Atlantic Geology

Recent Shoreline to Shelf Sedimentary Facies: Analogues of the Middle Paleozoic Sediments of Nova Scotia

Thomas E. Lane

Volume 11, Number 3, December 1975

URI: https://id.erudit.org/iderudit/ageo11_3rep01

See table of contents

Publisher(s)

Maritime Sediments Editorial Board

ISSN

0843-5561 (print)
1718-7885 (digital)

Explore this journal

Cite this article

Lane, T. E. (1975). Recent Shoreline to Shelf Sedimentary Facies: Analogues of the Middle Paleozoic Sediments of Nova Scotia. *Atlantic Geology*, *11*(3), 83–86.

Reports

Recent Shoreline to Shelf Sedimentary Facies: Analogues of the Middle Paleozoic Sediments of Nova Scotia

THOMAS E. LANE
Department of Geology, Dalhousie University, Halifax, Nova Scotia

Introduction

The S.E.P.M. (Eastern Section) Field Trip (1975) includes field stops at Middle Paleozoic sedimentary rocks in the Annapolis Valley area of the Meguma Belt (Stops 3 and 4) and in the Arisaig area (Stops 12 to 14) (see Fig. 1 of Harris, this volume). The Middle Paleozoic sediments of both areas comprise interbedded shale, mudstone, siltstone and sandstone, as described in the succeeding three papers of this volume. Previous faunal studies have shown that the bulk of these sediments were deposited in a shallow marine regime (littoral to neritic).

This paper describes clastic deposition in a shallow marine setting, with a view to providing a sedimentologic model for the Middle Paleozoic Sediments of Nova Scotia. This description is drawn from publications dealing with the Holocene shoreface to shelf sedimentary facies in the following regions: the North Sea (Reineck and Singh, 1973); the Atlantic Coast of the United States (Howard and Reineck, 1972; Duane *et al*, 1972; Swift *et al*, 1972; Sander and Kumar, 1975); the Gulf of Mexico (Bernard and Major, 1959); the Mediterranean - Gulf of Gaeta area (Reineck and Singh, 1971); and the Oregon Coast (Kulm *et al*, 1975; Clifton *et al*, 1971).

Sedimentologic Model

The nearshore, marine areas that border sandy coastlines can, in general, be divided into three zones on the basis of sedimentary facies. These are (1) an inshore sandy zone covering an inclined shoreface, (2) a transition zone of mixed sand and mud at the shoreface toe, and (3) the farthest offshore zone of predominantly mud deposition. Sediments are introduced into the nearshore from rivers and by coastal erosion. Once there, they are disseminated seaward by net flow. In general, the sediments become finer-grained with increasing distance from shore. Sands are deposited close to the shore, while muds are carried further seaward.

Surface waves generate oscillation and flow of the water mass above wave base (Fig. 1A). Wave action winnows the sediments, where the sea-bottom rises above wave base, and removes most of the mud but leaves a residue of sand (herein referred to as shoreface sand). The intensity of wave action, and hence the depth of wave base below mean low tide level, varies considerably from coast to coast. Off Sapelo Island on the southeast coast of the United States, for example, wave action tends to be relatively weak and as a consequence shoreface sands are restricted to a shallow zone several metres below low tide level (Fig. 1B). Conversely, wave action periodically is relatively intense off the Oregon coast and shoreface sands are deposited there to depths up to or exceeding 50 metres below low tide level.

Waves and wave-generated currents are less active seaward of the shoreface zone, and, therefore, sediments once deposited below the shoreface are more commonly left in place. In general, only sand or gravel can accumulate above mean wave base, whereas immediately below wave base both fine-grained and coarse-grained sediments are deposited. This accounts for an abrupt compositional change in the sediments between the shoreface zone and the transition zone. It bears repeating that the boundary between these zones represents the lower limit of frequent reworking of the sediments by wave- and current-action capable of eroding and suspending fine-grained sediments. Although in most instances this boundary coincides with wave base, tide-generated currents that exceed the depth of wave base are the controlling factors in some sea-bights and inlets.

