

Evolution and Preservation of Sand Ridges from the New Jersey Middle and Outer Shelf*

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Search and Discovery Article #50209 (2009)

Posted October 15, 2009

*Adapted from oral presentation at AAPG Convention, Denver, Colorado, June 7-10, 2009

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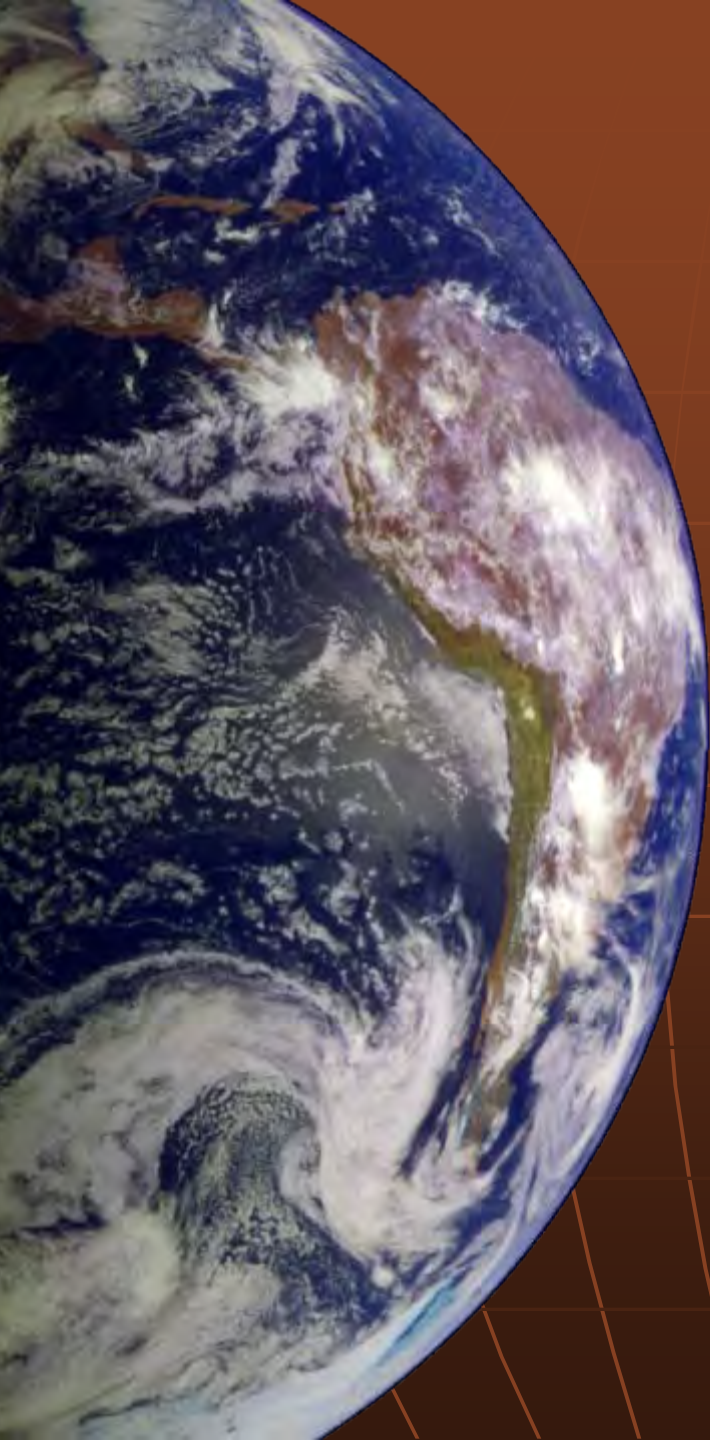
Abstract

Sand ridges on the northeast US Atlantic shelf form in the near shore environment, most likely in response to storm driven flows. With Holocene sea level rise, sand ridges are detached from the shoreface and transitioned into an offshore hydrodynamic regime. This paper reports on the results of more than a decade of high-resolution survey work over sand ridges on the New Jersey middle and outer shelf. The morphology and seismic structure of offshore sand ridges and smaller-scale features are investigated in an effort to place constraints on bedform evolution and sand bed preservation in these deeper waters.

The gross morphology of ridges (height, width, length) does not change with depth beyond ~20 m water depth, indicating that sand ridges do not grow in the offshore hydrodynamic regime. However, several lines of evidence indicate that sand ridges on the middle shelf (~20-50 m water depth) continue to substantively evolve: 1) ridge shape, which has an asymmetry opposite to that seen near shore; 2) a complex backscatter response, which indicates textural variations that are not consistent with near shore ridge development; 3) phase shifts between modern mid-shelf sand ridges and undulations in the underlying transgressive ravinement surface, which indicate substantial translation of the ridges from their formative locations; and 4) the presence of smaller-scale (~100-500 m wavelength, <1 m rms height), N-trending transverse bedforms on the seaward flanks of ridges, indicating sediment transport on the upcurrent flanks to a shoreward-directed flow.

In contrast, sand ridges on the outer shelf (~50-150 m water depth) have higher backscatter at the crests, lower backscatter in the swales, and have no secondary bedforms on their flanks, implying that these are largely winnowed, relict features. Longitudinal bedforms (ribbons) on the outer shelf inhabit large NE-oriented swales between clusters of ~ENE-trending ridges. Morphologic and seismic evidence suggests that the ribbon-floored swales represent erosional intrusions into the otherwise relict ridge morphology.

Truncation of both the transgressive ravinement and the moribund sand ridges place the erosion in a marine setting, post-dating the passage of the shoreface ravinement and the evolution of sand ridges that form initially in the near shore environment. These conclusions may have implications for understanding the preservation potential of transgressive sand sheets in the stratigraphic record.



Evolution and Preservation of Sand Ridges on the New Jersey Middle and Outer Shelf

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Goal: Understand sand ridge evolution across the shelf

Outline

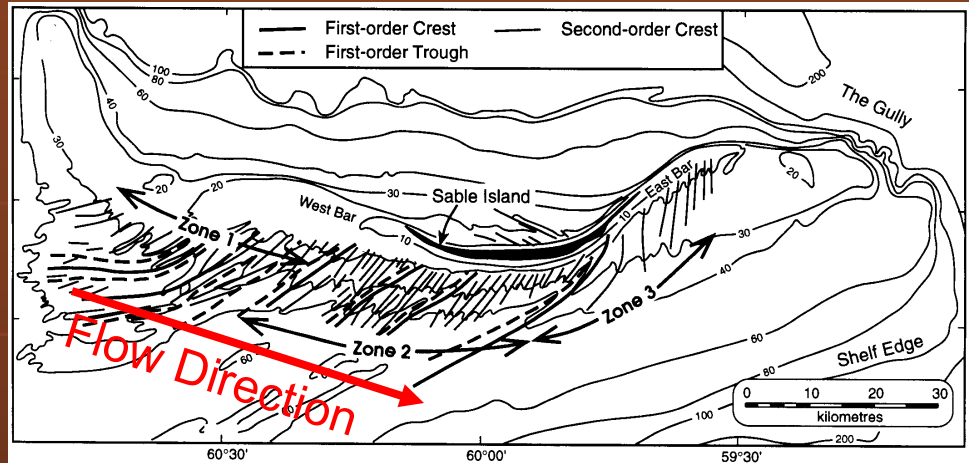
1. Sand ridge development in the near shore, Sable Island (Dalrymple and Hoogendoorn, 1997)
2. Evolution of shoreface detached ridges, New Jersey inner-to-middle shelf (Sneddon and Dalrymple, 1999)
3. Sand ridge morphology and structure on the middle New Jersey shelf
4. Sand ridge morphology and structure on the outer New Jersey shelf.
5. Shoreface to shelf break model for sand ridge evolution.

