BOOK REVIEWS

ACCRETION TECTONICS IN THE CIRCUM-PACIFIC REGIONS

M. Hashimoto and S. Uyeda (eds.)

D. Reidel, 1983, 358p. \$85 US (H).

It has become fashionable to produce handsome volumes of papers read at scientific meetings. Commonly only a loose thematic thread connects such contributions. In this respect the collection of papers under review, presenting the results of the Oji (Japan) International seminar held in September 1981, is an exception. First the topic of accretion tectonics is reasonably compact as a subject, and second the vast majority of the articles deal with the northern Pacific region. Thus thematically and geographically the main topic is well constrained. An additional emphasis on Japan helps in focussing the numerous diverse presentations.

The first paper on the "Break-up and Accretion Tectonics" by A. Nur and Z. Ben-Avraham (U.S.A.) provides a broad conceptual framework. Thereafter the volume is divided into six sections: North America to Northeast Asia (5 papers), Hokkaido, North Japan (5 papers), Southwest Japan (6 papers), Japanese Cenozoic ophiolites (2 papers), Southwest to South Pacific (3 papers), and geophysics and metallogenesis (3 papers). The level of editing is generally high although in places errors creep in, as for example on page 333 we find "Geophysics and Metal Logenesis!" There are here and there a few awkward renderings into English, but considering that most authors are Japanese, it is remarkable how well most of the papers read.

The thrust of the book is mainly geological, although there are a handful of specifically geophysical papers. In many instances geophysics and geology are explained in the same contribution. The paper by Shyoji Tonouchi and Kazuo Kobayashi is a particularly cogent example of combining palaeomagnetic and structural data on ophiolites and related rocks in South-Central Honshu, they suggest that in fairly recent geologic time there have been jumps in the position and orientation of the subduction zone. On a much more theoretical basis the article by Yoshiaki Ida represents an attempt to evaluate forces acting on subducted lithosphere. Y. Tomoda and H. Fujimoto examine the "roles of seamount, rise and ridge in lithospheric subduction."

Of geological papers the papers on Japan, as a batch, are outstanding. Virtually the whole area of the country from north to south is covered with the aid of petrology, petrochemistry, structural investigations and geophysical and geochemical data. The level of presentation is high and the basis of interpretation rests on plate tectonics and mechanisms of accretion. For anyone interested in relationships between structure, petrology and geochemistry in Japan and modern tectonic principles the book is a must. Moreover, the structure of the Japanese islands is then ably continued into the Soviet Union by B.A. Nalal'in and L.M. Parfenov, in a separate work by G. Kimura and others and then into Alaska by M. Churkin, Jr. Surprisingly all of these pieces fit. Of

course, because there is some overlap in geological topics there is some duplication: a block diagram on p. 216 is turned 180° and repeated on page 228. Yet, these are small blemishes and the wealth of material is not impaired.

Several papers emphasize the coexistence of ophiolites and mélanges and the settings where these are found. M. Komatsu and others interpret obductive thrust relationships with regard to the well-known ophiolite-mélange Kamiukotar Belt in Hokkaido. I. Suzuki and S. Hada describe a Cretaceous accretionary mélange that continues within one of the most fundamental terrains, the Shimanto Belt. In a very interesting discussion Y. Ogawa elucidates the relationships of oceanic crust, the overlying sediments and the mantle rocks during the lithospheric interaction in a situation where three major plates were involved. The author visualizes changes from normal subductive relationships to highly oblique transpression. This is a fascinating tale.

The volume is indispensable to all geologists who attempt to interpret pre-Mesozoic orogenic structures in terms of plate tectonics. After all, interpretations have to be supported by properly elucidated data. The days of the simple collision are over.

Nicholas Rast
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EARTH'S EARLIEST BIOSPHERE: ITS ORIGINS AND EVOLUTION

J. William Schopf (ed.)

Princeton University Press, Princeton, N.J.; USA 543p. 1983
(H) \$95, (P) \$42.50

This book chronicles a revolution in the understanding of the first three-quarters of earth's history: it is an end and a beginning. It is fitting that the first chapter is by Preston Cloud for he has done more than anyone to bring about a dramatic shift of prevailing views and to demonstrate the importance of biogeology and to integrate it with biochemistry, genetics, geochemistry, sedimentology, and atmospheric and aquatic chemistry in a geochronological framework.