Ancient nearshore marine clastics commonly are preserved as sequences of strata which coarsen upwards from predominantly shale to predominantly sandstone (Fig. 2). These fining-upward sequences record shoaling conditions due to progradation of the shoreline and/or regression of the sea. The dark shales at the base of these sequences were deposited relatively far from shore, in quiet water. Thin interbeds of parallel-laminated siltstone increase upwards in thickness and abundance. The uppermost of these shelf siltstones characteristically are relatively coarse-grained, and commonly are interbedded with muddy sandstone. The sediments of the transition zone (Fig. 2) are characterized by an exponential increase upwards in the ratio of sand to shale.

The sandstones of the shoreface zone typically occur as amalgamated flat beds of clean, well-sorted, quartz-rich arenites. These arenites tend to lie in sharp contact with the immediately underlying, transition-zone sediments. Sedimentary structures within the arenites in some cases indicate an upwards transition from shoreface to shoreline deposits. The shoreline (uppermost) sands commonly have irregular, erosional bedding surfaces and abundant, trough-type cross-bedding.

The depositional characteristics discussed above pertain to sediments deposited in nearshore areas continguous with shorelines having extensive supplies of sandy material. Strata of this general type are characteristic of the White Rock and Torbrook Formations but not of the Arisaig Group. The strata of the Arisaig Group contain relatively little arenite, hence, the paleoshoreline apparently supplied only small amounts of this material. The interfingering of muddy, coastal-plain strata in the Arisaig group (Upper Moydart and lower Knoydart Formations) further attests to a probable dominance of fine-grained sediments along the paleoshoreline. This type of deposition is depicted in Figure 3. It has no known Holocene analogues, but has been reported in the Upper Devonian of Western New York and