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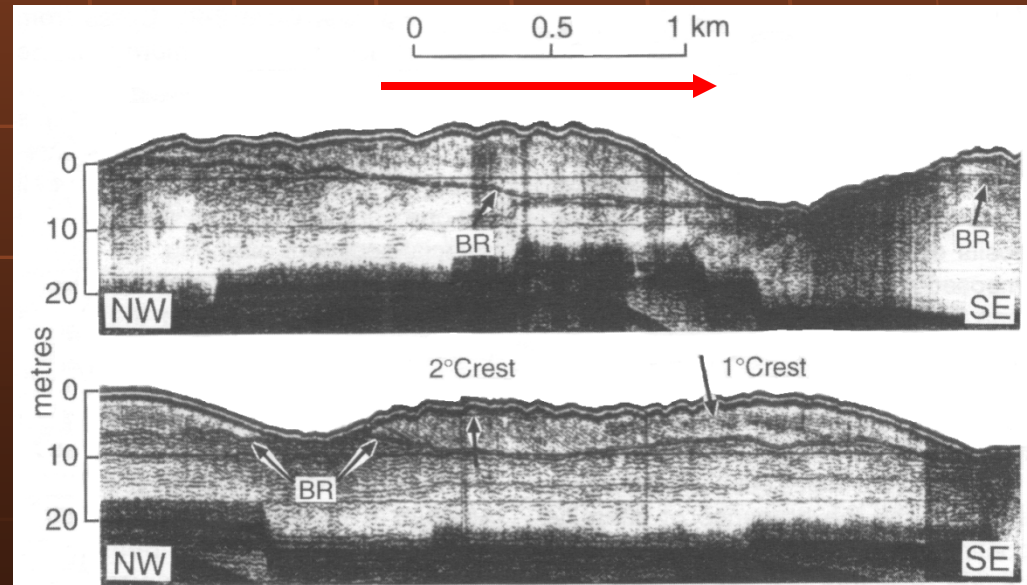
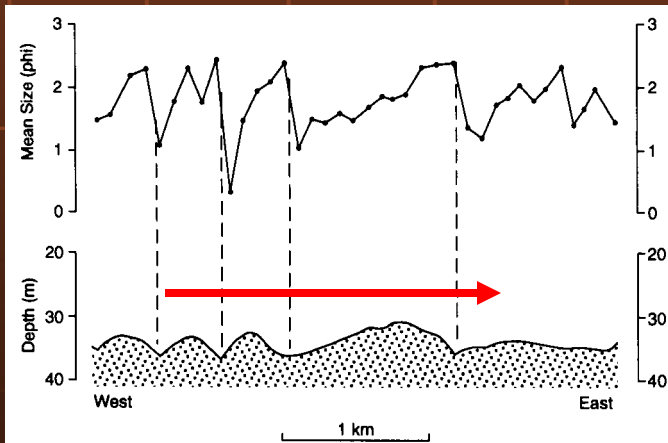
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Sable Island Sand Ridges

