Istituto Nazionale di Oceanografia e di Geofisica Sperimentale

# Università degli studi di Trieste

## LAUREA MAGISTRALE IN GEOSCIENZE

**Classe Scienze e Tecnologie Geologiche**

## Curriculum: Esplorazione Geologica

**Anno accademico 2025 - 2026**

# Analisi di Bacino e Stratigrafia Sequenziale (426SM)

Docente: **Michele Rebesco**

# Modulo 3.3
# Continental Shelf

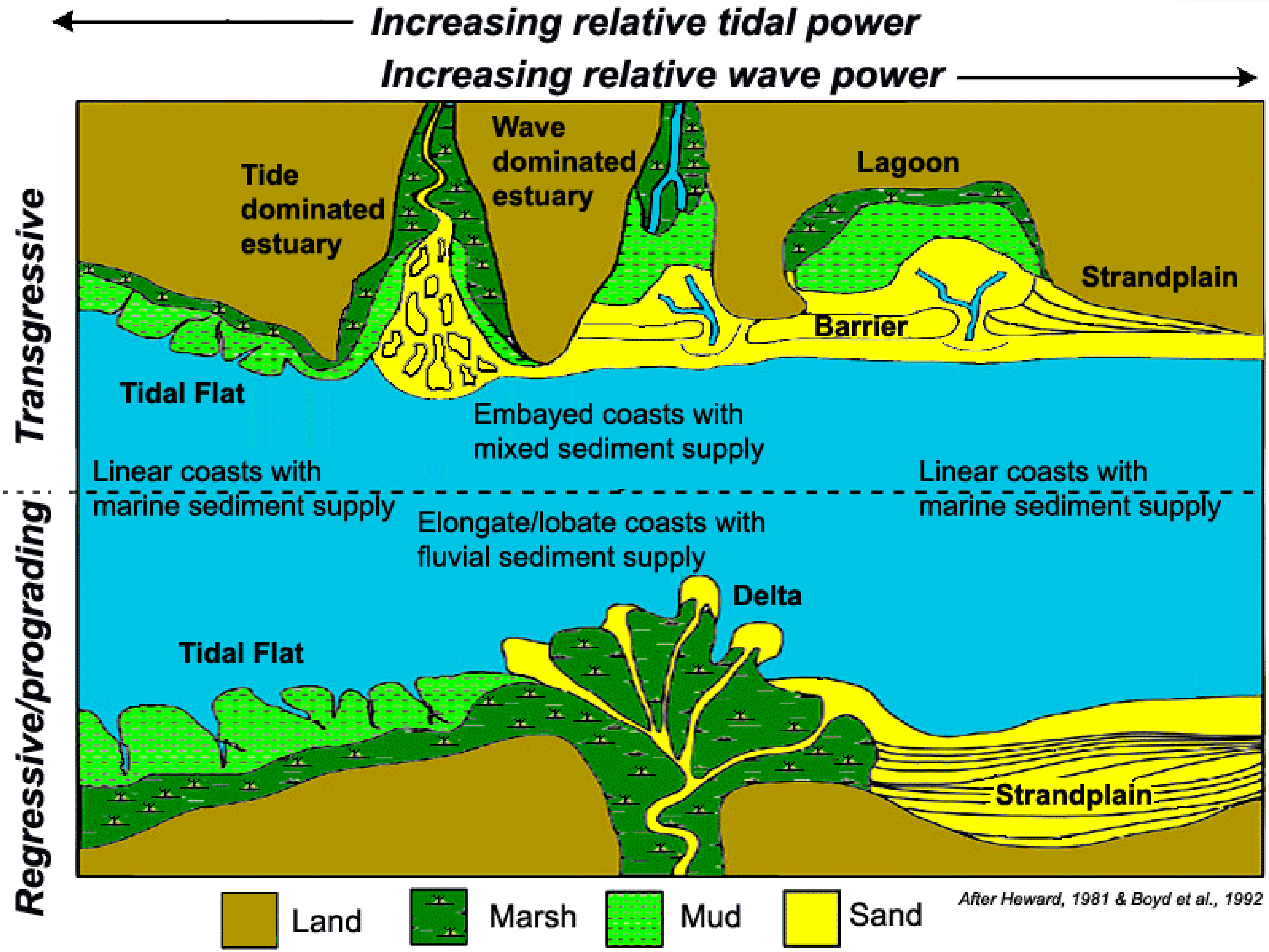
Outline:

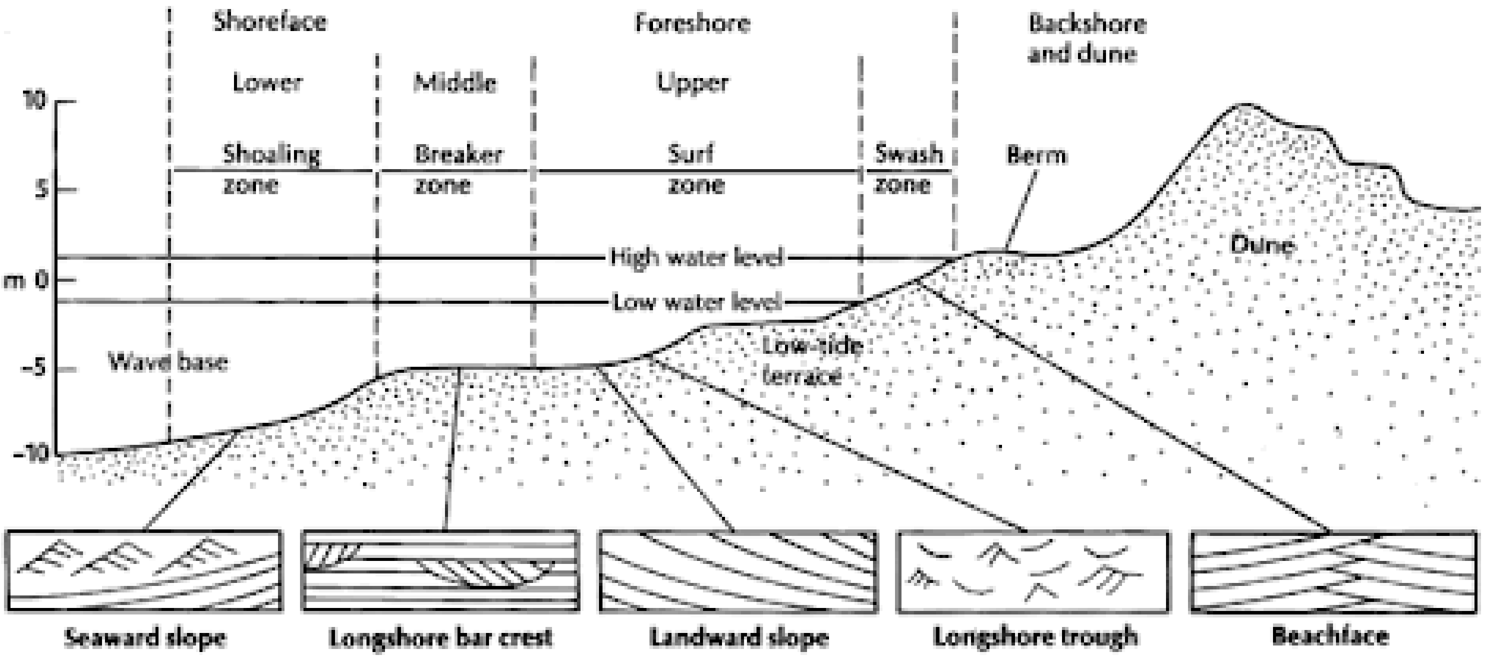
- Foreshore
- Inner continental shelf: Offshore – transition
- Storm dominated shelves
- Hummocky cross-stratification
- Tide dominated shelves
- Tidal bars and tidal dunes
- Ocean currents dominated shelves

# Barrier Islands

# Shoreline

At the shore clastic sedimentary depositional settings include beaches, estuaries or deltaic.





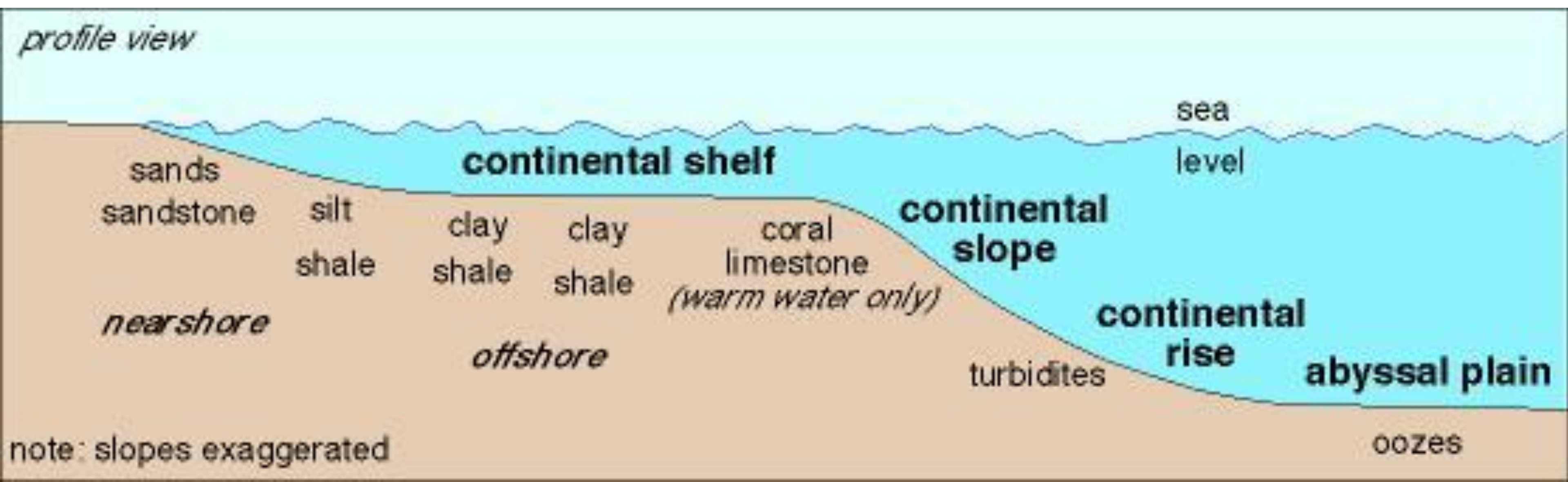

There are six major depositional environments within a Barrier Island system. The areas on the seaward side of barrier island systems are as listed; the shoreface, the foreshore and the backshore. These environments, along with sub-environments are shown in the figure below. We will also discuss the components of the landward side of barrier island systems which include the lagoon, the tidal inlets and tidal deltas.

SEPM STRATA
SEPM Stratigraphy Web

# Continental margins

SEPM STRATA
SEPM Stratigraphy Web

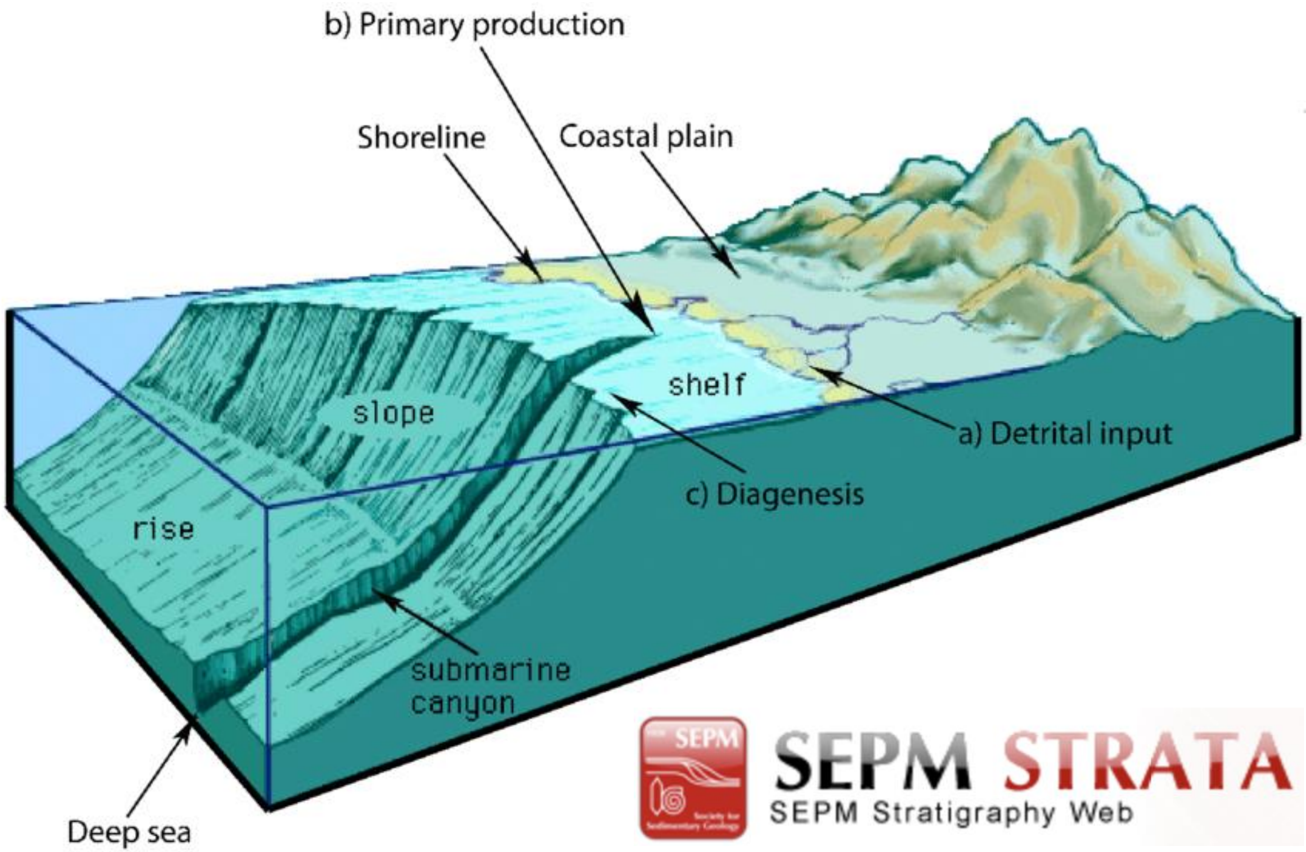
The siliciclastics of the continental margin are sourced from the shoreline; their character is a product of the local physical processes and the geology of the source terrain. Whatever the latitude, grain size tends to decrease with distance from shore, as distances of transportation and depths of water below wave base increase and mechanisms of sediment transportation vary.  Sediments accumulating offshore at higher latitudes may reflect glacial processes, their associated fluvial systems, the local hydrodynamic and oceanographic conditions.   Sediments to mid and lower latitude shelves similarly will be products of the local geology, local processes and conditions.

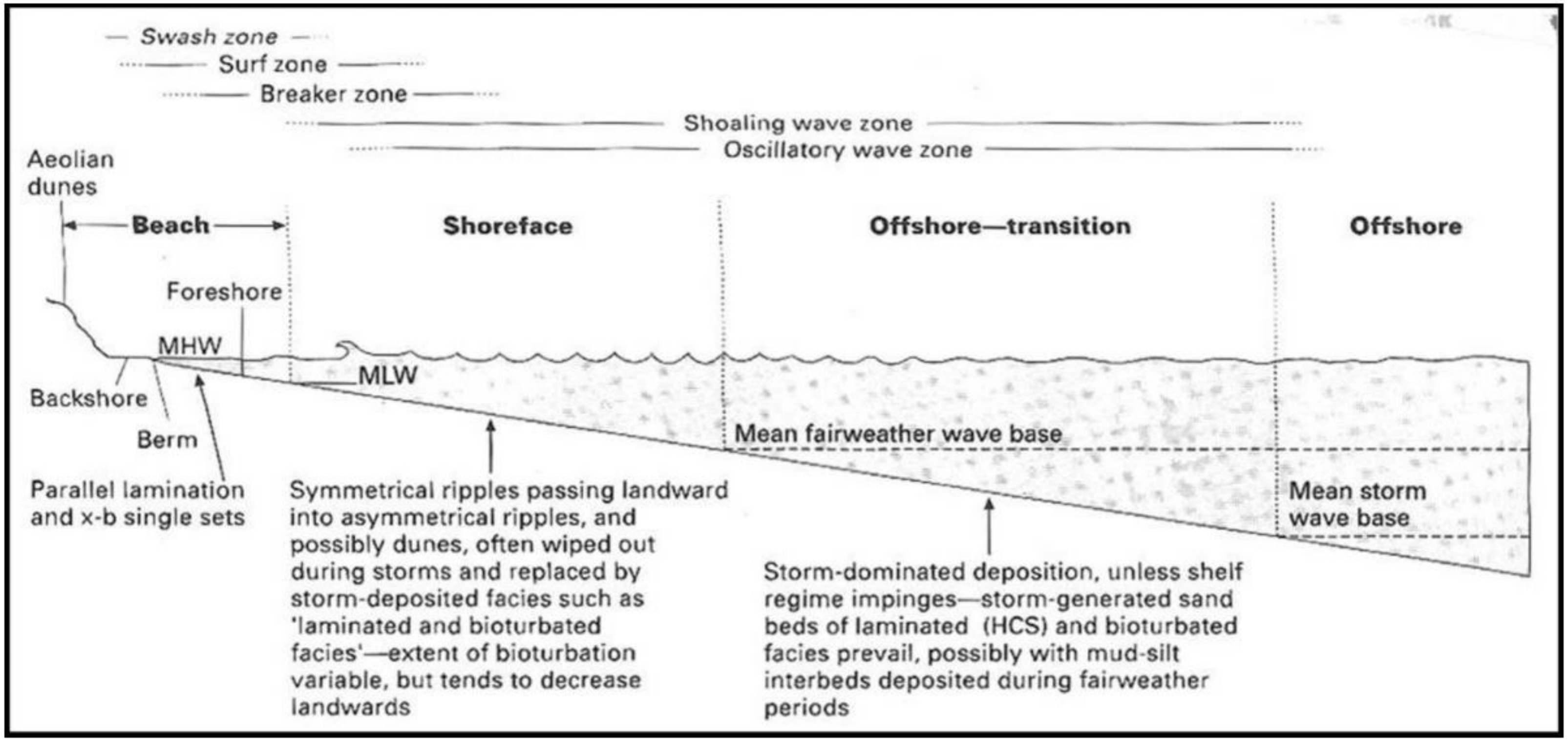


# Continental shelf

Continental shelves compose around 8% of the entire oceanic area and are underlain by continental crust, and slope seaward at an average slope of about 0.1º, or about 2 m/km. The width of continental shelves at the present sea-level stand varies from a few km to >400 km. Throughout geologic time, the width of continental shelves has varied greatly with the rise and fall of eustatic sea level. During periods of lower sea level, rivers may have flowed across the inner continental shelf accumulating sediments that were later reworked by waves and submarine currents and are known as relict sediments.

