cal scattering may be found there, applied to both elastic and inelastic reactions. Phenomena well known in optics as Fraunhofer diffraction, Fresnel diffraction, and glory scattering are observed in nuclear collisions and interpreted with the nuclear and Coulomb potentials.

Most of the chapters are devoted to the more violent collisions, which result in large energy losses or perhaps fusion of the two nuclei. The comparison of quantum potential theory, called time-dependent Hartree-Fock theory, with the empirical observations is well covered. Potential theory has mixed success for violent collisions; some observables, such as the fusion probability, can be explained, but others, such as the correlations between different measurable quantities, are incorrectly predicted. There is a large body of data on these correlations, and better success is found in interpreting them with classical concepts such as friction.

The physics becomes simpler for the fused nuclei, which are formed with a lot of internal energy that must be dissipated one way or another. The details of how this energy is dissipated, by emission of neutrons, gamma rays, and the like, are very well predicted by a statistical model that is presented in a "how-to" chapter explaining the use of the model. Statistical theory has old roots in nuclear physics and has recently been widely applied to describe chemical reactions. The new kinds of data appearing from heavy-ion collisions show that the model is applicable to a much broader range of nuclei and energies than previously suspected.

Additional chapters review the efforts to make superheavy nuclei and to observe new forms of matter at high energy and density, goals that have continued to be elusive. And what about the original impetus to study heavy-ion collisions, the fusion of nitrogen nuclei? Although not mentioned in the chapters, this particular reaction is described well by potentials and by the statistical model.

Finally, the reader should not be misled by the title word "treatise," which implies a systematic exposition. In fact the chapters are uncoordinated, often duplicated, and lack cross-referencing. Also, much of the material dates from mid-1981, so recent developments such as the discovery of element 109 in 1982 are relegated to footnotes or not mentioned at all.

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Marine Geology

The Geology of the Atlantic Ocean. K. O. EMERY and ELAZAR UCHUPI. Springer-Verlag, New York, 1984. xx, 1050 pp., illus., + charts. $98; charts alone, $45.

A few generations ago one could have synthesized the known geology of the entire Atlantic in a few pages. Today even a 1000-page tome like this one is not complete. The book probably marks the first and last time such a synthesis is attempted in a single volume at a scholarly level of detail.

Emery and Uchupi have tried to achieve a "broad synthesis" that they hope "may form a sort of plateau above which later studies can rise." Their intended audience is "mainly marine geologists and geophysicists" of all sorts. Not surprisingly the book is bountiful and polished in those areas in which the authors, both marine geologists, themselves have specialized—physiography, sediments, coastal processes, and the structure of continental margins. Among the strengths of the volume are thorough discussions of the Gulf of Mexico, the Caribbean, the continental shelves, and the coasts. The authors seem equally at home on land and under the sea. They also appear to be at home with other aspects of the subject, providing the reader with fascinating if sometimes digressive background on exploration of the Americas, mythology, and modern uses of the sea, including the nongeological. For example, one can read in this geology book about the Battle of Salamis fought in the Mediterranean in 480 B.C. and discover that sunken statuary is probably the most valuable sea-floor resource per unit weight. The discussions of petroleum reserves and the Law of the Sea are likely to be widely read for background information.

Each of the 5000 items in the bibliography is a separate doorway to some aspect of the Atlantic Ocean and its bounding continents. A number of these doors are rarely opened, and the volume may have saved some of the cited articles from oblivion.

The bibliography is so comprehensive, however, that the omission of several works of regional synthesis is conspicuous: a geological-geophysical atlas of the North Atlantic by P. R. Rona, a colored chart of bathymetry and plate tectonic evolution of the North Atlantic by R. K. Perry and others, colored maps of sediment thickness and depth to basement in the western North Atlantic by B. E. Tucholke and others, and the ongoing "Decade of North American Geology" project.

There are other gaps in the book. Relatively few pages are devoted to the igneous crust and the volcanic processes that have created it, and there is scarcely any mention of the submersible "field trips" into the mid-Atlantic Ridge rift valley. Among the 399 figures there is not a single photograph of the ocean floor or of any rock, sediment, or organism recovered from it. There is also little mention of seismicity, and no discussion of how earthquakes reveal the state of stress in the Atlantic lithosphere. Contour maps showing the thicknesses and speeds of seismic waves in several layers of the Atlantic oceanic crust are premature and probably misleading, given the limitations of the data. (In any case, the traditional "layered" crust is now largely considered a convenient construct rather than a reality.) The structure and composition of the Atlantic islands are not treated in any systematic way. This is particularly unfortunate in the case of Iceland, on which the mid-Atlantic Ridge "oceanic crustal factory" can be investigated with nothing more than strong boots and warm clothes. Regional variations in isotope and rare-earth chemistry in mid-Atlantic Ridge basalts are not mentioned even though some of the most exciting results in recent years have come from this field.

The volume is accompanied by a set of some 23 black-and-white charts, of which 11 pairs are Mercator charts covering the North Atlantic (5°S to 60°N) and South Atlantic (5°N to 60°S) and the 23rd is a pre-drift schematic reconstruction showing pre- and syn-rift geologic features. Each chart is a manageable piece of paper (85 by 55 centimeters). The information is portrayed clearly and boldly on the charts, as it is in the figures in the text. No magnifying lens is needed. The set of charts can be purchased separately, and marine geologists will want to order a spare set to take into the "field."

