Rises and falls

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Phanerozoic Sea-Level Changes. By Anthony Hallam. *Columbia University Press: 1992. Pp. 266. $57.50 (hbk); $28 (pbk).*

ONE of the most controversial topics in modern geology is how sea-level changes control sedimentary structures. Changes in sea level can be either eustatic (occurring worldwide) or local, depending on the cause (melting of ice sheets, movements of the ocean floor, sedimentation and so on). Peter Vail and colleagues at Exxon have proposed that seismic reflection records from continental margin sediments and detailed biostratigraphic drilling information give a record of sea-level change. But this idea is not accepted by all geologists. Anthony Hallam, an expert in sea-level studies for more than 30 years, intends to throw some light on the controversy by studying the record of sea-level change as revealed in continental sedimentary deposits.

The book is divided into four main sections. The first, which deals with the techniques of sea-level investigations, is sketchy, and for a detailed understanding of most of the concepts one would have to return to the original literature. An error has made a nonsense of equation 2.3, and the statement that sedimentation rates are proportional to water depth (p. 42) needs modification — this relationship is roughly true only for water depths less than the depth at which the sediment accumulation rate is greatest.

The best part of the book is the second section, which consists of a fairly detailed discussion of the sea-level record in continental deposits throughout the Phanerozoic. It is organized into three chapters, each discussing one era. Hallam compares sea levels as recorded by other scientists with the 'Exxon' curve. Data available to the Exxon group on the Palaeozoic (570–250 million years ago) were sufficiently sketchy that only general trends could be established for this period. But for the more recent Mesozoic and Cenozoic eras the Exxon curve is extremely detailed. On examining the sea-level curves presented for comparison with those from the Exxon group, I was struck not only by the dissimilarity in the timing of the third-order cycles (those whose average duration is about 2 million years) but by the differences in the appearance of the curves. Of course, scientists continue to disagree about how to interpret the curves, but I sometimes sense that Hallam is clutching at straws in identifying correlations between the two sets of curves. Also, there are fewer direct comparisons of sea-level curves than I would have liked, and on most sea-level curves there are no units for the rises and falls, even though these are often given in the original publications.

In the third part of the book, Hallam discusses the correlation of sea-level change with other phenomena such as isotopic variations, tectonic activity, extinctions and biogeographical changes. The fourth section covers the causes of sea-level change. This is in many ways the weakest of the four sections, but also, to my mind, the most interesting. The only way of producing the sea-level changes of the amount and duration required by the third order Exxon cycles is to invoke the production and melting of large continental ice sheets. As an example, during the Cretaceous there are four sea-level changes greater than 100 m in amplitude, which occur in much less than 1 million years (they appear as instantaneous changes in most representations). Few geologists believe, however, that there were any large continental ice sheets during the Cretaceous. So either the third-order sea-level changes were not eustatic but purely local, possibly produced by tectonic activity, or the changes were smaller or took longer than is suggested by the Exxon curve.

One topic scarcely covered by Hallam is sea-level change over the past century or so, as recorded by tide gauges. There are great variations in these measurements from place to place, variations now interpreted as being due to glacio-isostatic effects. The common signal that remains after accounting for these effects is due to global sea-level change, possibly produced by an anthropogenic factor. Glacio-isostatic effects can tell us much about the viscosity of the mantle, which controls the rate of isostasy, but there are large discrepancies between the various models of glacio-isostasy which need to be resolved. Global sea-level changes could be produced by global warming, either by the warming of surface water to give thermal expansion or by the melting of continental ice sheets. But because the rate of global sea-level change seems to have stayed the same over the past hundred years (at about 1 mm per year), the global warming is unlikely to have an anthropogenic cause, otherwise we would expect there to have been a recent acceleration as the rapidly increasing release of greenhouse gases into the atmosphere takes effect. Teasing apart the changes produced by global change and glacio-isostasy will soon be aided by new space-based geodetic techniques such as very-long-baseline interferometry, satellite laser ranging and the Global Positioning System. □

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WINGS of desire — this photograph comes from the second edition of *The Peregrine Falcon* by Derek Ratcliffe. In a review of the first edition (*Nature* 288, 519; 1980) C. M. White wrote that this detailed book would be "savoured by professional and laymen alike . . . truly the definitive work on a species that has become a *cause célèbre* for the environmentally conscious". Species numbers were then in decline owing to the introduction of pesticides; the new edition, however, reports on the reversal of this trend, and in particular on one of the triumphs of wildlife conservation — the full restoration of British and Irish peregrine populations. T&AD Poyser, £25.