BOOK REVIEWS

SHALLOW TETHYS 2

K.G. McKenzie (ed.)

Proceedings of the International Symposium on Shallow Tethys 2, Wagga Wagga. A.A. Balkema, Rotterdam, Boston, 1987, 544p., \$58.50 (US)

This is the proceedings of the second international symposium on "Shallow Tethys" convened in Australia in September 1986. The book contains 38 full papers and 14 abstracts, from a total of 52 authors. Thirty-two of the papers are palaeontological, with varying emphases on palaeobiogeography, palaeoecology, stratigraphy and sedimentation. The book appears to have been produced from author-prepared copies but with absolutely uniform type, and it is pleasing to the eye throughout. Although the editing was more "lenient than severe," the book reads remarkably well, with few errors apart from the annoying omission of a large number of missing references.

Most readers no doubt would want to know what is meant by the unusual title "Shallow Tethys." Many would expect that the shallower parts, the shelves or marginal epicontinental seas, of the Tethyan ocean are implied, and this is indeed what some authors who contributed full papers have understood. However, for many others the term seems to refer to an epicontinental sea that never was an ocean!

This view apparently was the moving spirit behind both of the Shallow Tethys symposia, as revealed by the following excerpt from the Foreword to the first symposium (Padova, Italy, 1982), "Several papers addressed the nature of the Tethys, a critical factor in modern geotectonic interpretations. Was it wide or narrow, shallow or deep? Referring to classical Tethys, the Mesozoic ocean separating Eurasia from Africa, one consensus appeared to be that, during the later Mesozoic at least, Tethys was not the broad deep ocean of classical theory but rather a number of relatively narrow sea lanes interrupted by continental blocks . . . in which depths were possibly not much greater than about 500 m. . . . It also seems likely that the vast wedge-shaped Tethys of Wegener's Pangaea reconstruction may have to be abandoned for a narrower (and shallower) seaway as proposed in some recent palaeogeographical syntheses."

A number of the authors (including the Editor) take the same view - one which in my opinion, ignores a vast body of diverse data: regional geological, palaeomagnetic, and even palaeobiogeographical! Carey and Boucot and Gray, for example, pay little attention to regional geology and palaeomagnetism and so end up with expanding Earth models, in an uncritical and dogmatic approach that provides little useful information. A magnificent contrast, on the other hand, is provided by Burrett and Stait and by Talent, Gratsianova and Yolkin, who treat with respect the palaeogeography of the "Tethyan" margin of Gondwana-Land and of the middle Palaeozoic of the entire Asia-Australia hemisphere. These are thoughtful and scholarly contributions with broad, diverse databases and a rigorous, critical evaluation of the available information.

Some authors, such as F. Ahmad, J.B. Waterhouse, and J.M. Dickinson, appear to have set up strawmen. The first two, for instance, attack the notion that the Indus-Yarlung Zangbo

line represents the suture of the Permo-Triassic Pangaeic embayment. Waterhouse states "in recent years a number of workers have stated that the suture between Gondwana and Laurasia extends along the Yarlung/Zangbo fault system in Tibet - continuous with the upper course of the Indus River and suture. To be blunt, this assertion is totally false." Being equally blunt, I would call this statement nonsense. First, in the last decade no one who knew anything about the Himalaya ever called the Indus-Yarlung Zangbo line the Gondwana-Land/Laurasia suture without specifying time, and, second, everyone has known that the Gondwana-Land/Laurasia suture, with respect to the late Palaeozoic-early Mesozoic Tethys, is in northern Tibet!

An additional unfortunate feature of these papers, shared by most in this book, is the constant confusion between the palaeobiogeographic and the tectonic concepts of Tethys. Many authors describe local details and then extrapolate without justification. For example, Xiang Liwen describes the Permian of the "Tethyan block," without reference to which of at least five such Tibetan units he is talking about, and of "South China" (presumably the Yangtze block). He concludes that "the Tethys" was shut by the end of the Permian, thereby ignoring 500,000 km² worth of Triassic flysch that lies between the Bayan Har and the Xikang Groups of the Songpan-Ganzi System.

