Coastal Sedimentation

The Atlantic Continental Margin: U.S. ROBERT E. SHERIDAN and JOHN A. GROW, Eds. Geological Society of America, Boulder, CO, 1988. x, 610 pp., illus., + charts in slipcase. $49.50. The Geology of North America, vol. I–2.

This addition to the Decade of North American Geology series marking the centennial of the Geological Society of America provides a summary of current investigation and thinking on the geology of the Atlantic coastal plain and continental margin of the United States. Included in the first of the book's six sections are a brief introduction by the editors, a paper on the physiography of the margin containing an extended discussion of slope processes and models from submarine canyon development, and a paper on the compressional, rifting (extensional), and subsidence history of the margin that produced its crustal framework and sedimentary features. The authors of the last-mentioned paper postulate that the Atlantic margin is the result of a simple shear where crustal failure takes place along low-angle detachment faults or low-angle crustal shear zones. The final paper in this section treats the history of studies of the Atlantic margin from the mid–19th century to the present.

The second section, on the stratigraphy and depositional history of the margin, consists of a paper on the geologic framework of the margin's four depocenters (Georges Bank basin, Baltimore canyon trough, Carolina trough, and Blake Plateau basin), two papers on the geology of the northern and the southern coastal plains, and a paper on the region's Neogene and Quaternary section. Whereas deposition of the older sedimentary units was controlled by initial rifting and subsequent thermal subsidence, emplacement of the younger units was influenced by glaciation, deglaciation, and associated drastic changes in sea level.

In the third section, Sheridan, Grow, and Klitgord present geophysical data from the margin and include a series of gravity models for the various depocenters; Manspeizer and Cousminer discuss the Late Triassic–Early Jurassic rift basins, suggesting that they are not due solely to extension but may have evolved as a result of an east-west trending, left lateral shear (a model similar to the one Ballard and I suggested in 1975 to explain the rift basin off the northeastern United States); and de Boer and others suggest that a tensional failure model best explains the Late Triassic–Early Jurassic rifts and associated magmatism and a hotspot model explains the Mesozoic-Cenozoic magmatism, with the remainder of the rifts being the products of upwelling of upper-mantle material following decompression at deep levels below fracture zones. Also included in this section are papers on the stratigraphy of Georges Bank, the Baltimore Canyon trough, the Blake Plateau basin and Carolina trough, and the Bahamas and a chapter on the paleoceanography of the margin (described within a rift-drift framework).

In the fourth section, a paper on the large aperture experiment in the Baltimore canyon trough reports the discovery that the area between the East Coast Magnetic Anomaly and oceanic basin is underlain by a layer with a velocity of 7.2 kilometers per second displaying continuity with layer 3 seaward and with the lower continental crust layer landward. Other papers treat subsidence and modeling of the margin, thermal evolution of the margin, and the effects of sea level changes on the margin's stratigraphy. The final paper in this section analyzes Tertiary sedimentation in the Baltimore canyon trough; with the aid of seismic and well data, the authors derive a curve of eustatic changes in sea level.

The fifth section, which deals with the economic potential of the margin, consists of papers on oil and gas, hydrogeology, sand and gravel, mineral resources, and geothermal resources. The sixth deals with geologic hazards. On the margin, the most severe conditions occur on Georges Bank and result from winter storms and tidal currents (D. W. Folfer). Results from the study of Cretaceous and Cenozoic tectonism indicate that since the Early Cretaceous the margin has been under compression, whereas from the Triassic to the Middle Jurassic it was under tension; the change was probably gradual, resulting in a period of little or no applied stress (D. C. Powell). The cause of seismicity in a passive margin is yet to be resolved (Seeber and Armbruster). Hazards posed by waste disposal are also discussed (Palmer), as are coastal geological hazards (Pilkey and Neal).

The concluding chapter, by the editors, is a synthesis of the previous papers. As is to be expected from such an extensive synthesis, there are different interpretations of the same data. For example, some authors place the initiation of seafloor spreading in the Bathonian (175 million years ago according to Palmer's scale), whereas others place this event in the Bajocian (180 million years ago) and equate it with the Mid-Cimmerian orogeny in western Europe. I favor the latter date. There is also disagreement as to when seafloor spreading began in the Gulf of Mexico, what the origin of the 7.2-kilometer layer seaward of the East Coast Magnetic Anomaly was, and what role transcurrent motion played in the formation of the margin's rift basins. These differences are minor, however, and do not detract from the quality of the compilation. I found the book to be an excellent summary of the research that has been done on the Atlantic margin during the last two decades. It will be a welcome addition to the libraries of those interested in passive margins, particularly the U.S. Atlantic margin.