Areas of shallow (average depth about 130 m) gradually sloping seafloor, extend from the shoreline to where there is a marked change in slope (the shelf break).

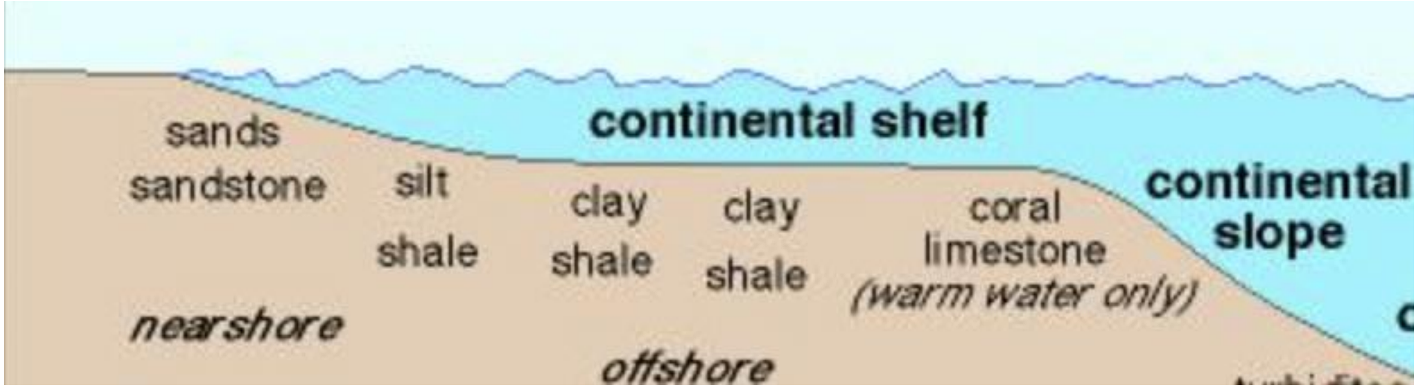



Swash zone
Surf zone
Breaker zone
Shoaling wave zone
Oscillatory wave zone
Aeolian dunes
Beach
Shoreface
Offshore—transition
Offshore
Foreshore
MHW
MLW
Backshore
Berm
Mean fairweather wave base
Mean storm wave base
Parallel lamination and x-b single sets
Symmetrical ripples passing landward into asymmetrical ripples, and possibly dunes, often wiped out during storms and replaced by storm-deposited facies such as 'laminated and bioturbated facies'—extent of bioturbation variable, but tends to decrease landwards
Storm-dominated deposition, unless shelf regime impinges—storm-generated sand beds of laminated (HCS) and bioturbated facies prevail, possibly with mud-silt interbeds deposited during fairweather periods

# History

Johnson, 1919: graded shelves (progressive offshore grain size decrease)

Shepard, 1932: relict sediments



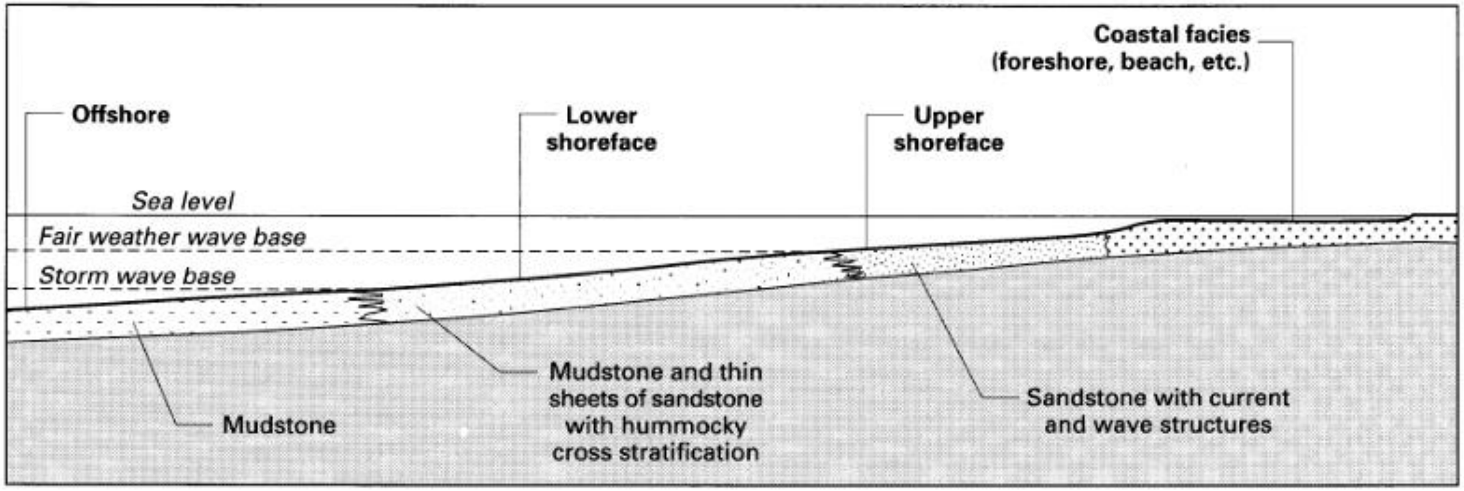

Not all sandy deposits occurring on modern shelves have been formed by processes occurring in the present day: the sea-level rise in the past 10 kyr, the Holocene transgression, has drowned former strand plain and barrier island ridges, along with sands deposited in the shoreface, leaving them as inactive relics in deeper water.

Swift and Niedoroda 1985:
1) Storm dominated shelves (80%)
2) Tide dominated shelves (17%)
3) Ocean currents dominated shelves (3%)

| Setting | Relationship to Waves & Tide | sedimentary structures |
|---|---|---|
| coastal plain | tidal zone, subject to storm wash-over | trough-cross bedded fill of tidal inlet, estuarine & fluvial channels; rooted seat earths & coals |
| foreshore & upper shoreface | zone of breaking waves & the wave swash zone | trough-cross stratified sandstone sometimes overlain by planar-cross bedded sandstone |
| lower shoreface & delta-front sandstones | just above fair-weather wave base | current ripple beds<br>wave ripple beds,<br>hummocky cross-beds<br>contorted beds |
| transition between offshore shelf & lower shore-face | between storm wave-base & fair-weather wave-base | alternations of hummocky cross-stratified sandstone<br>highly burrowed silty mudstones |
| offshore shelf | below storm wave-base | highly burrowed mudstones |

The relationship of the sediments of the Blackhawk Formation to depositional setting, tide and waves, and sedimentary structures (after Coe et al, 2003).

# Storm-dominated shelf facies



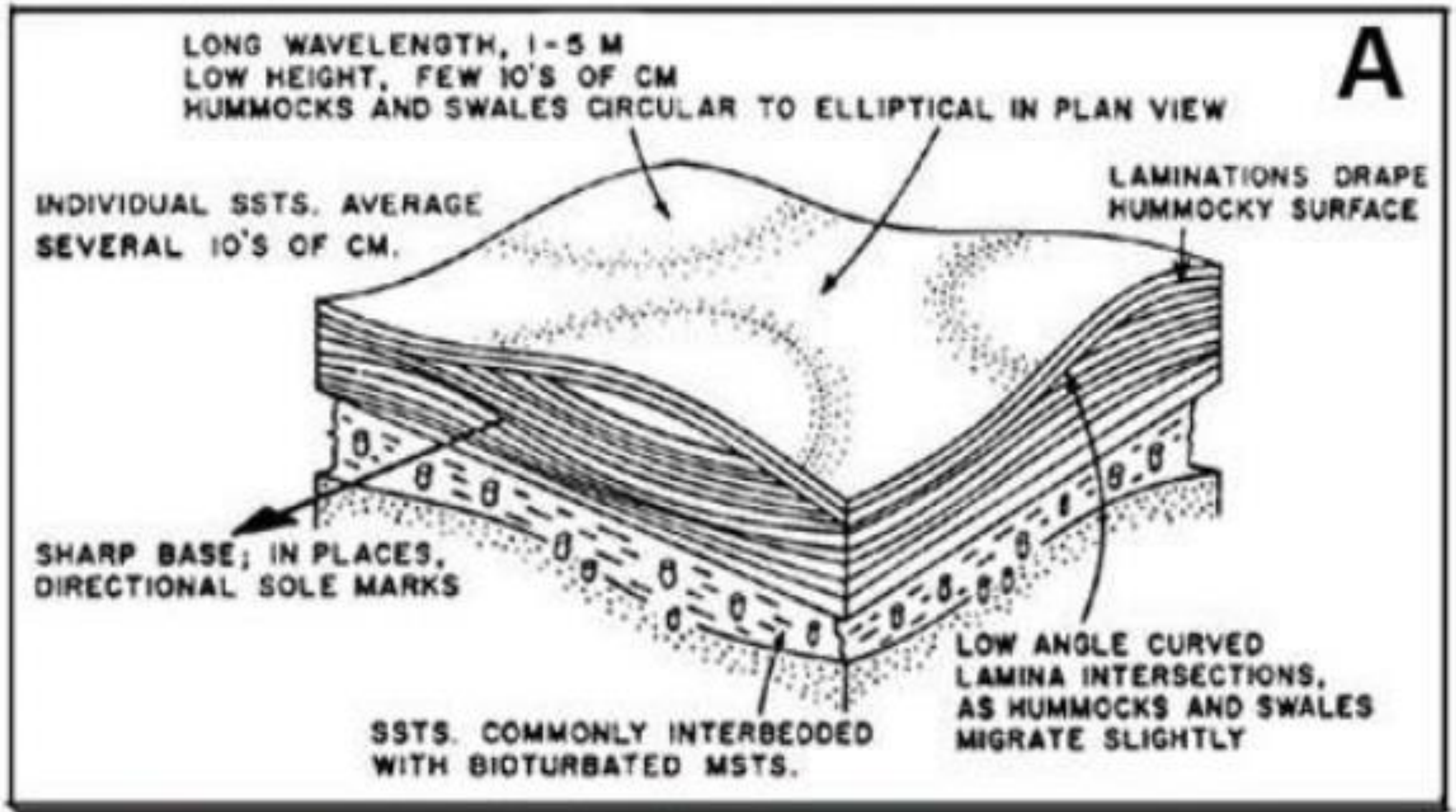
# Hummocky cross-stratification

Hummocky cross-stratification (HCS) is the sedimentary structure usually considered as diagnostic of surface storm activity at the shoreface-offshore transition.

Hummocks only occur beneath the fair-weather wave base and above the storm-weather wave base in subaqueous environments.

# HCS = below fairweather wave base

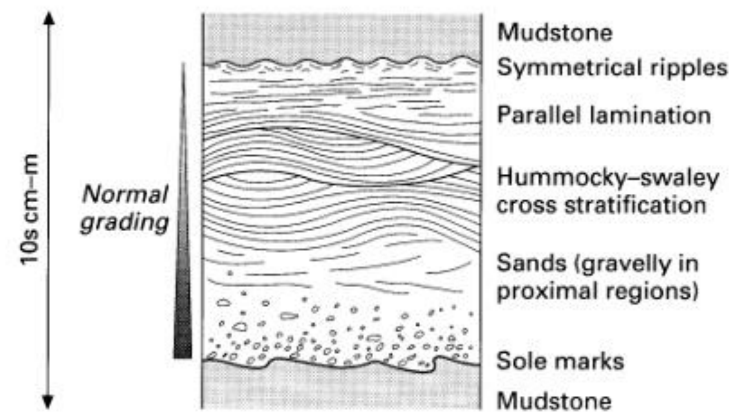
Storm waves acting below fairweather wave base are one of the main agents forming hummocky cross stratification. This interpretation is based on the nature of the interbedded bioturbated mudstones, and the fact that in the interbedded HCS sandstone/- bioturbated mudstone facies, medium scale angle-of-repose cross bedding is rare to absent.




This implies that either grain size is consistently too fine for the formation of medium scale cross bedding, or that there has been no fairweather reworking of the storm- formed hummocky cross stratification, hence suggesting original formation below fair-weather wave base.

# Tempestites

- The deposits that form during storm reworking of sediment on the shelf
- Sudden, catastrophic deposits
- Fining upwards sequence

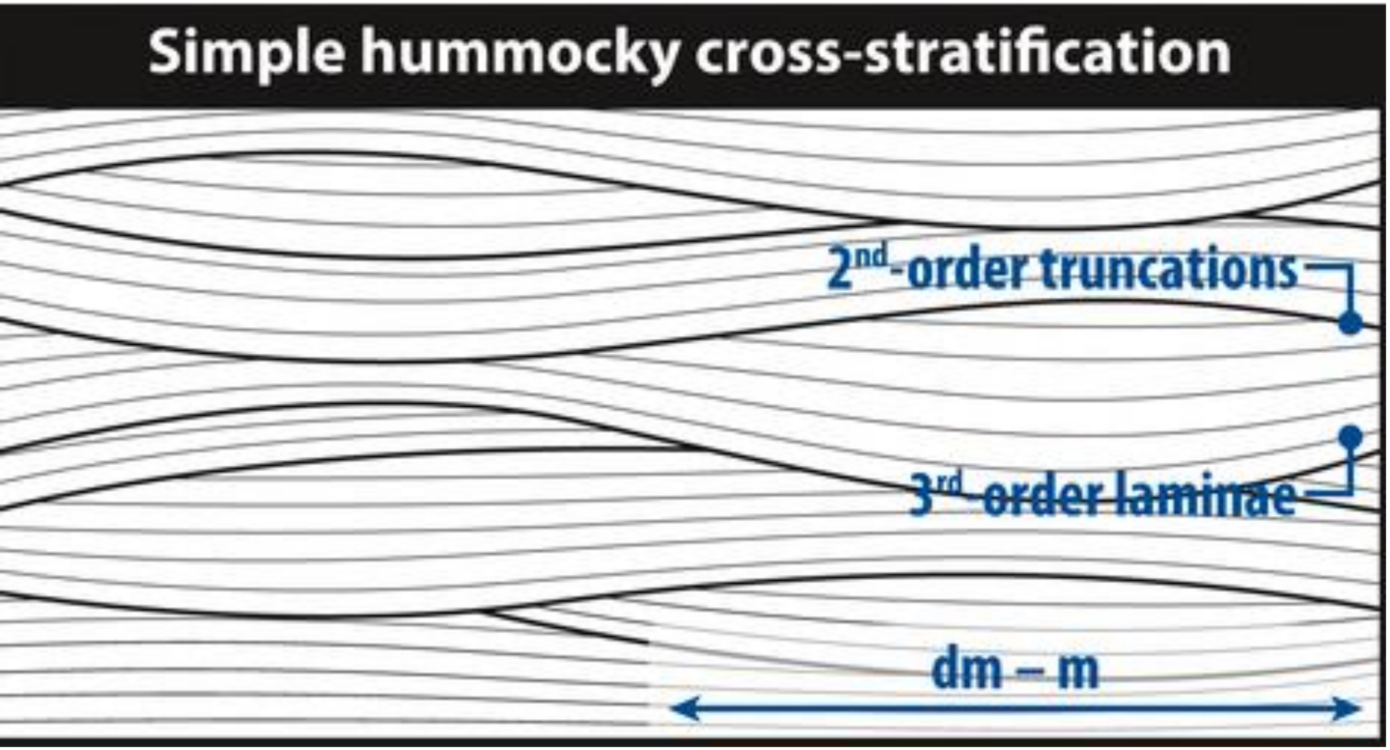


# Storm deposits make up a portion of the Cliff House Sandstone,

Chaco Culture National Historical Park, New Mexico.

