorum and (for what little there is) the rest of Tibet, too. Others besides myself might take issue with this author's claim (and grammar) that the Nyainqenthangla is a 'completely unique' structure in Tibet; while this part of the Yadong–Gulu rift is oblique to the overall northerly trend of the other segments, the structural kinematics are the same, as shown by the excellent studies of Armijo, Tapponnier, Mercier and Han. Another good paper in this section integrates metamorphic and isotopic age data for the northwest Himalaya, Kohistan–Ladakh, and the Karakorum, with particular attention to the relations and timing of assembly across the MKT and MMT fault boundaries between them. Lastly, there is a really useful synthesis of the Himalayan foreland basin, with a somewhat revised timescale applied to the magnetic reversal stratigraphy. While one might not accept the suggestion that the Indus fed the Ganges during part of the late Miocene, this is a superbly illustrated and well-written paper, and is the place to go if you want to find out what is known in the basin.