BOOK REVIEWS . . .

COMPUTER APPLICATIONS IN THE EARTH SCIENCES: AN UPDATE OF THE '70s

D.F. Merriam (ed.)

Plenum Press, New York, 1981, 385p., \$45.00 (U.S.)

What advances in computer applications have been made in the past 10 years, and what are the future possibilities? The question must interest geologists in many fields. At a meeting in Syracuse University, New York, in October 1979, leading experts in various subdisciplines responded and, as demonstrated in this publication, edited and indexed by D.F. Merriam, it was an idea that worked.

The number of references cited emphasize the book's value as a guide to recent literature. Topics include: mineral-resource evaluation (a paper with 22 references by F.P. Agterberg); biostratigraphy (136-J.C. Brower); geological photo-interpretation (19-K.L. Burns); petroleum exploration (20-J.C. Davis); seismic prospecting (8-M.B. Dobrin); resource forecasting (0-J.W. Harbaugh); mining geology (68-G.S. Koch Jr.); petrology (38-R.W. Le Maitre); stratigraphic analysis (154-C.J. Mann); geochemical and petrologic mixing (11-A.T. Miesch); paleontological research (6-D.M. Raup); paleoecology (20-R.A. Reymont); information systems (5-P.G. Sutterlin); structural geology (281-E.H.T. Whitten); an abstract on oceanography (W.W. Hay); and more general papers on systems behaviour and geoscience problem solving (48-J.C. Griffiths); the man-machine interface (12-D.B. McIntyre); and a look ahead to the '80s, (16-D.F. Merriam).

The largest success was in seismic reflection techniques. Digital methods increased the precision and dynamic range, and improved migration, filtering and modelling. In favourable cases with well control, the geological information obtained is nearly comparable to having a borehole at every shot point. Structure can be mapped, lithologies identified, stratigraphic relationships determined more accurately than before, and hydrocarbons may be directly detected. Colour displays of results complete an impressive over-all system.

Data banking has made great strides, particularly in the petroleum industry and with bibliographic data. Nearly all well and seismic records in most petroleum provinces in North America can be accessed interactively and displayed, separately or together, as maps, contour maps and sections. Log analysis on interactive mini-computers can give detailed interpretations, and even generate three-dimensional maps by processing several wells at once. Parallel developments in mining geology included easier access to geostatistical theory through textbooks at various levels, and its wide application in mining.

Notable progress was made in developing models for drill hole exploration and organization of exploration effort, analysis of data from the mineral industry, and display and interpretation from exploration geochemistry and geophysics. Appraisal of mineral and energy resources relied increasingly on the computer to organize and analyze the large volumes of available information. The need is stressed for geologists with a quantitative appreciation of the uncertainties of resource forecasting to understand the links with economics and to participate in policy formulation.

Industry has invested tens of millions of dollars in such applications and many of the results are proprietary. Wider availability and better integration and understanding of information has been achieved. In more academic fields, progress has been less spectacular, although the routine adoption of computer methods may be their highest accolade. A look through the index illustrates the broad front on which deeper understanding and refinement of methods have been achieved - graphics, finite element methods, mixing models,

Fourier analysis, Markov models, random walks, simulation experiments demonstrating unexpected results from certain processes (Raup), geostatistics, probability index maps, trend surfaces, splining, seriation, ecologs, factor analysis to name but a few.

Refreshingly, however, doubts have apparently been creeping in. It seems that the silent majority have been neglecting opportunities, progressing slowly, failing to adopt or even propose standards, and resisting public exposure of their primary data. When the clear, shared objectives of applied geology are lacking, therefore, can we look for a way ahead through better file-exchange procedures (Sutterlin) and user-friendly interfaces (McIntyre), or must we ponder more deeply on the characteristics of poorly reproducible observations (Burns) and complex systems (Griffiths)? Or does the Juggernaut Model (Griffiths) already have computer geology in its thrall?

The contributors look ahead: the perennial need to evaluate and consolidate; the need to develop more appropriate notations and language (Mann, Griffiths, McIntyre, Merriam); continuing absorption into geology of concepts from computer graphics and finite element methods; more, better and cheaper microcomputers and other hardware and communications; and the unexpected, unpredicted, breakthroughs.