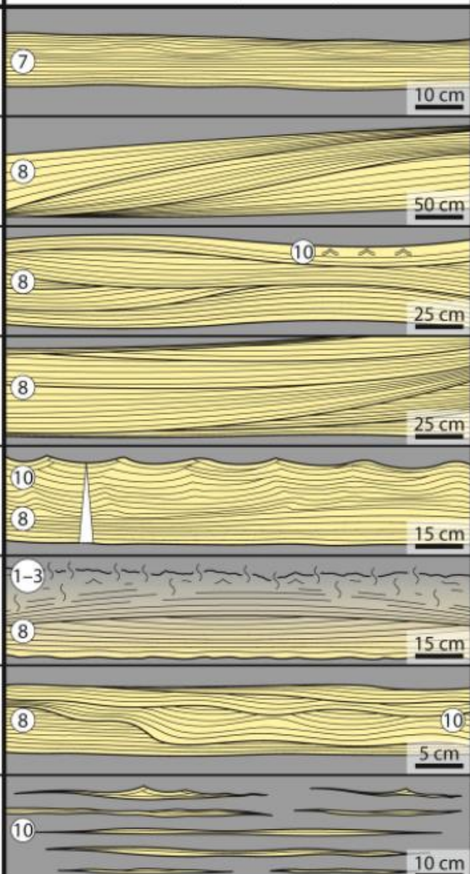
# Hummocky

This sedimentary structure, that often have long wavelengths (up to 5 m) and low heights (10s of centimeters), is common in coarse-grained siltstone to fine-grained sandstone and is predominantly characterized by isotropically oriented laminae that conformably thin and thicken over low-angle (<15°) truncations with convex-up build-ups (hummocks) and concave-up depressions (swales), respectively. The laminae and truncations tend to merge and become conformable when traced laterally.




Jelby et al 2019, Sedimentology

# Type 1 tempestites: Relatively steady flow deposits



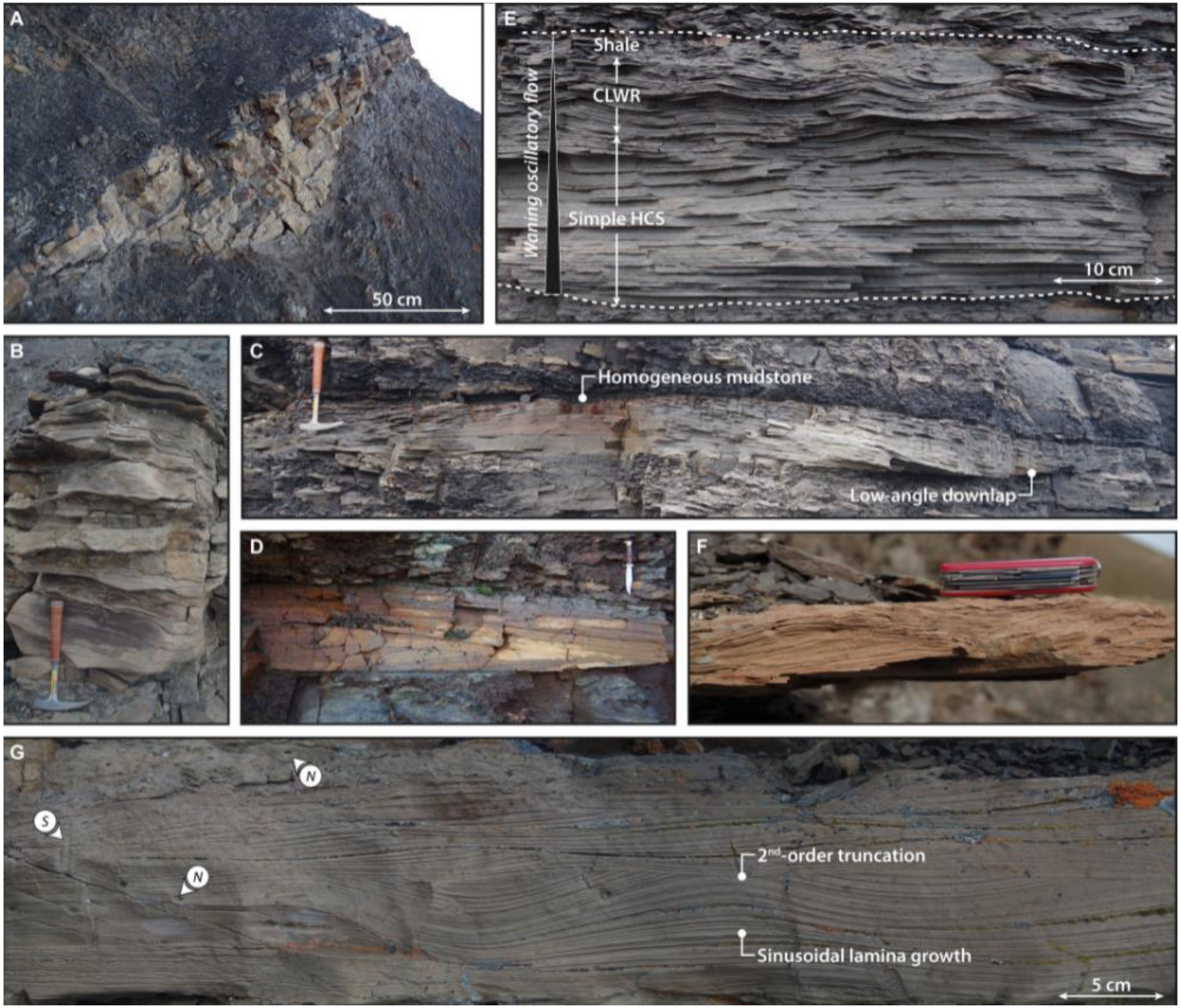

| | Stratification and facies numbers (encircled) | Representative figure numbers and description | | Variations, abundance and thickness | | | | |
|---|---|---|---|---|---|---|---|---|
| A | 7; 10 cm | 6A | **Planar and quasi-planar lamination** Laterally persistent bedding with subtle translations between distinctly planar, quasi-planar and undulatory lamination. | • Wave or combined-flow ripples at bed tops. • Upward increase in the degree of undulation or irregularity. | Common | V. thin to med. | 0.02–1.05 m | Proximal |
| B | 8; 50 cm | 6B | **Simple HCS: Anisotropic stratification** Locally asymmetric HCS expressed by sigmoidal lamina sets with dip angles below angle of repose (30°) and near-parallel truncations. | • Combined-flow ripples at bed tops. • Medium-bedded anisotropic HCS overlain by isotropic HCS. | Rare | Medium to thick | | |
| C | 10, 8; 25 cm | 6C–E+7A–C | **Simple HCS: Isotropic stratification** Successive HCS lamina sets and truncation surfaces, commonly capped by wave, combined-flow or climbing current ripples. | • Minor SSDS. • Internal ripples or shale pockets. • Basal gutter casts, parting lineation, gravel or shell lags. | Common | Thin to v. thick | | |
| D | 8; 25 cm | 7D | **Simple HCS: Swaley cross-stratification** Combined HCS–SCS characterized by locally dominant, low-angle, concave-up scours and swale-conformable lamination. | • Anisotropic stratification. • Wave ripples at bed tops. | Moderate | Medium to thick | 0.01–1.35 m | Intermediate |
| E | 10, 8; 15 cm | 7E | **Waning-storm facies arrangements** Conformably stratified tempestites characterized by simple HCS transitionally overlain by climbing 3D wave ripples. | • Fluid-mud deposits overlying bed tops. | Moderate | Medium to thick | | |
| F | 1–3, 8; 15 cm | 7E | **Fining-upward bed-sets** Simple HCS sandstone fining vertically into shale-dominated, bioturbated facies with local wave ripple cross-lamination. | • Dominance of bioturbation in tempestites and lack of bioturbation in shale-dominated facies. | Common | Thin to thick | | |
| G | 8, 10; 5 cm | 7F, G | **Wave ripple cross-lamination to micro-HCS** Bundled and bidirectional cross-lamination to sinusoidal lamination of vertically aggrading lamina sets and low-angle truncations. | • 2D wave ripple architecture. | Common | V. thin to thin | | |
| H | 10; 10 cm | 8A, B | **Incipient tempestites** Thin-bedded, lenticular tempestites dominated by pinch-and-swell lamination and round-crested incipient wave ripples. | • Sharp-crested wave ripples. • Combined-flow or current ripple cross-lamination. • Basal small-scale gutter casts. | Common | V. thin to thin | 0.01–0.06 m | Distal |

**Hydrodynamic interpretation**

- Sand deposition predominantly between the mean fair-weather and storm-wave bases.
- Oscillatory flows generated by relatively steady to waning storm waves.
- High aggradation rates.
- Occasional superimposition of unidirectional downwelling flows (related to coastal setup) resulting in oscillatory-dominated combined-flows.
- Distally weakening flow conditions and lower sediment supply.

Jelby et al 2019, Sedimentology

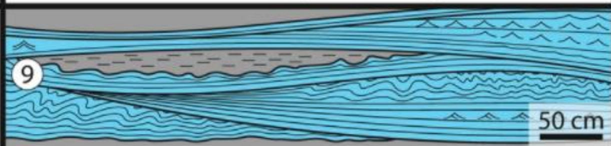
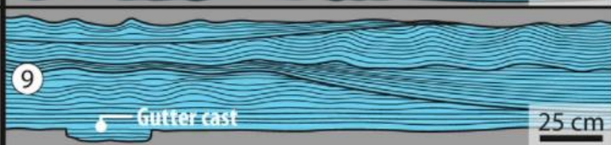
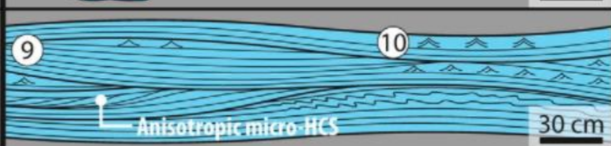
# Type 1 tempestites: Relatively steady flow deposits




In the intermediate localities, event beds of this type are predominantly thin to medium-bedded (although thick to very thick beds also frequently occur) and laterally restricted (<50 m).

Jelby et al 2019, Sedimentology

# Type 2 tempestites: Highly unsteady flow deposits

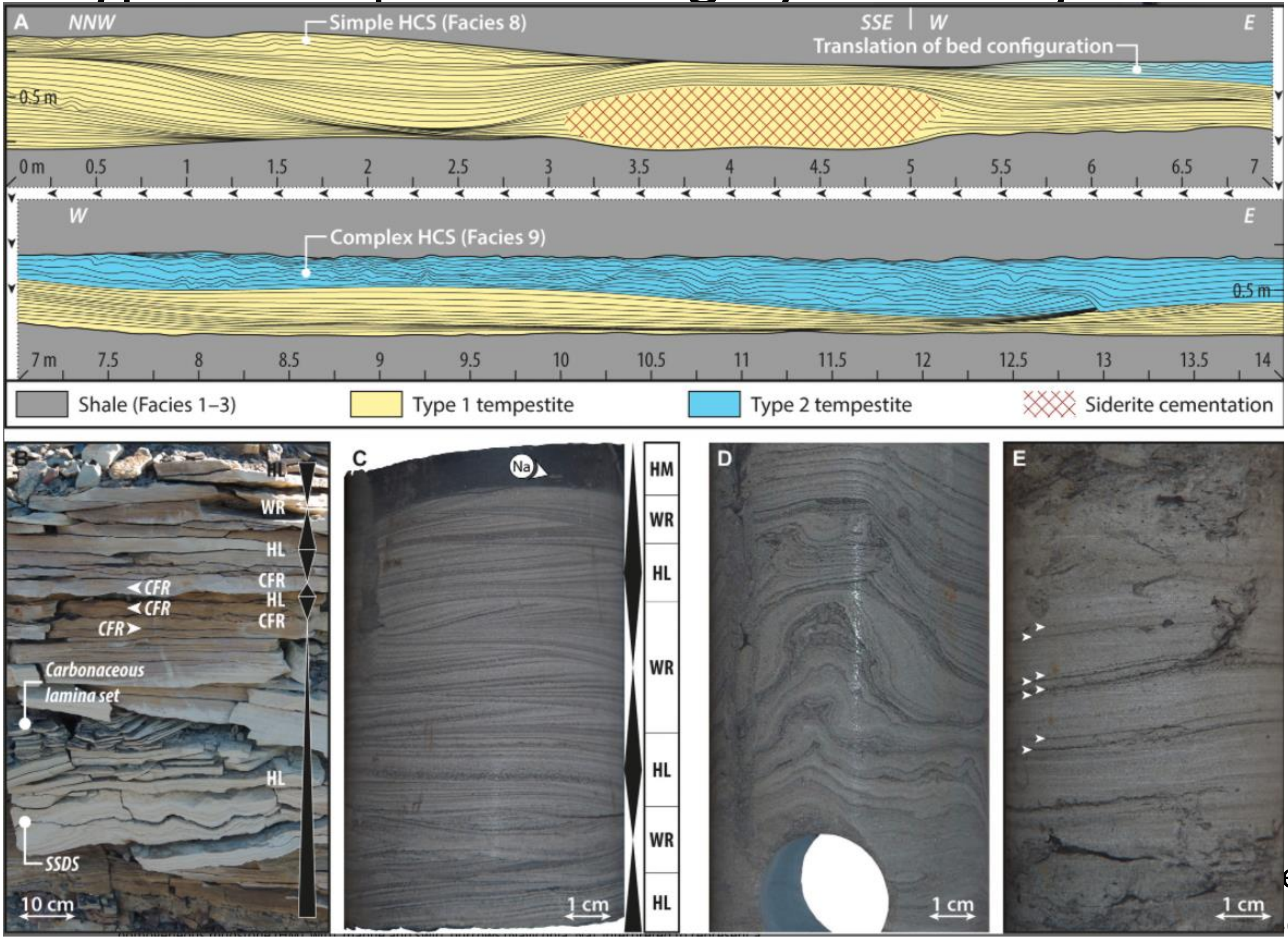
| | Stratification and facies numbers (encircled) | Representative figure numbers and description | | Variations, abundance and thickness | | | | |
|---|---|---|---|---|---|---|---|---|
| A |  | 10A–C | **Complex HCS: 'Compound' stratification** Isotropic HCS characterized by various ripple cross-lamination partly constituting lamina sets, and associated with abundant SSDS. | • Intercalated lamina sets of carbonaceous detritus. | Rare | Medium to thick | 0.20–0.88 m | **Proximal** |
| B |  | 11A | **Complex HCS: Transitional stratification** Isotropic HCS exhibiting frequent lateral translations into quasi-planar lamination with local minor SSDS. | • Wave, combined-flow or climbing current ripples at bed tops.<br>• Basal gutter casts. | Moderate | Medium to thick | 0.05–1.20 m | **Intermediate** |
| C |  | 11B–D | **Complex HCS: Ripple cross-lamination** Isotropic HCS displaying sporadic wave, combined-flow and current ripple cross-lamination, anisotropic micro-HCS and SSDS. | • Wave ripples at bed tops.<br>• Fluid-mud deposits overlying bed tops.<br>• Amalgamation and relict shale lenses. | Moderate | Med. to v. thick | | |
| D |  | 11E | **Complex HCS: Double draping** Double-draped, isotropic HCS characterized by alternating cm-thick and mm-thick third-order laminae, each draped by carbonaceous detritus. | • Fluid-mud deposits overlying bed tops. | Rare | Thin to medium | | |

**Hydrodynamic interpretation**

- Sand deposition predominantly between the mean fair-weather and storm-wave bases.
- Highly unsteady storm waves.
- Oscillatory flows with high aggradation rates.
- Episodic to periodic shifts in flow intensity, superimposition of unidirectional flows, multidirectional flow modes and syndepositional liquefaction.
- Distally weakening flow conditions and lower sediment supply.

