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Book Reviews / Critique

Book Reviews

Arctic Geology and Geophysics Proceedings of the Third International Symposium on Arctic Geology

Edited by Ashton F. Embry and
Hugh R. Balkwill
Canadian Society of Petroleum Geologists, Memoir 8, 552 Pages, 1982, $36.00; cloth

Reviewed by J. Ross McWhae
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The Third International Symposium on Arctic Geology was held in Calgary, Canada, in 1981. For practical reasons, only twenty-eight contributions could be published in the Proceedings, the theme of which was "Arctic Resources: Exploration and Exploitation".

This volume contains sixteen Canadian papers. Alaska is represented by two papers: Nilsen and Moore on a river-deposited Upper Devonian – Lower Mississippian conglomerate and Metz *et al.* on graben-related Late Paleozoic mineralization. Greenland is covered by three diverse papers: Peel treats the Lower Paleozoic stratigraphy, Hakansson and Pedersen the North Greenland tectonics and Callomon and Berkelund describe Late Jurassic ammonites.

Three papers deal with Svalbard (Spitsbergen), including a paper by Orheim on the Tertiary coal resources. Mork *et al.* discuss Triassic – Jurassic stratigraphy and Ohta treats regional tectonics. Ronnevik *et al.* contribute a geological review on the Barents Sea.

Mining geology and resource appraisals are treated in four papers: Gibson on Arctic Canada, papers by Metz and by Orheim, mentioned above, and the final summary by H.A. Meyerhoff.

It is noted with sadness that Dr. Howard A. Meyerhoff died shortly after submitting his paper. This volume must be considered partly as a dedication to the illustrious Meyerhoffs. Art A. Meyerhoff presents a magnificent 101-page summary of hydrocarbon resources in the Arctic and Subarctic regions. He discusses 121 basins or shelves in reasonable detail, including the Soviet Block where he has unique and detailed knowledge of the petroleum geology. Meyerhoff points to the apparent stability of basins for long periods of time in the Arctic; the Arctic Ocean is an example. This may give credence to his assertion of negligible continental drift in the Arctic. The Nares Strait debate (p. 534-535) on the amount of left lateral displacement on the "Wegener Fault", 250 km versus 25 km, may be ready for a 50/50 compromise if absolute rigidity in the continental plates is not mandatory. The case for plastic adjustment in continental plates adjacent to regions of known crustal thinning, such as below the Sverdrup Basin in the Canadian Arctic Islands adjacent to the Nares Strait, is gaining acceptance.

Peter Jones, of the Canadian contingent, has outlined an imaginative plate tectonic history relating consanguinous tectonic events in Arctic Canada. There are four other papers in the Beaufort-Mackenzie area: Poulton discusses the Jurassic sequence, while Dixon presents the Lower Cretaceous; Willumsen and Cote summarize the Tertiary Mackenzie Delta; Nentwich and Yole contribute an interesting paper on the Paleogene Mackenzie Delta with special reference to the petrology of the Reindeer Formation sandstone.

The Sverdrup Basin is presented in six contributions, commencing with Narbonne and Dixon's discussion of Upper Silurian rubbly limestones, followed by Smith and Stearn's treatment of the Devonian carbonate-clastic sequence of southwest Ellesmere Island and Raasch's contribution on Lower and Middle Devonian faunal zones of the Arctic Islands. Rift tectonics of the Western Sverdrup Basin in relation to hydrocarbon migration are discussed by Balkwill and Fox. Embry describes the very thick Upper Triassic to Lower Jurassic Heiberg delta. The Tertiary structural activity of northern Ellesmere Island is treated by Osadetz.

Five papers are presented on the eastern Canadian Arctic, with emphasis on Davis Strait where there is reasonable agreement on interpretation. Kiose *et al.* discuss exploration in this area, Rice and Shade show seismic data and discuss sea floor spreading, as do Srivastava *et al.* Seismic and core hole data are used by MacLean *et al.* to outline Baffin Shelf geology. Glacial marine sediments in Kane Basin are discussed by Kravitz.