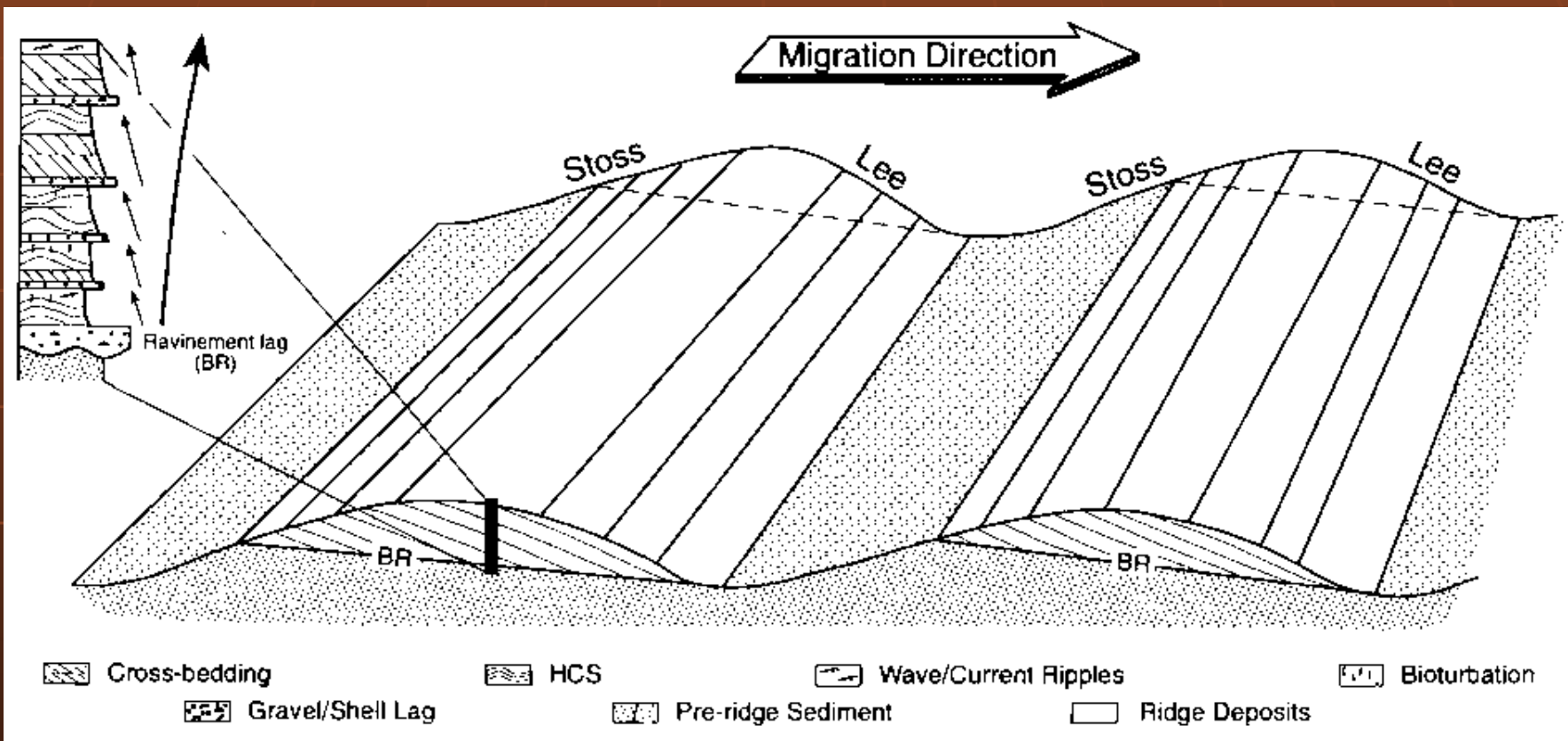


Dalrymple and Hoogendoorn, 1997



Sand Ridge Formation in the Near Shore

Dalrymple and Hoogendoorn, 1997

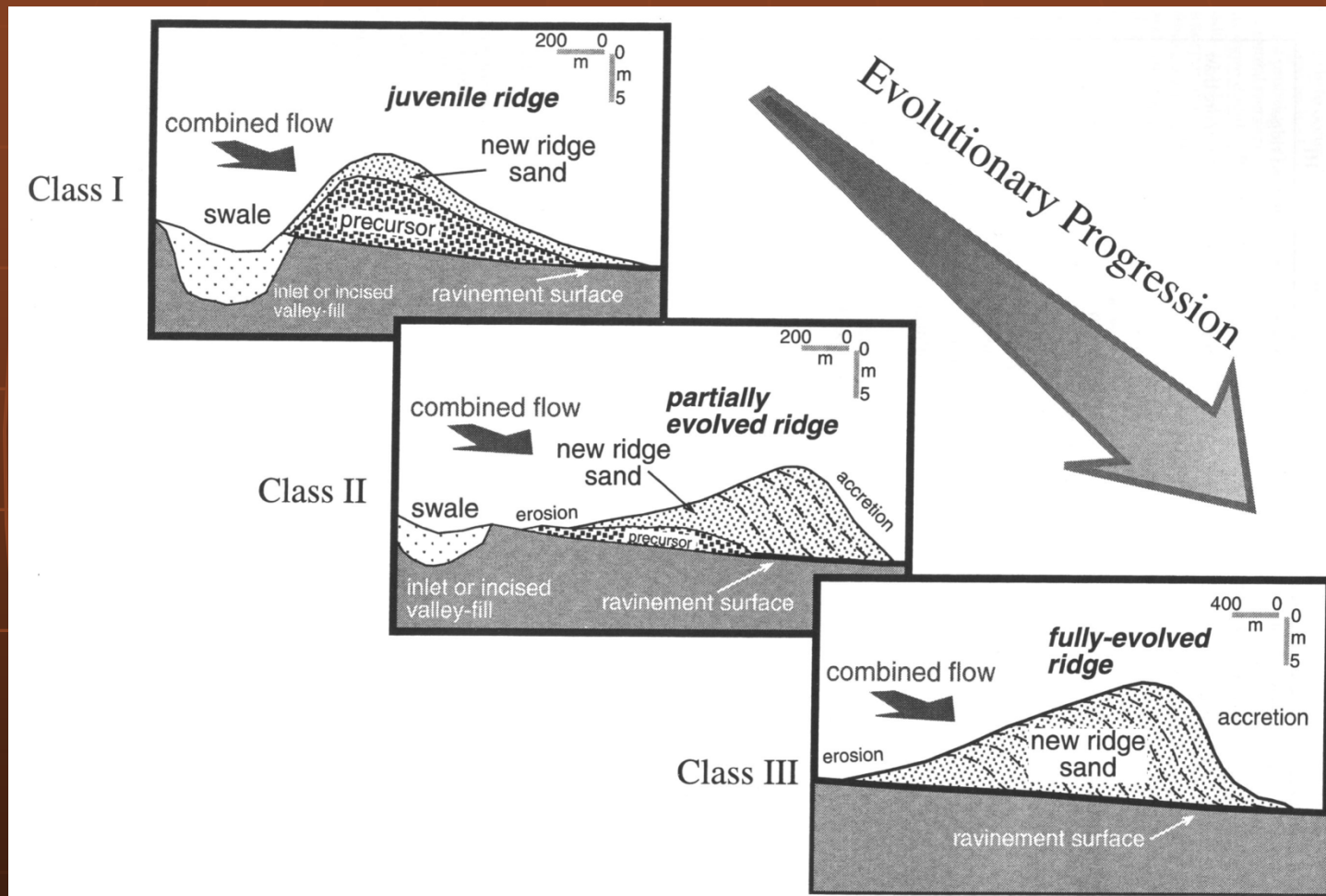


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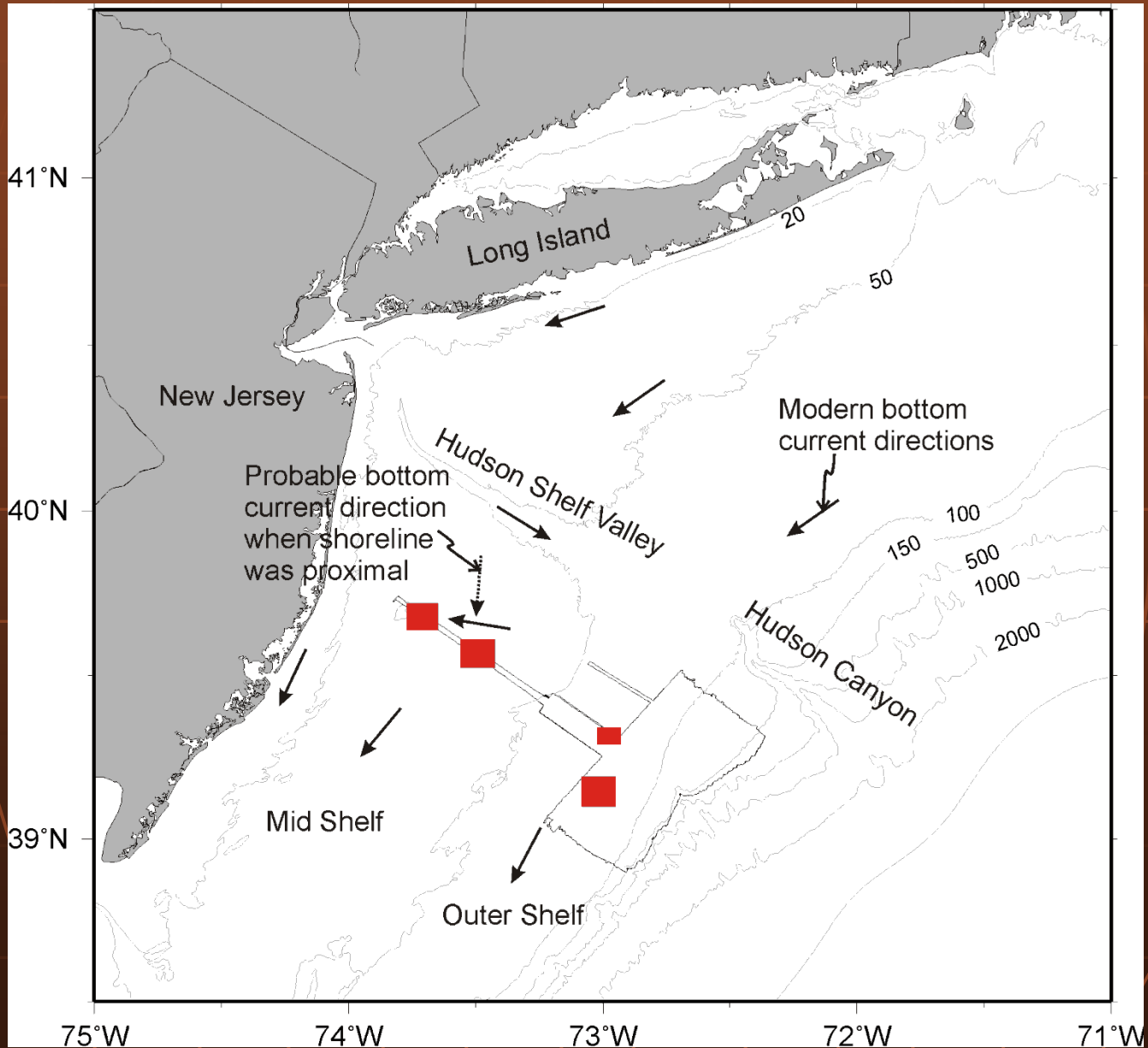
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Sand Ridge Evolution on the Inner Shelf