Over-all, this is a readable account of wide geological interest, which is also full of ideas for cross-fertilization and for the specialist in computer applications. My own prediction is that when Merriam comes to organize and edit the Update for the '80s, it will still be as far from the ideal price and publication time as this one, despite the wonders of digital text processing. My favourite speculation (torn from its context) on the wonders of the '80s is from Merriam himself: "Imagine being able to dictate your field notes or a manuscript and get a written draft." (p. 377)

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MANUEL DU PROSPECTEUR MINIER Manuels & Méthodes n° 2

J.-B. Chaussier et J. Morer (Coordination)

Bureau de Recherches Géologiques et Minières, Paris, France, 1981, 273 p., 100 FF (sous couverture cartonnée), 130 FF (sous couverture plastifiée).

L'expérience des géologues et prospecteurs ayant passé de longues années de leur vie sur le terrain est irremplaçable. Nous devons aux exigences de la formation interne du personnel du BRGM la compilation du bagage matériel et intellectuel nécessaire au prospecteur. Les documents rassemblés, à l'origine par J. Morer puis par J.-B. Chaussier, ont paru d'un intérêt tel qu'ils ont justifié une publication à large diffusion. Nous disposons ainsi d'un ouvrage faisant le tour, en un peu moins de 300 pages, des problèmes qui se posent aux hommes de terrain chargés de la prospection minière et des solutions préconisées par les spécialistes.

Les différents chapitres ont été écrits par 14 spécialistes des différents aspects de la prospection minière et la rédaction a été faite de manière à la rendre facilement accessible au "géologue de brousse", sans qu'aucune technique ne prenne un développement excessif dans l'ensemble des méthodes à mettre en oeuvre lors de la prospection minière. Ces spécialistes font bénéficier le lecteur de l'expérience qu'ils ont accumulée durant de très nombreuses missions dans différentes régions du globe: zones désertiques, forêts équatoriales et régions tempérées.

Des bibliographies sélectives renvoient aux lectures complémentaires nécessaires pour approfondir telle ou telle technique.

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Les chapitres dont la liste suit font effectivement le tour du problème:

- Préparation et organisation d'une mission de prospection minière en zone intertropicale: aménagement des camps de base, liste détaillée des matériels nécessaires aux missions (campement, bureau, pharmacie, véhicules), recommandations de circulation des véhicules en zone désertique.
- Prospection au marteau: outils, instruments et réactifs, emploi des réactifs, conduite des travaux, tenue du carnet de terrain, méthodes d'échantillonnage, préparation des échantillons.
- Prospection des alluvions, des éluvions et des formations littorales: techniques de prélèvement (en lits vifs, par puits, par sondages, lavage des graviers, examen des minéraux lourds, étiquetage des échantillons et emballage), méthodes et évaluation du tonnage, calcul des teneurs, cubage des gisements alluvionnaires, équipement pour prospection diamant. Ce chapitre donne en annexe les caractéristiques des appareils de sondage utilisés pour la prospection des formations littorales.
- Prospection géochimique: conception d'une campagne, mise en oeuvre des différentes étapes de la prospection, traitement des données.
- Prospection géophysique: utilité, principes et mise en oeuvre des principales méthodes de la polarisation spontanée, du magnétisme, de l'électro-magnétisme et de la scintillométrie-spectrométrie.
- Sondage en recherche minière: matériel, récupération d'échantillons et de carottes, contrôle de l'inclinaison des sondages.
- Le prospecteur dans les travaux miniers: creusement de galeries souterraines, évacuation des déblais, aérage des galeries, exhaure, éclairage. Echantillonnage en travaux miniers.

Ce livre fournit donc les informations que l'on pourrait trouver en rassemblant les plus récents traités de géophysique ou de géochimie appliquées, auxquelles il ajoute un grand nombre de "recettes" propres à faciliter le travail sur le terrain. Il ne prétend cependant pas se substituer aux traités scientifiques, puisqu'il a délibérément choisi de présenter le côté pratique des choses, vues par l'homme de terrain. Et c'est un parti que l'on aimerait voir pris plus souvent.