This is a fine, well balanced volume that covers the whole Arctic area without weighing too heavily on any one section. It is an indispensible "state of the art" summary of the petroleum and, to a lesser extent, the mining potential to 1982.

Carbonate Diagenesis as a Control on Stratigraphic Traps (With Examples From The Williston Basin)

By Mark W. Longman
American Association of Petroleum Geologists
Education Course Note Series
No. 21, 1982, 159 p.
$8.00 US single,
10 copies or more $7.00; paper

Reviewed by Eric Mountjoy
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This booklet is the publication of a short course originally presented at the AAPG Fall Education Conference in Calgary, 1981. It is essentially a review paper based on the author's brief experience as an exploration geologist in the Williston Basin and most of the examples he has used are from the U.S. side of the border. As in other AAPG Course Notes, this book is not meant to be exhaustive. It is aimed primarily at understanding what factors localize and control rapid porosity variations and which ones have an excellent potential for non-structural traps. Much of the porosity in carbonate rocks is controlled by diagenesis; hence a petroleum exploration geologist is often searching for a diagenetic trap rather than a stratigraphic one.

Longman begins with an interesting one-well producing field located in the Mississippian Mission Canyon Formation, with two dry holes drilled to the south and northwest. He analyses the various possible types of traps and stratigraphic variations that can explain the observed data. He goes on to discuss the question of how common are stratigraphic (and diagenetic) traps in the Williston Basin (Red River, Duperow, Nisku, and Mississippian). The chapter on the interpretation of carbonate lithology from well logs provides an excellent and succinct overview (14 pages) of the application of logs to carbonate sequences. Next, the basics of porosity and diagenesis are briefly outlined, including the Choquette and Pray (1970) porosity classification, and a short outline of the controls on porosity formation and cementation (this includes some highly speculative diagrams illustrating porosity-forming and destructive processes). Chapter 4, on Major nearsurface diagenetic environments, is simply a condensed version of Longman's (1980) AAPG review paper (v. 64, pp. 461-487). In the next two chapters the author briefly explores subsurface diagenesis (10 pages) and dolomitization (20 pages). He offers four rules, or guidelines, for determining the origin of reservoir-quality dolomites and applies them to a case study of the Ordovician of the Red River dolomites. He suggests a new model for dolomitization where Mg brines seeped *downwards* from an overlying anhydrite unit. Finally, Longman briefly looks at nine general models for the most common types of stratigraphic carbonate hydrocarbon reservoirs.

In a few pages Longman has done a commendable job in summarizing the essentials of carbonate stratigraphic traps and the logging of carbonate rocks and their diagenesis, including dolomitization. However, references are incomplete and emphasize the more basic or important papers. These course notes will prove useful to the senior undergraduate student and to those geologists who have not taken a recent course in carbonate sedimentology and diagenesis. Petroleum geologists will know most of what is in this book, except for some of the new and interesting ideas about diagenesis and its application to the Williston Basin.

Climatic Geomorphology

By J. Budel (translated by L. Fischer and D. Busche).
Princeton University Press,
443 p., 1982,
$50.00 cloth, $18.50. paper U.S.

Reviewed by A.M. Davis,
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Over the last thirty to forty years geomorphology has displayed a sometimes distinctive ethnicity. In Britain and North America the emphasis has been on process studies. In the U.S.S.R. applied geomorphology has dominated. Climatic geomorphology has been paramount in Germany and France. In the former the approach has been traditionally physical, in the latter it has been physical and biochemical (the role of vegetation has been stressed). However, both approaches are dependent on the same assumption: specific climates each produce a distinctive set of landforms. Although the term *climatic geomorphology* is used commonly to denote the study of contemporary relationships and the interpretation of polygenetic landscapes, it should be applied only to the former. The latter is more correctly climato-genetic geomorphology.

In Germany the preoccupation with climatic geomorphology derives from Koppen's work on climatic classification, Penck's theories of landscape development and Pench and Bruckner's investigations of the Pleistocene deposits of the Alpine foreland. The direction was firmly established by 1925, as the proceedings of the Dusseldorf Conference (Morphologie der Klimazonen) demonstrate. These have been described as the founding documents of climatic geomorphology.

