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REVIEWS

The Benthic Boundary Layer. Edited by I. N. McCave. Plenum Press, 1976. 323 pp. $27.50.

Bottom Turbulence. Edited by J. C. J. Nihoul. Elsevier, 1976. 306 pp. $39.50 or Dfl. 98.00.

The bottom of the deep ocean has seldom been visited by the instruments of modern fluid dynamics. The fluid is weakly stratified (with a buoyancy period of a few hours or more), there is only the mildest heat flow upwards from the solid earth (10^{-6} cal cm^{-1} s^{-1} on average) and the currents are modest (a few cm s^{-1} in most regions, up to 50 cm s^{-1} in the vicinity of western boundary currents). In terms of the one-dimensional analysis applied to other boundary layers, the turbulent Ekman thickness [$\sim 0{\cdot}4 \times$ (friction velocity/Coriolis frequency), approximately 5 m to 10 m] is small, relative to the remarkable isothermally mixed layers observed (from 10 m to 100 m thick). One is faced with a layer of rapidly rotating, unstratified turbulence separated, by a sharply defined temperature lid, from the more smoothly stratified ocean interior. The energy-containing eddies in the layer may be close to the transition between turbulence and inertial waves.

In shallow seas, or on continental shelves, the tides are concentrated and the flow may be more intense. It is in such areas that most of the field data have been collected.

What is fascinating is the breadth of interest of the group of researchers in the field. *The Benthic Boundary Layer* consists of the proceedings of a NATO-sponsored meeting held in France in November 1974. The topics involve the fluid dynamics, geochemistry and biology of the lowest few metres of the ocean, and the nature of the underlying sediments. It reads like the first tales of exploration of a new planet, where the data are sparse and simple questions are still being asked. The fluid-dynamical papers include 'Physics of the benthic boundary layer (BBL)', by Wimbush, 'Measurements of turbulence in the Irish Sea BBL', by Heathershaw, 'Engineering interest in the BBL', by Krone, and working-group reports from the meeting.

Bottom Turbulence contains the proceedings of the Eighth Liège Colloquium on Ocean Hydrodynamics. The papers emphasizing BBL dynamics most strongly deal with: bottom turbulence in stratified enclosed seas (Lozovatsky, Ozmidov & Nihoul), the effect of stratification (Weatherly & Van Leer), effects of suspended sediment and topography (Smith & McLean), the dynamics of the deep ocean BBL (Armi) and observations off Africa and Oregon (Kunder) and in the Florida Current (Weatherly).

The papers report observations of some familiar fluid-flow properties: burst-like intermittency, Ekman veering and billows upon density discontinuities. Experience gained from the atmospheric boundary layer may not be widely applicable, however, because of the much greater role of heating there. Though lacking this complexity of the atmospheric case, the BBL lies above topography that can be either far smoother (on abyssal plains) or rougher than is normally found on land. And, in common with the atmosphere, we must expect to find important convergence and divergence in the BBL beneath deep mesoscale eddies, and frontal surfaces developing where isotherms intersect the bottom.

The remaining papers in these volumes are equally interesting even to the non-specialist, and convince one that observations of mud waves, furrows, burrowing worms and the fluxes of nutrients and chemicals are, in fact, relevant to the fluid dynamics.

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