Book Reviews

Oceanography

The Sea. Ideas and observations on progress in the study of the seas. vol. 3, *The Earth Beneath the Sea: History*. M. N. Hill, Ed. Wiley, New York, 1963. xvi + 963 pp. Illus.

This is the third and last volume of *The Sea*, an ambitious project started about 4 years ago to provide up-to-date accounts of many of the ideas, observations, and trends of research in oceanography and related earth sciences. The first volume was on physical oceanography; the second dealt with the composition of sea water and with comparative and descriptive oceanography. The third volume, the subject of this review, is largely on the geology of the sea floor: topography, structure, sediments, the techniques and history of exploration, and the processes at work in and on the sea floor. Extensive information on the historical geology of the ocean basins is also included. The editors decided that, in all of its ramifications, marine biology alone would require three volumes, so information about that field was deliberately scattered among the three volumes. In volume 3 it is therefore necessary to call attention to a single purely biological paper: that by S. L. Miller on the origin of life, an excellent résumé of Miller's own work and that of others.

This third volume, *The Earth Beneath the Sea*, comprises 34 chapters written by 41 contributors—34 from the United States, 5 from England, and one each from France and Israel. The objective of the editors was not to write a textbook but to present "a balanced account of how oceanography, and the thoughts of oceanographers, were moving." This objective was achieved; the papers present an excellent summary of current work on the sea floor—the work carried on by the writers themselves (all are actively engaged in such studies) and by their colleagues. This is not a popular or a semipopular treatise. The articles are written at an advanced technical level, and together with their voluminous bibliographic references, they form a reference volume for professionals, in this and related fields, which will be useful for many years.

Probably the greatest advances made in marine geology during the past decade have been the result of geophysical explorations: seismic reflection and refraction, gravity, magnetics, and heat flow within the ocean basins. Volume 3 includes 11 papers in this general category. To a large extent, explosion seismology at sea has been developed by scientists at Lamont Geological Observatory, Woods Hole Oceanographic Institution, Scripps Institution of Oceanography, and Cambridge University. At each institution developments and techniques proceeded along slightly different lines. The first four papers in the treatise discuss, for the most part, the theories and techniques of explosion seismology at sea. These papers (by J. I. Ewing, Shor, Hill, and Hersey) form, in many respects, a basic text that summarizes the state of the art to date. In the recent past, the most significant developments in this field have been in the technique of continuous, nonexplosion, reflection profiling, a technique that will eliminate much explosion reflection surveying. Hersey summarizes this technique and many of the latest results obtained by its use in a paper that profited greatly by the delays in publishing this volume. Although his original manuscript was submitted in July 1960, the delays allowed Hersey to include references published into 1962; during this 2-year period, the evolution of equipment and the results derived therefrom constitute one of the most exciting developments in marine geology. This technique allows the recording of a continuous profile of the deep structure of the continental terrace and the deep-sea floor, and its use should result in the solution of some of the last, great problems about the structure of the sea floor. The recent development of ship-borne gravimeters and magnetometers and the results of their use are summarized by Worzel, Harrison, Bullard, and Mason; the techniques and meanings of heat-flow explorations are summarized by Bullard. The evidence related to the crustal structure of the earth, that is produced through studies of surface waves generated by earthquakes and atomic explosions, is discussed by Oliver and Dorman. All of these geophysical studies (and others in the volume) are interwoven by the contributors into our latest picture of the structure and history of the earth.

Nine papers are devoted to the topography and structure of the sea floor. Three of the world's leading authorities in the field (Menard, Heezen, and Guilcher) describe and discuss the latest findings with respect to the topography and structure of the deep sea and the continental shelf and slope. Following these papers are those that describe and discuss specific features: abyssal plains (Heezen and Laughton), oceanic islands, seamounts, guyots, and atolls (Menard and Ladd), the mid-oceanic ridge (Heezen and Ewing), trenches (Fisher and Hess), the minor or microtopography shown by deep-sea cameras (Laughton and Edgerton), and submarine canyons (Shepard). As one might expect, there is some disagreement and considerable overlap and duplication among these papers, but the overall effect of independent ideas and the rapid advances being made by parallel studies justify the space and effort.

Thirteen papers treat the general field of sedimentation. Those primarily concerned with the transportation of sediments include the papers on the hydrodynamics of sediment transport (by Inman and Bagnold), turbidity currents (by Heezen), and organic transportation (by Emery). Some special aspects of the geochemistry of sediments are discussed by Kaplan and Rittenberg (basin sedimentation and diagenesis) and by Koczy (natural radioactivity). Nafe and Drake list and discuss many of the physical properties of sediments, especially those of interest in geophysical studies.

Of special interest to those who work in the area of deep-sea sedimentation

are the paper on pelagic sediments (by Arrhenius) and that on the clays of the Pacific Ocean floor (by Griffin and Goldberg). These writers give a comprehensive account of the composition, geochemistry, and distribution, both areally and vertically, of pelagic sediments. Many of the papers primarily concerned with topography and structure also include important material in this area.