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Star Clusters

Dynamical Evolution of Globular Clusters. LYMAN SPITZER, JR. Princeton University Press, Princeton, NJ, 1988. xii, 180 pp., illus. $35; paper, $14.50. Princeton Series in Astrophysics.

No one yet knows for sure why the birth of our Galaxy gave rise, among other things, to a curious subset of dense, round clumps of stars known as the globular clusters, of which more than a hundred survive to this day. These little nuggets contain up to about 10^6 stars apiece and typically travel helter-skelter above, below, and through our spiral disk in highly inclined and eccentric orbits; several even orbit backwards, against the sense defined by our rotation.

Just as such orbits point to violent beginnings, the types of stars found in today's globular clusters, and also their fairly low abundances of heavy elements, attest to ages almost equal to the time elapsed since the Big Bang. But this near certainty that most globular clusters here and in other galaxies formed very early does not itself answer the question why or how. Did they arise from the earliest gravitational instabilities of the Hubble flow, well before galaxies themselves condensed, as several astronomers have suggested? Or are they relics of major gaseous clumps that may have developed just as the raw cosmic gas came crashing back to build at least the so-called spheroidal parts of galaxies? Or might they even be the last coherent pieces, like the nuclei of some extra-dense disk clusters, left over from several lesser spiral galaxies that formed and for a while lived separately, but eventually collided and merged into one?

Lyman Spitzer, who has contributed much to our understanding of interstellar material and plasma physics as well as star clusters during a long and distinguished career, obviously does not need to be reminded of such lingering big questions of origin and early dynamics. Yet in this monograph he frankly elects to ignore them all because "so little is known." Also ignored by him, in more obvious keeping with the title,

are nearly all effects of any internal thermonuclear evolution of the separate stars in the clusters, such as the mass loss via strong stellar winds or even explosions that must have occurred especially during the first billion years as any original massive stars ran out of accessible fuel. Likewise we find only a few asides about x-ray sources, black holes, and similar exotic topics in this book. After all such omissions, what is left for Spitzer to tell? The answer: a great deal.

Indeed, the charm of this monograph is that it skips all the bells and whistles of excessive realism and instead proceeds to idealize a typical globular cluster from the outset as nothing more than a quasi-steady collection of (possibly unequal) mass points subject only to Newton's laws of inertia and gravity. Predicting the gradual evolution of such an assembly sounds at first almost trivial, given the power of modern computers. But in fact it is nothing of the sort, once the number of players, as here, approaches one million and the time scales turn out to involve many thousands of internal orbits. Physical insight is still needed badly, and here Spitzer is at his best: He reviews how the slight "granularity" of the discrete masses tends to deflect or diffuse any given particle from the orbit it would have had in a truly smooth equilibrium; he discusses how such a diffusion must lead to a gradual shrinkage of the central regions of a cluster and to a gradual swelling and even evaporation of its outer parts; he points out how this same tendency toward equipartition can be exacerbated by a "mass segregation instability" whenever the masses of the individual particles or stars differ enough; and he also explains the curious thermodynamics involved in the phenomenon of "core collapse," or fairly rapid shrinkage of the innermost parts of a cluster, that occurs once the ratio of its central to its mean density comes to exceed a sizable critical value.

Much as in Spitzer's earlier books on ionized gases and the interstellar medium, the style here is terse and deductive. The author clearly enjoys noting once again how relatively simple laws applied to individuals can lead to complex collective phenomena, and without wasting too many words he shares his enthusiasm with us. One effect of this crisp exposition is to lure the reader before the book is even half done into the essence of some quite subtle matters like the Fokker-Planck equation or various Monte Carlo simulations and to leave one with the nice feeling that with just a little more effort one too can really understand them. Another benefit is that the swift trot through the basics of very idealized clusters in the first four chapters of this rather slender volume leaves one ready and almost eager to tackle in its last three chapters such realistic complications as the cumulatively damaging tidal shocks from the Galaxy, the development of binary stars and the surprisingly strong heating that results therefrom, and the still largely unfinished business of post-collapse evolution.