The papers making up the Mesozoic and Cainozoic sections of the book are much better informed. Many present useful palaeobiogeographical information, quite a few with rich faunal lists. Regional geological papers, though few, are of higher quality than their counterparts in the Palaeozoic section, the most outstanding being the very informative contribution by Yeates and co-workers on the Westralian Superbasin. Most of the papers here deal with the slope/shelf and the marginal platform ("shallow") areas of Neotethys, and the net effect is to present a distorted image of the Tethyan ocean, although individual authors may have had no such intention.

The editor's epilogue, entitled "Tethys and her progeny," thus arrives at the statement "Thousands of kilometres of oceanic crust necessary to validate the plate tectonics-based maps cannot be located on the ground." As long as such symposia do not include contributions from those who study the ground where the former ocean floor and deep-sea deposits of both Palaeo- and Neotethys are exposed (e.g. the Songpan-Ganzi System, Oman and the like), I fear that all future "Shallow Tethys" meetings will be doomed to reiterate the same curious and absurd conclusion.

Despite the abundance of palaeontological and palaeobiogeographic data presented in many of its constituent papers, this remains a shallow book. It is dominated by palaeontologists working on shallow-water fauna without displaying any understanding of fundamental Tethyan problems. They appear to communicate with neither those who study Tethyan deep-sea fossils, nor with those who for years have mapped Tethyan ophiolites and magmatic arcs or collected palaeomagnetic and palaeobiogeographic data that bear witness to the disappearance of vast oceanic tracts. Despite the editor's claim that the book is "crock-full of data in tectonics, sedimentology, palaeoecology, palaeobiology and palaeobiogeography," only the last two classes of data are indeed abundant, and in terms of tectonics, the book is out-of-date and very misleading. *Shallow Tethys 2* would be useful to those interested in the palaeobiogeography of the marginal areas of the Tethyan realm on continental crust, but it is misleading for beginners and quite useless for those who want one book on the Tethys.

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Book Reviews

MAFIC DYKE SWARMS

Henry C. Halls and Walter F. Fahrig (eds.)

Geological Association of Canada Special Paper 34, 1987, 503p., Cdn.\$65 (Members); Cdn.\$79 (Non-members) plus Cdn.\$3 for postage and handling

This collection of 41 papers by over 100 authors is the outcome of an international conference held at the University of Toronto in mid-1985. A principal aim of the volume, as expressed by the editors, is to promote a greater awareness of dyke emplacement throughout geological time, and to show that mafic swarms can provide useful information on the development of the lithosphere.

All papers are in English and are preceded by abstracts in both French and English. There is a helpful summary by H.C. Halls and a large map of the 43 known dyke swarms of the Canadian Shield, prepared by W.F. Fahrig and T.D. West. This map provides information on the distribution and age of dykes, but a review comparing all of the swarms with regard to mineral content and chemical composition would have formed a welcome addition to this volume.

The principal topics covered are the global distribution of mafic dyke swarms, fracture mechanics, heat flow, emplacement mechanism, geochemistry, crustal contamination, dating methods, aeromagnetic surveys (as an aid in locating dykes), remnant magnetization across dyke contacts (to determine maximum wall-rock temperatures), paleomagnetism, gravity measurements, dykes in oceanic crust, dykes as paleostress indicators, and dyke swarms as indicators of rifting and plate tectonics.

The book deals with dyke swarms of all ages, extending from 3.0 Ga to the present. Many papers describe dykes of a particular region and present information on their distribution, age and chemical composition. Included are the Canadian Shield, eastern U.S.A., Greenland, Iceland, Scotland, the Baltic Shield, the U.S.S.R., China, India, the Mediterranean region, Zimbabwe, Tanzania, Southern Africa, the Guiana Shield, Paraguay, Brazil, Australia, and Antarctica.

The term 'mafic' in the title means gabbroic; lamprophyre and other unusual rocks are not considered. The emphasis throughout is on geophysics and geochemistry, not on the petrology and mineralogy of these rocks. Topics related to mineral chemistry, the nucleation and growth of crystals, and phase relations are generally avoided.

Different parts of the book will interest different readers, but this reviewer found papers on the following topics to be outstanding: fracture mechanics, heat transfer, the Great Abitibi dyke, paleomagnetism of mafic dykes in the Fennoscandian Shield, the Troodos Ophiolite, the Great Dyke of Zimbabwe and tectonic settings of the Canadian Shield. The figures are generally excellent; in only a few are some of the symbols difficult to read. Printing and binding are of high quality, and the price is lower than expected.