Jelby et al 2019, Sedimentology

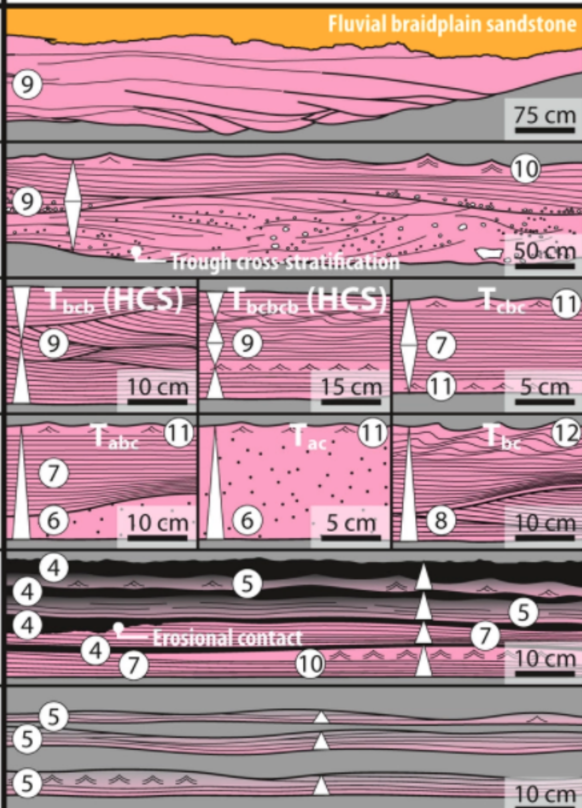
# Type 2 tempestites: Highly unsteady flow deposits




In the intermediate localities, event beds of this type are predominantly medium-bedded and subordinately thin-bedded or thick to very thick-bedded, and dominated by isotropic complex HCS

elby et al 2019, edimentology

# Type 3 tempestites: Wave-modified hyperpycnites



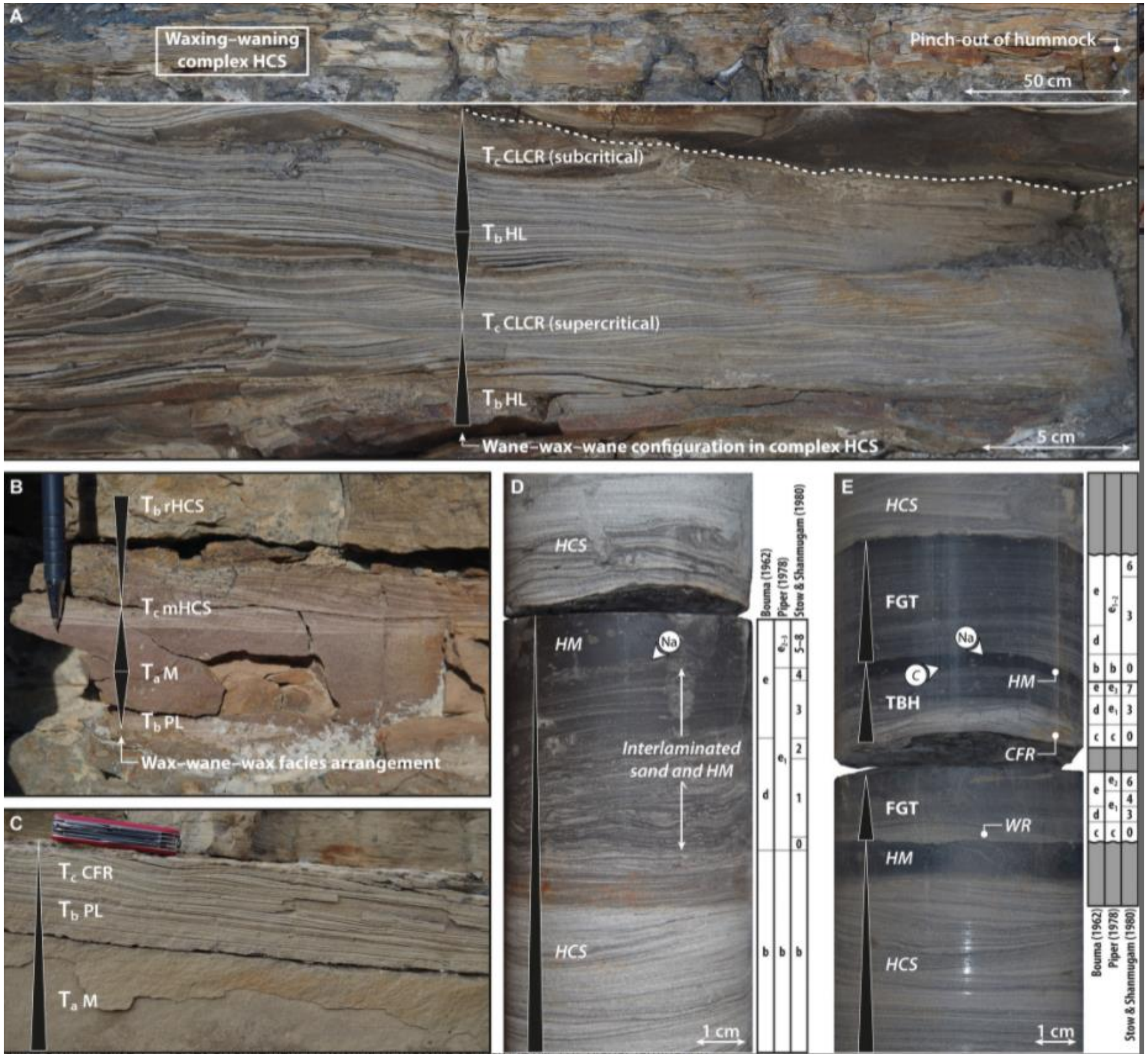

| | Stratification and facies numbers (encircled) | Representative figure numbers and description | | Variations, abundance and thickness | | | | |
|---|---|---|---|---|---|---|---|---|
| A | | 13A | **Complex HCS: Channelization** Metre-scale, erosional and laterally tapered HCS displaying compensational cut-and-fill architecture, lateral accretion and gravel lenses. | • 2D to trochoidal wave ripples at bed tops. | Rare | Thick | 0.05–0.80 m | Proximal |
| B | | 13B, C | **Complex HCS: Gravel-rich stratification** Normally or inverse-to-normally graded, gravel-rich isotropic HCS or quasi-planar lamination with local trough cross-stratification. | • Wave or combined-flow ripples at bed tops. • Anisotropic micro-HCS. • Coarse-tail grading. | Rare | Medium to thick | | |
| C | | 13D+14A, B | **Complex HCS: Wax–wane hyperpycnites** Laterally extensive beds characterized by vertical alternation of sedimentary structures within complex HCS or Bouma-like divisions. | • $T_{bcbc}$ configuration in complex HCS, and $T_{bacb}$ and $T_{cbcd}$ wax–wane facies arrangements. | Moderate | Thin to medium | | |
| D | | 14C | **Wave-modified turbidites** Relatively tabular beds with Bouma-like facies arrangements of massive bedding, planar lamination, simple HCS and various ripples. | • $T_{ab}$ and $T_{bcd}$ facies arrangements. | Moderate | Thin to thick | 0.02–0.35 m | Intermediate |
| E | | 14D, E | **Very thin to thin-bedded hyperpycnites** $T_{bcde}$, $T_{bd}$, $T_{bde}$, $T_{cd}$ and $T_{cde}$ divisions of sandstone and fluid-mud deposits with sharp, gradational or erosional contacts between facies. | • Lateral thickness changes of fluid-mud deposits. • Wave ripple sandstone lenses encased in fluid-mud deposits. | Common | V. thin to thin | | |
| F | | 14E | **Fine-grained, graded turbidites** Beds of siltstone grading into silty mudstone, resembling the $T_{e1-3}$ division of Piper (1978) and $T_{0-8}$ division of Stow & Shanmugam (1980). | • Carbonaceous-rich beds. • Bioturbated bedding with obliterated grading. | Moderate | V. thin to thin | | |

**Hydrodynamic interpretation**

- Sand and mud deposition predominantly between the mean fair-weather and storm-wave bases.
- Storm-wave-enhanced, hyperpycnal turbidity currents.
- Common hyperpycnal-flow waxing and waning.
- Local subaqueous channelization.
- Intermediate wave-enhanced surge-type turbidity currents and fluid-mud flows generated directly from proximal hyperpycnal flows.

Jelby et al 2019, Sedimentology

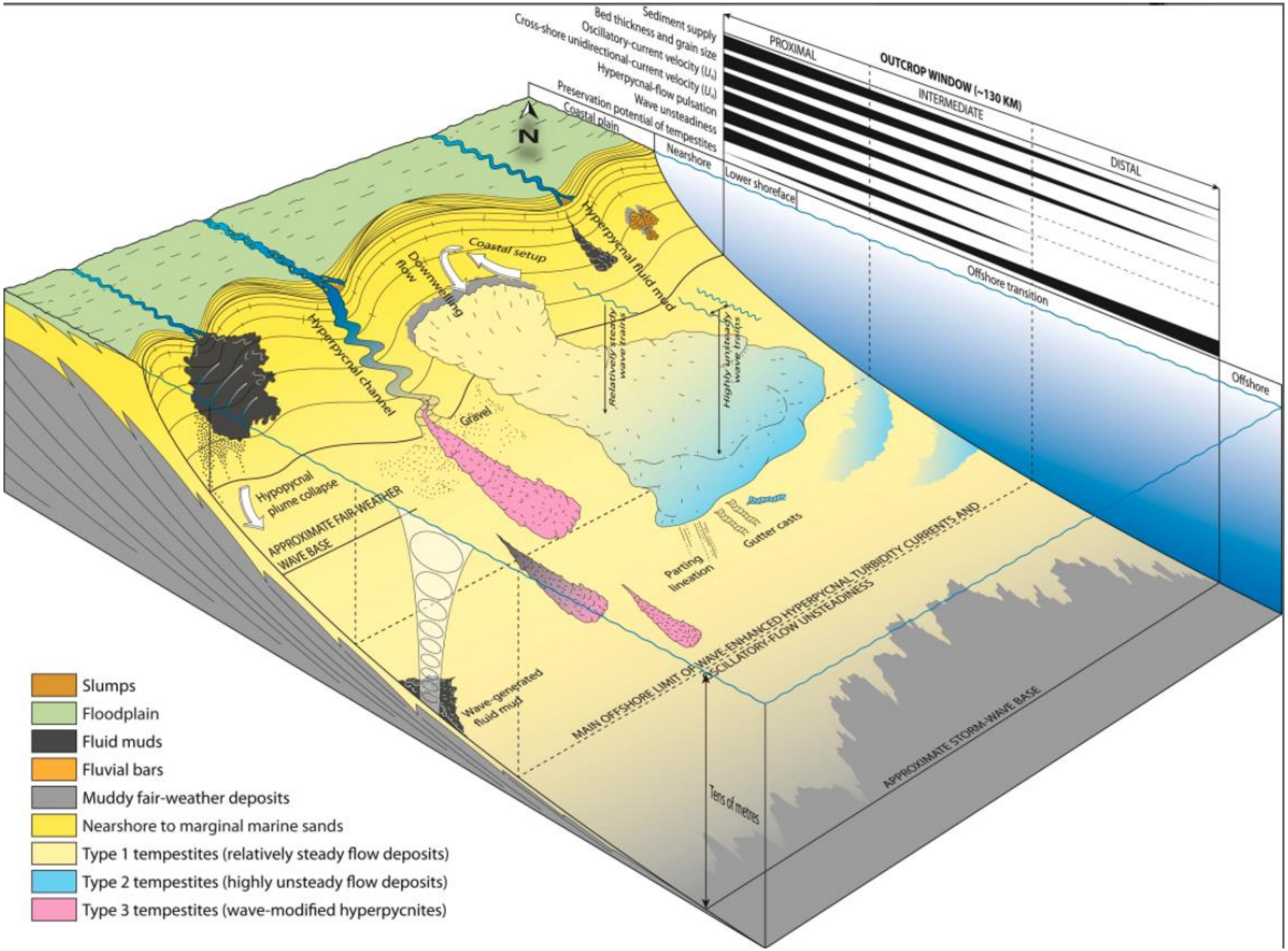
# Type 3 tempestites: Wave-modified hyperpycnites




In the intermediate localities, event beds of this type display four facies arrangements, of which two are characterized by thin to thick-bedded sandstone and two are characterized by very thin to thin-bedded couplets of sandstone and mudstone. The event beds are characterized by common interbedding with homogeneous shale, sand-streaked shale and bioturbated sandy shale.

Jelby et al 2019, Sedimentology

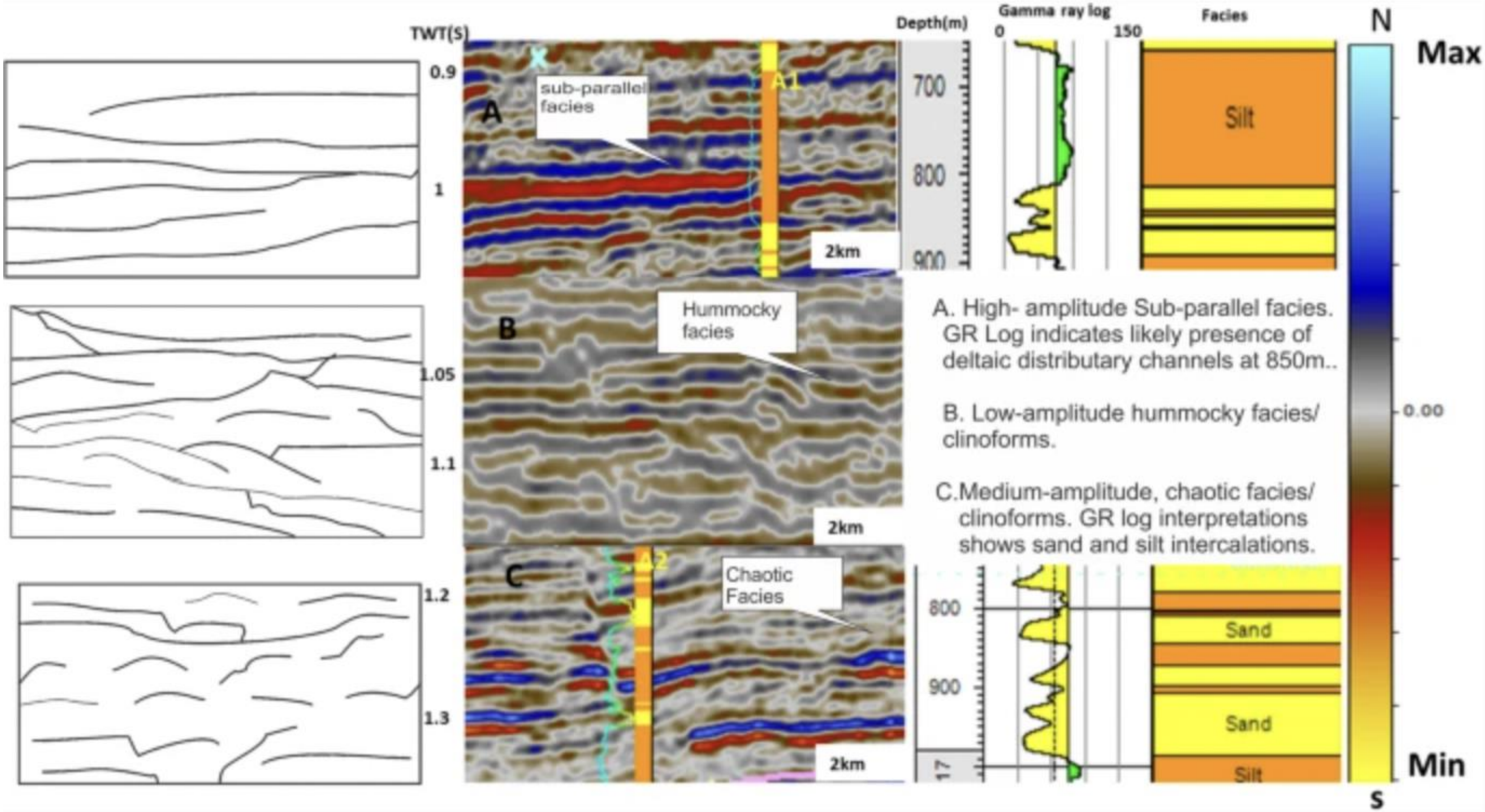
# Facies model of the Rurikfjellet Formation tempestites




Jelby et al 2019, Sedimentology

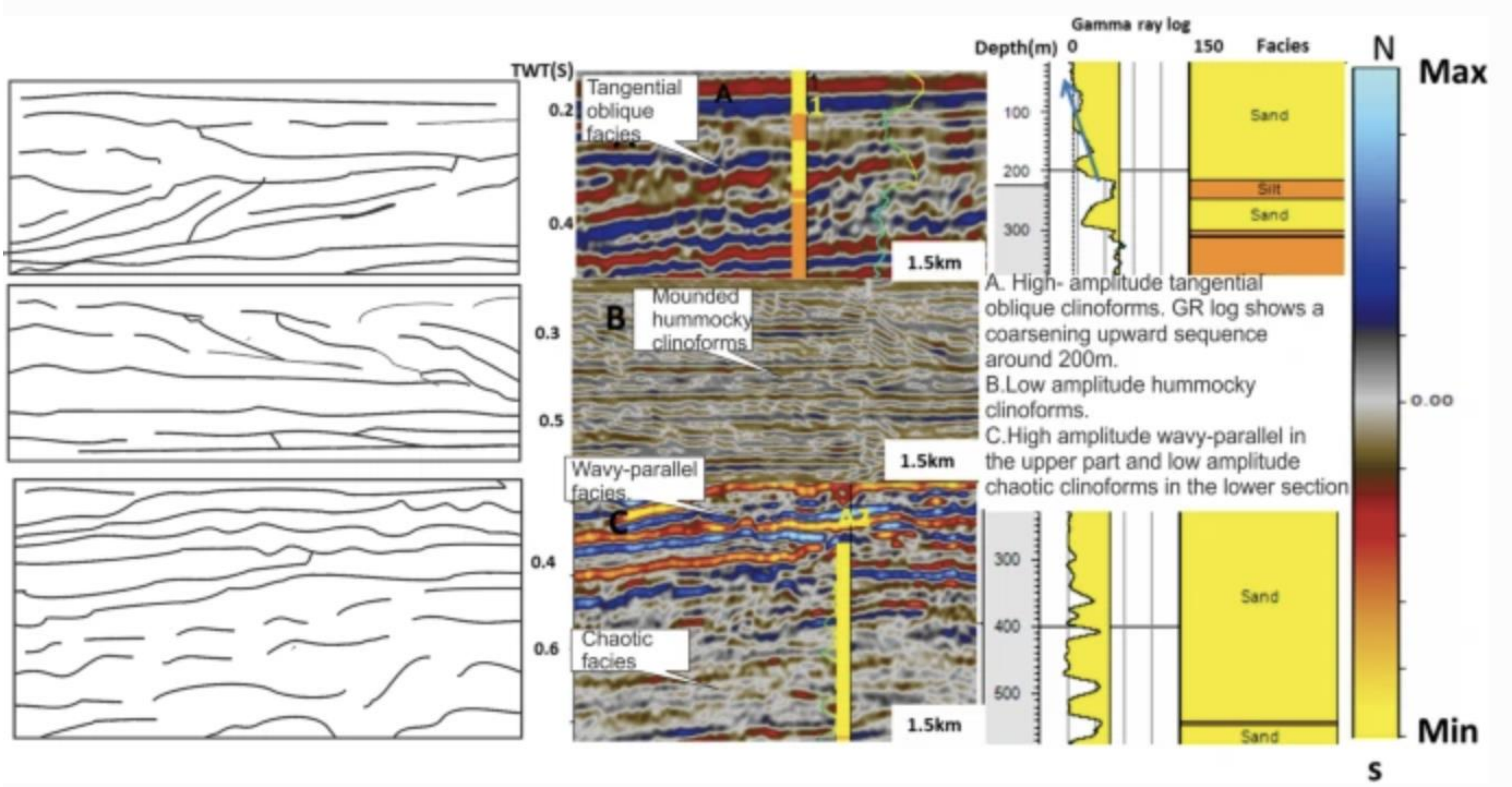
proximal–distal distribution of tempestite types, depositional environments, sediment supply, bed thickness and grain size, tempestite preservation potential and storm-depositional processes. Deposition took place from near storm-wave base to immediately above fair-weather wave base across a prodeltaic, low-gradient ramp.