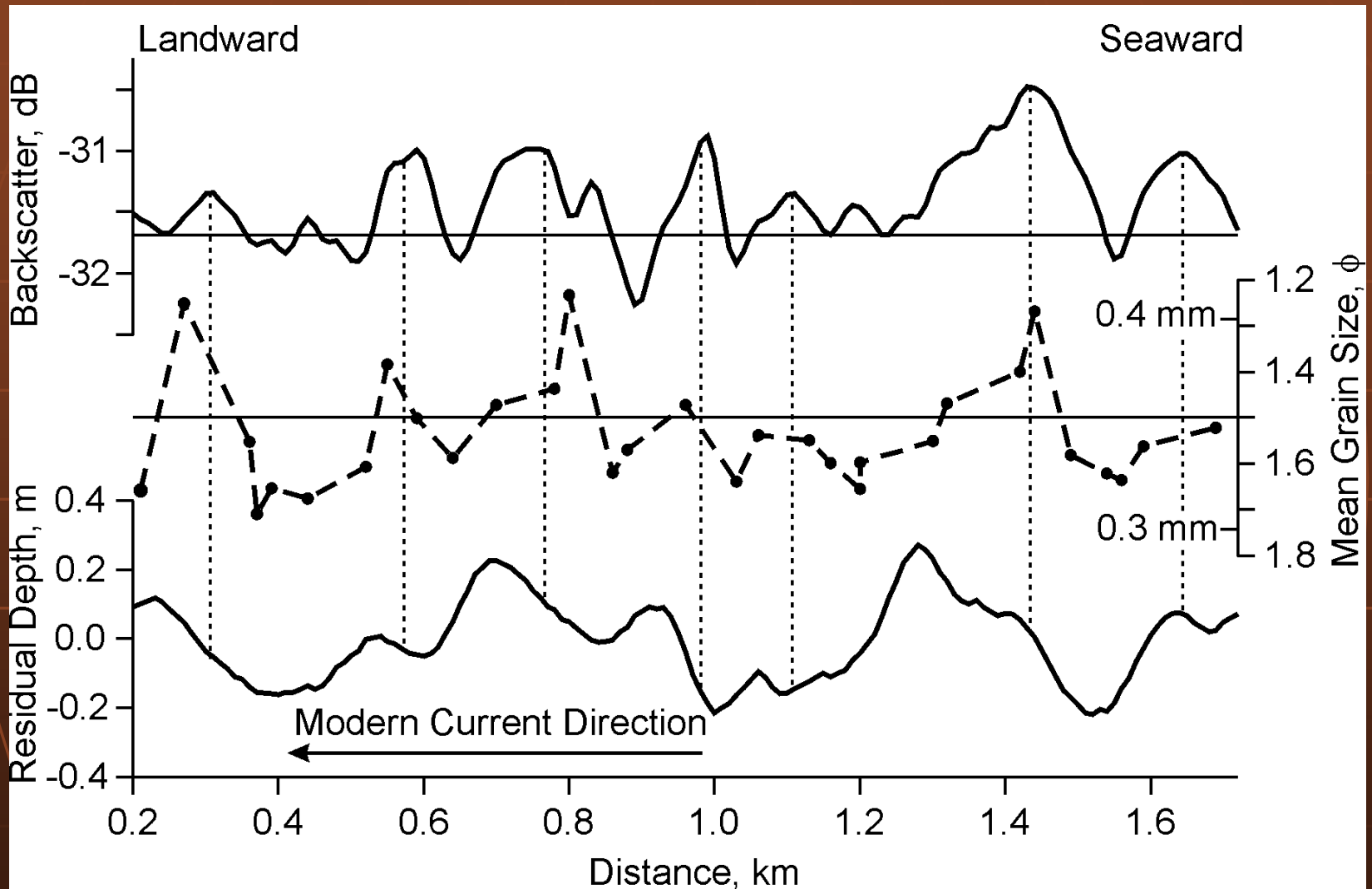


Sneddon and Dalrymple, 1999

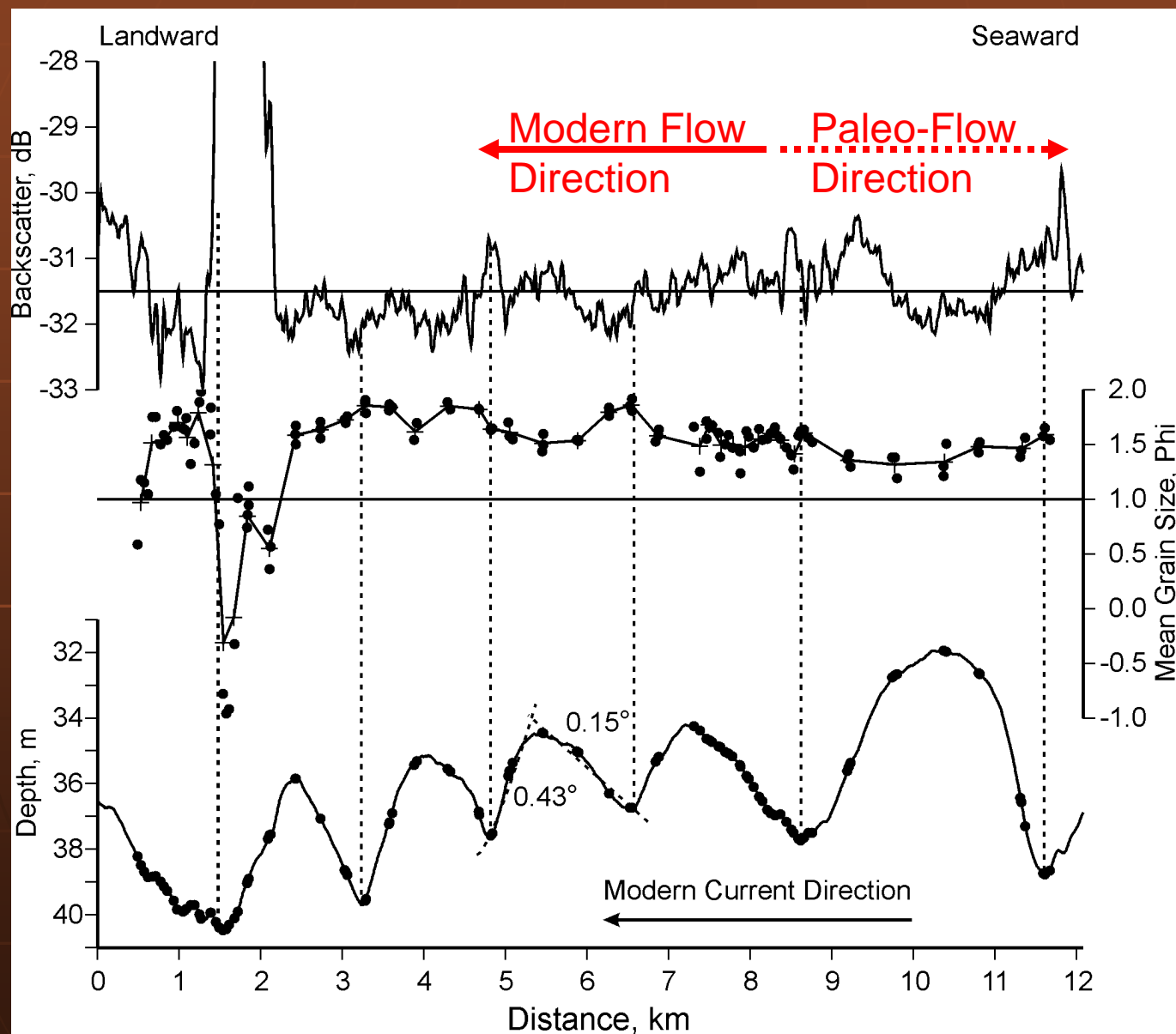
The New Jersey Shelf



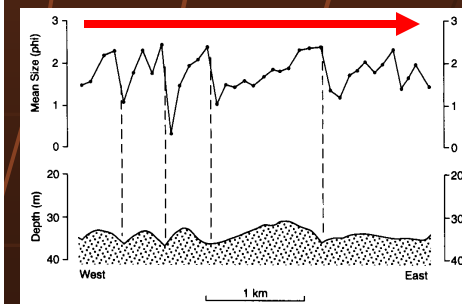
2nd-Order Features: Dunes



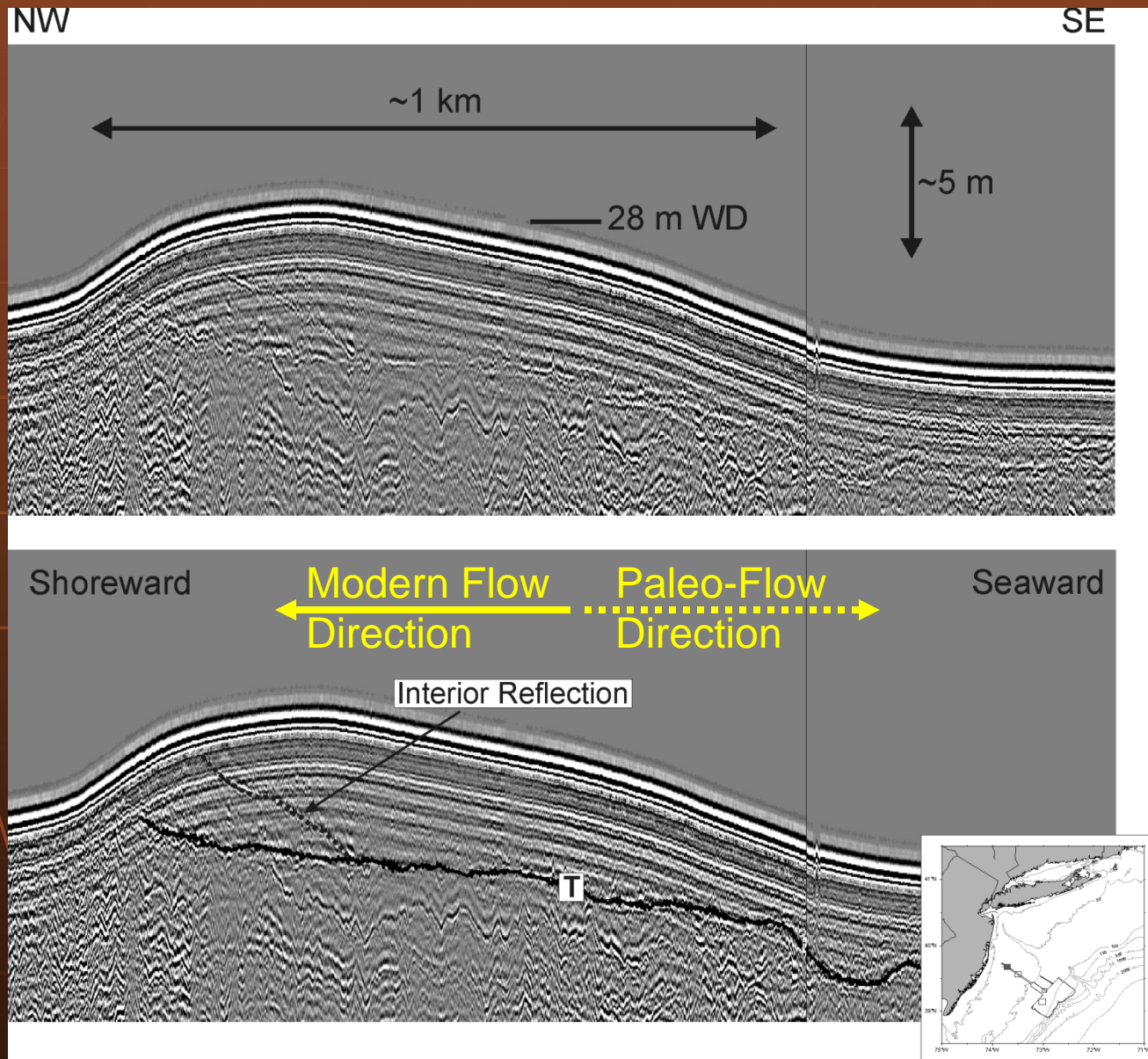
Ridge Grain Size and Bathymetry Profiles