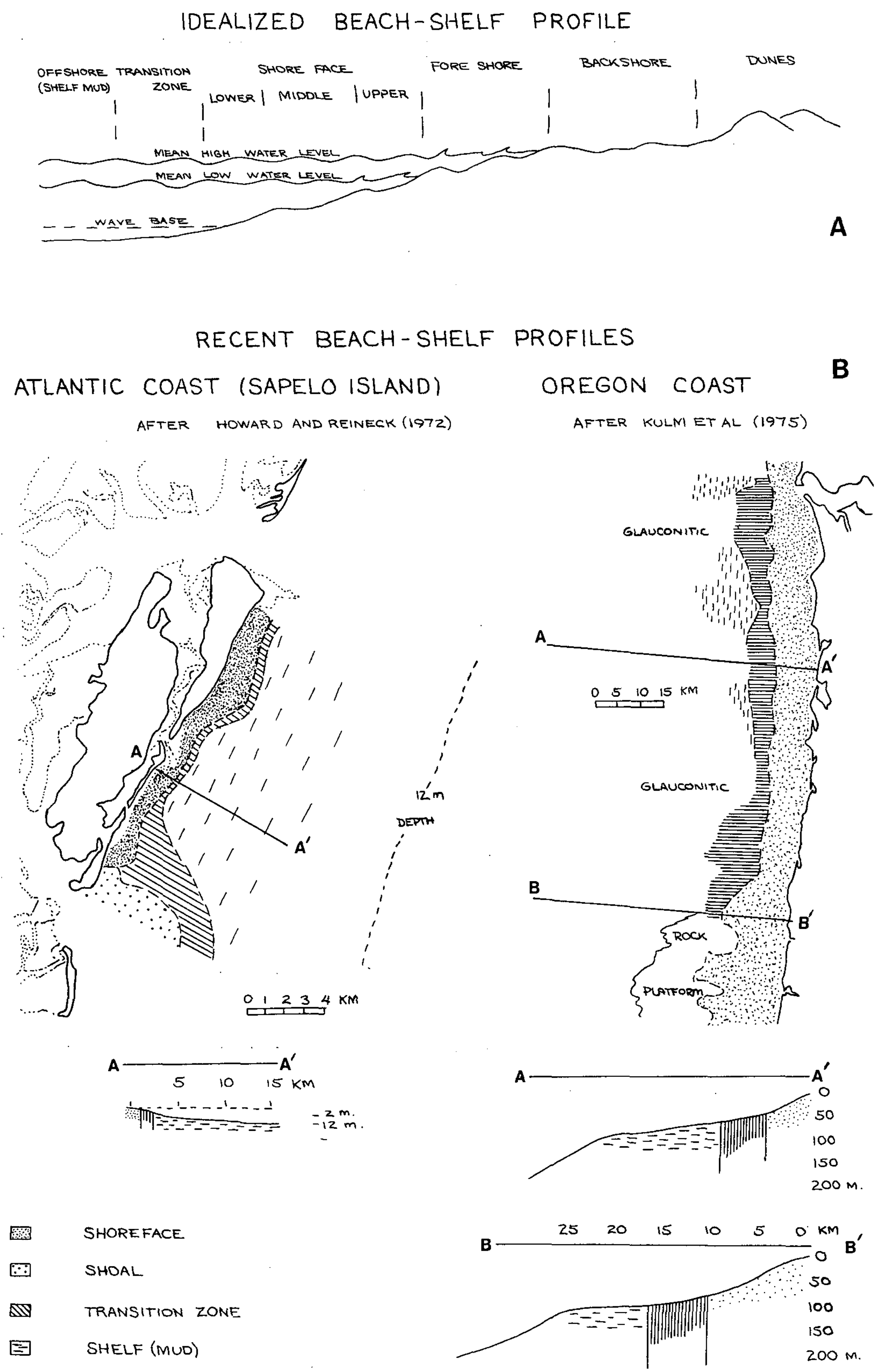

Fig. 1 (a) Diagram showing geomorphic zonation of a beach to inner shelf profile.
(b) Plan and sectional views of two modern inner shelf areas, the low-energy Atlantic coast and the high-energy, wave-dominated Oregon coast.

