BOOK REVIEWS . . .

MINERAL DEPOSITS AND THE EVOLUTION OF THE BIOSPHERE

H.D. Holland and M. Schidlowski (eds.)

Springer-Verlag, Berlin, F.R.G., 1982, 332 p., \$19.00 (U.S.)

This volume serves as a report on the Dahlem Workshop on Biospheric Evolution and Precambrian Metallogeny held in Berlin, September 1-5, 1980, and organized under the auspices of IGCP Project 157 "Early Organic Evolution and Mineral and Energy Resources". The first part consists of 12 review papers divided into three groups: past and present microbial processes and ecosystems, the morphological and chemical record of the Precambrian biosphere, and the relationship between biological processes and the formation of mineral deposits. The review papers that comprise the main part of the volume were presumably written to communicate with scientists outside the specialization of the author. This is a difficult task, but for the most part it has been accomplished with success.

The reviews are followed by four state-of-the-art reports: sedimentary iron deposits, evaporites and phosphorites; stratified sulphide deposits; reduced carbon compounds in sediments; and biogeochemical evolution of the ocean-atmosphere system. These reflect on the format of the workshop, which consisted of four interdisciplinary discussion groups, each with 12 members.

Several papers deal with bacterial evolution and the effects of these organisms on geochemical cycles. The first of these, by H.G. Trüper, is with reference to the sulphur cycle. Although it is not written for the geologist unfamiliar with the field, it includes a excellent summary of genetic mapping in evolutionary studies and the relevance of these results to geochemical evidence of biological evolution. K.H. Nealson provides a lucid account of the role of bacteria in the oxidation and reduction of iron.

The organic geochemistry of benthic microbial ecosystems is reviewed by K.L.H. Edmunds, S.C. Brassell and G. Eglinton. They emphasize the difficulty of using organic geochemical data from ancient sediments to characterize these ecosystems, but feel the field has potential. D.M. McKirdy and J.H. Hahn cover similar ground in their review of kerogen and hydrocarbons in Precambrian rocks. This is an optimistic paper and the authors have admirably succeeded in placing a diversity of geochemical data into geological and biological perspective.

S.L. Miller provides one of the most readable accounts of the beginnings of life in his paper on prebiotic synthesis of organic compounds. This paper should be read first as it serves as the biochemical hors d'oeuvre to many of the papers noted above and to J. Langridge's article on Precambrian evolutionary genetics. The latter subject is as far removed from the reviewer's experience as is bullfighting. It was thus pleasing to note that Langridge has made a serious effort to communicate with geologists. S.W. Awramik contributes an account of the Precambrian fossil record. He notes the many uncertainties that exist, but also shows how the much larger database obtained in recent years has clarified some problems.

M. Schidlowski provides the best available review of the content and isotopic compositions of reduced carbon in sediments, and A. Lerman examines the sedimentary balance through geological time with particular reference to the phosphorous, sulphur and carbon cycles. The quantitative, geochemical mass balance approach used by these authors complements the biological papers in the volume.

There are three papers dealing with mineral deposits. R.E. Folinsbee contributes a lucid review that provides an excellent background for the non-geologist on the distribution of mineral deposits in time. H.L. James and A.F. Trendall, as might be expected, provide a distinguished and current summary of the distribution in time and the paleoenvironmental significance of banded iron-formations. Finally, P.A. Trudinger and N. Williams present an up-to-the-minute review of stratified sulphide deposition in modern and ancient environments. They carefully examine the problem of distinguishing between biogenic and inorganic deposition of sulphide.

The state-of-the-art reports by the four groups provide a useful commentary on the review papers. Graduate students would be well advised to look over their recommendations for further work before choosing a thesis topic. Considering that A. Button, P. Cloud, A.M. Goodwin, H.D. Holland, H.L. James and A.F. Trendall attended the Dahlem workshop, this reviewer read with interest the consensus on the genesis of iron-formation by the group charged with that task (which did not include all of these gentlemen). For the Superior- and Hammersley-type iron-formation they favour a stratified ocean with iron, derived from a variety of sources, dissolved in a lower anoxic layer. The upper oxic layer is in contact with a weakly oxidizing atmosphere. Another group implies that the direct biogenic deposition of some stratified sulphide deposits may have been over-emphasized in the past.