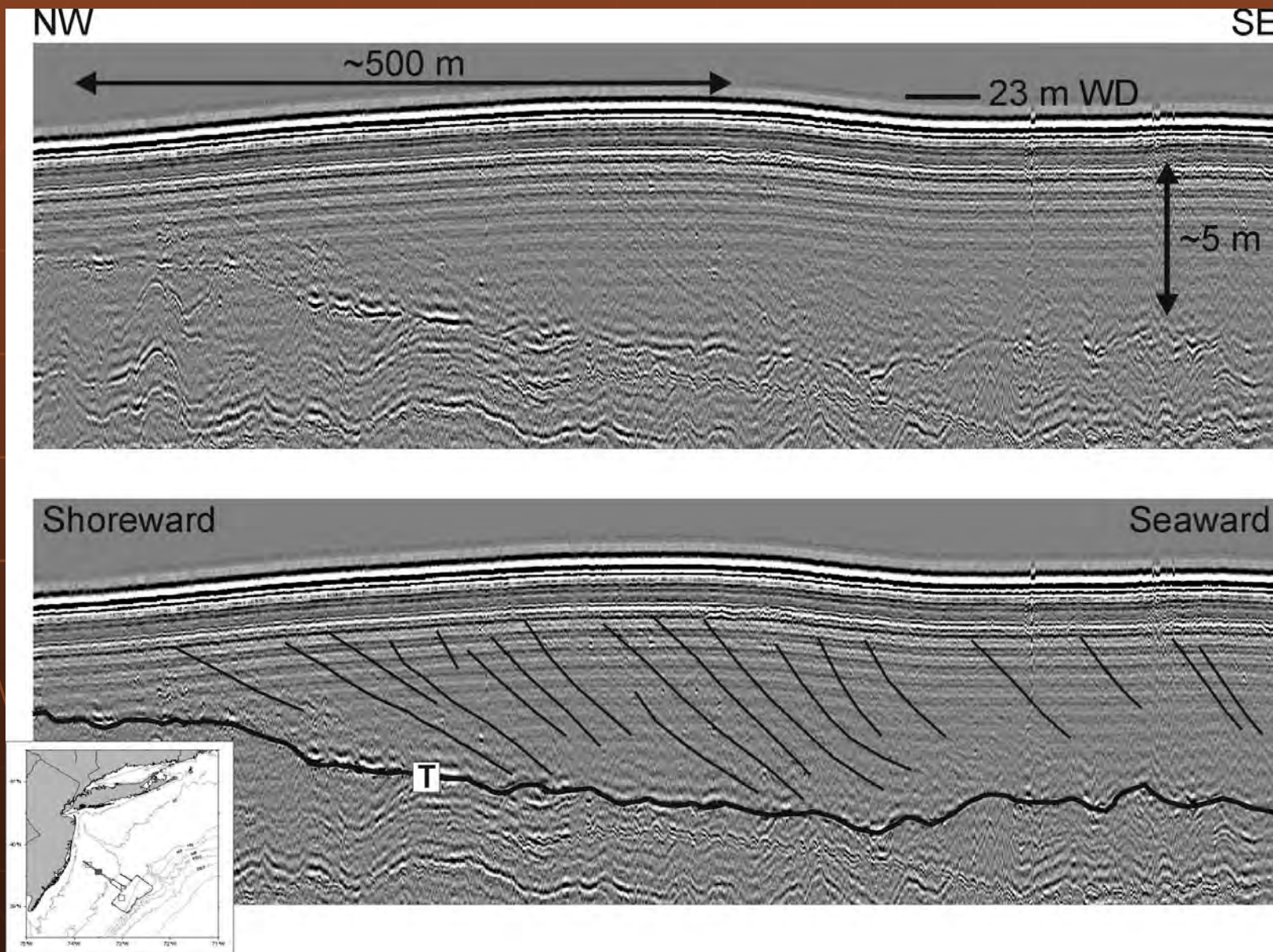
Sable-Island profile



Mid-Shelf Sand Ridge Internal Structures

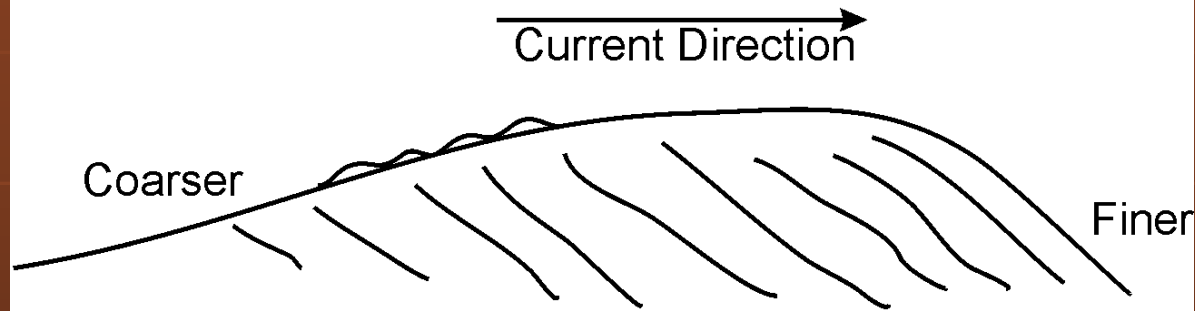


Mid-Shelf Sand Ridge Internal Structures

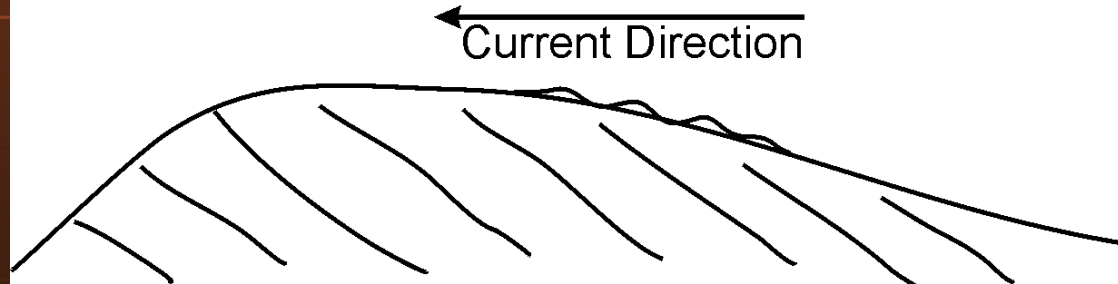


Comparison Summary

Sable Island near shore sand ridges