Cloud's work has been taken up by J. William Schopf who had the dream of a major multidisciplinary attack on the problem of life's origins. The dream became reality when he was given the Alan T. Waterman Award and these funds were matched by NASA. In 1978 he initiated the Precambrian Palaeobiology Research Group, a joint research program based at the University of California at Los Angeles. The result is this report. Of the twenty-one authors, sixteen are from the U.S., two each from Canada and Germany and one from Australia.

The book is organized so the reader can quickly trace the main evidence and argument through the wealth of information offered. Each of the fifteen chapters is an independent research report, with its own summary and cross-references. An invaluable introduction by Schopf emphasizes further the interdependence between them. There are four appendices, two glossaries, an index, and a single list of references with each referred back to the relevant chapter. The text-figures and tables are major features of the work and summarize large amounts of information and interpretation. The photographs are particularly striking and serve well to authenticate the claims made in the text.

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The story begins with the origin of the earth by "homogeneous accretion" 4.5 Ga ago, with the relatively rapid formation of the geomagnetic core, mantle differentiation and associated outgassing. The Archean rock record older than 2.5 Ga is reviewed and the physical conditions then prevailing inferred, and this leads on to consideration of cratonization and possibilities of plate tectonics through time. Concurrently with these events, prebiotic organic synthesis and the origin of life must have taken place. A variety of early atmospheres are modelled, and it appears that synthesis might have been possible in several kinds of reducing or neutral atmospheres; further possibilities for research are identified.

It is recognized that life may have originated during the Hadean stage of development of the Earth, a time from which rocks are as yet unknown. The earliest Archean rock sequences are mainly highly metamorphosed, and direct geochemical remnants in them of biologic or abiotic organic compounds may be all but obliterated. Nevertheless, attempts are made to trace the biochemical evolution of anaerobic energy conversion and the transition from fermentation to anoxygenic photosynthesis. The isotopic composition of sedimentary carbonates has varied within relatively narrow limits since early Precambrian, and carbon isotope ratios in sedimentary organic matter 3.5 Ga old and younger have values consistent with the existence of autotrophs. Isotope patterns of sedimentary sulphides attributable to microbial sulphate reducers can be traced back to about 2.7 Ga.

The first fossils are stromatolites, similar to forms that occur later in the Proterozoic and Phanerozoic. Eleven probable Archean occurrences are reported from North America, Southern Africa and Western Australia. The oldest are from the 3.5 Ga-old Warrawoona Group of Western Australia. They became an abundant component of the sedimentary environment by about 2.8 Ga. Out of a total of 28 Archean units reported to contain microorganisms, only two are authenticated. The earliest also occur in the Warrawoona Group associated with the first stromatolites. They consist of an entirely prokaryotic biota, which probably includes both heterotrophic and autotrophic forms, some or all anaerobic. Their complexity and diversity suggest that life may have started on Earth substantially earlier. The dominant life form by the late Archean may have been the cyanobacteria, producing free oxygen in the ocean, though this could also have begun earlier.

A major transformation of the geologic setting began 3.1 Ga ago with the onset of extensive cratonization and associated changes in internal heat flux, which had profound effects on the Earth's sedimentary regime. Environmental changes of importance to life accompanied this transition, and effects considered in this book include the formation and distribution of banded iron-formations, sedimentary sulphates, glaciogenic sequences, and red beds. But from the point of view of development of life there is no indication of profound changes in most biologically important parameters since the beginning of the rock record.

As free oxygen increased, there were changes in life involving the evolution of systems of protection against oxygen and of systems of metabolic and biosynthetic oxygen use. Out of some 40 reported occurrences of Early Proterozoic microfossils, 23 from four continents are authenticated and their morphology described and illustrated. Five principal categories are recognized, all prokaryotic. With the evolution of new metabolic systems, life forms increased in diversity. The end of the story may be considered to be marked by the appearance of the true eukaryote cell at about 1.5 Ga, thus opening the way to morphological evolution and the metazoa.