All in all, here is a very lucid and not too technical account of one corner of stellar dynamics that has witnessed a great deal of progress during the past one or two decades, written by one of its principal contributors. It should appeal to graduate students and other researchers in astronomy not only for its contents but also as a fine example of how to reexplain things. Just possibly, it might even inspire some readers to turn their thoughts much further back and finally conquer those murky but very challenging problems of origin and early evolution on which I was musing at the outset.

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Some Other Books of Interest

Plant Migration. The Dynamics of Geographic Patterning in Seed Plant Species. JONATHAN D. SAUER. University of California Press, Berkeley, 1988. xvi, 282 pp., illus. $45.

In the preface to this volume Sauer notes that the field of historical plant geography "has always depended on a typological approach [in which] distributions of species or other taxa are classified on the basis of rough similarity into types, such as arctic-alpine, eastern North America–western Europe disjuncts, and South African endemics," a basic assumption being that "taxa have similar present ranges because of shared migrational patterns rather than because of convergence from formerly dissimilar ranges." Acknowledging the value of this approach, he wishes in this book to try a different one: "a survey of case histories for which there is direct [fossil and historical] evidence of the process of migration through time." To that end he presents some 140 case histories, averaging about a page in length. The opening group, on migrations in modern times, is arranged by type of habitat, including shoreline and other naturally open habitats, with ten subdivisions, vegetation subject to natural perturbation or invasion, and artificially modified habitats. The second section represents prehistoric migrations, beginning with the last glacial and Holocene and moving backward in time, and is arranged according to fossil assemblage. A final, briefer section deals with migration as related to evolution. The various sections and subsections include comment on theoretical or methodological issues, and the volume concludes with the statement that the author is "pleased rather than disappointed" that he "can see no prospect of easy, simple generalization about seed plant migration."—**K.L.**

Phytolith Analysis. An Archaeological and Geological Perspective. DOLORES R. PIPERNO. Academic Press, San Diego, CA, 1987. xiv, 280 pp., illus. $49.

"There exists a group of plant microfossils that exhibit all the attributes necessary to achieve legitimacy and prominence in paleoethnobotany and paleoecology: production in large numbers, durability in ancient sediments, and sufficient morphological specificity to allow identification of a wide range of taxa." These microfossils—phytoliths, in the sense of silicified particles from higher plants—have not received sufficient attention in the view of the author of this book, and the book is intended to demonstrate and encourage their use. The book opens with a brief history of phytolith research. Chapters 2 and 3 describe the production, deposition, and dissolution and the morphology of phytoliths. Chapters 4 and 5 describe field (sampling) and laboratory techniques. Chapter 6 is devoted to method and theory in interpretation of phytolith assemblages. Two final chapters deal with the role of phytoliths in archeological reconstruction and in regional paleoecology. The text includes consideration of several "special topics"—attributes of maize phytoliths and phytolith data from the New World tropics, areas of the author's own research—and is augmented by a 24-page section of plates and two phytolith keys.—**K.L.**

Books Received

Analytical Gas Chromatography. Walter Jennings. Academic Press, San Diego, CA, 1987. x, 259 pp., illus. $39.95.

Atlas and Dissection Guide for Comparative Anatomy. Saul Wischnitzer. 4th ed. Freeman, New York, 1988. xx, 264 pp., illus. Paper. $16.95.

Atlas of Blood Cells. Function and Pathology. D. Zucker-Franklin *et al.* 2nd ed. Ermes, Milan, and Lea and Febiger, Philadelphia, 1988. Two volumes. xxx, 777 pp., illus. $225.

A Bibliography of Matrix Isolation Spectroscopy. 1954–1985. David W. Ball *et al.*, Eds. Rice University Press, Houston, TX, 1988. xvi, 643 pp. $90.

The Biochemistry of Plants. A Comprehensive Treatise. David D. Davies, Ed. Academic Press, San Diego, CA, 1987. Vol. 11, Biochemistry of Metabolism. xiv, 388 pp., illus. $85. Vol. 12, Physiology of Metabolism. xiv, 357 pp., illus. $85. Vol. 13, Methodology. xiv, 294 pp., illus. $65.

Biologically Active Ether Lipids. P. Braquet, H. K. Mangold, and B. B. Vargaftig, Eds. Karger, Basel, 1988. vi, 196 pp., illus. $110. Progress in Biochemical Pharmacology, vol. 22.