The volume is a useful contribution to biospheric evolution and Precambrian metallogeny. The participants were selected with care and no other publication provides such a broad and integrated view of the topics. At \$19.00 the book is a bargain.

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CRUSTAL EVOLUTION OF SOUTHERN AFRICA: 3.8 Billion Years of Earth History

A.J. Tankard, M.P.A. Jackson, K.A. Eriksson, D.K. Hobday, D.R. Hunter, W.E.L. Minter.

Springer-Verlag, New York, Heidelberg, Berlin, 1982, 523 p., 182 figs., \$45.80 (U.S.).

The six authors - no editor is named - have set themselves the ambitious task of unravelling and synthesizing the dynamic processes that have controlled the geological evolution of southern Africa. This region, which contains the unique Bushveld Complex and Vredefort Dome and once formed a centerpiece of Gondwanaland, provides an almost continuous record of 3.8 billion years of Earth history.

The book has been written at an opportune moment because during the past 15 years the long-established stratigraphic frame of southern Africa's geological history has been filled in with a wealth of detailed, process-oriented sedimentological, petrological and geochronological studies to which the authors themselves have made important contributions.

Especially noteworthy has been the progress achieved by the application of the facies concept, formerly neglected by South African geologists, to the thick sedimentary and volcanic piles so well preserved in the large Archean to Cenozoic depositories, which also contain much of southern Africa's mineral wealth. The interpretation of the magmatic processes and their evolutionary trends in space and time have greatly profited from numerous geochemical studies and investigations of isotope systematics. The authors use the recently revised stratigraphic nomenclature (South African Committee for Stratigraphy, 1980), which greatly increases the value of the book for teaching purposes.

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The synthesis is organized in 14 well-balanced chapters, each of which deals with some subjects of more than regional and theoretical interest to earth scientists. A few highlights are briefly mentioned: Chapter 1, appropriately, provides an overview of the tectonic framework, the gravity field and five crustal evolutionary stages (Archean to post-Gondwana).

Chapter 2 describes the 3.5-Ga-old Barberton greenstone belt, the type area for komatiitic volcanic rocks, which also contains the oldest well-preserved submarine fan deposits (Swaziland Group) and prograding delta complex (Moodies Group). Evidence of vigorous tidal action indicates that the Earth-Moon system already existed 3.5 Ga ago. Cratonization began about 3.0 Ga ago, whereas in the Zimbabwe Province greenstone belt formation continued for another 400 Ma.

Chapter 3 on the Limpopo Province covers a time span of more than 1 000 Ma. This province has been the site of repeated complex deformation and metamorphic events (up to granulite grade), followed by cratonization 2.5 Ga ago, and subsequently by 800 Ma of repeated uplift and erosion. These have supplied enormous volumes of detrital sediments to the large early Proterozoic epeiric basins of the Kaapvaal craton. No satisfactory geodynamic model has yet been proposed to explain this long history of mobility.

Chapters 4, 5, and 7 deal with the early Proterozoic basins. These contain the world's largest Au and U placer deposits (Witwatersrand Supergroup), the largest known early Proterozoic carbonate sequences (deposited in platform-platform edge to basinal environments and overlain by the extensive iron-formation of the Transvaal basin), and the first continental red beds (Waterberg Group).

The Bushveld Complex and Vredefort Dome are the subject of Chapter 6. The Bushveld magma was intruded through five vents into the Transvaal sequence, and the geochemistry of the magmatic layering is fully discussed. The astrobleme hypothesis of the origin of the Vredefort structure seems to have been refuted by the discovery of shatter cones on a fault-breccia produced by downfaulting of already overturned rocks.

Chapters 8 and 9 integrate, in an exemplary way, the numerous recent studies on the mid-Proterozoic Namaqua-Natal Province and the Pan-African geosynclines. The contrasting ensialic and plate tectonic models for the intracontinental branch of the Damara Belt are also succinctly presented.

In Chapters 10 and 11 the paleogeographic positions of the Cape and the Karroo Basins, and the depositional environments of their sediment sequences are clearly related to the position of the subcontinent in Gondwanaland. Important sediment sources were situated outside the present borders of the continent.