Julius Budel, new Emeritus Professor of Geography at Wurzburg, is the German school's leading theoretician. Many of his publications are "landmark". Much of the vocabulary is his. This book, a synthesis of nearly 50 years of research, is the first major translation of his work. As the translators note, although it may not be a definitive summary of German geomorphology, it is clearly representative.

Budel claims that the book presents a climatically-based "system of geomorphology". Nearly two thirds of it is devoted to investigations of contemporary climate-landform relationships (climatic geomorphology). The last section examines the role of climatic change in the creation of polygenetic landscapes (climato-genetic geomorphology). In the former, Budel recognized ten major morphoclimatic zones. Nine, including arid zones, are considered 'fluvial', The tenth is the glacial zone.

As stated earlier, the system is dependent on the assumption that specific climates create distinctive landforms. For those areas with large relict components, interpretation requires also the confidence that climatic changes produce an identifiable sequence of forms. Yet there are clearly difficulties in establishing contemporary relationships. As Budel states, "the relief-forming mechanisms depend on climatic effects which cannot be measured by the usual atmospheric data." The lack of coincidence between morphoclimatic and climatic zones raises doubts concerning the strength of climatic controls. The present-day relationships can be clarified by process studies, laboratory simulation and modelling, approaches that Budel appears to scorn.

The remaining one third of the volume, which focuses on climato-genetic geomorphology, is devoted to investigation of the relict elements in landscapes which may make up 95% of the relief in areas where presently operating processes are weak. Budel identifies four "relief-generations" from the Late Cretaceous to the Holocene and interprets their impacts in the various morphoclimatic zones.

The volume suffers from language that is sometimes turgid. To avoid ambiguity in translation, some German terms are retained (a glossary is provided). Unfortunately, the basis for climatic geo morphology remains questionable. Clearly, there is a hierarchy. Although, as Budel states, climatic geomorphology is a prerequisite for climato-genetic geomorphology, the former is itself dependent on identification and quantification of process. Climate-process relationships are not well understood.

Nevertheless, Budel's "system of geomorphology" represents an important attempt at synthesis in a discipline without strong coherence. Continuing research in Tertiary and Quaternary climatic changes, on the speed of geomorphic processes, and on the magnitude and frequency of events will undoubtedly force modification, but will also stimulate attempts at climate-based systematics. The book also is important because it represents the first synthesis of Budel's work. Inadvertently, it is a recent history of German geomorphology. The work is sweeping, often attractive, and certainly provocative. It is 'must' reading for North American geomorphologists, if only in terms of perspective.

Igneous Petrology

By C.J. Hughes
Elsevier Scientific Publishing Company, Amsterdam-Oxford-New York, 551pp, 1982. $32.75 US

Reviewed by N.T. Arndt
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During the last 10-15 years there has been no up-to-date text on igneous petrology that covered in reasonable detail both the theoretical and the descriptive aspects of the subject. C.J. Hughes's book does just this. In 551 pages the author looks at a very wide range of subjects, usually in enough detail to give the student a reasonable understanding of the important aspects of the subject, but not in the exhaustive detail that is characteristic of some competitive texts.

The first part of the book investigates the theoretical background. The opening chapter, called *Mineralogy of Igneous Rocks,* deals largely with the geochemical behaviour of elements, the factors controlling element substitution in minerals and the structure of minerals. Chemical compositions and mineral parageneses are given in a single long table. Of the following two chapters on the form and emplacement of igneous rocks, the first is concerned with volcanic activity, which includes an excellent section on fragmental volcanic rocks, and the second with the forms and structures of instrusive rocks. Classification and petrography come next, followed by a discussion of the physical properties and physical chemistry of magmas. This chapter includes a useful introduction to phase equilibria. In the chapter entitled *Differentiation of Igneous Rocks,* processes that effect the compositions of igneous rocks, such as crystal fractionation, assimilation and liquid immiscibility are discussed, with common reference being made to well selected examples. Finally, the concept of igneous rock series is introduced, the main types are presented and the various indices and diagrams used to discriminate between them are discussed.