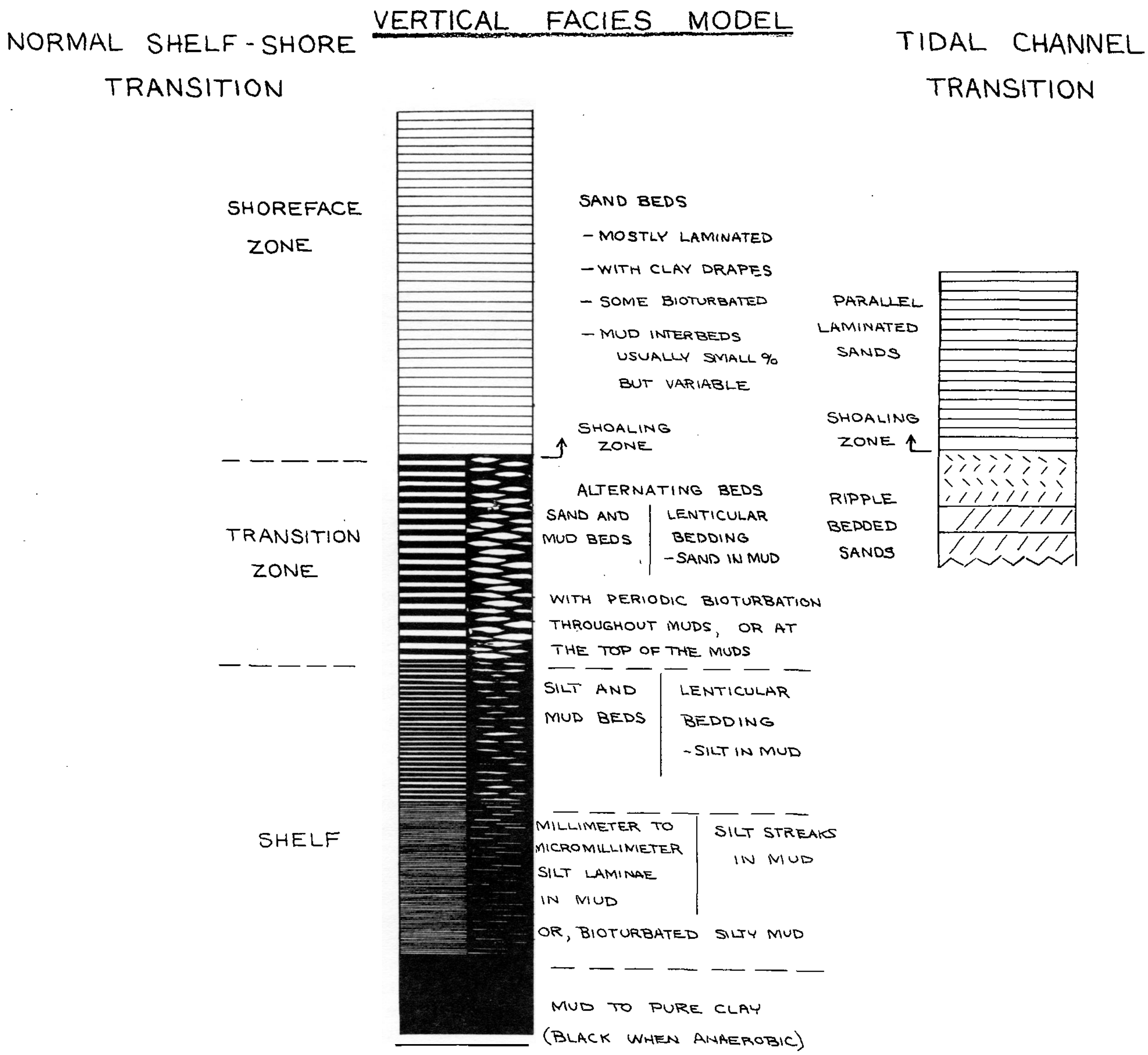

Fig. 2 Vertical sequence of inner shelf to shoreface facies resulting from progradational sedimentation. On the left, normal transition from shelf muds to shoreface sands; on right, transition from channel sands deposited by tide-generated currents to shoreface sands.

Pennsylvania (Sutton *et al*, 1970;Walker and Harms, 1971; Walker, 1971).

In nearshore areas where tide-generated currents play a dominant role (e.g., the North Sea), sands commonly are deposited well below wave base. The bulk of these sands generally are deposited in channels that migrate laterally with time. The channel sands typically have megaripple cross-lamination and generally are overlain by interbedded sand, silt and mud. These overlying sediments are channel-bank deposits and are characterized by parallel-lamination and small-scale ripple-lamination. The channel-bank deposits, in turn, commonly are overlain by shoreface sands that were deposited above wave base. This variant of the depositional model described above probably applies to some of the strata that can be observed in the White Rock Formation.

Most of the sediments carried to river mouths are trapped in banks, levees, flood plains, estuaries and lagoons before they can be discharged onto the adjoining shelf. It is only periodically, during floods, that flow from the rivers is strong enough to transport large amounts of sediment onto the nearshore shelf. The bulk of this sediment is mud and silt. Much of it is deposited on "delta fronts", but some of it is transported along the shore. The flooding of rivers, therefore, may cause periods of dominantly mud deposition on the shelf. Later, particularly during storms, waves and wave-generated currents may redistribute part of the mud and silt and deposit them further out on the shelf, as well as winnowing whatever sand remains behind. The rhythmetically bedded mudstone, siltstone and sandstone, as discussed above and as observed in the Middle Paleozoic formations of Nova Scotia, presumably reflect the effects on the shelf both of storm-wave activity and periodic (seasonal?) flooding of nearby rivers.

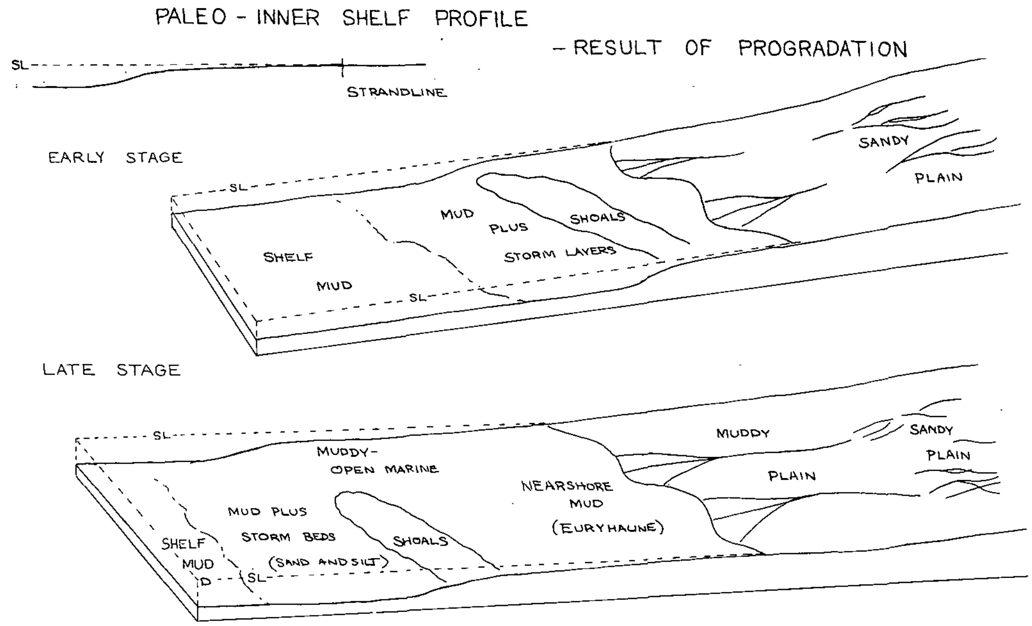

Fig. 3 Schematic representation of prograding deposition in an inner shelf to shore area in which the sediments supplied by adjoining rivers and coastal erosion are dominantly fine-grained. Shoals represent concentrations of winnowed sand. The letters "SL" refer to sea level.

