Document generated on 04/20/2024 3:21 a.m.

Geoscience Canada

Shelf Sediment Transport: Process and Pattern

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Volume 2, Number 2, May 1975

URI: https://id.erudit.org/iderudit/geocan2_2br10

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Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)
1911-4850 (digital)

Explore this journal

Cite this review

Middleton, G. V. (1975). Review of [Shelf Sediment Transport: Process and Pattern]. *Geoscience Canada*, *2*(2), 122–123.

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stratigraphers could possibly have guessed. The rate of sedimentation is so variable that most deposits should not be considered to form by "slow accumulation" but by rapid sedimentation alternating with long periods of reworking or non-deposition. Some sedimentation, probably more that was thought by Lyellian stratigraphers (though Lyell himself was remarkably flexible on the matter) was produced by "catastrophes" such as giant floods, hurricanes or turbidity currents. Other "depositional episodes" (Frasier, 1974) such as the growth of a single delta lobe, were probably completed in such a short period of geological time (a few hundreds or thousands of years) that, viewed across a hundred million years, they seem almost instantaneous. We know this, but is it in the text-books? Do we acknowledge it sufficiently in our current stratigraphic interpretations and terminology?

Ager is better at asking provocative questions than at providing a grand synthesis. The last chapter of his book ("The Nature of the Control") attempts to blend together American and European Phanerozoic stratigraphy with just a dash of plate tectonics. It still reads to me like the old story of "the seas swept in, the seas swept out". But the rest of the book can be recommended, the informal style makes easy reading and the ideas are worth pondering.

Reference

Frazier, D. E., 1974, Depositional-episodes: their relationship to the Quarternary stratigraphic framework in the northwestern portion of the Gulf Basin. Texas Bur. Econ. Geol., Geol. Circ. 74-1, 28 p.

MS received February 3, 1975

Shelf Sediment Transport: Process and Pattern

Edited by Donald J. P. Swift, David B. Duane and Orrin H. Pilkey
Dowden, Hutchinson and Ross, Inc., Stroudsburg, Pennsylvania, 656 p., 1972.
$35.00

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The modern continental shelves of the world are peculiarly interesting and yet frustrating areas of study for geologists. The shelves comprise some six percent of the total surface area of the globe and in places are hundreds of kms wide. The shelves include most of the broad areas of shallow marine sedimentation that now exist. The stratigraphic record tells us that much of the exposed geological column was deposited in broad shallow seas, and uniformitarianism suggests that geologists should study the sediments on modern shelves in order to understand the distribution of facies in ancient continental seas. The near exhaustion of some mineral resources under parts of the continents, and the discovery of substantial resources under some continental shelves, have spurred development of the technology which has now made possible the active exploitation of these resources, even in relatively deep water and under hostile climatic conditions.

The frustrating aspects of shelf geology, however, have tended to prevail over the interesting aspects. Early studies soon showed that many characteristics of the modern shelves can be explained only by reference to the rapid post-glacial rise in sea level. K. O. Emery has argued convincingly that most modern shelves are not yet readjusted to the conditions that now exist and that have prevailed over them for only the last 6000 years. This suggests that "the present is the key to the Pleistocene" but is not much help with the rest of the geological record. Skepticism about the value of studying modern shelf sediments has been strengthened by the realization that many ancient shallow marine sediments were deposited not on continental shelves but in vast, interior "epeiric" seas of which we have no modern examples.

Despite these frustrations, and others that arise from the difficulty and expense of operations, even in shallow water, that have to be carried out tens of miles from shore, some marine geologists have persisted with their studies of shelf sediments. This volume gives an excellent summary of work recently carried out at a number of U.S. institutions.

What has led to the most interesting results has been a change in the method of investigation. If modern shelves are largely relict, simply mapping the distribution of sediment types is of limited value: the patterns cannot be fully explained in terms of modern processes. Instead, it is necessary to obtain first an understanding of the actual processes operating on modern shelves. Armed with this understanding, it is then possible to see which aspects of modern shelves are, in fact, truly relict, which are better described as "palimpset" (a term introduced by Swift, Stanley and Curray to describe sediments that are derived from one environment but that have been substantially reworked in another) and which are truly modern. Ultimately, a firm understanding of process may yet enable marine geologists to "retrodict" the characteristics of shelves which, in the past, were able to achieve a closer approach to equilibrium between process and response.