In the latter part of the book the rocks themselves are described under the following headings: Igneous Rocks of Oceanic Areas; Continental Areas; above Benioff Seismic Zones; and of the Precambrian. It is possible to quibble with the treatment given to some rock types. For example, why are four pages devoted to lamproites? Why give a separate section to porphyry coppers when almost no mention is made of other concentrations of economic minerals in igneous rocks? Why is the excellent, but rather too brief, description of extraterrestrial igneous rocks included with Precambrian rocks and not expanded and given a separate chapter? However, in general the descriptions are complete but not overly long, and the discussions and interpretations are illuminating and instructive. The final two chapters are on petrogenesis and the degradation of igneous rocks. The petrogenesis section is a reasonable synopsis, although rather brief: most teachers would probably supplement this section with additional articles from the literature.

The book has two main faults. The first is that it is not especially up-to-date. Judging from the references cited and the treatment of some subjects, most of the book was written in 1977-1978. Because of this, no reference is made to some of the more exciting recent developments in igneous petrology, e.g., no mention is made of the role that magma mixing might play in the formation of oceanic basalts; nor is a single mention made of the Nd isotopic compositions of igneous rocks, although their Sr-isotopic compositions are discussed frequently. The dated impression is heightened by the use of outmoded terms such as *lime, soda* and *potash,* or *acid volcanics,* and by the sometimes peculiar language: we read on p. 397 that "It is salutary to be aware of these complications in SBZ volcanism".

My second criticism is of the book's miserly use of illustrations. The book contains no photomicrographs nor drawings of textures or petrographic relationships, not even in the 21-page chapter on petrography. Throughout the book, but especially in the descriptive chapters, tables of analyses rather than diagrams are used. On page 243 a graph that would illustrate the behaviour of trace elements in the Skaergaard intrusion is described in detail in the text, but the graph is not presented!

Yet these problems do not subtract significantly from the value of the book, which gives a complete and very well balanced treatment of the subject that is unmatched by any other text. Furthermore, with its better than average treatment of Precambrian rocks and its frequent references to Canadian localities, it is a text particularly well suited for students in Canadian universities. Its price is as low as could be expected for a hardcover (no paperback is yet offered). I recommend it highly.

Inorganic Chemistry and the Earth

By J.E. Fergusson
Pergamon Press, 1982, 400 p.
$40.00 U.S. cloth; $18.40 flexicover

Reviewed by K.R. Lum,
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This book is the sixth volume in the Pergamon Series on Environmental Science and is subtitled "Chemical Resources, Their Extraction, Use and Environmental Impact". Two of the previous volumes have focused on organic contaminants in the environment, and the present work will fill the need for a text that would address the geochemistry of the inorganic elements. The author's purpose is to encourage individuals with training in chemistry to join interdisciplinary groups in the study of the earth and to focus on the increasing problem of world resources and the effects of pollution on the global ecosystem. The book is directed at stimulating students to be active participants in such studies. The author recognizes the central importance of chemistry in discussions of earth science and the reader who has a good working knowledge of physical and inorganic chemistry will be impressed with the perspective that the author brings to their involvement in environmental geology.

Part 1 deals with the chemical elements in the environment and considers evidence and ideas on the formation and structure of the earth and the origins of the chemical elements. The atmosphere, hydrosphere and lithosphere are discussed in some detail to provide a framework for later elaboration on the interactions of chemical species in the natural environment. Part 2 provides a useful summary of mineral and energy resources. The formation of minerals and the principal methods of extraction of the elements from their ores are presented. This is followed by a discussion of the formation and use of the world's energy resources and includes a very brief section on energy costs and conservation. Part 3 is a lucid summary of the basic principles of chemical change and in fifteen pages encompasses energetics, kinetics, chemical equilibria and structure, bonding and reactivity. The author goes on to consider the production of some of the more important inorganic chemicals and this is followed by an interesting section on the chemistry of a selection of consumer products. Part 4 comprises about half of this book and the author is to be commended on undertaking a precis of the impact on the environment of inorganic elements. The consequences of man's activities are discussed in chapters dealing separately with the four major "spheres" of the earth, namely, the atmosphere, the hydrosphere, the biosphere, and the lithosphere. This follows a chapter on the environmental cycling of materials between these global reservoirs. The book ends with a short discussion of environmental analytical chemistry in which the author quite rightly draws attention to the importance of chemical analysis and how advances in this science have been essential to understanding the role of inorganic elements in the environment.