NJ mid-shelf ridges



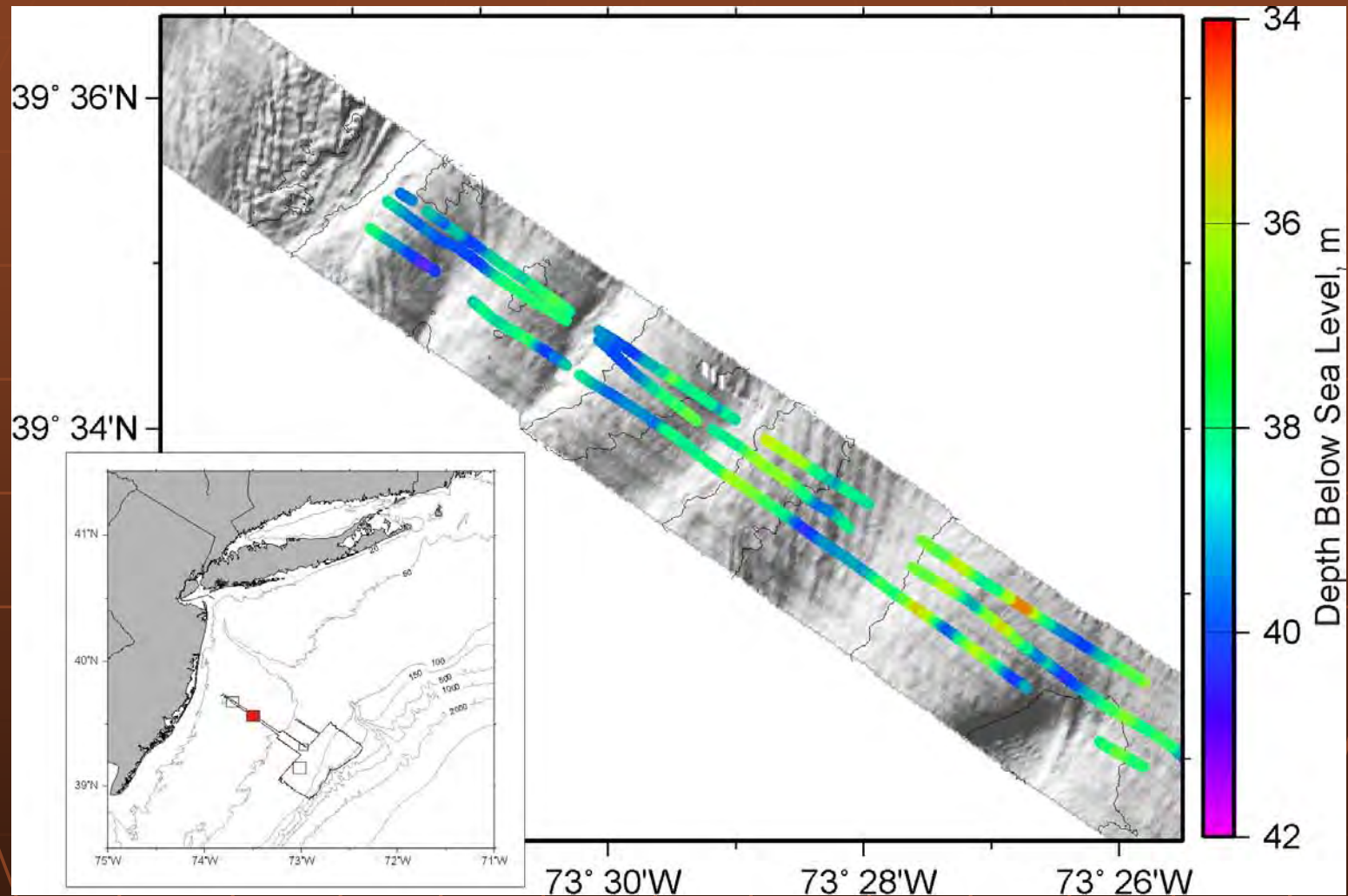
Unresolvable grain size asymmetry

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Transgressive Ravinement Surface

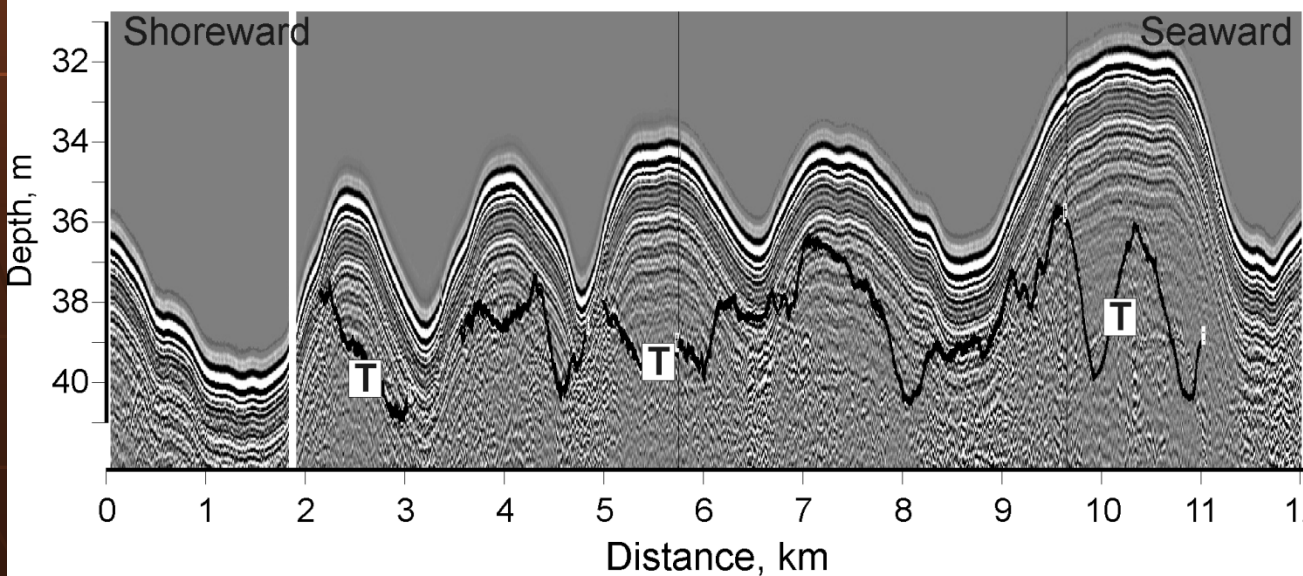
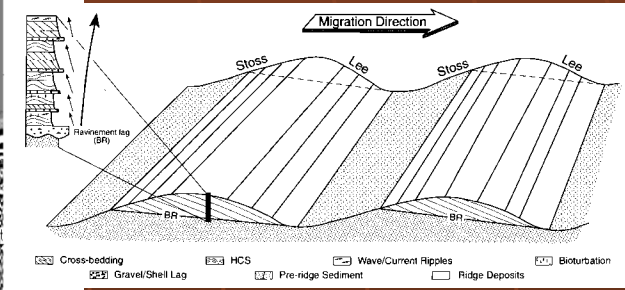
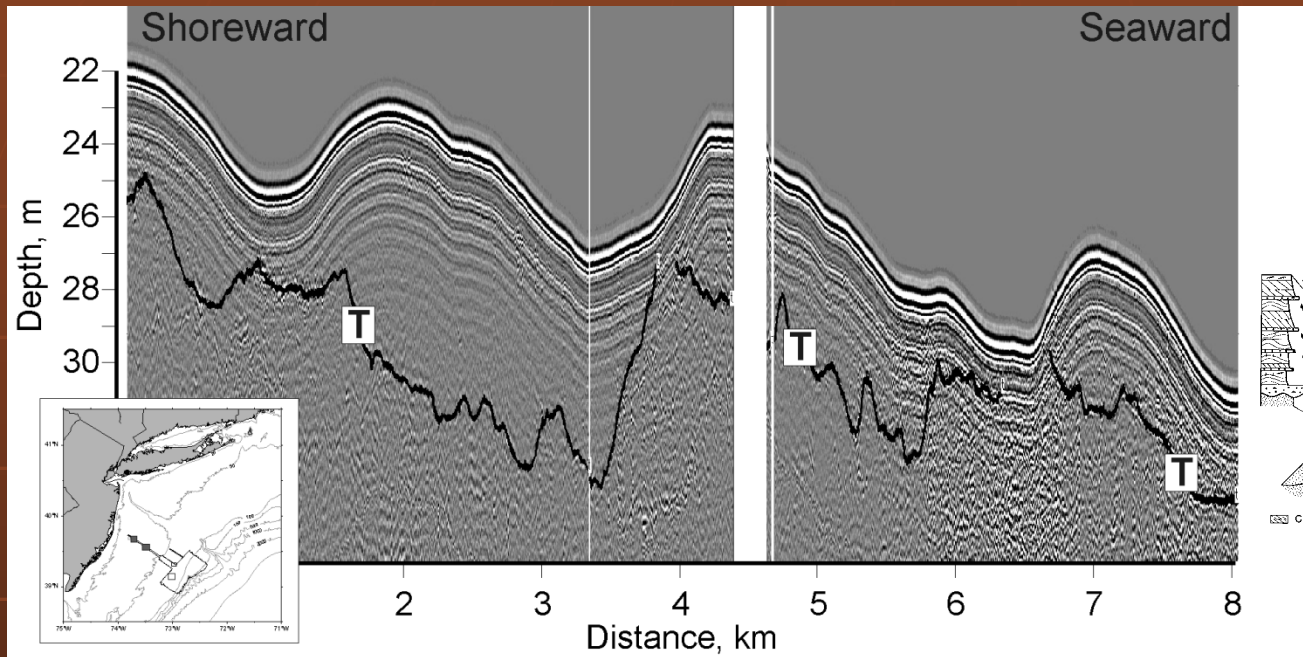