This brief summary cannot do justice to the wealth of information within this volume and the coherence with which it is presented. Although some of the ideas put forward are already being modified, this synthesis must stand as a major milestone on the long road to an understanding of the early evolution of the crust of the earth and the origin and influence of life.

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FIELD MAPPING FOR GEOLOGY STUDENTS

F. Ahmed and D.C. Almond

George Allen & Unwin, London, Boston, Sydney, 1983, 72p., \$6.95.

This book takes the student through the basic procedures involved in a geological mapping project, from planning and through field observations to the preparation of maps and the final report. The authors assume "that the user... has probably received at least a short introduction to mapping methods in the field." As a consequence, the techniques mentioned are not always described with the sort of explicit detail that could be followed by an absolute beginner. The level of geology assumed overall is about the second year of a degree program, though some of the information contained in check lists and appendices goes beyond that. The book is liberally laced with sound practical advice reflecting clearly the authors' field experience in Africa and the Middle East, so the book is relevant to many developing countries. Students who are not native speakers of English will appreciate the generally simple language and good use of illustrations in this book.

The opening chapter on planning discusses the choice of mapping scale in relation to available field time, and it mentions the desirability of making a preliminary photogeological interpretation. Hints are provided on how to get the most from field time using reconnaissance and carefully organized traverses.

The section on fieldwork clearly distinguishes observations from interpretations, and provides advice on sketching and collecting samples at an exposure. To jog the memory, there are extensive check-lists of lithology and primary structures for the main rock types. Field description of tectonic structures is very effectively aided by a series of diagrams illustrating terminology for fold, shape and attitude. In addition, cleavage/bedding relations, common structures that indicate direction of tectonic movement, fifteen types of way-up evidence and various styles of intrusive igneous contact are illustrated.

The fieldwork chapter also discusses selection of mapping units and how to map contacts. The description of field measurement techniques includes determination of scale and orientation of aerial photographs, strike and dip of planar structures, direction and plunge of linear structures, topographic height, and true thickness. Good use is made of explanatory diagrams throughout. The account of production of final maps and reports is straightforward, and is followed by appendices listing field equipment and supplies, map symbols, and common abbreviations used in rock description.

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The brevity and resulting low price of the book are to be applauded, but there are some important omissions. In particular no instruction is provided on how to use aerial photographs despite the recognition in the book of their value in all stages of field mapping. The book would have also benefitted from an example of a typical field notebook layout to help the student over initial uncertainties about what to record and how to record it. For similar reasons, examples from a variety of geological terrains would have been useful; the only one included represents an enviably simple sedimentary sequence.

Despite these criticisms, I like the book. The authors have tackled an extremely difficult topic in a logical fashion, and they have packed a great deal of well-presented information into this slim volume. The book conveys the feeling that Ahmed and Almond enjoy field mapping, and their advice shows a sympathetic awareness of students' problems. Armed with this text, students are more likely to find their first mapping assignment a useful, and perhaps even pleasurable, task; rather than a confusing and arduous exercise which may put them off field mapping for life!

R. Crossley
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PRINCIPLES OF LAKE SEDIMENTOLOGY

L. Håkanson and M. Jansson

Springer-Verlag, New York, 1983, 316p, \$39.00.

It is an unfortunate reflection of man's impact on the environment that modern limnology has become so much more concerned with interactions between sediment and water than it was, even a decade or so ago. The effects of level control, nutrient enrichment ("cultural eutrophication"), contaminant inputs, and depletion of fish and wildlife stocks have put great stress on many freshwater systems. This has led, in turn, to a much greater need to understand all limnological processes, including the role of sediments, and to devise various means of lake rehabilitation and enhancement.

In recent years, there have been many publications concerned with the role of sediments in lakes and other freshwater systems, with the result that the field of interest remains widely scattered through many disciplines and their associated journals. Håkanson and Jansson's contribution provides a timely and valuable access to this modern literature and serves as a useful link between diverse interests. Their book provides an overview of the role of sediments that is long overdue.