This Mineral Prospecting Manual provides a wealth of practical information on many aspects of prospecting. Written especially for the "bush geologist" in the tropics, it covers the preparation and organization of an expedition; field techniques for mapping, sampling, drilling; methods of appraising placer deposits, basic techniques of geophysical and geochemical exploration, and methods for small-scale mining. This manual represents the distillation of many years experience by BRGM overseas surveys and will be of practical assistance to the field geologist.

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ZAGROS, HINDU KISH, HIMALAYA, GEODYNAMIC EVOLUTION

H.K. Gupta and F.M. Delany (eds.)

Vol. 3, Geodynamic Series, American Geophysical Union.
Plenum Press, 1981, 386 p., \$28.00 (U.S.)

This volume forms the final report of the International

Geodynamics Project Working Group 6 and deals with the tectonics of the eastern part of the Alpine-Himalayan mountain belt, stretching from Iran to Burma. The book should be useful therefore to most structural geologists interested in mountain building and collision tectonic processes, as well as to those specifically involved in the local geology.

There have been six previous reports of this Working Group, published in journals ranging from *Tectonophysics* to various university bulletins. Although some articles repeat ideas and diagrams published in earlier reports, this may be considered a review volume and the repetition is excusable. Some topics that would be expected in such a review are missing. There is little or no discussion on the tectonics and geophysics of Tibet, nothing on neotectonics, practically nothing on the Tethyan ophiolites involved in the collision, and nothing on the exciting discoveries by French and Pakistani geologists of trapped mini-plates turned on end in northern Pakistan. Although the book does not give a thorough summary of Iranian and Himalayan tectonics, it does present a collection of 17 papers, some of which are of general review type, some of which emphasize local details.

The book begins with nine papers on regional and field geology and gives new data for Iran, Afghanistan and the Central Himalaya. M. Berberian and F. Berberian review data on the plutonism and active faulting in Iran, G. Stocklin gives what he calls "fragmental personal recollections" of the geology of Iran and summarizes some recent publications.

A. Gansser gives a general but short review of the tectonics of the entire region. He makes the important point that Himalayan metamorphism is generally restricted to already metamorphosed older rocks of Lower Palaeozoic or Precambrian age. Thus the mountain belt is not strictly a range born from Tethys, as most of it consists of the reworked northern edge of the Indian plate. The suture zone is only rarely seen as a normal ophiolite succession and is generally highly dissipated. Often it occurs as an ophiolitic melange. Gansser considers the suture to have formed from closure of very steep, narrow ocean basins, the sediments of which occur as exotic blocks in the melange.

P. Bordet and his colleagues then review the geodynamic evolution of the central Himalaya. They describe the development of the Main Central Thrust and discuss its famous reverse metamorphism, where the higher level rocks are of higher grade. V.S. Krishnaswamy summarizes the work of the Geological Survey of India in the Indian Himalaya. K.S. Valdiya and A.K. Sinha discuss some of the local structures of the west and central Himalaya, and describe what are probably some of the best exposed sequences of thrusts in the Himalayas. One slight disappointment with these regional geology papers, however, is that they do not use modern thrust terminology or current ideas on folds and thrusts. In the field geology section there are very few of the concepts predominant in publications dealing with other mountain belts. Ideas on thrust propagation, displacements, and displacement rates, for example, are not considered.

Thus it makes a refreshing change to turn to the geophysics section of the book and find that L. Seeber and his colleagues use present-day seismicity to trace faults and find their movement senses beneath the Himalayas. They show that the major faults change orientation from a 30° northerly dip in the basement rocks to bedding parallel detachment faults beneath the sedimentary wedge of the foothills. In the western Himalayas fault movement changes dramatically with depth, with thrust faulting above a detachment zone but strike-slip faulting beneath it. The authors recognize frontal and lateral steps in the thrusts and in one place describe a large wedge of basement that is trying to drive itself beneath the cover to the south causing local backthrusts above the wedge. They note that the line where the basement thrust

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flattens into the detachment fault, is arcuate, tracing out a small circle. From this they nicely predict the dip of the thrust in the basement. This paper, therefore, is important not only for Himalayan tectonics but for all studies of collision tectonics and foreland thrust and fold belts. It will certainly be helpful to anyone attempting to interpret structural or seismic reflection profiles through older mountain belts such as the Appalachians or Caledonides.

