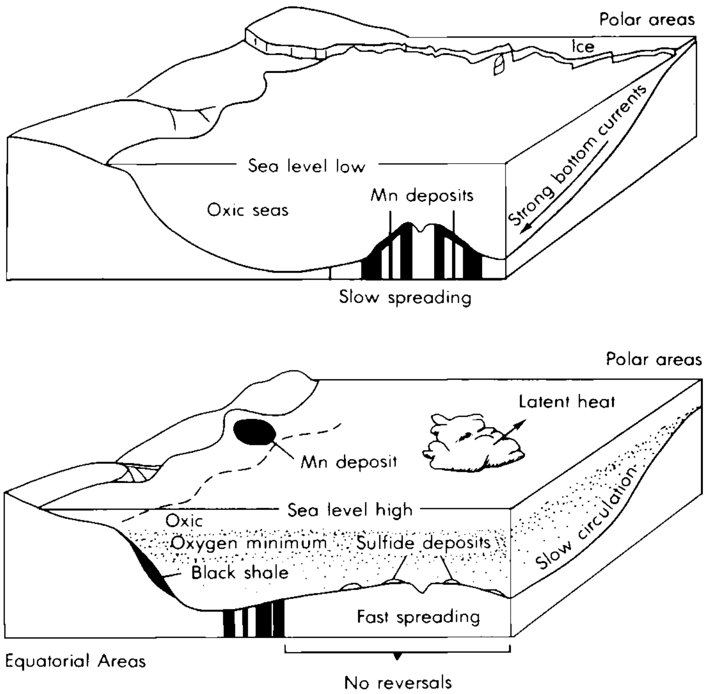

Fig. 2. Cartoon contrasting (*top*) state of rapid magnetic reversals, slow spreading, low sea level, cold high-gradient climate and oxic oceans (icehouse state of *Fischer* [1981]) and (*bottom*) state of magnetic quiet, fast spreading, high sea level, warm low-gradient climate and dysaerobic oceans (greenhouse state). Degree of oxygen depletion proportional to stippling; oxygen minimum zones would intersect only seamounts, plateaus, and basin margins in the deeper Pacific.

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Meetings

Water in Silicate Melts

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Water is one of the more important volatile species in magmas, both in terms of its abundance and its influence on the properties of a given magma. Many workers in the geological sciences have measured, modeled, and speculated on the interaction of water with silicate melts as a function of pressure. At the same time, glass and materials scientists have collected a considerable body of data on the effect of water on the properties of liquid and glassy silicates at 1 atmosphere (1.01325×10^5 N m^{-2}) and below. A special session on "Solubility and Transport Properties of Water in Silicate Melts" was held during the 1983 AGU Spring Meeting, May 30–June 3, in Baltimore. The session had three main objectives: (1) review the present data base and discuss the status of current models in order to identify areas where further work is needed; (2) introduce interested geologists to the large body of work being carried out in the glass and materials sciences; and (3) consider static properties, such as thermodynamic relations, structure of hydrous melts, and dynamic properties including diffusion and viscosity. This report summarizes the major topics discussed. More detailed information may be found in the published abstracts (*Eos*, May 3, 1983, pp. 338–343).

The session opened with two papers setting the geological perspective of water solubility in magmas. J. Eichelberger and H. Westrich discussed the observed water content and distribution in obsidian flows, where the average observed water content reflects the solubility of water in rhyolite liquid at near 1 atmosphere pressure. They considered the effect of degassing on water distribution within observed flows, and on the water content of ejected material during explosive eruption. J. Clemens reviewed measured and estimated contents of water for a variety of andesitic to granitic rocks. He found melt-water contents between 0.7 and 7 wt % water depending on the sample and source conditions (but with a general average value near 3 wt %), and he discussed the relative merits of methods for estimating water content. J. P. Coutures and G. Urbain presented a survey of solubility results obtained by glass and materials scientists for silicate glasses and liquids near 1 atmosphere. These water solubilities generally fall around 0.05–0.2 wt %, with some possible systematics as a function of composition. Discrepancies between different data sets, however, preclude any detailed correlations at present.

P. McMillan and J. Holloway summarized some water solubility measurements on synthetic and natural silicate melts at high pressures. Again, some systematic behavior with composition was noted, but the present data base is too limited to explore this fully. E. Stolper, L. Silver, and R. Aines summarized their recent infrared spectroscopic work on the speciation of water in hydrous silicate glasses and presented the results of new studies at high temperature. They found that both hydroxyl and molecular water species coexist to at least 550°C, supporting their dissolution model for water in molten silicates.

The next two papers concerned modeling of thermodynamic relations for hydrous melts. D. Eggler considered the dissolution reaction of water in diopside melt, and discussed Henrian, Henrian analogue ($a = x^2$), and non-Henrian expressions for its activity-composition relations. A. Boettcher presented experimentally determined melting curves in the systems $NaAlSi_3O_8$-H_2O-CO_2 and SiO_2-H_2O-CO_2. He compared and contrasted mixing relations in the fluids and silicate liquids for these two systems. These data suggested that CO_2 is soluble in SiO_2 liquids at high pressures (greater than or equal to 15 kbar) and high water contents. Discussion which followed this general topic emphasized that useful thermodynamic descriptions for such hydrous systems need not be simply correlated with structural changes in the melt.

