

BOOK REVIEWS

LISITZIN, E. 1974. **Sea-level changes**. Elsevier Oceanogr. Ser. 8. Elsevier Sci. Publ. Co., Amsterdam, Oxford, New York. vi + 286 p. \$28.90.

The times are past when geodesists used to regard mean sea level as an invariant, equipotential surface, but the study of its variations in space and time is a relatively new branch of oceanography to which few scientists have devoted a substantial part of their careers. Dr. Lisitzin is one of those few, and her book may well be the first to be written entirely on the subject. It is a subject of especial interest in her native country, Finland, because of the fast rise of the Fennoscandian land mass and the peculiarities of the Baltic as a nearly enclosed sea, but Dr. Lisitzin's fields of research have also extended to many other ocean areas. The term "sea level," with or without its most common adjective, can mean different things depending on what cutoff frequencies are assumed. In an effort to be comprehensive Dr. Lisitzin tackles every class of motion which can be sensed with a common tide-gauge, from tsunamis and seiches through tidal surges and seasonal variations to eustatic and other long term secular changes. Some of these subjects take her rather outside her realm of expertise so that she relies heavily on describing the work of others, sometimes uncritically. But the overall impression is of a fairly unified approach to a broad area.

The approach is mostly nonmathematical, with the emphasis on maps and tables of statistics. Equations are quoted here and there, and in some cases these are all that is needed to describe the relationships between quasi-static physical quantities. But essentially dynamic phenomena such as tides or seiches are hardly comprehensible to the average reader without some further mathematical argument. There seems little point in writing out the dynamical tidal equations three times with minor variations (p. 24, 28, 34), but giving no idea of how they may yield a simple solution such as a Kelvin wave (not even mentioned), or how frequency and wave number are related. Another area, even more relevant to the central subject matter, which would have benefited from some mathematics, is that of low-pass filtering. The nearest information given is a table (p. 206) quoted from Rossiter, showing how the main tidal constituents are reduced by a monthly or annual mean. Here, not even the very simple formula involved is quoted.

The 50-odd pages on astronomical tides survey their principal characteristics adequately for the general reader of the book. One could criticize points of technical detail, but I prefer merely to

mention that most of the references are rather elderly. Hansen's 1952 Atlantic cotidal map rides again (p. 27). So does Doodson's tide predicting machine (p. 211). Students of mean sea level tend to be more interested in the tides of longer period, and the author devotes more space to these than usual. Extensive results are quoted for constituents with periods from 18.6 years to 9.1 days, largely from the work of Maximov, although some of these constituents are practically impossible to extract meaningfully from the noise background, given normal spans of tide gauge records. It is a pity Wunsch's (1967) work on the long period tides was overlooked. The 14-month sea level variation due to the Chandler motion of the pole—the author objects to the term 'pole tide'—is discussed fairly thoroughly, except for the signal: noise problem, and an optimistic global map by Maximov is reproduced.

The four chapters which follow, on various aspects of nontidal variations, are really the core of the book. Here the author is on home ground, with valuable and wide-ranging results from her own long experience. First, the effect on sea level of atmospheric pressure, wind, water density, currents and evaporation/precipitation are discussed at length. Atmospheric effects include storm surges, which have shorter time scales than the other effects discussed. Within the limitations of dynamical description mentioned earlier, the account is adequate and includes an account of the famous North Sea surge of 1953. In interrelating sea level and current, the author shows how she was able to estimate the mean circulation pattern in the Mediterranean Sea west of Italy from the coastal sea level records.

Another chapter, probably the best, is devoted entirely to the seasonal cycle in sea level, rightly regarded not as a tide (Sa Ssa, etc.) but as a complex product of global variations in temperature, barometric pressure, and wind stress. Extensive statistics are quoted from several oceans and analyzed in terms of these factors. The recent (1973) analysis by Gill and Niiler is briefly discussed (the most up-to-date reference in the whole book). A particularly detailed analysis is made of the Gulf of Bothnia, which has an interesting seasonal signature, and finally the global seasonal balance of the total oceanic water budget is estimated.

