approach, listing and labeling parts of the ocean, its currents, water masses, edges, and so on. The latter part, on chemical cycles in the ocean, is better. But there is no general discussion of the importance to living things of the scarcity of life in most of the sea, of the continuous motion of the medium, of the constancy of the environment in most of the ocean, or of the importance of gravity in a fluid medium compared with a solid substratum.

An enormous amount of work has obviously gone into the treatise and will continue to go into it. It is generally successful as a comprehensive review of what is known about marine ecology, but this collection of knowledge belongs in institutional libraries, not on personal bookshelves.

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Particles and Flow

Hydraulics of Sediment Transport. WALTER HANS GRAF. McGraw-Hill, New York, 1971. xii, 514 pp., illus. $22.50. McGraw-Hill Series in Water Resources and Environmental Engineering.

Although this is basically an engineering textbook, it provides a first-rate review of the literature (682 references) and therefore should be a valuable sourcebook for scientists.

Part 1 is a short history (23 pages) of sediment transport starting about 7200 years ago, part 2 is an introduction (43 pages) to the hydrodynamics of fluid-particle systems, part 3 is a detailed treatment (346 pages) of sediment transport in open channels, and part 4 deals with sediment transport in closed pipes. The development is mathematical throughout. The apparent (or typographical) organization is excellent, with topics and subtopics numbered, in a modified decimal system, down almost to the paragraph level.

Despite the fact that the treatment is basically historical, the text is not ideal for the beginner. For example, the von Kármán vortex street is mentioned without definition on page 41, there is no listing of von Kármán (or Kármán) in the indexes, and there is no treatment of this phenomenon prior to page 41.

The author reviews the problem of the settling velocity of particles, pointing out the failure of *all* physically based efforts to make verifiable predictions at Reynolds numbers above 2. He discusses various complicating effects but seems not to be aware of self-induced particle rotation (due to a phenomenon which is essentially the von Kármán vortex street) and its effects on nearby grains. He attacks the problem of using "average velocity" to represent the flow and to predict the scour, points out that "bed velocity" is generally not available, and shows that the natural historical development has been to turn to the "bottom shear stress" as a good substitute. Kalinske's important observation, that velocity fluctuations are critical, is reported but not exploited; the reviewer feels that this is the direction that sediment-transport research must now take.

Graf is aware (also from Kalinske's work) that saltation is unimportant in water, a fact overlooked by many a textbook writer. He treats the "lift" problem in fair detail, without recourse to saltation, but also without providing a satisfactory mechanism. His discussion of the "regime" (equilibrium) concept leans heavily on work by Blench and a summary by Leopold *et al.* Meandering is treated in light of the fact—apparently not appreciated by very many persons—that bed load is not necessary for initiation, but no clear-cut principle emerges. The river profile is analyzed in terms of the simplest cases only. A good presentation of modeling and model laws is given.

Overall, this book is a fine summary of sediment transport, strong in both mathematics and historical sequence, but it breaks no new ground, and it rarely even points in the direction that research might go.

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Books Received

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