This is a monumental contribution to geology. The editors, authors and publishers are to be congratulated on producing a source of information and inspiration to the earth scientists everywhere.

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SALINE WATER AND GASES IN CRYSTALLINE ROCKS

P. Fritz and S.K. Frape (eds.)

Special Paper 33, Geological Association of Canada, St. John's, NF, Canada, 1987, 259p., \$39.00 (Cdn.)

The preface to this important book starts with the statement "The permanent removal of toxic materials from the biosphere has become a major task for industrial societies." This was as true in 1985 when the Geological Association of Canada held a symposium of which this book is the outcome, as it is today. Time is running out for the industrial societies, and toxic and nuclear wastes, continue to accumulate at a rate that demands resolution within the next decade.

Although the papers presented at the symposium address crystalline rocks as disposal media, there is much here for those concerned with toxic waste disposal in sedimentary rocks. However, one is struck by the fact that this is a geochemical book with little emphasis on flow in fractured rocks. Society cannot dispose of toxic materials underground without considering both hydro-geological and geochemical aspects. This reviewer has been equally critical of hydrogeological papers that do not deal with the geochemical aspects of waste disposal: resolution of the toxic waste disposal problem must come from the broad fields of hydrogeology and geochemistry. Nevertheless, this book is a milestone summary of knowledge with respect to the geochemistry of saline water and gases in crystalline rocks.

The book opens with two general papers on the fluid inventory of the crust and normative salt characterization of natural waters, followed by seven papers on Canadian Shield brines, seven on saline water in crystalline rocks of Europe (Finland, U.K., Czechoslovakia, Switzerland, U.S.S.R.), and four dealing with special aspects of gases. Major emphasis is on inorganic and stable isotope geochemistry, and most papers have detailed tables of analytical data. As might be expected, presentation of the data varies, from simple Schoeller-type diagrams and composition-versus-depth plots to activity ratio plots and water-rock equilibria calculations. Illustrations are generally satisfactory, with some notable exceptions. The editing is good, and there is an excellent seven-page index.

Although some authors may feel, perhaps with justification, that they have solved the problem of the origin of saline water and gases in crystalline rocks, it will be clear to the reader that more problems remain unresolved than have been answered. To anyone concerned with the geochemical aspects of toxic waste disposal (in crystalline or sedimentary rocks) this volume will be a gold mine of information and, doubtless, an inspiration to approach their own geochemical problems in a new light. This book is also highly recommended to hydrogeologists because it shows what can be done with detailed geochemical analyses of water and gases. Perhaps some day we shall see a more integrated geochemical-hydrogeological volume. In the meantime the editors are to be congratulated on organizing the symposium and producing this book.

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Book Reviews

VOLCANISM IN HAWAII

Robert W. Decker, Thomas L. Wright and Peter H. Stauffer (eds.)

Vol. 1 and 2, U.S. Geological Survey Professional Paper 1350, 1987, 1667p., \$95 (US)

Research on Hawaii has played a major role in the fields of volcanology and basalt petrology over the past 75 years. The work of Yoder and Tilley (1962) and Macdonald and Katsura (1964) laid the foundations for recent advances in the classification and understanding of basaltic rocks. It is in the comprehension of how basaltic volcanoes work, however, that Hawaiian studies have dominated. Geophysical, petrological and field investigations of active basaltic volcanoes were largely pioneered on Hawaii. The classic paper of Eaton and Murata (1960) provided the first real insight into the internal plumbing of an active volcano. In recent years the recognition that effusive volcanism is an important process in planetary bodies other than the Earth has further stimulated research on accessible volcanoes like those of Hawaii. With such a tradition it is not surprising that these two volumes represent a major contribution to volcanology.

This work is not intended to provide an integrated overview of current knowledge on Hawaii. Each chapter is a free-standing contribution written by different authors; indeed some (e.g. Chapters 1 and 2) present conflicting interpretations, but these are freely admitted. The chapters are very different in their nature and intent, some representing the end product of many years of research with detailed and carefully argued models, whereas others describe new fields of study still very much at the exploratory stage. The standard of presentation, particularly of maps and diagrams, is of high quality, and the whole work is full of valuable data.