A large, up-to-date bibliography is given at the end of the book. The list is divided into categories reflecting the chapter headings and in addition to monographs and general texts the author has provided references to key papers in the primary literature.

Although the text is marred by the occasional typographic error and in some sections gives the impression that it was rushed to press, the author has succeeded in his objective. The book is a good read, contains much useful data and should be welcomed by those interested in applying chemistry to the solution of geological problems.

Pedology

By P. Duchaufour
(Translated by T.R. Paton)
Allen and Unwin, Inc.,
1982, 448 p.
$50.00 US Cloth; $24.95 Paper

Reviewed by L.J. Evans,
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This book is a translation from the French of *Pedologie 1. Pedogenese et classification,* originally published by Masson, Paris in 1977. The translation was made by Dr. T.R. Paton of the Department of Earth Sciences, Macquarie University, Australia. The author is an eminent French pedologist and probably the father of modern French pedology. In this book he draws upon his vast experience of some 30 years in the field of soil science.

The book is divided into two parts. The first part, The Physicochemical Processes of Pedogenesis, includes chapters on weathering and clay formation, the dynamics of organic matter, movement of materials within soils and principles of the origin and development of soils. The second part, Pedogenesis: The Basis of Soil Classification, contains a general introduction to soil classification and then nine chapters on the principal properties, origin and classification of the major soils of the world. Sixteen black and white plates are included in the text, and they are of a quality superior to those in the original French edition. The book includes abundant references—between 20 to 90 per chapter.

This work is largely a summary both of the French school of pedology, and the European and Russian schools. The approach is mainly descriptive, with numerous field examples of the relationships between soils and geological materials, climate, topography and vegetation. Emphasis is placed upon the changes in soil morphology resulting from the interaction of these various soil-forming factors. Discussions of the chemical and mineralogical changes which occur during soil formation are rather limited, and the application of thermodynamic principles to mineral—water interactions is negligible. The work is, however, an excellent summary of our understanding of soil morphology and the factors which influence soil distribution.

The translation from the French is excellent, with a style that flows easily, and thus the text has not suffered the fate of Millot's *Geology of Clays.* The translator has, however, taken it upon himself to update some of the references and even introduce some of his own terms, e.g., *perfection* as the English equivalent for *lessivage.*

When compared with others covering similar topics, this text is probably the most comprehensive. It is written at a senior undergraduate to graduate level, and for this reason it is probably not as good an undergraduate text as is FitzPatrick's *Soils.* For earth scientists wishing to purchase just one textbook on pedology, I would highly recommend this text, and at $25 (U.S.) it is a bargain.

The Road to Jaramillo: Critical years of the revolution in Earth Sciences

By William Glen
Stanford University Press
1982, 459 p.
$47.50 US cloth

Reviewed by Pierre Lapointe
Energy, Mines and Resources
1 Observatory Crescent
Ottawa, Ontario K2A 0Y3

My first reaction after reading this book was to draw an analogy to a scene in a French film of a few years back called "Anatomie d'un coup de foudre". In this scene the audience is shown the lives of a man and a woman from their difficult births up until the time they meet one another. What does this have to do with the book under review here? Well, that is what the book is all about: the birth and growth of modern Earth Sciences. The first part of this work describes the birth and difficult youth of Potassium-Argon dating. In the second part the birth and youth of paleomagnetism is recounted. The third part examines the result of the work done in the first two sections, namely the polarity time scale and the development of one of the most critical steps in modern Earth Sciences, the Vine-Matthews-Morley hypothesis.