M. Berberian and U. Chandra present a useful catalogue and review of fault plane solutions and their tectonic implications for the whole region. K.L. Kaila uses deep seismic soundings to interpret the deep structure of the western Himalayas, showing that both the Moho and a block of crust are offset by what are possibly deep faults. He also examines the seismicity of the Pamirs and northern Tibet and concludes that the northern boundary of the Indian plate does not lie along the Indus Suture, but north of the Tarim Basin. Kaila's plate reconstruction differs from the familiar one in which the Indus Suture in southern Tibet is considered to mark the boundary between India and Asia. Palaeomagnetic evidence suggests that the Indus Suture was closed during Eocene times when India and Asia were about 1 000 km apart. The Indus Suture is unlikely to be the main plate boundary, thus Kaila's suggestion of a major suture to the north of Tibet is worth serious consideration.

Of the other papers on geophysics, H.K. Gupta and S.C. Bhatic discuss crustal thickness beneath the Himalayas and Tibet and R.N. Singh estimates the stresses in the northern part of the Indian shield. C. Klootwijk discusses the Himalayan plate tectonic models using palaeomagnetic data.

In the geochronology-geochemistry section, A.R. Crawford provides a thorough review of the isotopic data, dealing not so much with the more recent events but debating more the older Precambrian and Phanerozoic ages. Presumably these reflect the range in ages shown by the old northern margin to Gondwanaland. Finally, V.D. Rao discusses the geochemistry of a relatively undisturbed ophiolite sequence in the Kashmir Himalaya.

There are over 320 pages of text and numerous clear maps and diagrams, as well as detailed geological maps of Afghanistan and parts of the central Himalaya. The editors point out at the beginning that both the tectonics and logistics make this a difficult area in which to work. The impression is given though that the Working Group was successful in bringing together a wide range of scientists involved with the geology of the eastern Alpine-Himalayan belt. It does have a good and rapid publication record. This report should be an important source of reference to anyone thinking of working in the region.

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THE DEEP SEA DRILLING PROJECT: A DECADE OF PROGRESS

John E. Warme, Robert G. Douglas and Edward L. Winterer (eds.)

Society of Economic Paleontologists and Mineralogists (1981),
Special Publication 32, 564 pp., U.S. \$27.50 (cloth)

A symposium on the results of the Deep Sea Drilling Project (DSDP) was held April 4, 1979 during the AAPG annual meeting in Houston, Texas, U.S.A. The current volume presents 24 papers given on that occasion, supplemented by additional contributions solicited by the editors to develop a more complete overview of deep sea drilling during the past 10 years. The volume consists of two parts. The first half presents broad, generalized review papers on the subject of continental margins structure and development, deep sea

sediments and geochemistry; the second half is concerned with more specific aspects of biostratigraphy, zonation and paleoceanographic interpretations of the results.

R. Revelle sets the scene with the history of deep sea drilling. It is hard to believe that it is only 15 years since the most learned and mathematically able geophysicists and geologists published conclusive demonstrations that continental drift is impossible, and that somewhere in the deep ocean there is a place where sediments as far back as one to two billion years are stacked on top of each other. We now know that because the oldest rocks on the ocean floor are less than 180 Ma, the history of the present oceans does not predate the Mesozoic.

The increasing interest in mid-plate volcanism and accompanying vertical tectonics is examined in the first, thought-provoking article by D.A. Clague. He demonstrates that although the hot spot theory can explain the origin of some of the linear island chains, such as the Hawaiian-Emperor chain, it cannot explain the origin of the Line Islands, or the Mid-Pacific mountains. Similarly, the cause of the outbreak of widespread volcanic activity in the Central Pacific and Atlantic during the mid-Cretaceous is also unexplained. Is it a manifestation of an overriding mechanism of changes in the Earth's interior not accounted for by plate tectonics?

