The Ocean and Its Terrain

The Ever-Changing Sea. DAVID B. ERICSON and GOESTA WOLLIN. Knopf, New York, 1967. xiv + 366 pp., illus. $7.95.

This interesting and readable book is a welcome addition to the growing popular literature on oceanography. As long as the current public enthusiasm for oceanography continues, and probably beyond, we will see attempts to communicate the spirit and aspirations of the field to the layman. The educated public seems to have difficulty in understanding oceanography, confusing it with stunts and fortune hunting of various sorts. Another cogent account is welcome.

I suspect that the time when any one or two authors could range authoritatively over the entire field has long since passed. Ericson and Wollin make a worthwhile effort at covering a substantial fraction of oceanography, but their book is obviously at its best where their professional interests and enthusiasm coincide with their exposition. If the book has heroes, they are the echo-sounder, the piston-corer, and Maurice Ewing, not necessarily in that order. The modern and startling developments in our knowledge of the seafloor are described with gusto and insight. Alternative and conflicting hypotheses are compared to the growing mass of information. The need to revise and discard ideas as fresh information becomes available is made clear.

Some of the excitement, tedium, and discomfort of shipboard work—the heart of oceanography—is successfully communicated. The great drama of drifting continents, sea-floor spreading, continental flooding, and mountain building is told with restraint and without any lapse into melodrama. As is probably inevitable in a popularization, hypotheses tend to translate into facts; but this is a quibble.

In discussing the nongeological or geophysical aspects of oceanography, the book is less successful. There is little mention of chemical oceanography, and the chapter on biology is almost perfunctory, being mainly a catalog of some of the more startling fauna of the deep. Two chapters are devoted to physical oceanography, but even here the authors' main interest in the sea floor is readily apparent.

The discussion of oceanic circulation is good, though at times oversimplified and misleading. The temptation to reproduce a picture of an Ekman spiral, surely one of the most discussed and least observed of all oceanic phenomena, has not been resisted. Surface waves and tsunamis are treated in standard fashion with little detail.

I would say that the authors have written a good book that would be better off with a more restricted title.

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The Sun's Surface

The Solar Granulation. R. J. BRAY and R. E. LOUGHHEAD. Chapman and Hall, London, 1967 (distributed in the United States by Barnes and Noble, New York). xiv + 150 pp., illus. $11. International Astrophysics Series, vol. 8.

This monograph is the second on subjects in solar astronomy by the authors (the first, *Sunspots*, was published by Wiley in 1964) and follows a format essentially identical with that of the earlier book, being divided into the same four principal sections: historical introduction, observations, theoretical studies, and high-resolution observing methods.

The surface of the sun, when viewed with a powerful telescope during times of good atmospheric seeing conditions, appears to consist of an irregular pattern of bright polygonal cells separated by dark lanes. These cells, which apparently are due to nonstationary convection in the outer convection zone of the sun, are called granules and number about 2 million over the solar surface. The average separation between granule centers is about 2000 kilometers and the average lifetime of the granules is about 8 minutes. The major part of Bray and Loughhead's text discusses the granulation, but in addition the authors also describe umbral granules, facular granules, and the newly discovered (1960) phenomenon of supergranulation, also a convection cell-pattern, but with a typical scale of 30,000 kilometers and a lifetime of 20 hours, which apparently has its origin much deeper in the convection zone than the ordinary granulation.

From the time of the first serious studies by Herschel, Nasmyth, Dawes, Secchi, and Huggins in the 19th century, the granulation has been a source of controversy among solar astronomers, up to the very present. The primary reason for these debates has been the great difficulty of obtaining high-resolution (1 arc-second or better) photographs of the sun which satisfactorily resolve individual granules. Great strides forward in observing techniques have recently been made which will soon settle many of the arguments. In fact, many important advances have occurred since the authors' bibliography was completed in February 1966 which contradict or modify a number of their conclusions. For example, the contention that granules remain stable during their lifetimes and exhibit no horizontal oscillations has been disproved in a remarkable 45-minute movie recently obtained by J. Rösch at Pic-du-Midi, and observations from Kitt Peak National Observatory and Sacramento Peak Observatory indicate that granule velocities are typically 1 to 3 kilometers per second, a full order of magnitude greater than those described in the text. Also, it is now known that the intensity and velocity patterns of the granulation and supergranulation are indeed related, not independent. It is regrettable that no mention is made in the text of the short-period (1- to 5-second) oscillations discovered by R. Howard or of the observation by J. Evans that many granules are sharply inclined from the vertical.

The chapter on theoretical studies of granulation provides an excellent introduction to this very difficult subject and is also valuable as a source of references to detailed work in the field. Up to the present, theorists have had only limited success in predicting observed phenomena, and the authors discuss a number of approaches to solving the equations of convection theory, both linear and nonlinear.

The most disappointing section of the book is that on high-resolution observing methods, which seems quite incomplete and somewhat repetitive of the similar section in the earlier monograph on sunspots. First, the authors discuss a very controversial subject, namely, the origins of atmospheric seeing. They present some of their own published data, but do not mention detailed studies made at Mt. Wilson Observatory, at Aerospace Corporation, and at the Fraunhofer Institute which would have been valuable inclusions. Second, they describe three new solar instruments but do not discuss those two instruments which may contribute most to high-resolution solar astronomy in the