the overall effect of the structure. Quite often the execution of a programme of improvement has created problems as severe as those it was conceived to solve, and differences of professional opinion about how problems should be tackled are often wide enough to demonstrate that basic understanding of the forces and motions involved is quite inadequate. It is too early for any complete theory, even of such an apparently elementary problem as the spacing, height and length of a system of groins, but there are partial and practical answers to many difficult questions, and the body of sound information is growing so rapidly that all designers are likely to gain useful guidance from it if they are prepared to face up to the unavoidably difficult analysis and reasoning. A large part of the book is devoted to waves, since they are important in almost every aspect of oceanographical engineering, and also because it is to this aspect of the subject that Prof. Wiegels' experience is most outstanding. He does not deal in detail with fouling organisms, submarine geology, underwater acoustics and sea-ice in which he has not specialized, or with corrosion and erosion of materials, or with measuring instruments for which the existing literature is already so large. But his 532 pages provide broad coverage and depth of information about most of the things that civil engineers want to know about the sea and which are not easy for them to enquire into.

The wave chapters review our knowledge of the theory of wind waves, much of it the outcome of recent work. They emphasize the need for further advanced theory and experiment because of the growing evidence we have of the importance of non-linear effects which could reasonably be neglected in the first approaches to the subject. Solitary and impulsively generated waves are also considered, with special reference to seismic seawaves, storm surges and harbour oscillations. These are followed by studies of the effect of beaches and structures on waves, including the effects of different kinds of breakwaters and resonant absorbers, of the nature of wave forces on different kinds of beaches and structures, and the longshore drifts and beach changes produced by them. There is a separate chapter on modern wave-forecasting procedures and their reliability, and a short note on tides and other changes in water-level and mean sea-level. Perhaps there should have been a more specific consideration of wave set-up—the inshore changes of sea-level which can be produced by oncoming swell without the agency of local wind. There is a chapter on the functional design of fixed and floating structures, piers, breakwaters, sea-walls, groins, underwater pipelines and sewer outfalls, and another on ship motion and on moorings.

Characteristics of ocean water, currents and mixing processes are described, but there is not much about ocean drilling, deep-sea prospecting, deep submergence vehicles and the increasing range of deep-sea technology, which is now referred to as oceanology.

The index is scarcely adequate, but it would be very difficult to refer to everything in a book so densely packed with information, tables, diagrams and references. It is quite an easy book to find one's way about in, and very rewarding.

G. E. R. DEACON

PRINCIPLES OF HISTORICAL GEOLOGY

Stratigraphy and Life History

By Prof. Marshall Kay and Prof. Edwin H. Colbert. Pp. 736. (New York and London: John Wiley and Sons, Inc., 1965.) 74s.

THE student reader of an introductory text on historical geology is faced with several difficulties additional to those of mastering new conceptions and a new vocabulary. In particular, the demands made on his geographical knowledge are considerable; and for this reason the most

useful elementary books are usually those describing the rocks of his homeland. This noteworthy volume by Prof. M. Kay and Prof. E. H. Colbert is concerned principally with the United States. Elsewhere, therefore, it is unlikely to be prescribed other than as collateral reading; but its very existence emphasizes the need for an equally well-illustrated introduction to the geology of Western Europe. Geology, like charity, should begin at home but not remain there.

In the usual fashion the book begins with a description of the rocks of the Pre-Cambrian era and then discusses the Phanerozoic systems one by one; but it is unique in that it essays to explain the principles of stratigraphical, petrographical and geochronological correlation by reference to the non-fossiliferous Pre-Cambrian formations, particularly the ore-bearing rocks of Michigan, Minnesota and Ontario. In fulfilling this difficult task it is remarkably successful. The principles of faunal correlation and faunal provinces are introduced with the description of Cambrian strata; and thereafter appropriate opportunities are taken to bring in various broad concepts on the tectonic control of sedimentation and similar matters. The palaeontology of the various systems, related in very general terms, dovetails with the accounts of the rocks and their palaeogeography; but there are three separate chapters on life in the Palaeozoic, Mesozoic and Cenozoic, and a fourth giving a systematic review of fossil organisms. The emphasis throughout is on the establishment of the principles which guide geological thinking. A chapter on continental drift is lucid reading but it is doubtful if one on the evolution of the crust in North America expresses its ideas sharply enough to be understood by the average undergraduate. A penultimate chapter on the origin of the Earth, by Dean B. McLaughlin, seems too remote to be relevant.

When the authors' writing touches on geochemistry it is much less felicitous and slips are frequent. On pp. 66–69 we are told that "there are two forms of isotopes of uranium", that ^{204}Pb is primary lead, and that ^{40}K forms 1 per cent of natural potassium (although the accompanying diagram gives the correct value of 0.012 per cent); and it is wrongly implied that an age determination can be derived from the ratio $^{235}\text{U} : ^{238}\text{U}$. On pp. 82–83 it is not made clear that the figure of 2,700 m.y. for the oldest rocks relates solely to North America—there are much older formations in Russia and southern Africa; or that the age of 1,700 m.y. given for the Gunflint and Biwabik iron formations is their metamorphic date—the date of sedimentation is much older, as shown on p. 49. Similarly on p. 594 it is said that "there are two isotopes of carbon having atomic weights of 14 and 12: the latter is common carbon". On p. 91 the uraniferous hydrocarbon in the Cambrian shales of Sweden is wrongly referred to as pitchblende; and a reader could pardonably gain the impression that dolomites do not appear before the Silurian (all earlier references are to limestone) and that all dolomites are penecontemporaneous. Students should not be encouraged to use the old term Protozoic for the Pre-Cambrian in view of potential confusion with Proterozoic. It does not appear in the American Geological Institute's dictionary.

In its wealth of illustrations, this text-book is the most lavish of its kind yet produced. A large page size (30 cm × 24 cm) has permitted about half the total space to be occupied by photographs and diagrams, accompanied by lengthy explanations; but only a persistent reader will finally locate a description of the frontispiece photograph on p. 436, and of the dust jacket on p. 176. A coloured geological map of North America is printed inside the jacket. Reproductions of dioramas of palaeontological habitat groups, mostly from exhibits in American museums, present a vivid representation of life through the ages. Some other diagrams of fossils (particularly of microfossils) could have been improved by the addition of a scale.

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