B. E. Tucholke then provides an example of interpretation of deep sea seismic reflectors in terms of their lithostratigraphic and chronostratigraphic significance. Interpretation of geophysical data is also an important part of R.E. Sheridan's discussion of recent research on passive continental margins. He argues that drilling on the margin clearly indicates variability in its origin and evolution. Although two basically different mechanisms of the rifting process have been recognized in the Atlantic - one starting with doming and vertical uplift, the other with subsidence into an intracratonic basin - both of these mechanisms operate in the same developing oceanic basin.

It is true that major progress was made in understanding the development of convergent margins and subduction zones, but the review by R. Von Huene shows that margin development was influenced by a much greater range of tectonic processes than anticipated. Drilling along the Middle America trench has provided direct evidence for extensive subduction and accretion but the subduction process in the geomorphologically most conspicuous fore-arc basins of the western Pacific must remain hypothetical until a drilling vessel with deeper penetration capability becomes available.

The next three papers, devoted to the study of deep sea sediments, begin with a discussion by J. Thiede and his colleagues of the distribution of major pelagic sediment components in the North Atlantic during the last 140 Ma. Data on linear sedimentation trends compiled at DSDP sites in the North Atlantic allow them to comment on properties of surface, intermediate and bottom waters, which they interpret in terms of climate as a driving force of paleo-oceanographic changes. It is surprising to see that pelagic sediments in the North Atlantic, which received a dominant share of continental runoff, are dominated by biogenic, rather than terrigenous detrital material. It is difficult to understand their conclusion that no correlation can be established between compensation depth and the sea level curves of Vail (1977), but that a good correlation exists with Pitman's (1978) sea level curves. Both the Vail and Pitman curves show essentially the same trend except that Vail's is more detailed.

"Turbidites After Ten Years of Deep Sea Drilling - Wringing Out the Mop", by K. Kelts and M.A. Arthur, appears to be the freshest review article in the volume. DSDP has never directly attacked the problem of the turbidite theory, and all the data were obtained as a byproduct of drilling for differ-

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ent objectives. Flysch-type turbidites are rare in the deep sea; Bouma-type sequences were only cored off Morocco and in the Bengal and Cape Basins. Volumetrically more important but difficult to record, however, are fine-grained turbidites and turbidite muds. The turbidites are important indicators of construction and sea level changes on the continental margins, tectonic evolution of mid-oceanic ridges and seamounts and synchronism of volcanic events. The authors stress that future DSDP drilling should be oriented toward closer examination of deep-sea fans, contourites and fine grained turbidites.

Siliceous rocks recovered during 70 DSDP Legs are reviewed by K. Pisciotto, who focusses on present and past distribution of the siliceous deposits in the oceans, transportation of silica as a function of time and temperature, oxygen isotopic composition, and seismic reflection characteristics. Using an analogy with the present distribution of siliceous sediments (high latitude areas, zones of coastal upwelling and productive equatorial zones), he shows that the occurrence of fossil siliceous rocks can be an indication of past climates and ocean divergence. He comments that the oxygen isotope values of opal-CT studies may reflect elevated temperature during burial rather than water paleo-temperatures.

The geochemically-oriented papers are introduced by J.M. Gieskes in "Deep Sea Drilling Interstitial-Water Studies: Implications for Chemical Alteration of the Oceanic Crust." One result of interest to oil geologists is the observation that on continental margins fresh water derived from the continent penetrates aquifers more than 320 km from land.

"Organic Geochemistry," by K. Kvenvolden is concerned mainly with the methods used for core studies. He concludes that most of the organic matter in deep hemipelagic sediments is terrestrial in origin, and therefore these sediments should be considered mainly as a source of gas, contradicting the general belief that deep sea sediments will be a prolific source of liquid hydrocarbons. His chapter ends with a comprehensive index which lists papers on organic geochemistry from 44 DSDP Legs.