The authors state that they have attempted to present a book on "how and why" and to provide a multidisciplinary perspective, and in both cases they have achieved much success. The authors cover much more than the title indicates, the book is indeed a compendium of sediment-water interaction in lacustrine systems. As noted by Håkanson and Jansson, their work has been strongly influenced by two conferences on sediment-water interaction held in 1976 (Amsterdam) and in 1981 (Kingston, Ontario; incorrectly referred to as Hamilton). Interestingly, these meetings also spawned another

recent publication published by Unesco in its Technical Papers in Hydrology series (#26). This is designed as a guide for the collection and interpretation of sediment quality data.

The first chapter describes lake types and sediment types, relying much upon the literature. In the chapter on sampling, the authors draw more from their own experience and, although descriptions and discussions are kept short, the use of numerous figures helps to clarify the text. The authors review both equipment and sampling patterns and densities in one chapter and, as a result, some important aspects of sampling have received less detail than they deserve.

The chapter on physical and chemical parameters provides a brief but sufficient coverage of sediment water content, loss on ignition, bulk density and grain size (and size distribution analysis), but its treatment of chemical parameters is inadequate, and would have been better as a separate discussion. The review of organic compounds could then have been included in the later chapter on bacterial decomposition; the remaining description of minerals in lake sediments would then receive better focus. The discussion of biological parameters is a useful adjunct and certainly helps the reader to appreciate not only the range of forms and species but also their roles in sediment formation and reworking. It is also helpful that the role of bacteria is given special attention although, again, the authors may be criticised for not providing yet more detail ... especially since they state that "the importance of bacteria and bacterial processes in sediments is paramount."

The chapter on sedimentation in lakes and water dynamics deals with transport and settlement of particulates, drawing from many excellent studies on Swedish lakes. In the following discussion on lake bottom dynamics, the authors briefly discuss entrainment and turbidity currents, and Håkanson draws heavily on his own work relating basin morphometry and wind/wave interaction. The discussions of sedimentary structures are well supported by core photographs, and the significance of bioturbation is well illustrated and described. Both dynamic and empirical approaches to the biological transport of sediments are presented, including a computer program. Unfortunately, however, the discussions on sediment dating provide little more than an introduction to the topic. The authors barely mention varve analysis and completely omit reference to such classical techniques as pollen stratigraphy.

The chapter on phosphorus release seems out of place, the topic being more easily considered earlier with chemical processes or perhaps within the last chapter, which presents a series of case histories illustrating the use of sediment studies in pollution assessment.

The book covers a broad spectrum in environmental science, but it lacks sufficient depth in places, and the selection and sequence of chapter headings does not always lead to an easy flow of thought. The authors have drawn heavily upon European and North American studies and, unfortunately, there is little reference to lake systems in other parts of the world. The authors also tend to ignore the effects of geological change upon the distribution of sediment types, and it must be stressed that not all sediment at the surface of a lake bed is of modern age. Nevertheless, the authors have packed a wealth of useful information into a relatively small volume, which demonstrates the significance of lake sediments in environmental studies, and presents several interesting case histories. The book will certainly help managers to understand the value of sediment studies, and it will be of equal value to students. For the scientist and engineer, additionally, it provides an excellent source of many recent references.

Peter Sly
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Book Reviews ...

CIRCUM-PACIFIC PLUTONIC TERRANES:

J.A. Roddick, (ed.)

Geological Society of America Memoir 159, Boulder, Colorado, U.S.A., 1983, 316p, Price \$42.00.

This volume contains 17 review articles on the Phanerozoic granitic rocks of various segments of the Pacific margin, from New Zealand clockwise around to Chile. A product of IGCP Project 30, it provides many good descriptive summaries. The best of the reviews, particularly those by C.S. Hutchison on Southeast Asia and by D.W. Hyndman on the Idaho Batholith, are excellent summaries of field, petrographic, geochemical, and geochronological data. Most of the rest present useful, if limited, summaries of chemical and modal data, but not generally in forms that permit the reader to evaluate conclusions. A few papers are vague and cursory, and many show by ambiguities, inconsistencies, and the use of obscure place names not on accompanying maps, a lack of critical review.