The formation of fault-controlled Mesozoic landlocked and offshore basins is dealt with in Chapter 12, which also discusses the breakup of Gondwanaland. Chapter 13 presents an overview of the numerous Proterozoic to Cretaceous carbonatites, kimberlites and alkaline complexes, and looks at relationships and genesis. Finally, Chapter 14 deals with Cenozoic changes of sea levels, climates and faunas, the australopithecine cave breccias, and diamondiferous river and coastal terraces.

The authors have covered the enormous sweep of time and the wide range of subjects in well-balanced chapters, and have presented controversial ideas and interpretative models without bias. The book has been brought up to date, almost to the time of publication, by the inclusion of numerous personal communications. The subject matter is fully covered by 48 pages of references and a 20-page index. The tables and figures are informative and easy to read.

There are no serious omissions, although a stratigraphic table of the important volcanosedimentary Sinclair sequence in Namibia could have been included. The reviewer noted only one factual error: the depth of the Fish River Canyon is only 500 m, not 1 000 m.

The authors have written the book for "advanced undergraduates, graduate students and professional geologists". They have succeeded admirably. The book is a must for every geoscience library.

Alex L. du Toit would have been proud of the dedication.

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THE SEA FLOOR

E. Seibold and W.H. Berger.

Springer-Verlag, Berlin, F.R.G., 1981, 288p. \$20.00 (U.S.)

This book is intended as a brief survey of marine geology, written in the belief that "to study introductory geology and oceanography and environmental science one needs a summary of the tectonics and morphology of the sea floor, of the geologic processes active in the deep-sea and in shelf seas, and of the climatic record in deep sea sediments." The authors have endeavoured to write for those who might be interested in the subject, including those who have no formal training in the natural sciences.

The Sea Floor was developed from a book published earlier by Eugen Seibold, the senior author, and used as a supplementary college text in Germany. This edition has been rewritten and translated into English by W.H. Berger, who has also added discussions of deep-sea sedimentation, Pleistocene oceanography, and results from the Deep Sea Drilling Project.

The book begins with a useful and concise historical perspective of the pioneers of marine geology, and provides a nice human touch to the science that follows. The first two chapters concerning the origin and morphology of the ocean margins and basins provide a necessary prelude to the main thrust of the book, although they can be found in almost all introductory geology texts. In this book, however, a pleasing style emerges that continues throughout. The clear, almost chatty writing style, is inquisitive rather than didactic, emphasizing what is not yet known. Provocative questions are scattered throughout almost as though one were listening to a lecture rather than reading a book. The connection between chapters is natural so that the text flows and is not compartmentalized into separate and distinct elements.

The real core of the book - the physical, chemical and biological environment that comprises the sea floor - begins in Chapter 3. Here, the sources and composition of marine sediments are nicely summarized. This is followed by chapters on waves and currents and sea-level processes that are discussed in an intelligible fashion. Chapter 6 on organisms on and in the sea floor is a disappointing treatment with only 18 pages devoted to such an important and relevant topic. It is followed, however, by a discussion on the importance of climatic zonation on marine sedimentation. Deep-sea sedimentation is well-documented in Chapter 8, but here the brevity of description begins to wear thin even although diagrams and tables are crammed with information.

One of the most stimulating parts of the book is contained in Chapter 9 on Paleoceanography: The Deep-Sea Record - an engaging account of what has been accomplished by looking at deep sea cores. The final chapter outlines the resources of the ocean floor, although like the chapter on organisms, this is rather thin and certainly could have been expanded.

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Following the text, there are nine appendices spanning 13 pages, which range from topographic and bathymetric statistics to the geologic time scale, periodic table of elements, common minerals and rocks, geochemical abundances, radio-isotopes and dating, and a systematic overview of the major marine organisms important in sea floor processes. The diagrams are all good quality and the text is only slightly marred by a few typographical errors.

This is a good book. It is a lucid text for someone not familiar with the nature of the sea floor, yet who has some training in the natural sciences in order to appreciate the value of the book. It is an excellent overview, although it lacks the depth required for a full course text, except perhaps during the early years of university.

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THE CENOZOIC ERA: TERTIARY AND QUATERNARY

Charles Pomerol

D. Curray and D.T. Donovan (eds.) Translated by D.W. and E.E. Humphries

Ellis Horwood Ltd., Chichester and Halsted Press (J. Wiley and Sons), New York, 272 p., \$67.95 (U.S.)