Let's look at the different sections. In the first part of the book the reader will find a detailed historical description of the pioneering work, with special emphasis on the Berkeley team. The influence of Reynold's "time machine" on this radiometric technique is of prime importance. The pioneer work of Curtis and Everdeen in dating young rocks and producing a K/Ar time scale, which later became a key to the polarity time scale, is well delivered and annotated with numerous personal details.

The second part is concerned with paleomagnetism. After an introduction to early workers, Koenisberger, Thellier, Rimbert,

Runcorn, to name a few, this section focuses on the two schools of thought in those days, the directionalists and the reversalists. the directionalists (Runcorn, Irving) were mainly concerned with changes in the direction of the magnetic field through time; the reversalists (Doell, Cox) were mainly concerned with the behaviour of the field, the normal and reversed polarity. How these two groups evolved is highly interesting reading, as, for example, in the fascinating section on the beginnings of the Menlo Park rock magnetic laboratory.

After reading the first and second, descriptive, parts of the book one wonders how the pieces of the puzzle will ever fit together. The simple fact is that a paleomagnetic laboratory was located close to a radiometric dating laboratory. This led to these two groups working together (not without clashes), and opened the road to a major advancement in the Earth Sciences.

The third part of this work relates the origin of the polarity time scale. The interaction and competition of the Australian team with the Berkeley one—the powerful influence of people like Jaeger, Turner, Verhoogen and others—is written in a passionate way. The author then gives many lengthy descriptions (my only negative feeling about this book) of the series of polarity time scales produced by both the Berkeley and the Australian groups, ending finally with the Jaramillo event (from rocks near Jaramillo Creek in New Mexico), the marker in the final step of this new era in modern Earth Sciences, the Vine-Matthews-Morley hypothesis. I was most happy to see this worldwide hypothesis renamed to include Morley's contribution. Finally, the reader is taken through the different steps in the acceptance of the seafloor spreading theory and the beginning of the new era in Earth Science thinking.

This book is a historical review of the different steps which led to a major breakthrough in the Earth Sciences. This was the author's aim, and in it he has succeeded. A book for 'those who cared'; a book on how it all came about.

Sedimentary Basins of Mediterranean Margins,

Edited by F.C. Wezel.
C.N.R. Italian Project of Oceanography
Tecnoprint, Bologna
1981, 520 p. Free of charge.

Reviewed by Peter Sonnenfeld
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The Mediterranean Sea is possibly one of the most intensely studied regions of Neogene and Recent orogenic and sedimentogenic events. The International Conference on Sedimentary Basins of Mediterranean Margins, held under the auspices of the Italian National Research Council at Urbino, Italy, October 20-22, 1980, was the first of a spate of symposia on Mediterranean geology. Its proceedings, comprising 35 articles (nine in French) by 67 authors are grouped somewhat arbitrarily into nine topics, ranging from structure and tectonics to sedimentology and paleoclimatology. After an introduction by the editor, a variety of opinions and interpretations are presented. Most papers deal with regional problems; only Morelli provides a synthesis of the individual marginal basins around the Mediterranean Sea with vertical movements that allowed up to 10 km of Neogene sediments to be accumulated.

One group of papers deals with crustal data. Articles by Cassinis, Fabbri *et al.*, Nicolich, Mauffret *et al.*, Selli, and Wezel trace different boundaries between European and African crustal fragments, but document domal upwarping, distension, rifting, drifting and later collapse accompanied by depression; intermittent strong subsidence since the early Miocene accelerated during the Plio-Quaternary. Upper Miocene (Messinian) halite deposition in the Tyrrhenian Sea is restricted to rapidly subsiding grabens; Fabbri *et al.* recognize here a mid-Pliocene unconformity and locally a late Pliocene unconformity. Bartole, however, recognizes also a lower Pliocene unconformity on top of Karstified Messinian sediments. On a more local scale, Fanucci showed that the Ligurian basin itself was the site of several structural styles subsiding since the Miocene.