Four papers examined the diffusion of water in hydrous glasses and melts and the effect of water on diffusion of other species. M. Tomozawa described the importance of water in the glass sciences and then presented the results of several studies of water diffusion in silicate glasses. One interesting result was the large observed dependency of the diffusion coefficient on the stress regime in nonhydrostatic experiments at relatively low pressure and temperature.

Two papers by K. Lapham and J. Karsten reviewed water diffusion studies in silicate melts and glasses and presented some results of their recent studies on diffusion of water in obsidian. Observed variations in the diffusion coefficient with temperature and composition were summarized and current models for the "water" diffusion mechanism were discussed. Lapham noted no pressure dependence of the diffusion coefficient in her obsidian study, in contrast to that observed by M. Tomozawa. This difference may be partly due to the higher pressures and temperatures involved in the obsidian runs and perhaps the hydrostatic nature of these latter experiments.

T. M. Harrison and E. B. Watson discussed the effect of water content on the diffusion of zirconium in granitic melts. They found a large increase in diffusivity and solubility at higher water contents and discussed the effect of this on ziron dissolution kinetics in hydrous granitic magmas.

The afternoon poster session included a number of presentations directly related to the discussions in the morning.

From informal discussions before, during, and after the meeting, we feel that the following general conclusions may be drawn. First, there are relatively few published estimates for water contents of primary igneous magmas, and more solubility data are necessary for synthetic and natural compositions at both high and low pressures. Likewise, diffusion data as a function of pressure, temperature, and composition are scant. Evidently more experiments are needed. Second, empirical modeling of thermodynamic and dynamic properties is a useful and necessary field, especially for those interested mainly in calculation of the effect of water on bulk properties. At the same time, mechanistic studies at the molecular level will lead to a better understanding of water-melt interactions at the microscopic level. More spectroscopic studies are needed on hydrous glasses, and especially on hydrous melts at pressure and temperature. We feel that both empirical modeling and structural studies are worthwhile and should be pursued with as much interplay between the two approaches as possible.

This meeting report was prepared by Paul McMillan, *who is with the Department of Chemistry, Arizona State University, Tempe, AZ 85287 and* Edward Stolper, *who is with the Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91109.*

Books

Geophysics in the Affairs of Man: A Personalized History of Exploration Geophysics and its Allied Sciences of Seismology and Oceanography

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C. C. Bates, T. F. Gaskell, and R. B. Rice, Permagon, Oxford, xx + 492 pp., 1982, $25.

Reviewed by Carl Kisslinger

This book traces the developments of the applications of the geophysical sciences to a variety of societal needs from misty beginnings to now, with emphasis on the "golden age," the early 1920's through the 1960's. The phrase "applied geophysics" is so often taken as synonymous with "geophysical exploration" that the broader viewpoint of this work is especially welcome. The authors certainly devoted much of their treatment to exploration geophysics, as is appropriate in view of the large commitment of human and financial resources to this endeavor and the practical importance of the results. However, they have also included interesting sketches of military applications of geophysical techniques and the important technological advances that have come from these, as well as much material on ocean science. Atmospheric and space science receives less detailed coverage.

The opening chapter, historical background to the developments of the 20th century, is brief, incomplete, and uneven in its coverage. An adequate treatment could well have doubled the size of the book, but some landmark developments that I looked for are missing. The heart of the book is the decade-by-decade story of each of the major themes (exploration, ocean science, global seismology) from the end of World War I through the 1960's. The story is told in terms of the personalities who built the subjects and the events that shaped their progress. It was fun to read this review and interpretation of one's teachers and friends. This is a humanized history of the grand projects that have moved geophysics ahead, the key technical developments along the way and the interplay of the creative minds responsible for progress.

The origins of seismic exploration for oil are explored, with emphasis on developments in the United States, but with a fair treatment of European contributions. Gravity and magnetic methods are treated in less detail. The parallel growth of earthquake seismology and oceanography in the 1930's is presented in terms of the leaders who emerged and the institutions that nurtured the efforts.

The enormous impact of World War II on technical and theoretical developments important to geophysics follows. The progress in all areas in the postwar period is highlighted by the story of Project Vela-Uniform, the search for methods to monitor underground nuclear tests that jerked seismology into the modern era within a few years, beginning in 1959. The continuation of this effort to the present is a theme through the rest of the book. Progress and the new leadership that emerged in the 1970's and 1980's are not treated in any detail. The commercial aspects of exploration geophysics, a big business indeed, are also explored in a personalized way through the stories of a number of the companies, large and small.

The tale rambles a bit along the way and the authors get immersed in great detail in places where they are talking about topics with which they have been closely associated. As a reader who cannot ignore a footnote, I found the flow of the text interrupted continuously by the need to drop to the bottom of the page for the ancillary information offered. I was amused by the penchant for military titles used throughout (Rear Admiral Lloyd Berkner, USNR; Lieutenant "Jimmy" Carter, USN (Retired)).

I liked very much the personal evaluations by a number of well-known geophysicists of their own achievements and experiences. The book closes with this section, which should help remind today's students that the advancement of science, including triumphs and blunders, results from the efforts of people very much like themselves.

The authors have some strong prejudices that come through clearly in places. They don't like "environmentalists" and they take a dim view of a variety of national social programs of the recent past, including affirma-