BOOK REVIEWS

ASPECTS OF DIAGENESIS

P.A. Scholle and P.R. Schluger (Eds.)

Society of Economic Paleontologists and Mineralogists,
Special Publication No. 26, 443 pp., \$15.00 (members), \$19.00
(non-members).

The 24 papers in this volume review recent progress in the study of diagenesis, a subject of increasing importance to academics and professionals concerned with the formation, migration, trapping, and exploitation of hydrocarbons. Eight symposium papers on diagenetic paleotemperature (Scholle), and 16 papers which treat the diagenesis of clastic reservoirs (Schluger) cover a broad range of topics in clastic diagenesis.

The first half of the paleotemperatures section is concerned with organic metamorphism and conodont alteration index (CAI), coal rank (vitrinite reflectance), and "graphitization". The authors demonstrate the power of organic alteration of solids as a paleothermometer, but also show how the information is related to organic maturation of fluid hydrocarbons. The conodont coloration paper applies CAI to many geological problems including geothermal gradients, amounts of structural shortening, and upper temperature limits of oil and gas production.

The second half of the first part deals with inorganic paleothermometers. Clay minerals, zeolites, fluid inclusions, fission tracks and oxygen isotope fractionation have all been utilized. The clay minerals are not treated as phase assemblages, but as paleothermometers, in spite of the clear indications of the importance of assemblages and fluid compositions later in this volume. The zeolites are subject to a more modern petrologic approach integrating assemblage data, thermochemical data, experiments, and organic paleothermometers. Oxygen isotope fractionation is shown to be useful at temperatures greater than 100°C, and the temperatures obtained correlate well with mineral assemblages. Fluid inclusions have been used to demonstrate the importance of fluid composition during diagenesis. Fission tracks have been employed to document the thermal and uplift history of a sedimentary basin.

The second part of this volume (diagenesis of clastic reservoirs) can be divided into three sections: principles of clastic diagenesis, broad regional studies, and studies of individual formations. The papers are directed to studying diagenetic hydrocarbon traps and the effects of diagenesis on reservoir quality.

Papers in the section on diagenetic principles recognize the profound effects of sediment composition, fluid composition, shale dewatering, reaction kinetics, and tectonic setting on the observed diagenetic path. Occlusion of primary porosity and the development of secondary porosity is of concern to most authors. The quality of observation is high, but from a theoretical standpoint the papers are uneven, ranging from a complex diffusion model which combines mass transfer with chemical reactions, to a calculation of the number of pore volumes of solution which must be transmitted through a rock in order to destroy the porosity, ignoring ionic diffusion as a potential process. Various authors document the importance and recognition of secondary porosity, relating CO₂ production to dissolution.

Regional studies have concentrated on relatively immature sediments, usually arc-derived or volcanoclastic rocks. The general conclusion is that "dirty" clastic rocks make poor reservoirs. Again, the observations are excellent, but the theoretical treatment concentrates on isothermal calculations and does not accommodate the progressive nature of diagenetic changes.

Specific studies of individual formations demonstrate the power of the SEM as a petrographic tool. Most authors can document very detailed sequences of cementation, beginning in early diagenesis. Some studies indicate that diagenetic reactions are beneficial, either creating porosity or armouring grains from further diagenetic damage. The overriding concern of all authors is the control exerted by interstitial fluid compositions.

The number of papers in this volume indicates the increasing importance of diagenesis, especially in hydrocarbon exploitation. The quality of the descriptive parts, especially the photomicrographs and SEM photomicrographs is uniformly high. Although most authors have recognized the great importance of mineral reactions, initial bulk composition, reaction kinetics, and fluid flow rates in the study of diagenesis, these theoretical topics have not kept pace with the descriptive material. This is not surprising in view of the recent explosion of interest in diagenesis, and at \$19 this volume represents a bargain, not to be missed by students, professionals and academics.

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CENOZOIC TECTONICS AND REGIONAL GEOPHYSICS OF THE WESTERN CORDILLERA

R.B. Smith and G.P. Eaton (eds.)

The Geological Society of America, Inc., Boulder, Colorado,
U.S.A., 1978, Memoir 152, 388 pp., \$55.00.

This recent addition to the G.S.A. memoir series is the product of two closely related meetings: a Penrose conference on Cenozoic Tectonics and Regional Geophysics of the Intermontane West, held at Alta, Utah in September 1975, and a special symposium on Cenozoic Tectonics and Regional Geophysics of the Western Cordillera, convened two months later at the Society's annual meeting in Salt Lake City. There are few regions where the implications of plate tectonics have been tested against as large a body of quantitative geological and geophysical data as the Western Cordillera of the U.S.A. The basic framework of Atwater's 1970 model is still widely accepted, but new data and new interpretation have revealed a region infinitely more complex than that conceived nine years ago.

The 16 papers assembled in this volume deal primarily with that part of the western Cordillera between latitude 37° and the Canadian border, with emphasis on the development of Basin and Range structures and igneous activity. For those not familiar with the area, the opening paper by Stewart presents an excellent review of both data and ideas which provides a cohesive framework for the papers that follow. For those working in the region or on related problems, the book contains a wealth of factual data, much of it published for the first time; this includes: regional maps showing the distribution of igneous rocks; faults; fault-plane solutions; seismicity; P_n-velocities; heat-flow; gravity and magnetic data; and crustal structure of the various geological provinces of the region. Although each author draws liberally on data from several disciplines for purposes of correlation and modeling, there is an attempt to organize the book on a topical basis; most papers emphasize some particular aspect of geology or geophysics. Except for the unfortunate omission of Cenozoic stratigraphy and sedimentation, the papers touch on nearly every aspect of tectonics.