Three papers are devoted to carbonates. Diagenesis of oceanic carbonate is reviewed in a highly interesting contribution by R.E. Garrison who concludes that early diagenetic cements are rare in the deep sea carbonates and that diagenesis is dominated by burial.

Lithification proceeds without an external source of calcium carbonate. ^{18}O studies show a general increase in negative values with increasing depth and age, thus supporting Pisciotto's conclusion that diagenesis affects ^{18}O values. From studies of oceanic carbonate sedimentation rates, T.A. Davies and T.R. Worsley note that the global land-sea flux of carbonates for the past 60 Ma is surprisingly close to that of recent rivers (12.2×10^{14} g/y). Global carbonate flux through time appears to be simply related to the changing land-sea ratio. According to their data, the maximum low sea level stand correlates with high pelagic carbonate flux; this conclusion contradicts the views of Thiede and his colleagues. A paper by S.O. Schlanger reviews the occurrence of shallow water limestones in oceanic basins drilled by DSDP as useful indicators of postdepositional uplift, subsidence and latitudinal changes.

W.R. Riedel introduces the section on biostratigraphy and its application in paleoceanography. His paper on "DSDP Biostratigraphy in Retrospect and Prospect" provides a useful annotated bibliography of 480 biostratigraphic papers based on studies of DSDP cores. Biostratigraphic zonation and resolution of Cenozoic-late Cretaceous nannofossils and silicoflagellates is the subject of three papers by T.C. Moore, Jr. and K. Romine, D. Bukry and H. Thierstein. Southern latitude biostratigraphy and zonation is discussed by F.M. Weaver and A.M. Gombos, Jr. (diatoms), M.S. Srinivasan and

J.P. Kennett (planctonic foraminifera), and W. Wise, Jr. (nannofossils, diatoms and silicoflagellates). A similar treatment of north latitude biostratigraphy and implications for paleoceanography is missing, which demonstrates the uneven coverage of the oceans by DSDP.

W.H. Berger, E. Vincent and H.R. Thierstein examine Cenozoic ocean evolution from a view of gradualism or catastrophic development. They suggest that the deep sea record is punctuated by rapid changes or "Climatic Events". They see the changes as a result of disequilibrium potential within transient reservoirs of hydrosphere, biosphere, or reactive lithosphere, which can collapse under certain conditions such as changes in plate arrangement, climatic changes or sea level variations.

A different approach to the cooling history of the North Atlantic is presented by R. Poore, who uses spatial distribution of ice-rafted mineral grains to estimate the onset of Northern Hemisphere glaciation at 3.0 Ma.

The last two articles look at mid-Cretaceous paleoceanography (P.H. Roth and J.L. Bowdler) and deposition of black shales (H. Weissert). Both papers emphasize the importance of oceanographic events modified by local events in the deposition of organic matter enriched shales in the Atlantic, Pacific and Indian Oceans. Weissert notes the wide range of interpretation of the causes for the occurrence of the shales, without resolving or narrowing this range.

All papers in this volume are concise and well written, providing a wealth of data and information to the reader. This publication compliments similar volumes of the DSDP Ewing Series on results published by the American Geophysical Union. In this respect this reviewer feels it is unfortunate that this volume is not part of that series. This publication will be an essential source of references for research workers in industry who are interested in continental margins and deep sea basins as well as for oceanographers and students through the 1980s. The editors did an excellent job on this well-organized volume and, considering that the cost of the Deep Sea Drilling Project up to 1980 was \$137 million, the \$27.50 pricetag for this book is a real bargain.

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CHEMISTRY AND GEOCHEMISTRY OF SOLUTIONS AT HIGH TEMPERATURES AND PRESSURES

D.T. Rickard and F.E. Wickman (eds.)

Pergamon Press Inc., Maxwell House, Fairview Park, Elmsford, New York 10523, U.S.A., 1981, 564 p., \$170.00 U.S. (H).