Chapter 5 deals with the spatial and chapter 6 the secular variations of "mean sea level" on a global scale. The former deals especially with the topographical pattern produced by the current/density field, starting with Defant's classic work on the Atlantic Ocean. The tricky problem of the "level of no motion" is treated rather super-

ficially; one must turn to works on dynamical oceanography for a more profound discussion. A modern map of the geoid, with its humps and hollows of tens of meters variation in (geocentric) sea level, as derived from satellite orbits, would have made an edifying addition, but variations of gravity other than spheroidal are hardly mentioned. The survey of secular variations in sea level naturally considers the difficult partition between slow crustal movement and the true rise of oceanic sea level since about 1890. The manmade tragedy of Venice is given due attention.

After the four central chapters, the remaining ones are rather miscellaneous. Those on seiches and tsunamis have already been mentioned. They, and some sections on data reduction and on tide tables, are short and somewhat light in substance. More substantial sections discuss the statistics of extreme high and low sea levels and questions of pollution in relation to water exchange—in nearly enclosed seas like the Baltic water exchange and rate of change of mean sea level are closely related. These studies will attract readers with engineering problems in mind. The author closes with an interesting article on ancient historical and semi-legendary events involving sea level changes, and their interpretation in modern terms.

Apart from occasional awkwardness in the choice of a word or the turn of a phrase, the standard of English is excellent throughout.

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Reference

WUNSCH, C. 1967. The long-period tides. *Rev. Geophys.* **5**: 447–475.

SULLIVAN, W. 1974. **Continents in motion: The new earth debate.** McGraw-Hill, New York. xiv + 399 p. \$17.50.

The past decade has seen a revolution in our view of the earth—the development of plate tectonic theory. This unifying concept hypothesizes that the earth's crust is constantly recycled. Some ten (or more) blocks move as discrete units away from the midocean ridges where new crust is formed toward the trenches where the crust is pulled down to be resorbed into the earth's mantle. The ocean floor is constantly being renewed. And the continents are accumulations of lighter rocks that are more than twenty times older than the sea floor.

Twenty years ago, any respectable geologist risked ridicule to support this wild idea. Now, virtually every geological journal has a paper using

it to explain distributions of fossil reptiles, glacial deposits, and accumulations of oil and gas. And prospects are encouraging that the theory will guide prospecting for geothermal power sources and provide useful insights for predicting earthquakes.

Walter Sullivan, dean of American science writers, presents an excellent historical survey and statement of the present status of plate tectonic theory. He traces the development of the concept from its formulation by Alfred Wegener, to the FAMOUS Experiment (French-American Mid-Ocean Undersea Study) carried out in the summers of 1973 and 1974. The impact of the theory on our view of the earth equals in scope the changed view of biology brought about by Darwin's theory. In the book ideas are explored in the context of this original development and fascinating glimpses are offered of some of the key people who brought about this revolution—J. Tuzo Wilson, Harry Hess, Maurice Ewing, and Sir Edward Bullard.

Satellite photos illustrate the massive changes in the continents—rifting and mountain building—brought about through continent-moving forces. Drawings and photography portray some of the individuals involved and illustrate major principles.

Sullivan has done a superb job of portraying the concept and transmitting the excitement of discovery that accompanied its development. So, if you want to learn (painlessly) about the present status of geology, this book is a must. And, even if you are a geologist but could not follow the development of plate tectonics on a weekly basis as it has expanded in an explosive fashion, there is a lot here for you.

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INDERBITZEN, A. L. [ED.]. 1974. **Deep-sea sediments: Physical and mechanical properties.** *Marine Science*, v. 2, Plenum Publ. Corp., New York. ix + 497 p. \$35.00.

This excellent book on physical and mechanical properties of deep-sea sediments contains 23 papers from a seminar held under the sponsorship of the Office of Naval Research, Ocean Science and Technology Division. It is divided into four groups of contributions and contains at the end the results of three workshops.

The first group of four papers presents an overview of the subject. The contributions on prediction of deep-sea sediment properties, marine geomechanics, and mechanics problems present overviews that may be too difficult to follow for