Over the past decade, Pomerol, an imaginative and resourceful professor at the University of Paris (VI), has attempted to fill a very serious gap in geological literature by re-creating the historical record of stratigraphy and paleogeography in terms of new global tectonics. Three volumes (in French) covered *Ère Cénozoïque* (1973), *Mésozoïque* (1975) and *Pré-cambrien et Paléozoïque* (1977). Ellis Horwood has now taken the initiative in getting one of these volumes into the hands of the English-speaking world, and the Humphries, who translated the work, combined experienced, professional and linguistic skills to bring us a superbly crafted work.

The French original and the English translation are almost identical in length, benefitting from the advantage of scientific English in its ability to express things in a more compact style. The French edition had the visual advantage of two colours, but little has been lost in the English monochrome maps. However, the photographs, mainly of fossils and classical type sections, are too high in contrast and much better in the original. This is my only really serious criticism. The book will be extremely useful for monolingual, English-speaking students, as a richly illustrated guide to the classic type areas, and for its re-creation of past environments on a wide scale.

The main thrust of the volume is toward key definitions and type sections, together with enough stratigraphic paleontology for anyone to find their way through the fossil lists. Chapter 1 introduces the era and in just eight pages gives a light treatment of Cenozoic global plate evolution. Chapter 2 gives a general picture of the Paleogene, enriching the stratigraphic paleontology with copious figures and very detailed diagrammatic illustrations of the various zone fossils. Chapter 3 presents in satisfying richness (57p.) the Paleogene of France. Where else would one go for so many classical type sections? And Chapter 4, the rest of Europe.

Chapters 5, 6 and 7 deal with the Neogene, in general, in France and in Europe. Next come three interesting regional chapters on the Cenozoic of North Africa (8), North Sea (9), and the Channel (10). In 10 pages Chapter 11 deals with the Tertiary of the rest of the world - scarcely more than one vitamin pill for a hungry person. And finally comes the Quaternary (12) which gets 33 pages, an unusually generous treatment in a world that often refers to anything above the

Pliocene as "overburden." The indexes at the end are useful, though rather brief. The reference list is extremely good, although more than 95 per cent French.

The Cenozoic Era is worth a very detailed study because it is not only the youngest major unit of geologic time, but by far the best known. Many principles can be learned here that for the earlier eras must be assumed, or inferred on the basis of less completely preserved records.

Paleogeographically, the Cenozoic covers a time span of progressive global evolution from a rather symmetrical, thalassocratic world warmed by continuous equatorial seaways, to a highly asymmetric, epeirocratic world with its oceanic circulations segmented and broken into N-S oceans. Climatically the Cenozoic marks an era of secular change from oceanicity to continentality, associated with a concurrent eustatic fall of about 300m.

Superimposed on all these secular trends are the pulsations provided in part by intercontinental collisions (notably the "Pyrenean" near the Eocene/Oligocene boundary, and "Rhodanian" phase about the Miocene/Pliocene boundary). Pomerol (p. 147) makes the point that in the late Miocene and leading up to the Messinian "salinity crisis", Africa and Europe were united "for the first time in the Earth's history." So much for Pangaea. In this reviewer's opinion it was the blockage of the warm, E-W currents of Tethys that ultimately led to global cooling and the continental asymmetry that resulted in the extreme climatic fluctuations of the Quaternary Ice Age, although Kennett and others present strong evidence for the role played by the opening of the E-W circum-Antarctic ocean and its cold currents. The more general refrigeration did not in fact begin until the Pliocene.

There are the small, inevitable little errors. For example, Saale gets a footnote "Polish River", intended for Vistula (p. 225). But by and large the standards of printing and proofing are excellent. For those geologists contemplating a serious study trip to Europe, there could be no better general guide than Pomerol. For actual guidebooks to the quarries and outcrops the wise traveller should visit Masson in Paris and get appropriate volumes of the Pomerol-edited regional guides, which, shaped and planned like Michelin guides, effectively direct one to the precise spots (see EPISODES, 1981/1, p. 41).

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MINERAL DEPOSITS AND GLOBAL TECTONIC SETTINGS

A.H.G. Mitchell and M.S. Garson.