Ginsberg and his associates provide a comprehensive account of calcareous sediments in shallow water, and Guilcher covers the whole of the continental terrace in his discussions of the sediments of estuaries, deltas, shelf, and slope.

The contributions to stratigraphy and geology that have resulted from work on, and study of, the micropaleontology of deep-sea sediments are summarized by Ericson and Riedel (in separate papers). The last paper in the volume is by an especially noteworthy combination of two authorities on the continental and marine Pleistocene record (Flint and Emiliani).

One hazard that the professional researcher must accept in contributing to a volume of this type is that of delay—one contributor, or the publisher, may delay publication to such an extent that the papers are out of date before they are in print. Many of the papers in this volume were written more than three years ago, but the volume was so seriously delayed that these early birds had an unexpected dividend: the manuscripts could be revised to include references to work published into 1962.

This volume, a "snapshot" of the working oceanographer who is studying the sea floor, is concerned with the ocenographer's latest works and with his methods of working. It is not a textbook, nor is it comprehensive. The editors, however, obviated any criticism of an unbalanced presentation with M. N. Hills's qualifying remarks in the preface. A fully balanced and complete treatise would have occupied several more volumes. Professionals in the field can only be grateful to the contributors for the immense labors they have devoted to writing and editing this volume; for many years *The Earth Beneath the Sea* will be a valuable reference work on the geology of the sea floor.

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Technology and Development

Science, Technology, and Development. The United States papers prepared for the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas. vol. 1, *Natural Resources.* Energy; Water and river basin development (378 pp. $1.25); vol. 2, *Natural Resources.* Minerals and mining; Mapping and geodetic control (355 pp. $1); vol. 3, *Agriculture* (262 pp. 75¢); vol. 4, *Industrial Development* (190 pp. 55¢); vol. 5, *Transportation* (155 pp. 50¢); vol. 6, *Health and Nutrition* (196 pp. 60¢); vol. 7, *Social Problems of Development and Urbanization* (89 pp. 35¢); vol. 8, *Organization, Planning, and Programming for Economic Development* (144 pp. 45¢); vol. 9, *Scientific and Technological Policy, Planning, and Organization* (60 pp. 30¢); vol. 10, *International Cooperation and Problems of Transfer and Adaptation* (63 pp. 30¢); vol. 11, *Human Resources—Training of Scientific and Technical Personnel* (204 pp. 60¢); vol. 12, *Communications* (162 pp. 50¢). Superintendent of Documents, G.P.O., Washington, D.C. Paper.

A Selected List of U.S. Readings on Development. Prepared for the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas. Saul M. Katz and Frank McGowan. Agency for International Development, Washington, D.C., 1963 (order from Superintendent of Documents, G.P.O., Washington, D.C.). 363 pp. $1.25.

In February 1963 the United Nations held a world conference, at Geneva, on the application of science and technology for the benefit of the less developed areas. Participating countries were invited to submit papers related to a wide-ranging agenda. The response from around the world was so overwhelming that only a portion of the offerings from major countries could be accepted and reproduced by the conference secretariat. Therefore, those who were organizing the participation of the delegation from the United States —a special science conference staff (directed by David Tilson, assisted by a public advisory board chaired by Walsh McDermott of Cornell University Medical College) in the Agency for International Development of the Department of State—conceived the brilliant idea of making all of the U.S. papers available for separate distribution and for future reference and study in a paperback series. The 12 volumes in the series included all the American papers prepared for the conference, among them some crowded out of the official conference documentation. The resulting five-and-a-half-inch bookshelf on science, technology, and development, together with a separate volume which is a selected and annotated bibliography of American books and articles on development, was distributed by the U.S. delegation at the conference and subsequently by U.S. missions overseas.

The papers touch nearly every major area of science and technology, always with the focus on problems of newly developing countries. All are succinct (to meet conference requirements). The authors were chosen as recognized experts and scholars in their fields, and many have done admirable jobs of pithy elucidation. Broad scope, brevity, and authoritativeness make these volumes something like a small encyclopedia of current knowledge on the opportunities and problems that arise when countries in the early stages of modernization turn to science and technology for help in rising out of poverty.

Papers on natural resources range from "Rural electrification and rural development" to "Modern techniques and instruments for surveys and mapping"; on agriculture, from "Organizing for agricultural development" to "Basic principles in weed control"; on health, from "Principles of health service planning" to "Advances toward prevention and control of trachoma"; and on communications, from "Basic planning for a communications system" to "Low power drain television receiving systems."

The conference agenda interpreted science and technology to include not only the physical and biological sciences and the corresponding technologies but also the social sciences and the social technologies. This was wise, for the fact emerges, from paper after paper, that the major obstacles to better utilization of existing physical and biological knowledge, for bettering human life in the newly developing countries, are social obstacles. The willingness to accept technological innovation, the creation of a favorable environment for