The Mercator projection is ideal for plotting points and tracks of constant heading, Mercator having designed it for that purpose. However, any attempt to display data from a part of the earth as large as the Atlantic on a flat piece of paper involves distortion, and, on the projection used by Emery and Uchupi, a feature of a given size appears 100 percent larger at the northern and southern limits than it does at the equator. Portraying the continuation of the Atlantic through Iceland and into the Arctic would be quite hopeless on such a pro-

jection, and this may be a reason why the authors stopped at 60°N. Certainly there are no plate tectonic or other geological grounds for picking 60°N as a northern limit.

The charts emphasize physiography and sediments to the exclusion of "geophysical" parameters such as gravity and magnetic anomalies and earthquake epicenters. Though large areas of the equatorial and South Atlantic have scarcely been visited by research ships except for isolated traverses, the set of charts as a whole shows a uniform degree of detail. The reader is not made aware of where a chart is simply a cartoon predicting what "textures" are likely to be encountered.

Though the book is flawed, it is a monumental volume that every serious researcher of the Atlantic and its coastal lands will want to own and that many others will want to consult.

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A Biologization at Stake

The Biology of Learning. P. MARLER and H. S. TERRACE, Eds. Springer-Verlag, New York, 1984. x, 739 pp., illus. $31. Dahlem Workshop Reports. Life Sciences Research Report 29. From a workshop, Berlin, Oct. 1983.

In October 1983, 47 psychologists and biologists from six countries gathered to participate in an experiment—its goal, "to reconcile learning theory and natural behavior"; its method, the Dahlem Workshop model. In the volume resulting from the workshop the desired direction of reconciliatory effects is made clear from the start: at issue is learning as the psychologist sees it. How useful are species-general concepts of learning? Is there a future for theories developed largely from a narrow range of animals exposed to arbitrary tasks? The psychologists' habit of looking for species-general patterns of learning emerged historically from earlier philosophical concerns with the mind and from evolutionary considerations concerning mental continuity across animals and humans. But the inability of psychology at the turn of the century to reconcile concepts of mind with those of behavior also figured prominently in forging the history of the subject. Criticism, skepticism, and calls for change are thus nothing new to this area of psychology. The possibility that learning theorists have in fact become habituated to negative comments from intra- and interdisciplinary sources must be kept in mind as one reads the volume. It may explain why they appear so docile in the face of the possibly impending biologization signaled by the volume's title.

The volume begins with five general papers that expose the differences of opinion to be reconciled. H. S. Terrace and H. M. Jenkins contribute the psychologists' views. Terrace provides a sympathetic although critical review of learning theory. Jenkins gives a more contemporary insider's view of conditioning mechanisms while also reiterating that the goal of such work is not only to understand broader forms of learning but also to learn to manipulate and change behavior. The behavioral biologists' view is presented by J. L. Gould and P. Marler, who outline it largely in relation to, or perhaps as a reaction to, the deficiencies they perceive in the psychological perspective. The biological view is presented with much less explanation of methods and concepts and with scant historical perspective, the latter an especially unfortunate lack. The study of behavior is a comparatively recent development in the biological sciences, and behavioral biologists seem to struggle at times to convince their colleagues that the study of the lives of animals is as significant as the study of the lives of cells. An account of how behavioral biologists defend their level of analysis would have been highly informative, if not somewhat therapeutic, for the psychologists.

The two final chapters of the opening group seem somewhat out of place. P. P. G. Bateson advocates a functional-developmental view of learning that tolerates neither the "arcane abstractions" of learning theory nor the "circumlocutions" of biologists about nature and nurture. J.-P. Changeux and colleagues provide the metaphors of Darwinian selection and antibody synthesis to conceptualize learning. Both papers deserve to be read for their interdisciplinary optimism but seem misplaced as general issue papers because neither developmental nor selectionist views figure prominently in the conference. And missing as an opening paper is a treatment of the physiological analysis of learning. Given that more than a third of the subsequent position papers deal primarily with this level of analysis, a paper actively integrating physiology, psychology, and behavioral biology would have been useful—all the more so given that the participants clearly held diverse opinions on, as Gould and Marler put it, the need "to move from words to wiring" (p. 61).

Four sets of position papers and four group reports follow. The study of invertebrates comes first, all participants stressing that the diversity of invertebrate forms and niches coupled with the simple nature of their nervous systems makes them ideal for the integrative study of learning and physiology. W. G. Quinn in detailing work on mollusks reviews the potential utility for learning theory of a "cell-biological alphabet," as Hawkins and Kandel have labeled it. And if, as Quinn puts it, the appeal of *Aplysia* as a model is its resemblance to an old Philco radio, then the appeal of the honeybee is its similarity to the silicon chip. Bees are the subject of papers by B. Heinrich, C. L. Sahley, and J. L. Gould and monopolize the group report. Here more than anywhere in the volume an animal in its world comes alive as we ponder how bees tell time, find food, "major" and "minor" in flower specialties, navigate to and from the hive, and negotiate paths to the nectar. Much of the life comes from Gould, a master interdisciplinary assimilator, especially when he forgets about wiring and gives us words.

The report of the group discussion on invertebrate learning, written by R. Menzel, reveals that the participants judge that reconciliation will come "when we have the neural substrate in our hands." It is of course easier to do so literally and metaphorically with invertebrates. This group report should be a source of positive reinforcement to psychologists because it provides strong validation of the relevance of learning theory to natural behavior.

The next workshop, on learning in nonmammalian vertebrates, deals mainly with birds, especially with pecking by pigeons, following by newly hatched fowl, and singing by songbirds. Here the participants find less to agree on, in part because of the disparate nature of the topics and in part because of apparently unequal interest in reconciliation. Three psychologists describe the considerable diversity of opinion among learning theorists on the nature of general laws of learning. K. L. Hollis suggests that the abstraction of general learning theory can be useful much as are abstractions