Durand-Delga shows a picture of western Mediterranean abyssal plains resulting from the generation of oceanic crust by distension, while Bousquet and Philip present a theme of compression around new oceanic crust in the same area. Reutter visualizes subduction of oceanic crust and obduction of the continental margin as origin of the Appennine chain, where Tuscany is overriding the Corsican fragment, and Bousquet and Philip, and also Mascle *et al.* continue the trace of a subduction zone along the Hellenic Arc in the eastern Mediterranean Sea. However, Belderson *et al.* interpret the Calabrian and Hellenic Arcs as due to outward radial growth on the sides of mantle diapirs, and Finetti places crustal thinning and doming into the Jurassic, followed by compression and collapse. Subsiding intramontane basins are, according to Giese, caused by a local inversion of the density gradient within the crust.

Three papers, by Morlotti *et al.*, Raffi and Rio, and Torelli and Buccheri recognized in cored Tyrrhenian sediments the postglacial climatic optimum, the diachronous end of the last glacial stage. Borsetti correlates Neogene and older biostratigraphy with Tyrrhenian seismostratigraphic units. The magmatism in the Tyrrhenian, the western and the eastern Mediterranean Sea, is examined in three papers by Bellon, Beccaluva *et al.*, and Innocenti *et al.*

Wezel *et al.* presented in a separate paper the depositional style of elongated sediment-filled, slope-centred troughs off the Tyrrhenian coast of Sicily, Sardinia and Corsica. Initially, these are fault-controlled blocks tilting towards the land; after a Plio-Quaternary inversion of the profile they become basinward tilted with accompanying rejuvenation of canyons and clinoform progradation on slopes. In a thought-provoking article, Winnock gives detailed evidence on how young the present morphology of the Mediterranean sea floor is by outlining major Pliocene vertical movements and normal faulting in the Pelagian Sea between Tunisia and Sicily, where Messinian beds were displaced up to 5 km.

Belfiore studied the heavy mineral dispersal on the eastern margin of Sardinia; Vanucci *et al.* found the clays which accumulate in the Malta and Pantelleria troughs to be eolian dust (Kaolinite) of African provenance mixed with alteration products of local volcanic glass. For Monaco, reworked sediments comprise the bulk of deposits both in the western Ionian Sea and on the continental slope along the coast of northern Spain, and Aloisi *et al.* discuss the morphology and structure of deep-sea fans generated by the discharge of Ebro and Rhone rivers. Got shows that mudflows, partially reworked in slope basins, cascaded down into grabens of the Hellenic Arc. Feldhausen *et al.* describe late Pleistocene and mid-Holocene uniformly textured muds in the Hellenic Trench that are gravity-emplaced during high sediment flux caused by rising sea level. Tomadin details the composition and provenance of clays in the Tyrrhenian, Ionian and Adriatic seas, differentiating between turbidity currents, delta plumes, surficial and intermediate water circulation and eolian transport. The

book concludes with an account by Flores of the hydrocarbon potential of the Italian offshore areas: gas production is confined to Neogene clastics, oil production to Paleogene and Mesozoic carbonates.

Overall, the book suffers somewhat from the lack of adequate maps to orient a reader who is unfamiliar with the area, and abbreviations, such as DSS, DRS or OGS are frequently used without explanation. Nonetheless, a large data base is compiled to illustrate comprehensively the importance of Neogene, mainly Plio-Quaternary dilatation and vertical movements in the Mediterranean area, compared to the subordinate significance of horizontal displacements and of local compression. The distension is possibly due to mantle diapirism. Although the vertical movements may at times utilize ancient fracture lines, most of them do not seem to predate the late Oligocene. The combination of magmatism, block faulting, and flyschoid deposition has caused Wezel to draw analogies with certain basins in pre-orogenic Appennines. The book serves as a good documentation of events in a rapidly subsiding set of connected basins, starved of adequate terrigenous sediment supply whenever the rate of subsidence exceeded the rate of alimentation.

Note: This book may be ordered free of charge from:
Direzione P.F. Oceanografia & Fondi Marini
C.N.R.
Via Nizza, 128
00198. Roma, Italy