Most of the contributions contain extensive bibliographies through 1980, though some authors heavily cite their own publications.

Only Hyndman integrates experimental and petrologic data and concepts with his interpretations, and he alone considers variations in magmatic systems as functions of depth, recognizing that the Idaho Batholith is floored by migmatites. Other authors who discuss petrogenesis do so mostly in simplistic terms of magmas that are batch-melted here and crystallized there. One looks in vain for sophisticated concepts of zone refining, variable wall-rock interaction, depth variations of mineral phases and water contents, and for analyses of obliquely eroded crustal sections that provide direct information on vertical variations.

A.J.R. White and B.W. Chappell recycle their often-published speculations on what they designate as "S-type" (sedimentary source), "I-type" (igneous source), and "A-type" (anorogenic) Australian granites. They present some excellent new data, but still appear to be unaware that the solubility of water in melts and the availability of water in crustal rocks both vary with depth. Such variations must be integrated in any viable analysis of the contrast between granites crystallized from warm wet magmas (most "S" granites) and those from hot dry magmas (most "I" granites).

Plate-tectonic concepts appear to have had minimal impact on most authors in this volume, for only a few think it likely that the rocks of their particular domains are products of plate interactions. The volcanism of modern continents is mainly a byproduct of subduction of oceanic lithosphere, and it is my own conviction that the formation of igneous rocks and high-temperature metamorphic rocks at all levels in continental crust has been dominated throughout geologic time by arc magmatism.

G. Gastil (for Mexico and southern California) and Hyndman properly emphasize that collisions of oceanic island arcs with North America provide explanations for features in their

respective areas. Hutchison largely adopts my own multi-plate analysis of Southeast Asia, though he seems to accept rather uncritically "dates" based on the assumption that whole-rock strontium isotope analyses of unrelated samples with high initial ratios of $^{87}\text{Sr}/^{86}\text{Sr}$ can be used to define isochrons. A similar analysis of Thailand by S. Suensilpong and his colleagues is accompanied by very little data.

Relationships in Peru also in my view require multi-plate complexities, but E.J. Cobbing and W.S. Pitcher present an unlikely model of exclusively Andean subduction. Chile (L. Aguirre), British Columbia (J.A. Roddick), southeast Alaska (D.A. Brew and R.P. Morrell), northeast U.S.S.R. (N.A. Shilo and colleagues), southeast Australia (White and Chappell), and New Zealand (A.J. Tulloch) are other regions that, for me, need multi-plate explanations; they receive, however, only a variety of "stabilist" assumptions from their authors. Korean granites (O.J. Kim and D.S. Lee) are explained in terms of a geometrically impossible plate system. Melanesia (T.J. Griffin) is explained in terms of a hybrid of arc magmatism for active island arcs, and assorted non-arc processes for continental magmatism.

Other authors give little attention to tectonic or thermal settings. Instead of considering plausible heat sources, and of analyzing tectonics in terms compatible with modern analogs and with physical principles, there are conjectures involving, for example, brittle faults that cut the entire crust at magmatic temperatures, and melting due to "crustal buckling" or to uniquely high crustal radioactivity. Nevertheless, any petrologist working with granitic rocks will find much of value here for regions with which he is unfamiliar. The book, however, is generally a poor place in which to seek new concepts.

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INTERNATIONAL SYMPOSIUM ON PAN-AFRICAN CRUSTAL EVOLUTION IN ARABIA AND NORTHEAST AFRICA

The second IGCP-164 symposium will be held from the 1st to the 10th of February 1985 in the Faculty of Earth Sciences, King Abdulaziz University, Jeddah, Saudi Arabia. Field excursions are planned after the symposium. Papers are invited. For details, please write to Dr. Ahmed Al-Shanti, Project Leader, IGCP-164, P.O. Box 1744, Jeddah 21441, Saudi Arabia.

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