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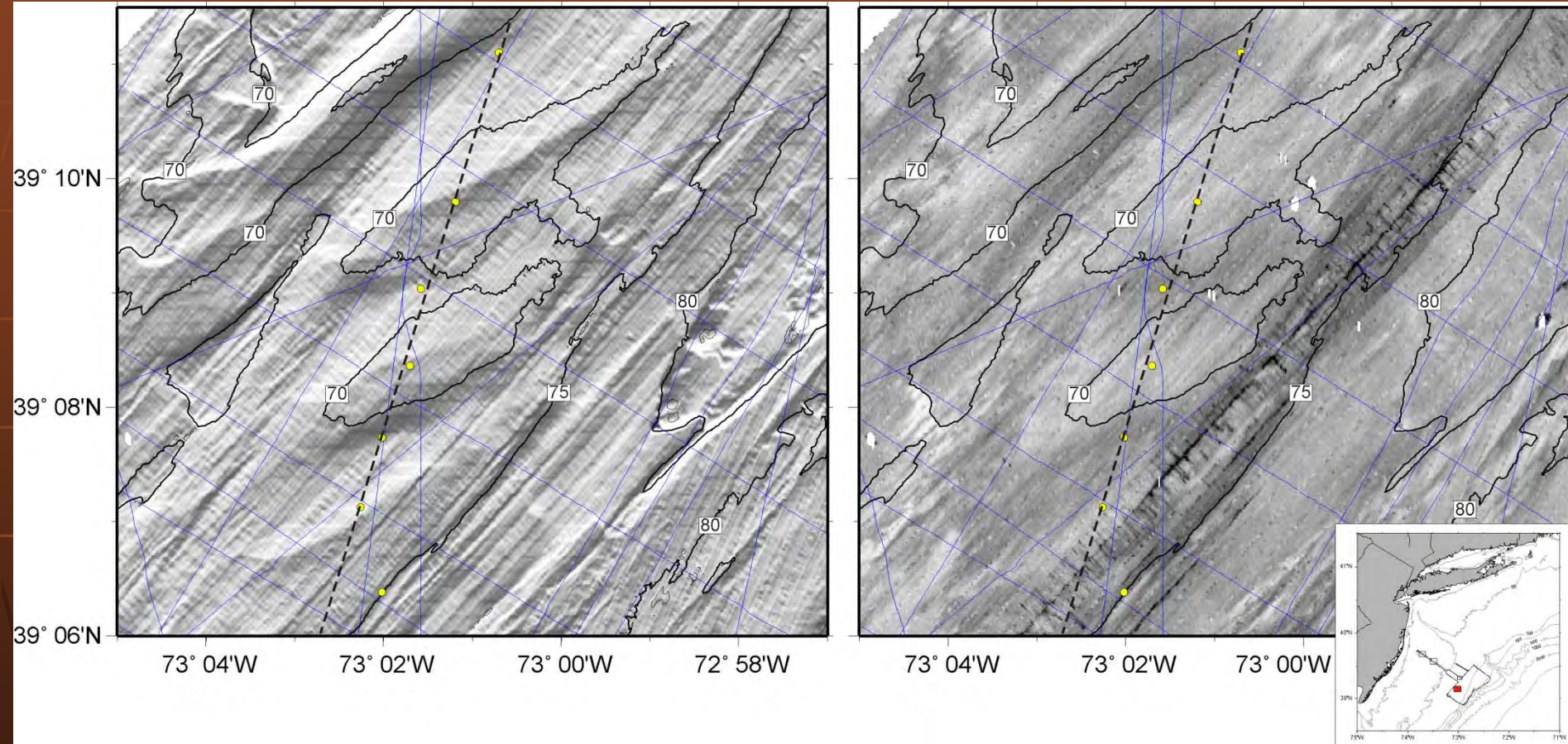
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Transgressive Ravinement Surface