Structural evolution based mainly on interpretation of faulting is treated in three papers. Silver, using gravity as

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well as structural data, describes a profound difference in deformational style along parts of the continental margin adjacent to converging and transcurrent plate boundaries. Best and Hamblin, in a well illustrated paper on the origin of the northern Basin and Range, argue convincingly that both extensional faulting and volcanism are consistent with progressive regional tumescence, whereas Shoemaker and others document the influence that pre-existing faults as old as Precambrian have had on Cenozoic and contemporary tectonics of the southern part of the province.

Papers by Eaton et al. and Mabey et al. deal respectively with regional gravity and regional magnetic patterns. The complex magnetic signatures associated with crustal rocks disappear in a "quiet basement zone" that corresponds approximately with the Great Basin and with a profound gravity low. The remarkable bilateral symmetry of this deep-seated anomaly, coupled with high heat flow and topography, suggests that active spreading over a major mantle upwelling beneath the continental margin is an integral part of the contemporary tectonic framework.

Blackwell presents a new heat-flow map of the western U.S. and discusses its significance with respect to heat generation and non-conductive energy loss associated with volcanism and regional hydrothermal convection. Lachenbruch and Sass give a revised version of their 1977 heat-flow map and examine its relationship to extension rate, lithosphere thickness and asthenosphere flux for three simple, thermotectonic models. Their rigorous mathematical analysis, though based on a steady state assumption, indicates some useful constraints on the interpretation of heat-flow in regions of extensional tectonics.

A compilation of fault-plane solutions by Smith and Lindh is presented in both tabular and map form. These data, along with regional seismicity and Cenozoic geology, form the basis of a complex but well presented and convincing model of intraplate tectonics by Smith. He interprets the pattern of seismicity, volcanism and faulting as outlining active subplates, each with its own motion controlled by oblique convergence and upper mantle thermal upwelling. A comprehensive review of both earthquake activity and P-wave velocity profiles by Hill, documents profound differences in crustal and upper mantle structures for 19 different tectonic units in the western states.

Igneous history is treated in three papers and two regional maps. The latter, compiled by Stewart and Carlson, show the distribution of volcanic and intrusive rocks as well as generalized radiometric ages. An analysis of the structure and volcanic history by Christiansen and McKee emphasizes the outward progression of both volcanism and extensional faulting with time, and their relationship to major plate interaction. Armstrong's concise, well illustrated review of the igneous history of the northwestern states documents the episodic nature of igneous events. He makes no attempt to fit his data into an all-encompassing model, but rather leaves the reader with some disturbing questions that no model has yet satisfactorily answered. Similarly, a careful quantitative analysis of Cascade volcanism by White and McBirney raises serious doubts regarding some of our most cherished concepts of volcanic arcs. Their data on timing, volume and chemistry point to some complex, multi-stage process of evolution, but provide no evidence that the magma was generated in a subducted plate.

This volume is not a definitive work on Cenozoic tectonics of the western U.S., but rather a superbly edited and illustrated progress report that brings together a wealth of data and ideas on what continues to be one of the most fascinating and enigmatic regions on earth. Like the western Cordillera itself, many of the ideas expressed are clearly in a state of active evolution and, despite the size and diversity of the

data base, the flawless, unifying model remains as elusive as ever. It is a stimulating account of science in action that invites the reader to get involved and join the search for that critical concept or piece of data that is obviously still missing.

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THE DEVONIAN SYSTEM

M.R. House, C.T. Scrutton and M.G. Bassett (eds.)

Special Papers in Palaeontology, No. 23, The Palaeontological Association, London, 1979, 353 pp., 102 text-figs., 1 plate, \$60.00 (Hard Cover), \$45.00 (Soft Cover).

This volume is composed of a broad but selective range of papers given at the Palaeontological Association's International Symposium on the Devonian System held at Bristol in 1978. Included are "keynote" addresses and solicited articles. Although one might question why certain papers and authors were selected and others not, the final choice seems reasonably fair.

A wide variety of topics is covered: a number of specialists offer up-to-date versions of the "state of the art" in their respective disciplines; both "old" and new information has been summarized in easily retrievable form, and well-known authors, as well as newcomers to the "Friends of the Devonian" had their say. Altogether, the book offers something for both connoisseurs in search of "titbits", and for the working geologists interested in the more general aspects of Devonian studies.

The papers are well edited and of a standard which varies from acceptable to excellent. The only shortcoming of the book is that rigorous and uniform standards were not also applied to the many charts and text figures which are of central importance to this type of documentary presentation.

The opening dedication to Academician D.V. Nalivkin is a timely reminder of the protean work and contribution of one of those giants in the geological and natural sciences.

The first part of the book contains two contributions on the "History of the Devonian System" and five papers on the "Tectonic Setting and Facies of the Devonian". The real focus and strength of the book, however, is in a series of 22 biostratigraphic papers devoted to discussion of the biostratigraphic usefulness of all fossil groups, of both plant and animal origin; traditionally they have been used to correlate Devonian rock sequences and hold promise of becoming useful in future studies. The number of these fossil groups is impressive. Paleontologists will welcome these contributions as useful summaries which contain not only well-known (if diffuse) information, but also some new ideas and findings. "Die-hard" sceptics, especially among "practising" geologists, will find visible proof that fossils are not only present in an amazing variety and abundance in Devonian rock sequences, but are also eminently useful. The many lines on the charts substantiate this point.

Inevitably, the quality of such a number of biostratigraphic papers is not uniform. This imbalance is a reflection, in part, of the variable writing skills of individual authors, and the disparate state of our knowledge of the various fossil groups.

I have placed this book on my shopping list for two reasons: the subject is a special treat, while the book's price - if affordable - makes it a precious gift.

W.K. Braun
University of Saskatchewan, Canada

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