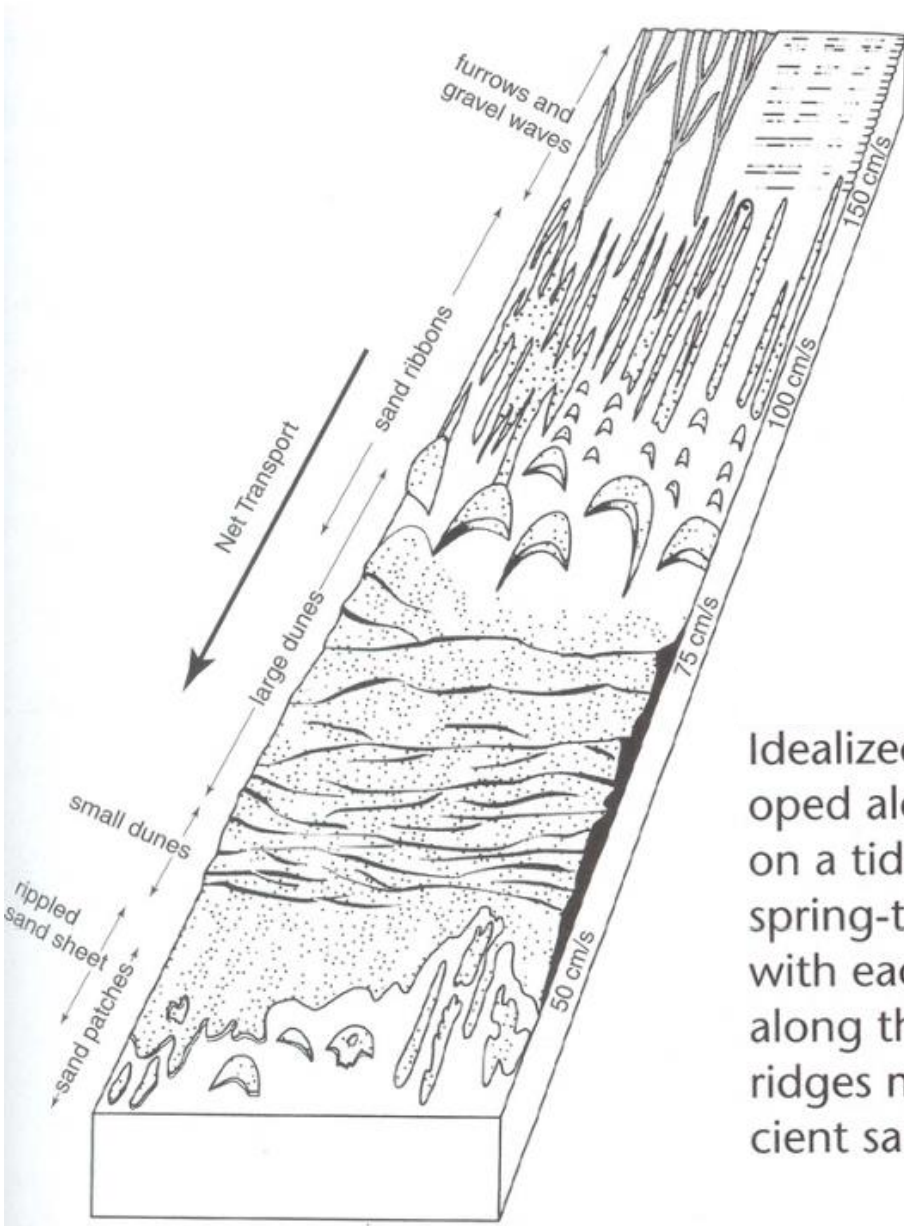
## storm and wave-dominated shelf environment




Samakinde et al. (2021). J Petrol Explor Prod Technol 11, 45–61.

SF2 configurations in the Central part could represent strata forming as small clinoform lobes in a pro-deltaic environment



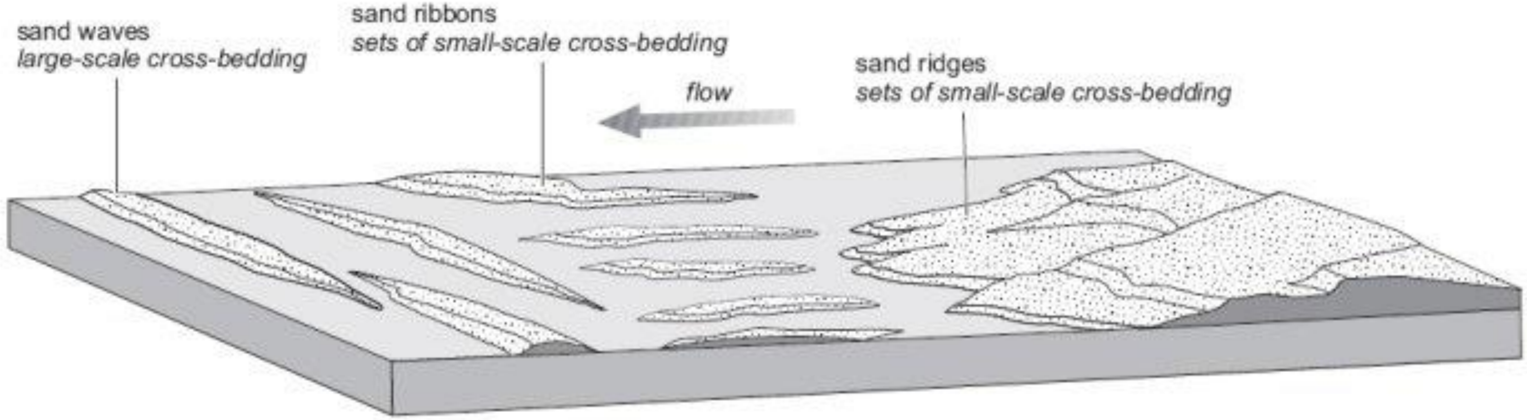



## Tide-dominated shelves

Tide-dominated shelves are defined as those where the tidal range is macrotidal, greater than 3-4m, and typical tidal current speeds (at mean spring) range from 60 to > 100cm/s. these account for ~17% of the worlds modern shelves

Idealized sequence of bedforms developed along a sediment transport path on a tide-dominated shelf. Maximum spring-tide current velocities associated with each bedform type are shown along the edges of the diagram. Sand ridges may form in the dune belt if sufficient sand is present. [After Belderson, R.

## Deposition on tide-dominated shelves




### Offshore sand ridges

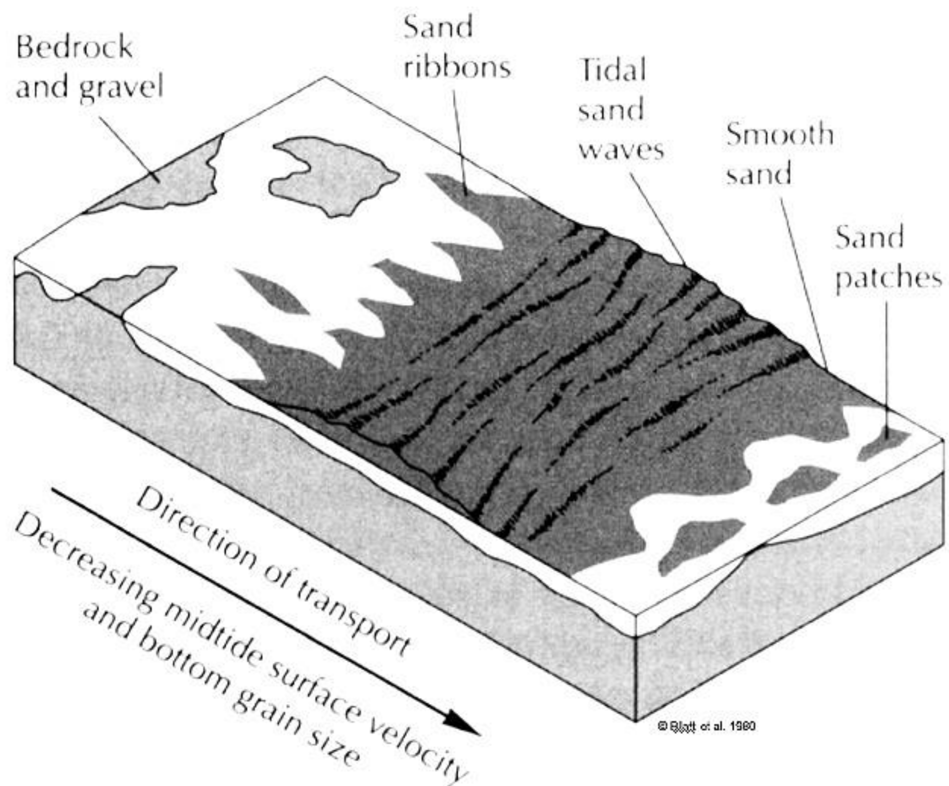
Near shorelines that experience strong tidal currents large sand ridges are found on modem shelves.

The ridges form parallel to the shoreline in water depths of up to 50m and may be tens of metres high, in places rising almost to sea level.

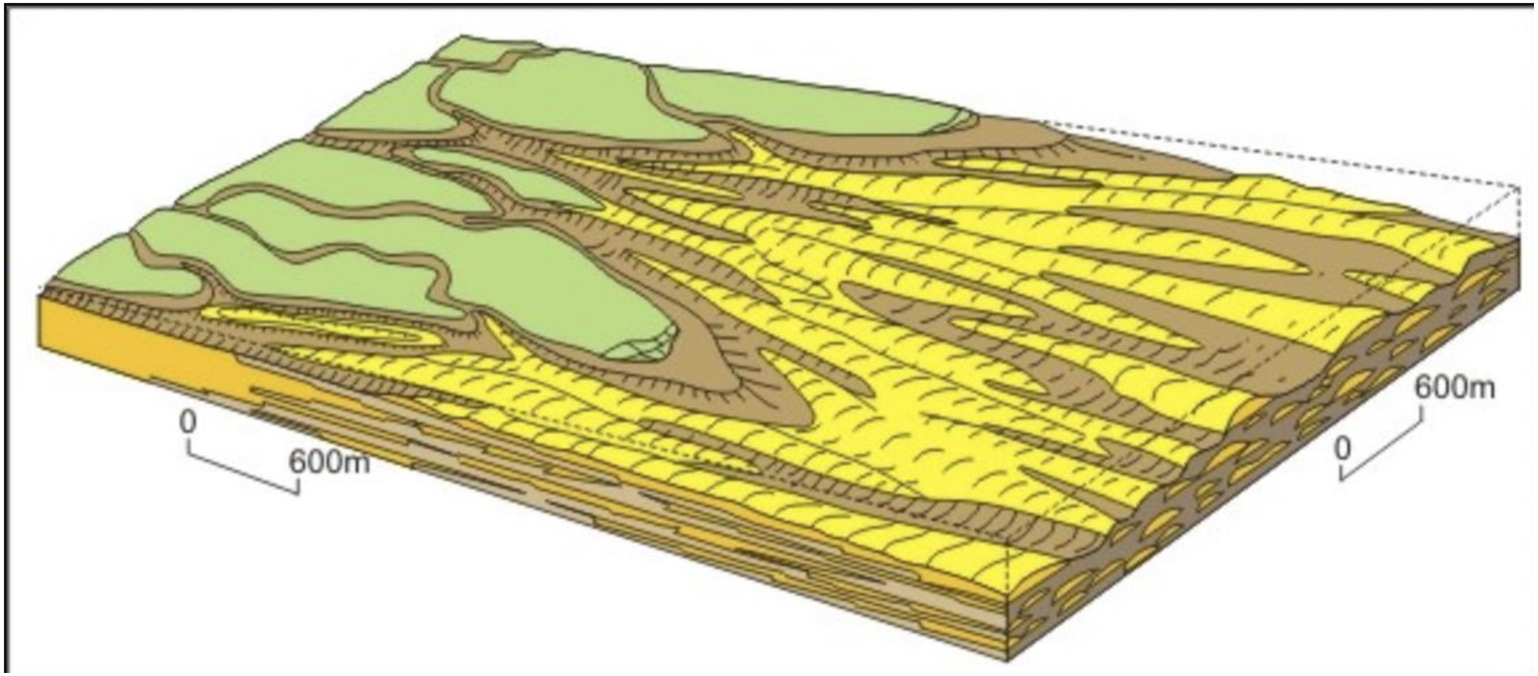
The sands are moderately well sorted, medium grained but the deposits may include some mud occurring as clay laminae deposited during slack phases of the tidal flow.

# Tide dominated:

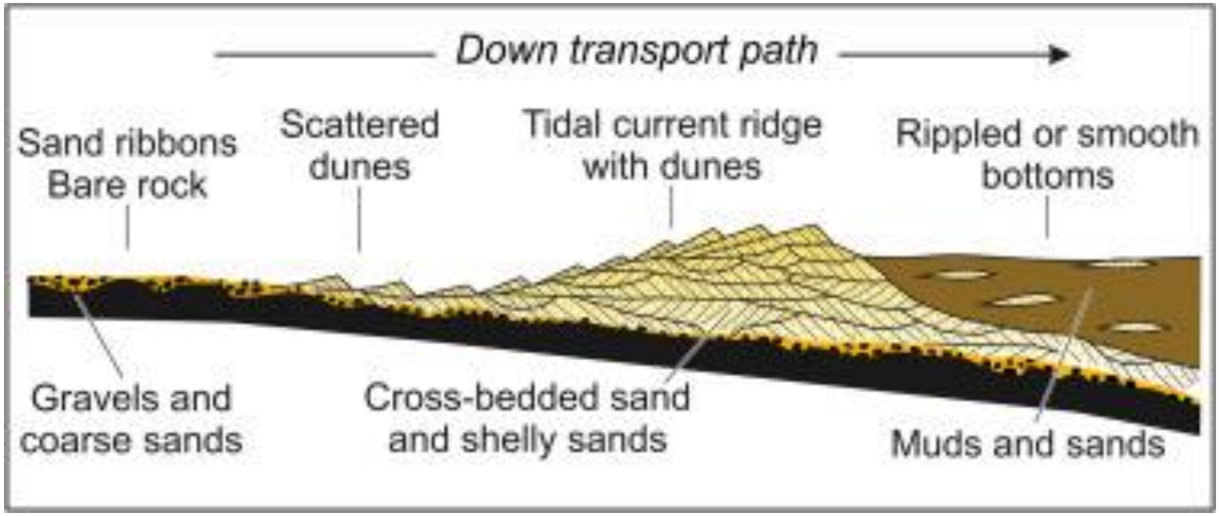
Where tidal ranges are large (>2 m) and currents are fast (50 to 100 cm/s) asymmetrical sand ribbons or tidal ridges are formed on the continental shelf at oblique angles to strike.
At tidal currents of less than 50 cm/s, strike elongate sheets or waves of sand develop (right). A tidal sand wave has a crest of 3 to 15 meters and wavelengths of 150 to 500 meters. They are composed of low angle cross-beds (dipping at 5 to 6 degrees, which along with cross sets that are no more than a few meters in thickness, differentiates them from eolian sand dunes).