Outer Shelf Ridges

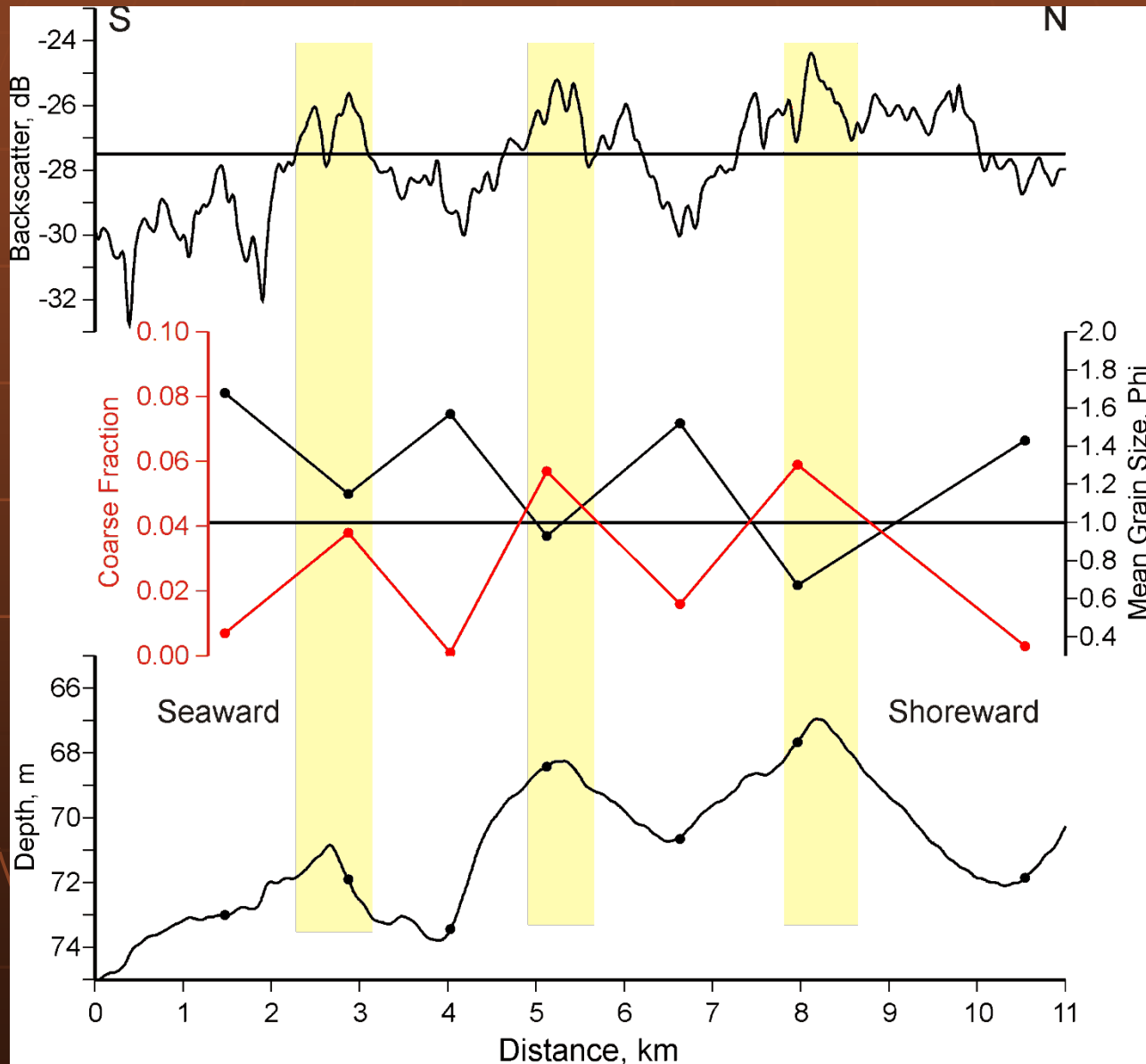


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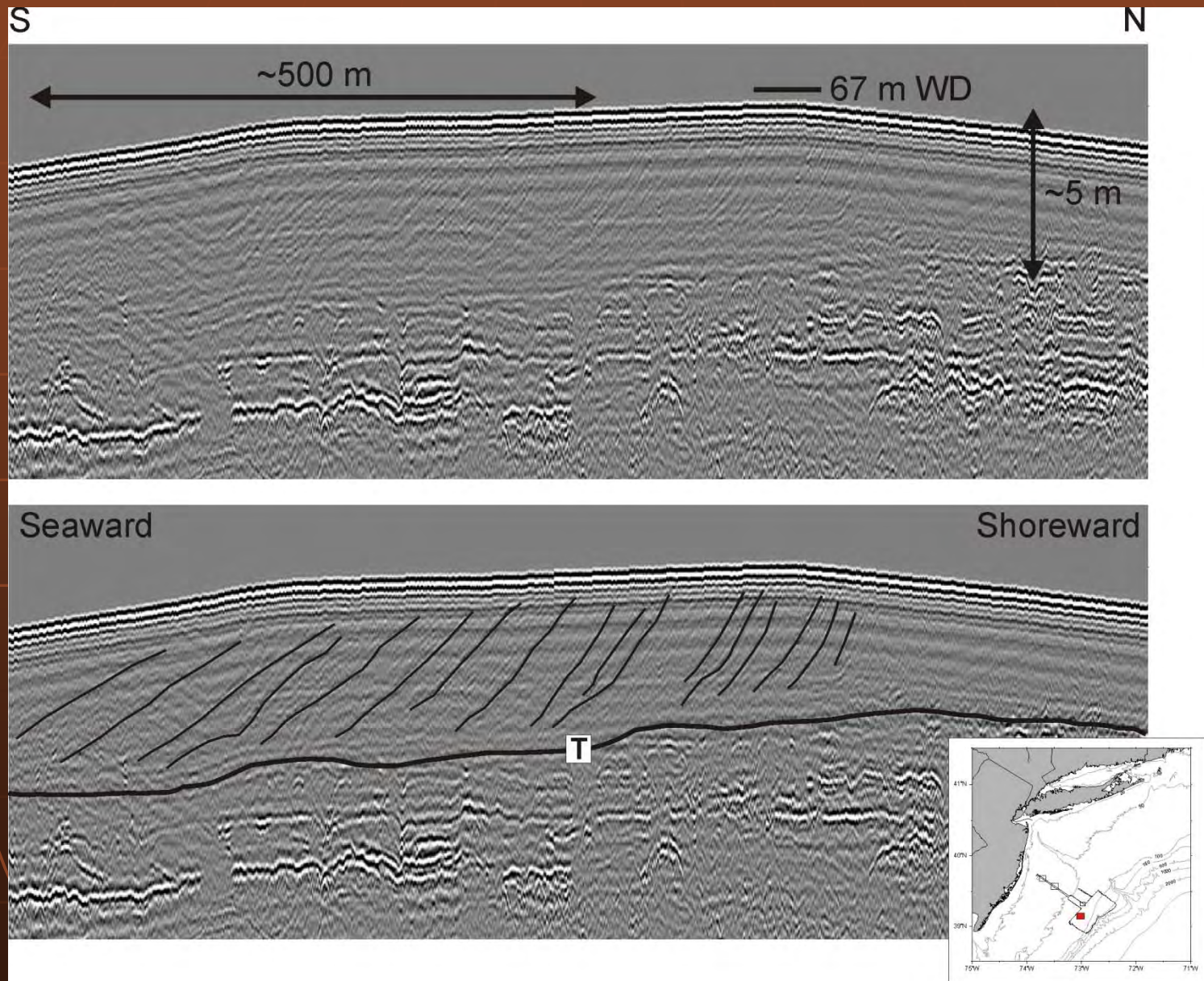
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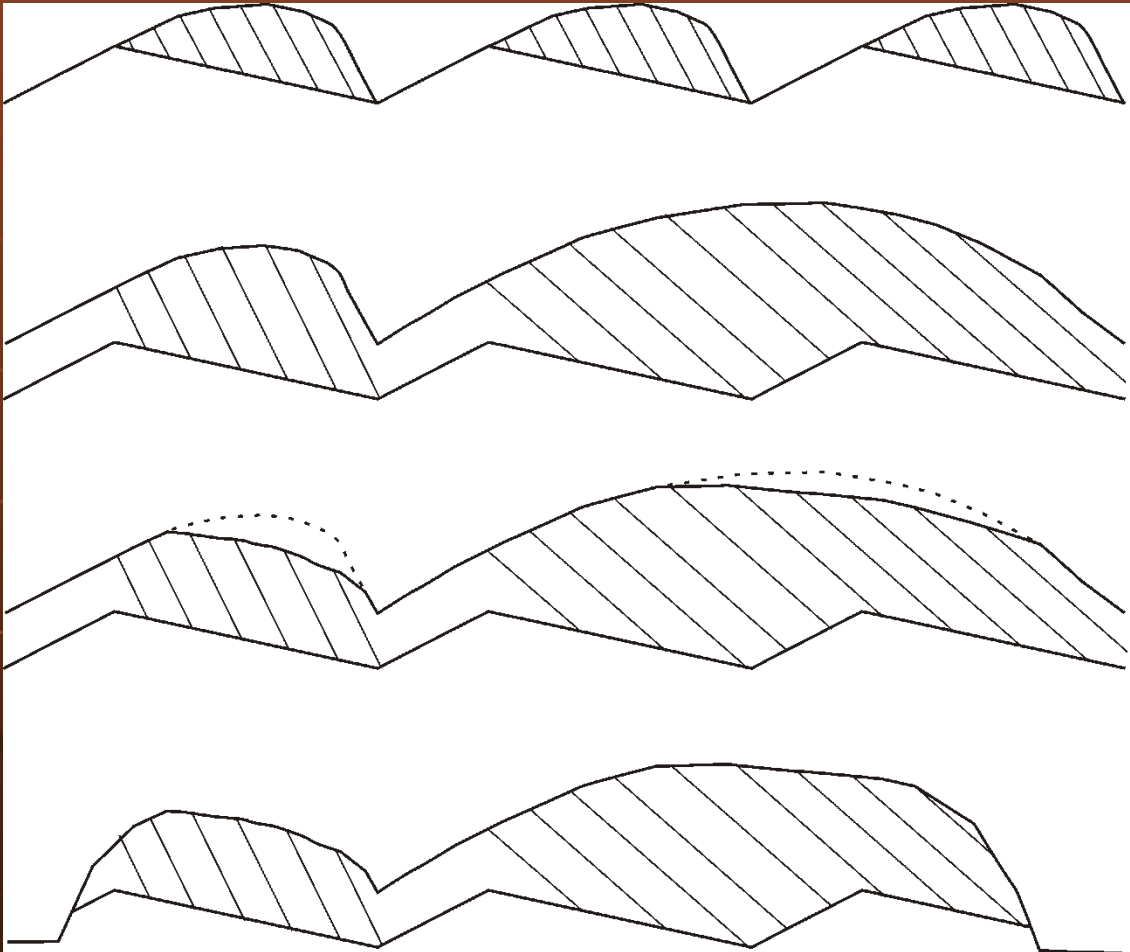
Ridge Grain Size and Bathymetry Profiles



Outer-Shelf Sand Ridge Internal Structures



Sand Ridge Evolution Model



Shoreface: dune-form development, significant modification of basal ravinement topography (i.e., *Dalrymple and Hoogendoorn, 1997*)

Inner shelf: growth of sand sheet through continued dune-form processes; burial of basal ravinement topography (i.e., *Sneddon and Hoogendoorn, 1999*).

Middle shelf: cessation of dune-form processes; erosive sculpting of ridges

Outer shelf: armoring of tops of sand ridges through winnowing; erosion of thinnest parts of sand sheet and re-exposure of ravinement.

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References

Dalrymple, R.W. and E.L. Hoogendoorn, 1997, Erosion and deposition on migrating shoreface-attached ridges, Sable Island, Eastern Canada: *Geoscience Canada*, v. 24/1, p. 25-36.

Snedden, J.W. and R.W. Dalrymple, 1999, Modern shelf sand ridges; from historical perspective to a unified hydrodynamic and evolutionary model: *Special Publication Society for Sedimentary Geology*, v. 64, p. 13-28.