Much of the muddy sediment that is deposited on the shelf remains highly water-laden due to constant reworking by currents and burrowing organisms. However, some of the mud is relatively little disturbed and eventually becomes dewatered and cohesive. The cohesive mud can then only be eroded by currents of relatively high energy. Thus muddy sediments may be preserved and interbedded with coarser sediments, even though current action periodically may be fairly strong. Some organisms serve to reinforce mud stability, particularly *in situ* forms that live in dense concentrations such as algae, bryozoaus and crinoids. Such factors probably played an important part in the preservation of the nearshore marine shales of the Arisaig Group.

References

BERNARD, H.A., MAJOR, C.F., 1959, The Galveston barrier island and environs - a model for predicting reservoir occurrence and trend; Trans. Gulf Coast Assoc. Geol. Soc., v. 9, p. 221-224.

CLIFTON, H.E., HUNTER, R.E., PHILLIPS, R.L., 1971, Depositional structures and processes in the non-barred high energy nearshore; J. Sediment. Petrol., v. 41, p. 651-670.

DUANE, D.B., FIELD, M.E., MEISBURGER, E.P., SWIFT. D.J.P., WILLIAMS, S.J., 1972, Linear shoals on the Atlantic Inner Continental Shelf, Florida to Long Island, in Swift, D.J.P., Duane, D.B., Pilkey, O.H. (eds.), Shelf sediment transport: process and patterns; Dowden, Hutchinson and Ross, Inc., 656 p.

HOWARD, J.D., and REINECK, H.E., 1972, Georgia coastal region, Sapelo Island, U.S.A.: Sedimentology and Biology IV - Physical and biogenic sedimentary structures of the nearshore shelf; Senckenbergiana Marit., v. 4, p. 81-123.

KULM, L.D., ROUSH, R.C., HARTLETT, J.C., NEUDECK, R.H., CHAMBERS, D.M. and RUNGE, E.J., 1975, Oregon continental shelf sedimentation: interrelationships of facies distribution and sedimentary processes; J. Geol., v. 83, p. 145-175.

REINECK, H.E., and SINGH, I.B., 1971, Der Golf von Gaeta tyrrhenisches Meer. 3. Die Gefuge von Vorstrand-und Schelfsedimenten; Senckenbergiana Marit., v. 3, p. 185-201.

REINECK, H.E., and SINGH, I.B., 1973, Depositional sedimentary environments with reference to terrigeneous clastics; Springer-Verlag, 439 p.

SANDER, J.E., KUMAR, N., 1975, Evidence of shoreface retreat and in-place "drowning" during Holocene submergence of barriers, shelf off Fire Island, New York; Geol. Soc. Amer., Bull., v. 86, p. 65-76.

SUTTON, R.G., BOWEN, Z.P., and MCALESTER, A.L., 1970, Marine shelf environments of the Upper Devonian Sonyea Group of New York; Geol. Soc. Amer., Bull., v. 81, p. 2975-2992.

SWIFT, D.J.P., KOFOED, J.W., SAULSBURY, F.B., SEARS, P., 1972, Holocene evolution of the shelf surface, central and southern Atlantic shelf of North America, in Swift, D.J.P., Duane, D.B., Pilkey, O.H. (eds.), Shelf sediment transport: process and pattern; Dowden, Hutchinson, and Ross, Inc., 656 p.

WALKER, R.G., 1971, Non-deltaic depositional environments in the Catskill clastic wedge (upper Devonian), Central Pennsylvania; Geol. Soc. Amer., Bull., v. 82, p. 1305-1326.

WALKER, R.G., and HARMS, J.C., 1971, The "Catskill Delta", a prograding muddy shoreline in central Pennsylvania; J. Geol., v. 79, p. 389-399.