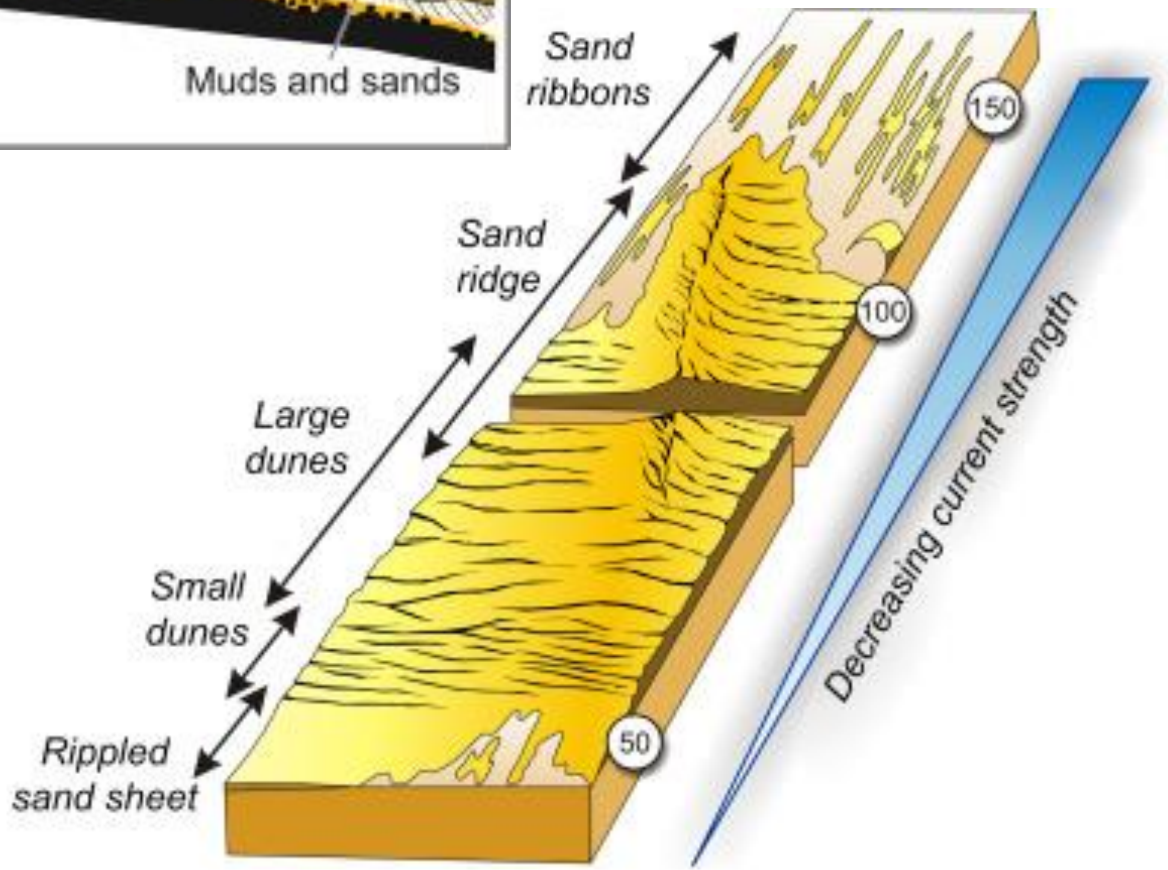



UNIVERSITY OF MARYLAND
DEPARTMENT OF GEOLOGY




asymmetrical sand ribbons or tidal ridges are formed on the continental shelf at oblique angles to strike.


Down transport path
Sand ribbons
Bare rock
Scattered dunes
Tidal current ridge with dunes
Rippled or smooth bottoms
Gravels and coarse sands
Cross-bedded sand and shelly sands
Muds and sands

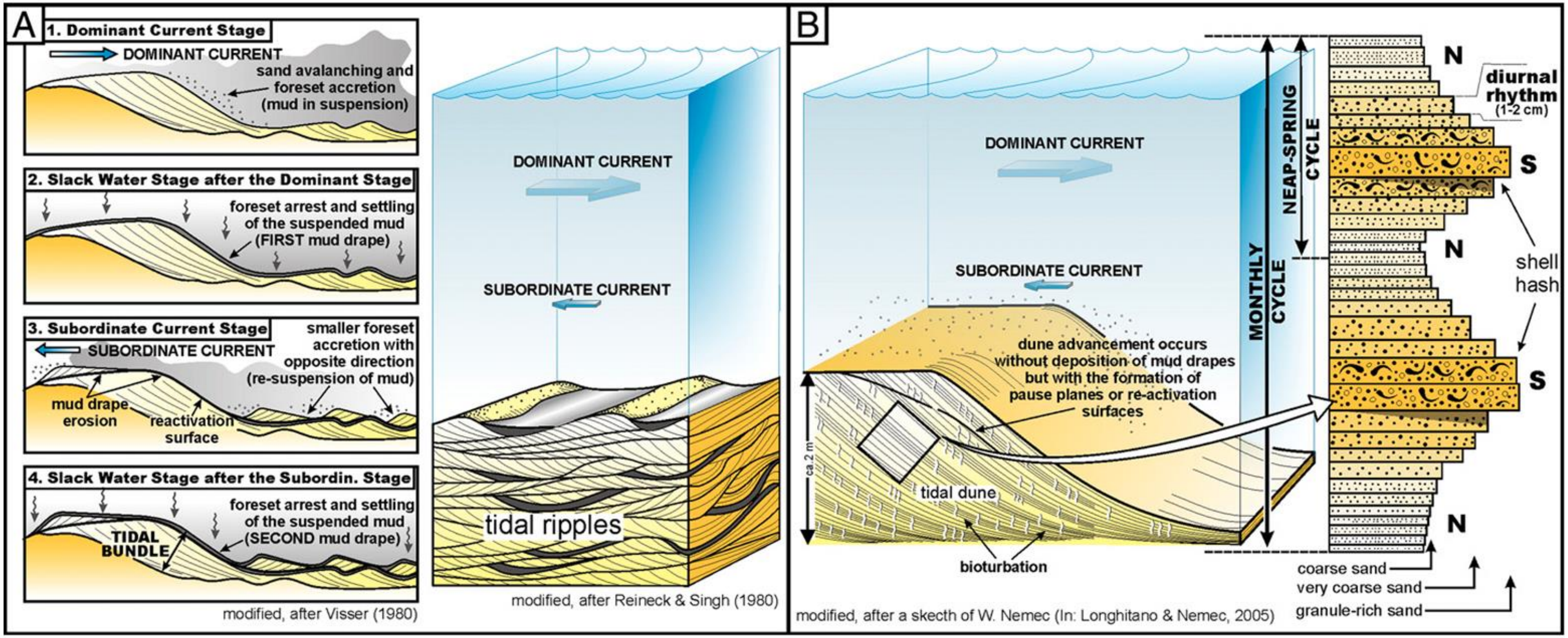

Sand ribbons
Sand ridge
Large dunes
Small dunes
Rippled sand sheet
150
100
50
Decreasing current strength


low angle cross-beds (dipping at 5 to 6 degrees

# Tidalites

Longhitano et al., 2012. Sedimentary Geology

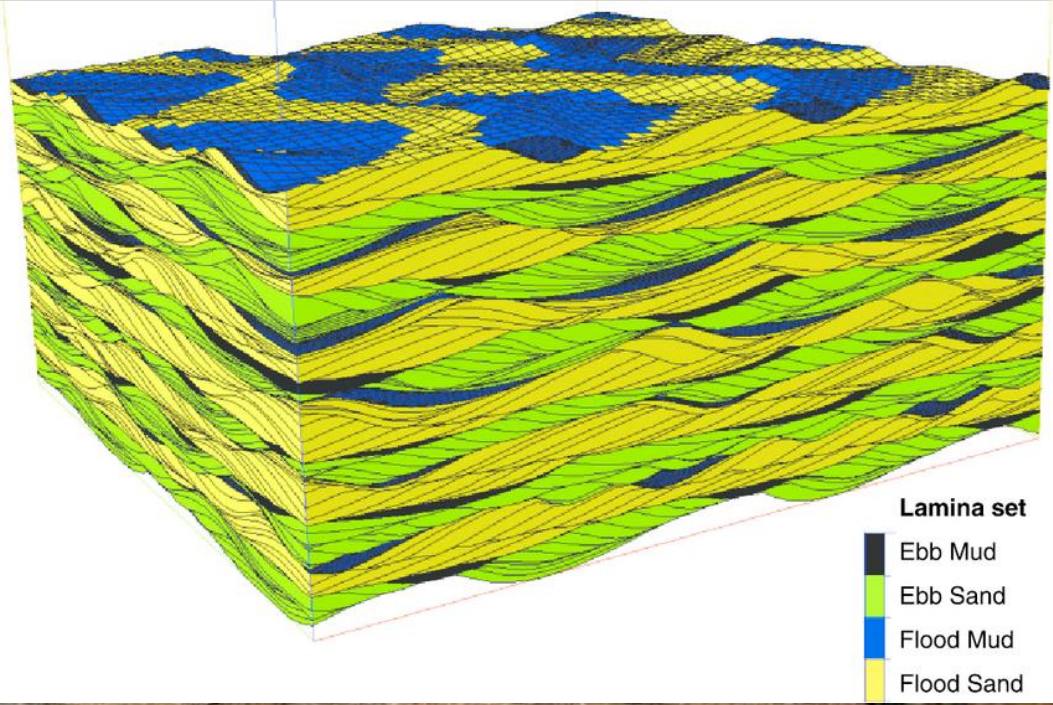
vary from thin, muddy heterolithic strata (lenticular, wavy or mud-flasered bedding) to sand-rich unidirectional, bi-directional (herring-bone) or 'bundled' cross-stratification



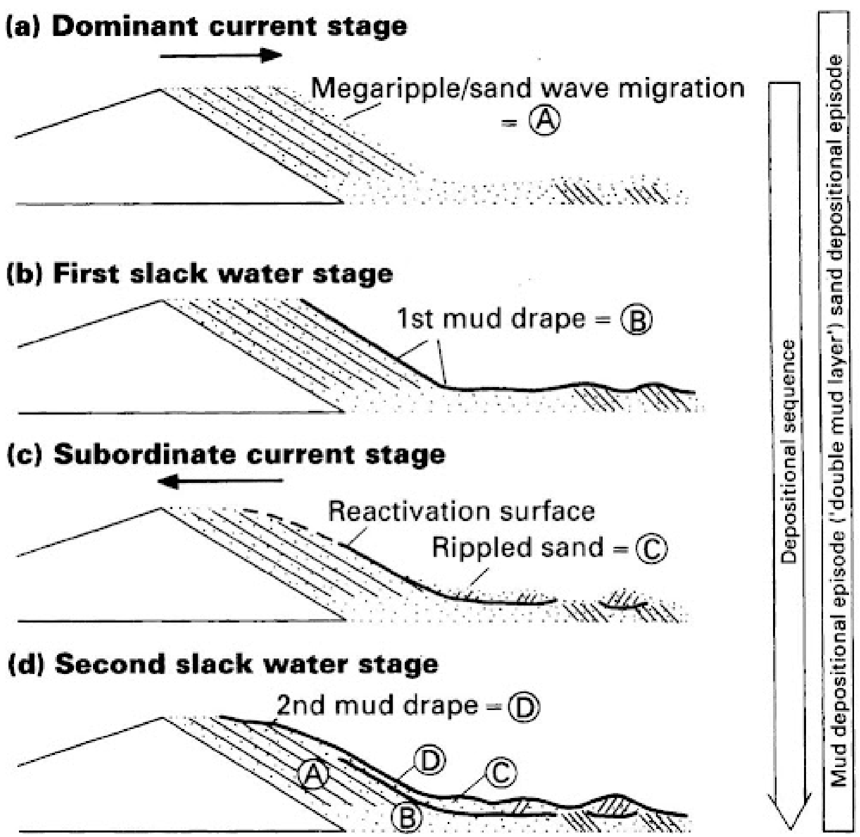

A) Typical dune bedform generated in a mud-rich system after a complete tidal cycle and characterized by a strongly asymmetric current. (B) Bundles of coarsening- and fining-upward lamina sets within cross-stratified deposits developed in mud-free siliciclastic subtidal

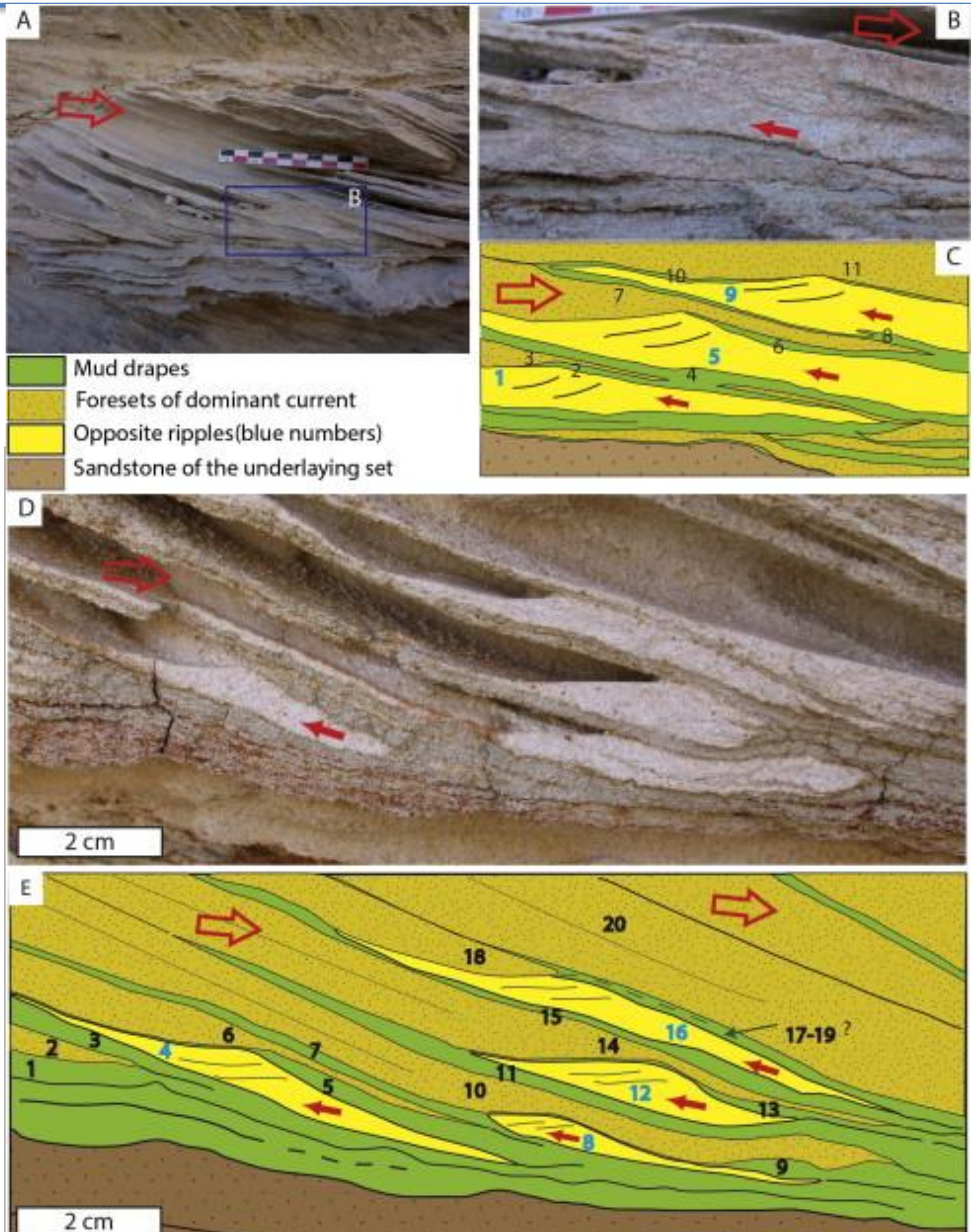
# Flaser beds

a sedimentary, bi-directional, bedding pattern created when a sediment is exposed to intermittent flows, leading to alternating rippled sand and mud layers.



