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,