This volume is the result of the proceedings of a Nobel Symposium organized by the Royal Swedish Academy of Sciences and held in Sweden on September 17-21, 1979. It is a compilation of 24 papers, including both an introduction and summary by the editors. The volume is divided into five parts: I - fluids and the supercritical state; II - electrolyte solutions at high temperatures and pressure; III - silicate melts, fused salts and very concentrated solutions; IV - experimental methods and apparatus, and V - reaction at extended conditions in natural and man-made conditions.

The articles in the volume are mostly compilations of data up to 1980, with some original data given. Despite the problems of integrating articles by different authors with different interests and backgrounds, the articles presented are highly informative and useful. A particularly attractive aspect of this volume is that after each paper there is a written discussion of the article by interested participants and the

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author(s). In a way the discussion section allows the reader to gauge where weaknesses presented in the article might be and where additional work could be done.

Part I is divided into a section on naturally occurring fluids (E. Roedder), the thermodynamic properties of fluid mixtures (J.S. Rowlinson), and non-thermodynamic properties and chemical phenomena of fluids and fluid mixtures (E.U. Franck). The part emphasizes the problem of integrating articles by different authors with different interests and backgrounds to create a balanced view. Despite this, the articles presented are highly informative and useful.

Part II contains a survey of experimental physico-chemical properties of water and aqueous solutions with a discussion of theories used to describe these properties (S.D. Hamann). The rest is divided into a largely experimental view of electrolyte solutions (T.M. Seward), predicting thermodynamic properties (H.C. Helgeson) and fluids in volcanic and geothermal systems (G.F. Sigvaldason). The excellent papers by Seward and Helgeson compare and contrast experimental and thermodynamic predictions. Seward points out that existing experimental data on solutions at high temperatures and pressures are scarce, thereby requiring the use of thermodynamic prediction as a first step.

Part III begins with a comprehensive article by C.W. Burnham on the nature of multi-component aluminosilicate melts which is indispensable to students of granitic rocks. The paper by K. Grjotheim on the characteristics and thermodynamics of fused salt points out that study of exchange equilibria in fused salt and slags can be useful in interpreting the behaviour of aqueous electrolytes. The third and final paper by K.S. Pitzer deals with the characteristics of concentrated aqueous solutions at relatively low temperatures.

Part IV is essential to understanding how much of the data presented in this book was determined. Articles on the

measurement of liquid compressibility (E. Whalley), viscosity and thermal conductivity (J. Keston) and solubilities (H.L. Barnes), join papers on the spectroscopic investigation of fluids (M. Buback), hydrothermal crystallization (A. Rabenau) and an interesting article on transport properties of magma (H.S. Yoder, Jr.).

Part V covers a large spectrum of topics, most of which taken individually are excellent, but as a whole do not complement each other. One on chemical transport reactions in gases (H. Schäffer) applies mainly to experimental systems, not natural ones. S.M.F. Sheppard's paper on stable isotope geochemistry of fluids gives an excellent review of the topic. R. Simmon deals with enhancement of oil recovery and outlines a way of viewing the movement of solutions which may be useful in high-temperature aqueous fluids. In discussing metamorphic solutions and reactions, H.P. Eugster deals with predicting the composition of metamorphic solutions from mineral assemblages when the right mineral assemblage and laboratory calibrations are available. P.B. Barton Jr. reviews the physical-chemical conditions of ore deposition. I.D. Ryabchikov looks briefly at the mobilization of ore metals by supercritical fluids from crystallizing magmas and attempts to deal with the production of ore-bearing hydrothermal solutions by cooling plutons.

The volume is well edited scientifically and technically and has a pleasing format. It summarizes many of the study areas which are becoming more important as geologists find that many high temperature fluids deviate significantly from being dilute H₂O or are, in fact, extremely concentrated. Approaches made by geochemists in trying to solve problems related to supercritical, high temperature, high pressure fluids must be very informative. As such, this volume should be an indispensable part of the library of any worker on high temperature and pressure fluids.

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Journal of Metamorphic Geology

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The journal will be published quarterly starting in March 1983 and the subscription rates for 1983 are £40.00 (U.K.), £48.00 (Overseas) and \$97.50 (U.S.A. and Canada) post free, including delivery by air freight to North America.

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