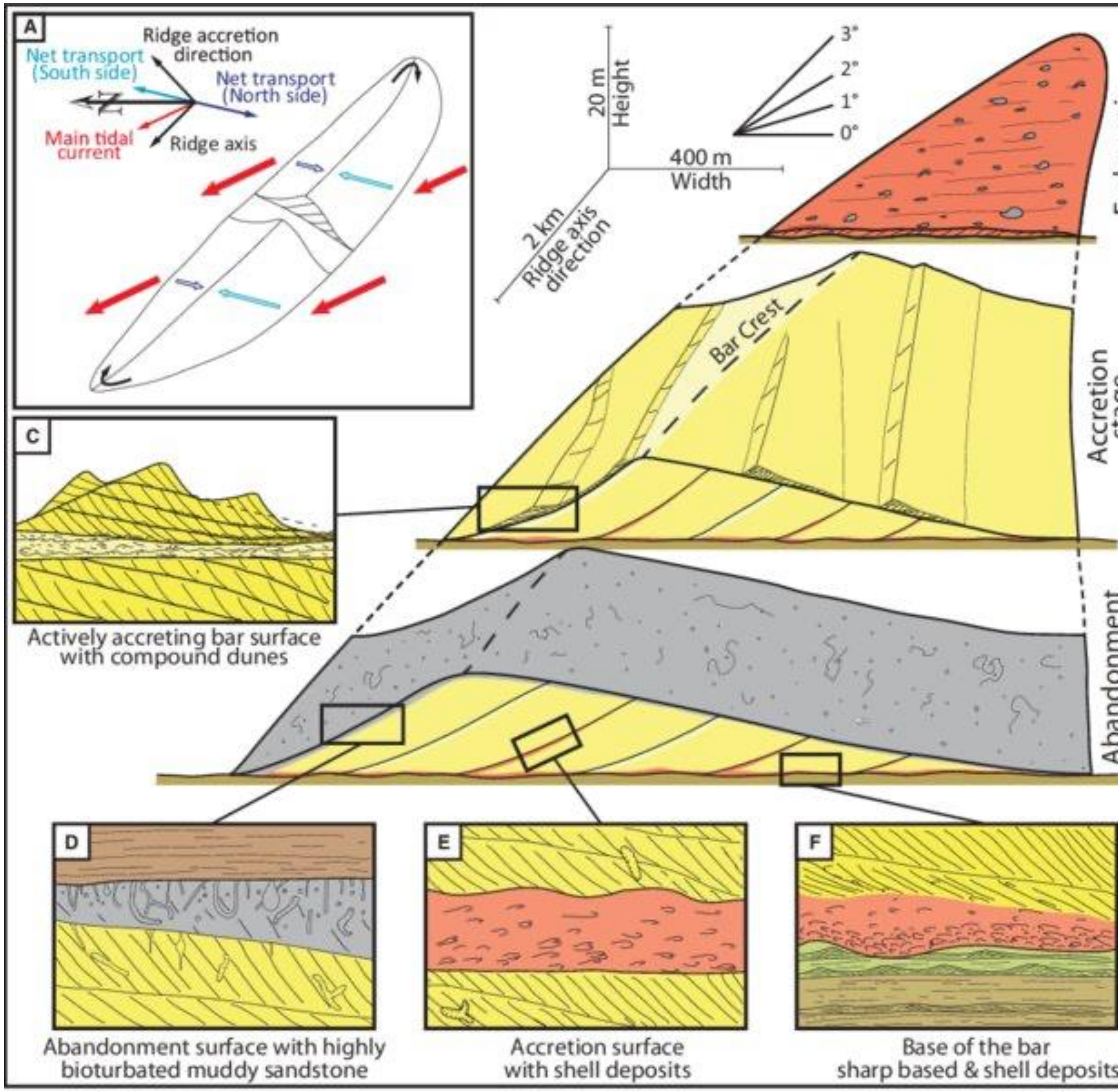

# Mud couplets



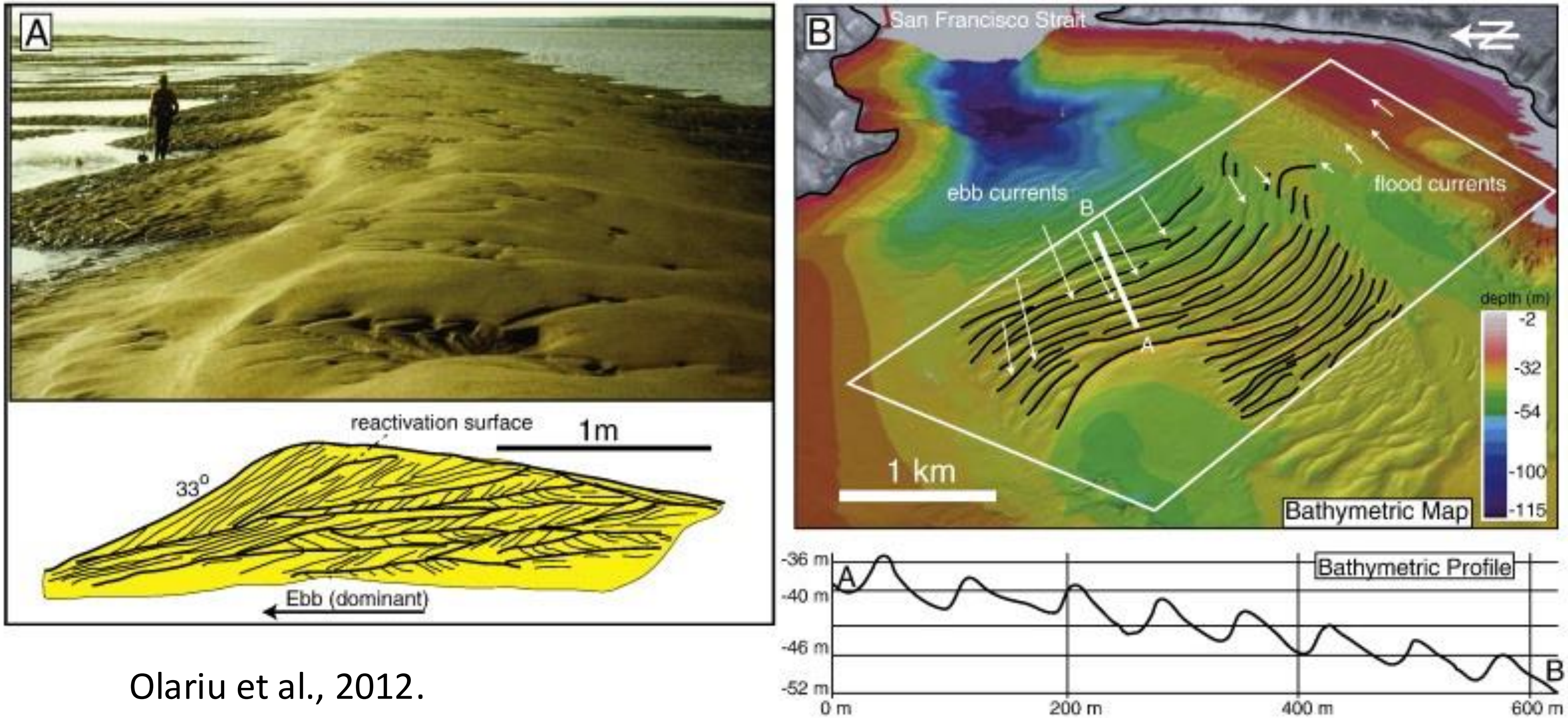
# Facies model and reconstruction of a transgressive tidal-shelf ridge

(A) Reconstruction of the main tidal currents and the resultant net sediment transport. (B) Evolutionary stages of the tidal ridge. The embryonic stage represents the basal erosional surface with a thin veneer of shell rich sandstone. The accretion stage shows compound dunes accreting in the north side of the ridge, while dunes with net erosion migrate in the south side of the ridge. The abandonment stage is characterized by hemipelagic deposition and intense bioturbation. (C) Detail of the compound dune accretion. (D) Abandonment facies and highly bioturbated upper boundary of the ridge. (E) Detail of the accretion surfaces with shell rich sandstones. (F) Detail of the bottom surface eroding into previous offshore and offshore-transition deposits.




Lopez et al., 2016. Sedimentology

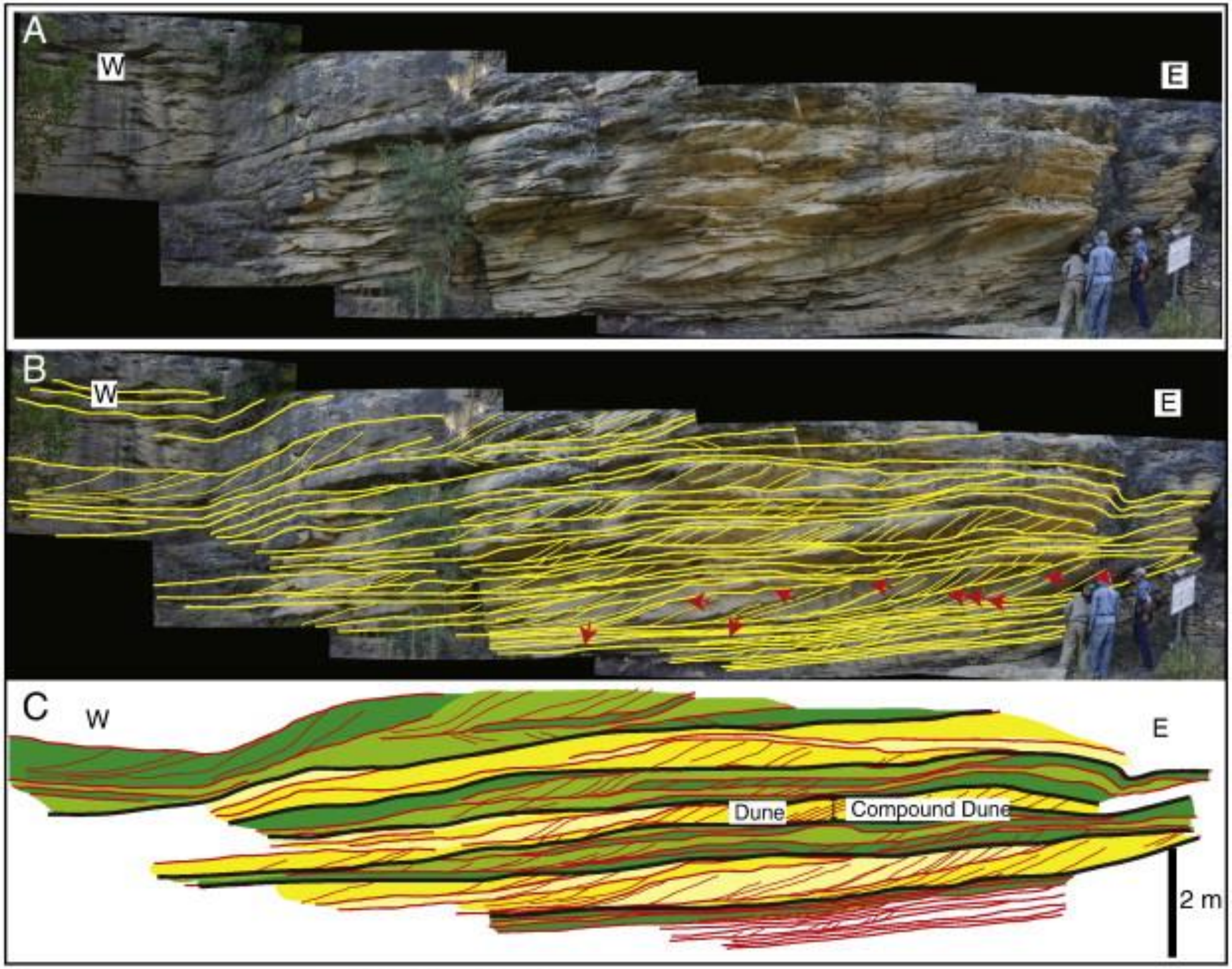
# Tidal dunes in modern environments.




Olariu et al., 2012.

A – Photo and trench showing the internal structure of compound tidal dunes in Cobequid Bay, Bay of Fundy. B – Oblique view of the dunes seaward of the mouth of the San Francisco Bay entrance. Note (1) the height of the dunes is about 3–4 m and the wavelength 100 m, and (2) the spatial segregation of areas with ebb- and flood-dominant currents.

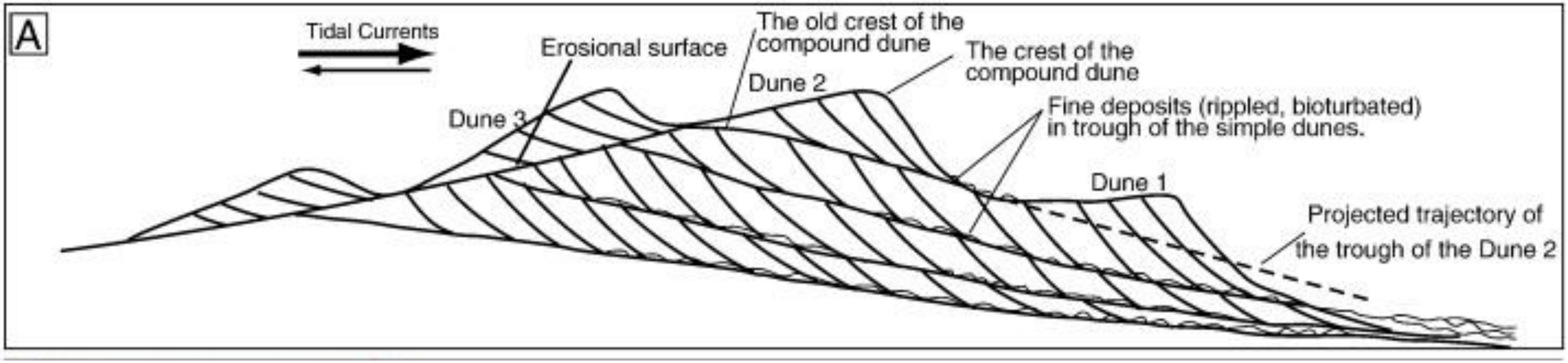
# Olariu et al., 2012.




Photomosaic and bedding diagrams for the compound dunes. Different colors in C represent the cosets of different compound dunes. In these examples, the smaller simple dunes are a large fraction of the height of the larger compound dune on which they were superimposed.

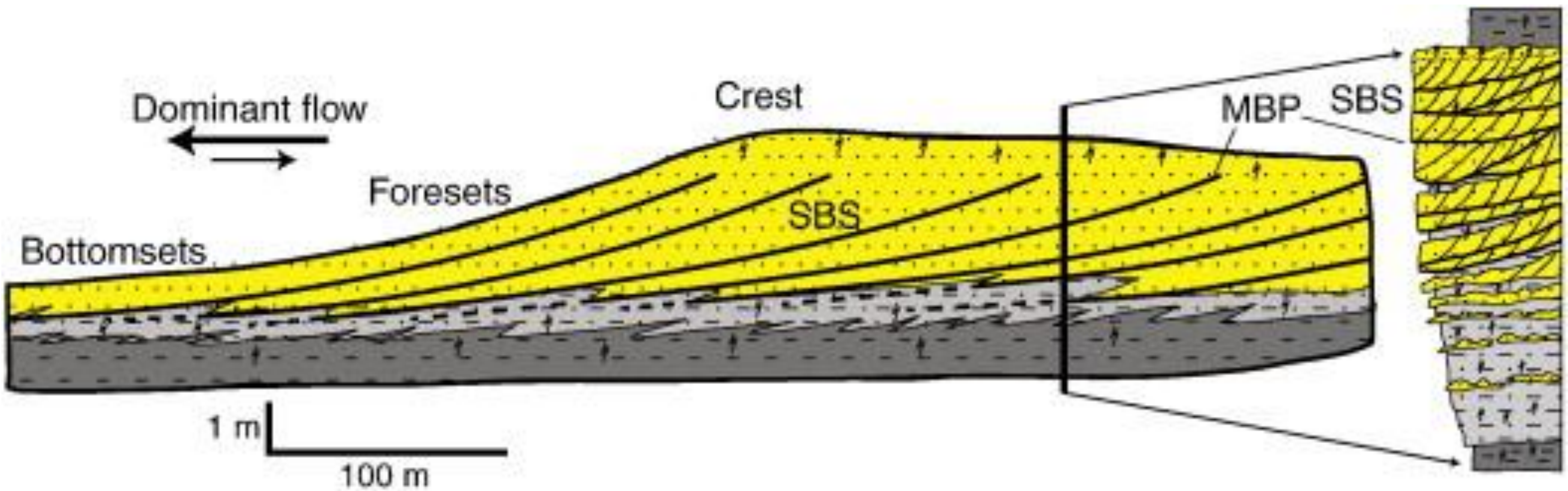
# Compound tidal dune model

Formation of a compound tidal dune. Note that the inferred trajectory of successive troughs of the superimposed simple dunes (dashed line) causes truncation of the cross-strata deposited by the preceding simple dune



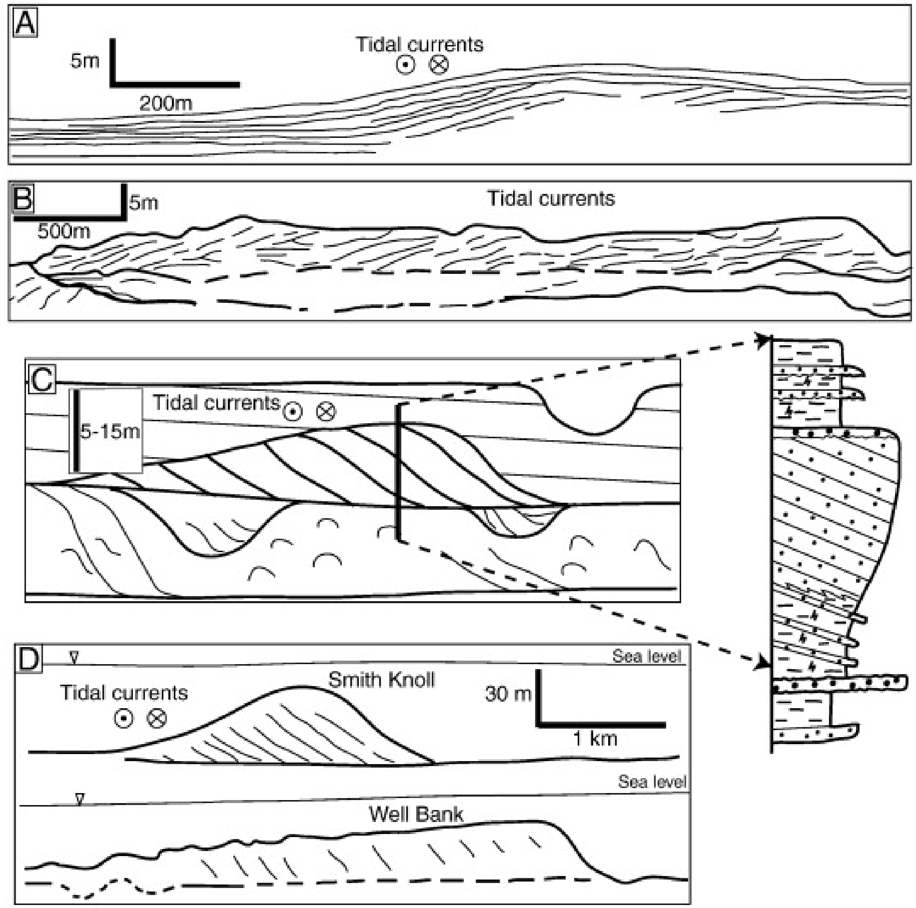

Olariu et al., 2012.