The first section of Volume 1 (Physiography, Tectonics, and Submarine Geology) consists of six chapters. The first provides a valuable overview of the tectonic association of the Hawaii-Emperor Chain, the structure and evolution of the volcanoes and a discussion of the main hypotheses (e.g. propagating fracture, shear-melting, heat injection), which have been proposed to account for Hawaiian magmatism. Chapter 6 describes the new submarine volcano, Loini, growing on the sea floor to the southeast of Hawaii, and others in this section deal with the structure and physiography of the Hawaiian Ridge and associated subsidence.

The section "Geology of the Island of Hawaii" begins with a review of the development of the understanding of the geological history of the Hawaiian Islands and their volcanoes. Chapters on the stratigraphy and eruptive history of Kilauea and Mauna Loa volcanoes are accompanied by maps and diagrams that are most instructive. Valuable and detailed documentation of actual eruptions of both Kilauea and Mauna Loa are provided, while other chapters in this section deal with specific topics such as subglacial eruptions, intrusive bodies, the view from space, problems with C-isotope dating and finally an overview on volcanic hazards.

Volume 1 ends with a section entitled "Petrogenesis and Volcanic Gases," which starts with a useful summary of recent advances in Hawaiian petrology and geochemistry. The use of trace elements and Pb, Sr, Nd isotopes give an insight into three magmatic source regions recognized and

mechanisms of magma supply. The nature of the source regions are further assessed through noble gas systematics, which suggest an input from both MORB-type and a deep primitive source. It is pleasing to see that the value of phenocrysts and xenocrysts in providing a record of magma history is considered, with a discussion of the significance of diverse olivine types in lavas of the 1959 eruption.

The last eight chapters of volume 1 deal with the emission of eruptive gases. Mauna Loa and Kilauea volcanoes provide ready access for the collection and analysis of volcanic gases, and much of what is known about gases associated with basaltic magmas is represented here. A detailed analysis of CO₂ and SO₂ emission rates at Kilauea and data on the composition of gases from Mauna Loa are included. A last paper looks at the impact on plants by the discharge of Hg from Kilauea and Mauna Loa.

Volume II begins with a section on the structure of the Hawaiian volcanoes, the first part of which is a photo-glossary which, though attractive, I found rather out of place. This is followed by an analysis of the crustal structure beneath Kilauea and Mauna Loa based on seismic-refraction and gravity data, and with information on the likely nature of the intrusive cores to the summit region and rift zones. Seismic data (earthquake focal mechanisms) together with deformation and eruption data are used to test mechanisms of magma transport. A detailed field analysis of the dike complex of Koolau Volcano (Oahu) and the implications of this for the structure of rift zones is also provided. Other chapters are concerned with aeromagnetic and regional self-potential anomalies.

The next section, "Dynamics," begins with a perceptive overview of the dynamics of Hawaiian volcanoes. This is followed by a detailed analysis of the seismicity of Kilauea's magma system, which shows how plotting earthquake data in 3-dimensions builds up a picture of the magma system from a depth of 60 km up into the summit reservoir and rift systems. Ground deformation data is also used to reveal high-level magma movements in Kilauea Volcano. The effects of earth tides on the magma reservoir of Kilauea and the origin of volcanic tremor are then discussed.

A rather philosophical discussion on the uniqueness of volcanic systems is followed by a stimulating account of the elasticity and "contractancy" of Hawaiian olivine tholeiite, which provides a model for the upward climb of the subcaldera magma reservoir as a shield volcano progresses from youth to maturity. Other chapters in this section assess the nature of magma injection and heat and mass transport in the rift systems, and the interaction between groundwater and the magmatic system with the generation of hydrothermal brine systems. The development of aa flows, rheological estimates of the 1984 Mauna Loa lava, and the role of lava tubes are dealt with in the final three scientific chapters of this section. It is a pity that there was not also a further chapter dealing with the wealth of data and interpretation on pahoehoe lavas. Volume 2 closes with three papers on the historical record of investigations of Hawaiian volcanism.

At a time when government agencies are contracting their academic work, the USGS is to be congratulated on the high quality of these two volumes. Together with the earlier USGS Professional Paper 1250 on the 1980 eruptions of Mount St. Helens, they represent classic contributions to the study of effusive and explosive volcanism respectively. Anyone working on basaltic volcanism should possess the Hawaii volumes, a necessary addition to any geological library.

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