Most of the papers in the volume deal with physical aspects of sedimentation (there are no papers on carbonates or on specifically chemical or biological problems). Many papers explore the hydrodynamics of processes acting on the shelves: some are theoretically-based research papers, such as the paper by Sternberg on predicting bedload movement and transport rates, the paper by Southard and Cacchione on sediment movement by internal waves that form at the thermocline and break as the water shallows, the paper by Schubel and Okubo on diffusion of fine grained sediment across the shelfs to the ocean basins, and by Komar and others on the characteristics and occurrence of deep water oscillatory ripple marks. A few papers briefly

review relevant aspects of physical oceanography. Other papers report the results of extensive field investigations which determined not only the sediment distribution but also the dynamics of the water masses: examples are studies by Smith and Hopkins, and by Sternberg and McManus (both concerned with the shelf off the State of Washington), the paper by Ludwick on tidal sand waves, and the paper on the entrances of Georgia estuaries by Oertel and Howard.

A few papers try to develop general models: they include the stochastic model for sediment sorting derived by Swift, Ludwick and Boehmer, a general model for the distribution of fine grain sediments discussed by McCave, and a general paper on the evolution of the Holocene shelf surface on the U.S. Atlantic coast, by Swift, Kofoed, Saulsbury and Sears.

This is a big book, and it is not possible to mention all the interesting things to be found in it. It does not pretend to give all the answers, even for the few shelves that get most of the attention. But it does show a new approach to studies of shallow marine clastic sediments, and it gives an interesting preview of the results that are likely to be achieved in the future.

MS received September 17, 1974.

Stratigraphic Traps in Sandstones - Exploration Techniques

by Daniel A. Busch
American Association of Petroleum Geologists, Memoir 21, 174 p. 1974.
AAPG and SEPM Members $12.00; Others $15.00.

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According to the author, this book "should be of particular benefit to explorationists who work for small companies or independents, and to geological consultants not in a position to pursue research actively". Unfortunately, the book is both conceptually and factually between 12 and 20 years out of date. The last 10 years of intensive research in recent sediments, and sedimentology and stratigraphy of ancient rocks, are mostly ignored, and hence the basis for the stratigraphic traps is very dated. Analysis of the references shows that the modal five-year period of citations is 1955-59 (63 references), with a steady decrease (47, 39, 24) in the following five-year peroids.

Chapters 1, 2 and 3 (30 p.) cover terrigenous deposition in marginal-marine areas, and fundamental concepts related thereto. This part of the book is based upon ideas and diagrams from Grabau (1913), and emphasizes concepts of cyclic subsidence and cyclic uplift. Busch's own ideas of Genetic Increments of Strata (GIS) and Genetic Sequences of Strata (GSS) are introduced, but are unrelated to process except to state that one GIS is "an interval of strata representing one cycle of sedimentation". The types of "cycle" are not specified.

Chapters 4 and 5 (40 p.) cover recent and ancient beach, barrier bar and offshore bar sands. The chapter on recent sands does not mention the fundamental concept of barrier bar origin from subsiding beach ridges (Hoyt, 1968), nor does it discuss the fundamental gradational-based, coarsening-upward sequence that results from barrier bar progradation. Our understanding of beaches and barriers has changed so much in the last 10 years that these two chapters are of little use. The recent and ancient examples that Busch cites are not integrated into an exploration model - they remain as disconnected examples.

Chapter 6 (35 p.) is devoted to recent and ancient channel sandstones, and does attempt to generalize on exploration techniques. However, the basis of the models is still very out-of-date, with the most recent introductory references for basic information dating from 1963.

Chapter 7 (36 p.) is on deltas. The classification is morphological (Arcuate, Estuarine, Birdfoot, Lobate, Arcuate, Cuspate), and does not mention the more conceptually useful ideas of High-Constructive and High-Destructive deltas. Although citing Scruton (1960), Busch does not mention constructive and destructive elements, nor detrital lenses alternating with bounding layers, nor the idea of coarsening-upward sequences. In the five pages at the end of the chapter on delta prospecting, Busch is basing his exploration models on ideas of cyclic subsidence, and does not consider local delta switching (as in the last 5000 years of Mississippi Delta construction) as a useful exploration possibility.

The book ends here, without even mentioning deep water sands, turbidites and hydrocarbon accumulations in the Los Angeles and Ventura Basins. It can only be recommended to those who wish to base their exploration techniques on ideas current in the late 1950s.

MS received December 20, 1974.