Academic Press, London, U.K., 1981, 405 p., 23.60 pounds; \$48.50 (U.S.)

The "plate tectonics revolution" made the 1970s the most exciting decade ever in the earth sciences, and the study of mineral deposits in that context was probably the most dynamic aspect of that revolution. In this book Mitchell and Garson emphasize plate tectonic settings, which they divide into six main environments: con-tinental hot spots, rifts and aulacogens; passive continental margins and interior basins; oceanic settings; subduction-related settings; collision-related settings; and transform faults and lineaments in continental crust.

These environments are examined in 22 subdivisions, many of which are repetitive (for example, "Cyprus-type" ophiolitic deposits are discussed under five different settings on p. 120, 168, 250, 260, and 292), as well as to a number of "red herrings" which have little tectonic and no metallogenic significance. For example, in Chapter 7 on "Transform

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Faults and Lineaments in Continental Crust", the authors use 20 pages to discuss hypothetical relationships between these features and ore deposits; if true, these relationships would invalidate the main plate tectonic theme of the book, as they themselves recognize on p. 335.

Much of the book is highly conjectural, as illustrated by the following two quotes:

"The size of the (Proterozoic U-bearing) sedimentary basins above the unconformity suggests that they are related in some way to tectonic processes at plate boundaries; possibly they may have formed either on overriding continental plates landward of an arc system or within continents undergoing incipient rifting." (p. 111).

"Had plate convergence continued in the Missouri area, the mineralized province would have become a foreland thrust belt and the outer arc would have been largely eroded." (p. 289)

Each chapter concludes with a speculative section termed "preservation potential." It would be an unwise exploration geologist who decided not to look for a particular type of deposit because of its poor preservation potential. At least one of any type of deposit must have been preserved, in order for it to be recognized!

The chapters on specific environments are followed by one (Chapter 8) on "Mineral Deposits and the Wilson Orogenic Cycle," which is well done but more appropriate for the introduction. The final chapter on "Plate Tectonics as a Guide to Mineral Exploration" is not the grand finale one would expect, but simply a disappointing collection of generalities. Indeed the authors' opening tenet that "The geological guides to the mineral potential of an area, however sophisticated in detail, all fall within one of three main concepts, involving lineaments, stratigraphic correlation or analogy" would be disputed by most exploration geologists.

The quality of figures in the book varies greatly and the letters or ornamentation on many are blurred or faint. Many have errors or are poorly explained, e.g., Figure 2 (no symbol

for Sn/W, Cu/Zn, fluorite; no explanation of JA, AM, etc.), Figure 5 (black belts need explanation; what is the line of section?), Figure 33 (is the scale km or mi?).

There are numerous annoying errors in the text, such as the statement on p. 116 that the Mid-Atlantic Ridge has "a narrow inner rift valley floor at least 2 400 km deep, and several kilometres wide". Other errors could mislead the unsuspecting student (e.g., Zn/Y ratios, p. 141; Mg/Ro ratios, p. 144; and Rocky Downs, Australia, p. 109 and 110). I expect that many would be surprised to find that the Roxby Downs/Olympic Dam deposit is an "unconformity vein-type deposit" (p. 109) or, having been called the most important discovery of the century, that it and other deposits of the Adelaidean sequence of South Australia are "sub-economic" (p. 67). The book would clearly have benefitted from some rigorous proofreading, especially by an economic geologist. I also trust that the inaccurate and outdated description of the Newfoundland sector of the Appalachians is not a measure of reliability for other areas discussed.

In my opinion the book should not be recommended to the "many Heads of Earth Science Departments" who requested it as a reliable "textbook for use by senior undergraduate and postgraduate geology students" nor to "economic and exploration geologists and other earth scientists" as an indication of "recent advances in understanding of global patterns of tectonics and mineralization" (Preface, p. ix).

Despite these severe criticisms, Mitchell and Garson are probably two of the best-informed English-speaking geologists for these vast areas because of their extensive experience in southeast Asia, the south Pacific, and Africa. This comes through in the book for they repeatedly turn to these regions for examples, especially of tectonic settings and mineral deposits. Thus, the volume does provide a valuable overview of and reference to these regions. On that basis, it deserves to be on library shelves as an essay by two authors experienced in global tectonics, with their views and speculations on one aspect of the plate tectonics revolution.

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