BOOK REVIEWS

Sea-Level Fluctuations

Phanerozoic Sea-Level Changes. ANTHONY HALLAM. Columbia University Press, New York, 1992. xii, 266 pp., illus. $50; paper, $28. Perspectives in Paleobiology and Earth History.

A central theme in modern stratigraphy is the role of fluctuations of sea level in determining the facies anatomy of marine sediments. Until about 15 years ago, sea-level fluctuations were estimated from depth changes in strata and from the relative extent of strata onto continental interiors. A new approach was introduced with development of the reflection seismic method for imaging strata beneath continental margins; stratigraphers recognized recurrent patterns in the organization of sedimentary "sequences"—packages of strata separated one from another by unconformities, that is, by buried surfaces of erosion or nondeposition. In the 1970s Exxon geologists, led by Peter Vail, related the sequences to cycles of sea-level rise and fall; this model gained widespread acceptance. A further conjecture by the Exxon group, backed by only the scantiest published data (most relevant data are proprietary), was that the sea-level cycles are eustatic, that is, global, and are not due to merely local or regional causes, such as tectonics. The conjecture was published as a curve of sea level against time. Legions of stratigraphers are busy applying or challenging the Exxon curve. Hallam devotes much of his book to challenging the model with field data, from the Cambrian to the Holocene.

Hallam began contributing to sea-level studies more than 30 years ago. Even though his own base has been in strata of the Jurassic period, he has ranged up and down the geologic column. No one is more qualified to review the evidence, effects, and causes of Phanerozoic sea-level fluctuations, and Hallam meets our expectations.

Hallam sets the stage with what one might have hoped would be a model format. He shows a regional chart with a column of sequence boundaries next to a column of tectonic events, in which the influence of local and regional tectonics can at least be accorded a visible place. Alas, this device is not further exploited.

As shown in Hallam's period-by-period account of the history of sea level, study of the Paleozoic periods is least rewarding, except in the sense that it shows the weakness of both the database and the methodology. In the absence of seismic data, Paleozoic sea levels are estimated from the reconstructed extent of shallow, epeiric seas onto cratons. Intercontinental correlation uncertainties and erosional removal of shoreline facies weaken comparisons.

In the Mesozoic, except for the broadest trends (for example, sea level rose gradually through most of the Jurassic), the differences among regions are marked. At the scale of a few millions of years, the conflicts among sea-level curves developed by various workers, even for the same regions, are extreme—this in spite of the much larger database for the Jurassic and Cretaceous than for the Paleozoic, and in spite of more precise biostratigraphic tools.

During the Cenozoic, starting some time at least as far back as the Oligocene, glaciers waxed and waned on Antarctica, providing a mechanism for changes in sea level. Yet, as Hallam points out, there are actually large regional departures from the expected scheme, not only in magnitude but even in the direction of change. These departures are ascribed to tectonism. Hallam nicely reviews the evidence from the Pleistocene and the Holocene, providing a summary of hydro-isostatic effects, which can lead to uneven sea-level falls and rises along adjacent stretches of coast.

What effects might changes in sea level have on the physical and organic worlds? Although Hallam looks at a host of marine sedimentary facies (mineralogy of ooids, proportion of carbonates on shelves and in ocean basins, occurrence of turbidites and of ferruginous and phosphatic sediments) and isotopic compositions (^{13}C, ^{34}S, ^{87}Sr), surefire associations with sea level are wanting.

Changes in the organic world (extinctions, radiations, and biogeographic patterns) have long been known to be in phase with sea level: Cuvier and Brogniart's early–19th-century hypothesis of "new worlds" of fossils, prompting the notion of new and spontaneous creations, corresponds in fact to the bases of cycles of transgression and regression in the Paris Basin. From Hallam's review, the connection between transgression and radiation appears tighter than that between regression and extinction.

Causes of sea-level changes are given critical and well-balanced treatment. Tectono-eustasy, glacio-eustasy, ground-water storage, basin desiccation, and geoidal changes each receive a brief hearing. The final conclusions follow the rule of minimum astonishment: major cycles of continental assemblage and dispersal govern the longest cycles (hundreds of millions of years), whereas large-scale sea-floor tectonics (global spreading rates, ridge length) and mid-plate volcanism probably control the second-order cycles (tens of millions of years). Third-order (about 1- to 5-million-year) cycles—the most controversial—are left as an unsolved problem, except for the Neogene, where glacio-eustasy is implicated.

As Hallam freely admits, his treatment is somewhat Eurocentric rather than global. This is mainly the fault of the database, but Hallam occasionally shows his colors: "Local tectonics cannot satisfactorily explain the synchronous alternation of [Cenozoic] shallow marine and nonmarine facies and correlative unconformities across a wide region embracing the Paris and London-Hampshire Basins and Belgium, and the dominant control is likely to have been eustatic" (p. 125). Perhaps any future attempt at synthesis should await a much more global set of data.

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Single-Cell Fossils

Fossil Prokaryotes and Protists. JERE H. LIPPS. Blackwell Scientific, Cambridge, MA, 1993. x, 342 pp., illus. Paper, $49.95.

While prokaryotes and single-celled protists are the oldest and often most abundant fossilized organisms in the rock record, they are also often the least understood or appreciated. Why? Because they are less conspicuous, harder to find, and harder to identify. *Fossil Prokaryotes and Protists* represents a step in improving the plight of these neglected fossils. Designed to be used as a textbook for an advanced paleobiology course that deals specifically with single-celled organisms, it assumes some knowledge of biology, paleobiology, and geology, although it can be handled fairly well by the non-expert if one proceeds systematically through it.

The opening chapters of the book deal with general aspects of unicellular orga-