Olariu et al., 2012. Tidal dunes versus tidal bars. Sedimentary Geology 279, 134-155




Schematic model for a “tidal bar” (modified from Mutti et al., 1985). SBS-single sigmoidal bed set, MBP-master bedding plane. Note the overall coarsening-upward pattern on the vertical succession (right side) and the forward-accretion architecture (flow from right to left).

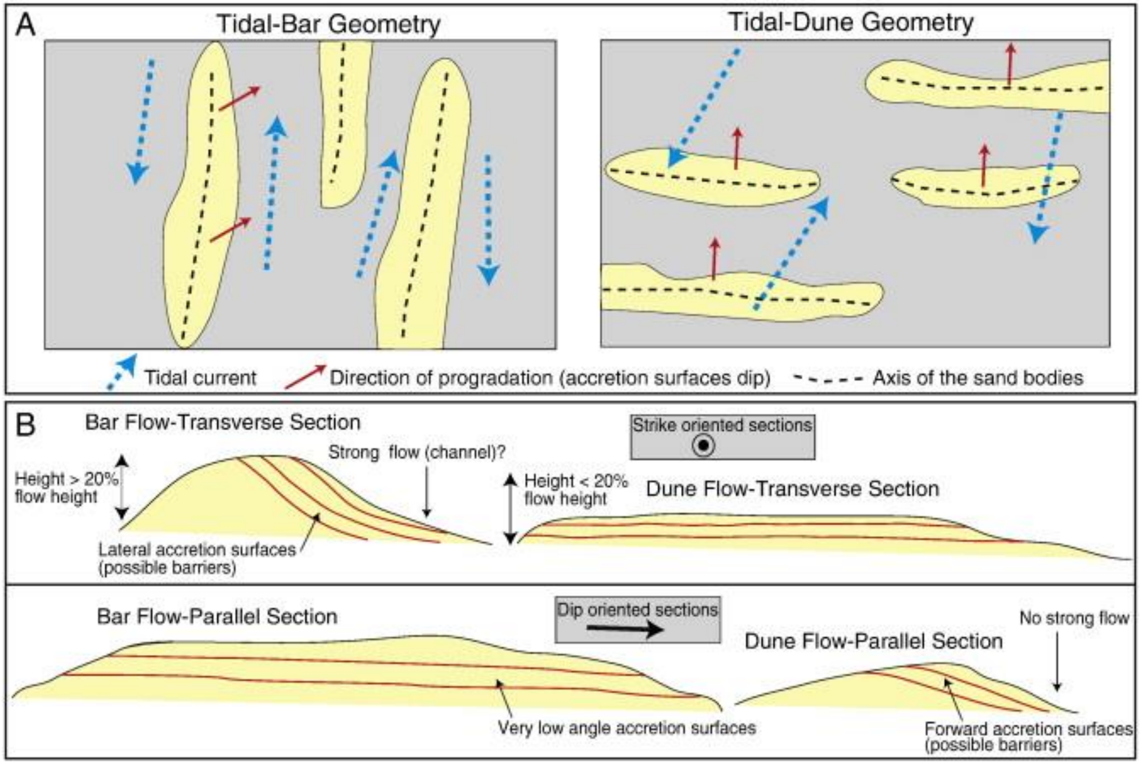
Examples of tidal bars in modern environments. Note the presence of inclined stratification in all examples, formed by migration perpendicular to the tidal currents. A – Fly River Delta tidal bar (after Dalrymple et al., 2003). B – Cobequid Bay, Bay of Fundy (from Dalrymple and Zaitlin, 1994). C – Sand ridges (tidal bars) on the East China Sea shelf (Berné et al., 2002). D – Sand ridges in English Bight (Houbolt, 1968).




Olariu et al., 2012.

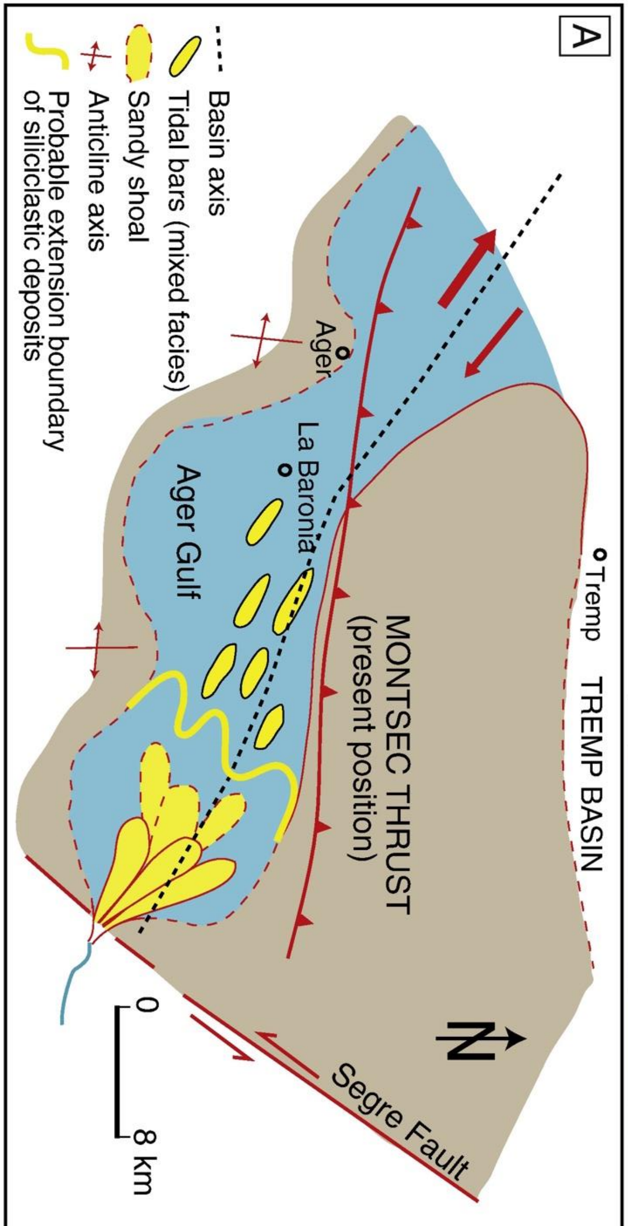
Istituto Nazionale di Oceanografia e di Geofisica Sperimentale

# Olariu et al., 2012.



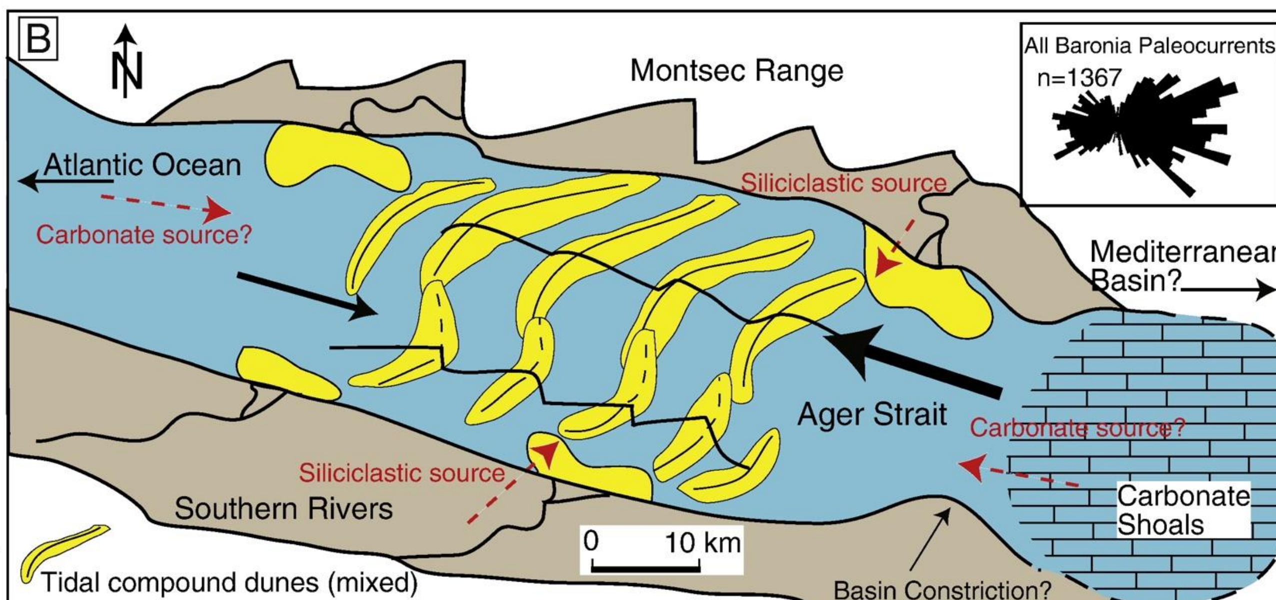

The morphological and architectural differences between tidal dunes and bars. A – Plan-view morphology indicating the long-axis (crest) orientation relative to the tidal currents. B – Internal architecture (orientation of the master surfaces) relative to the tidal currents.

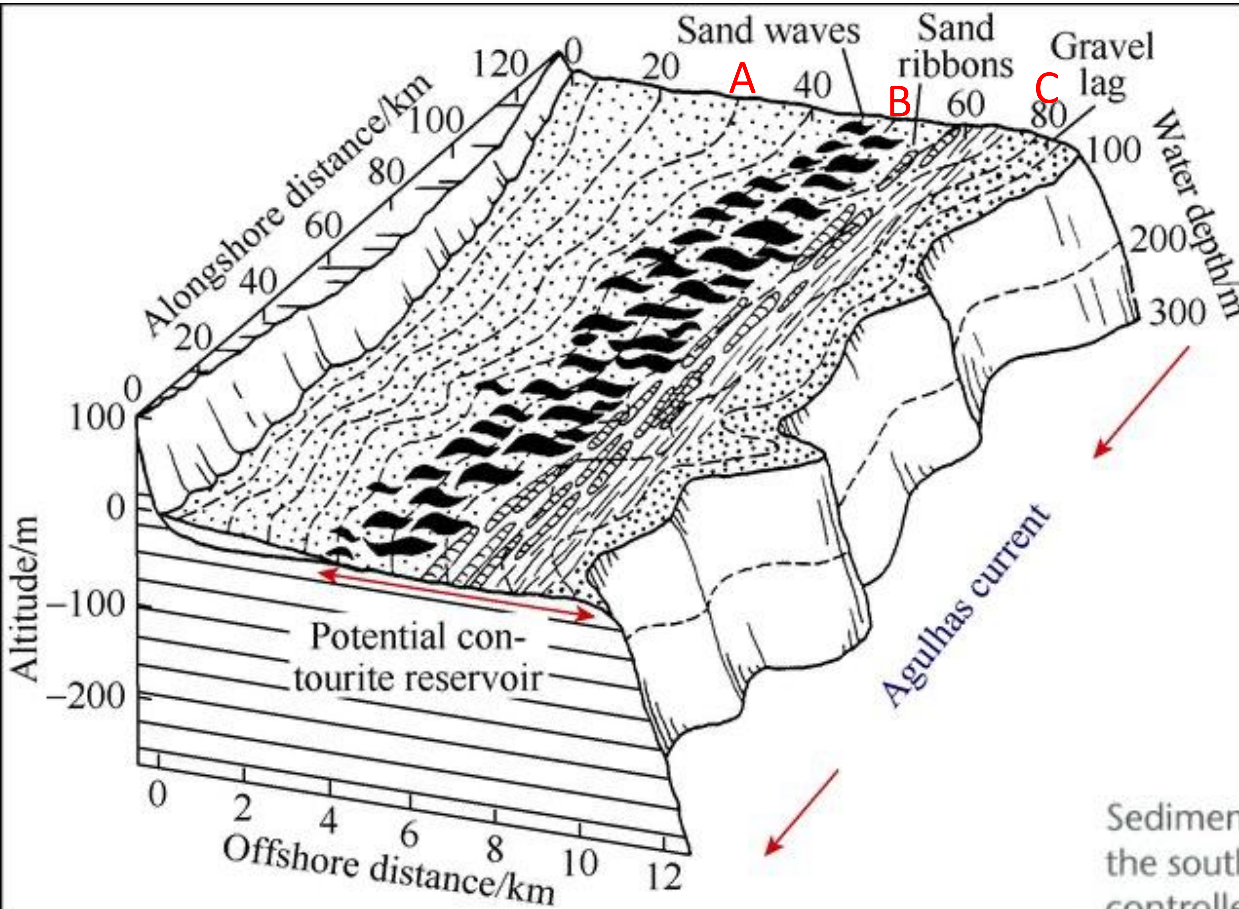
# Two possible paleogeographical reconstructions




Olariu et al., 2012.

A – Paleogeographical reconstruction of Ager Gulf during the deposition of the lower unit of the Baronia (modified after Mutti et al., 1985). B – Our preferred paleogeographical reconstruction of the Ager Strait, with a carbonate platform to the east of the Ager Basin and the widespread development of large subaqueous dunes. The dunes have north–south crests, with mutually evasive areas in which the dominant currents have opposite directions.





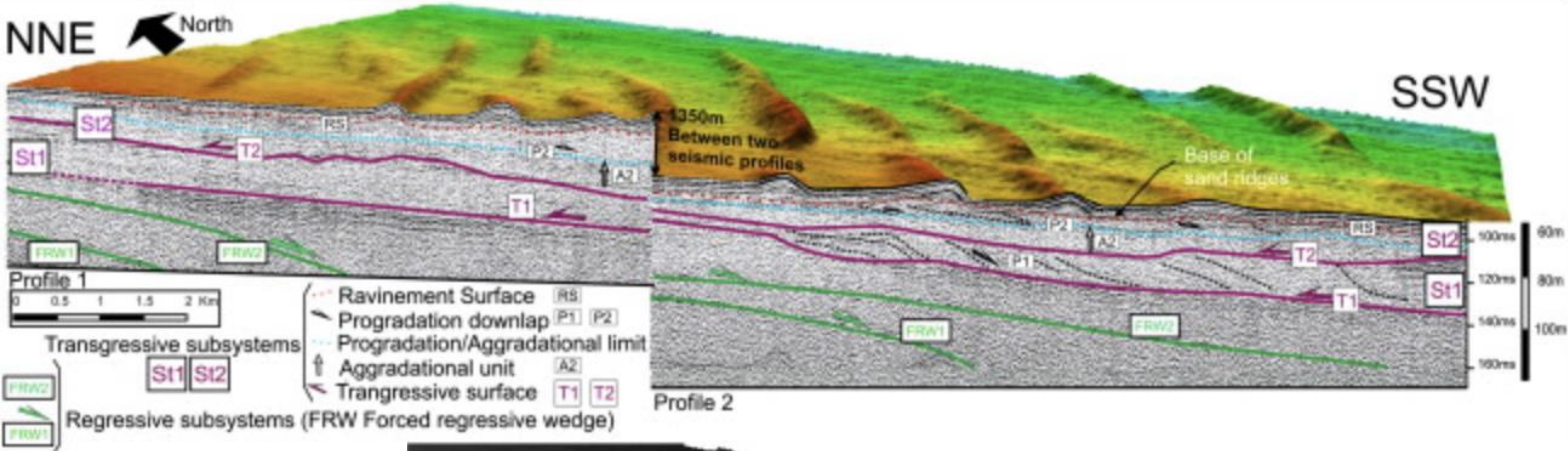

# Ocean-current-dominated shelves are generally narrow (less than 10 km) and lie adjacent to strong geostrophic currents

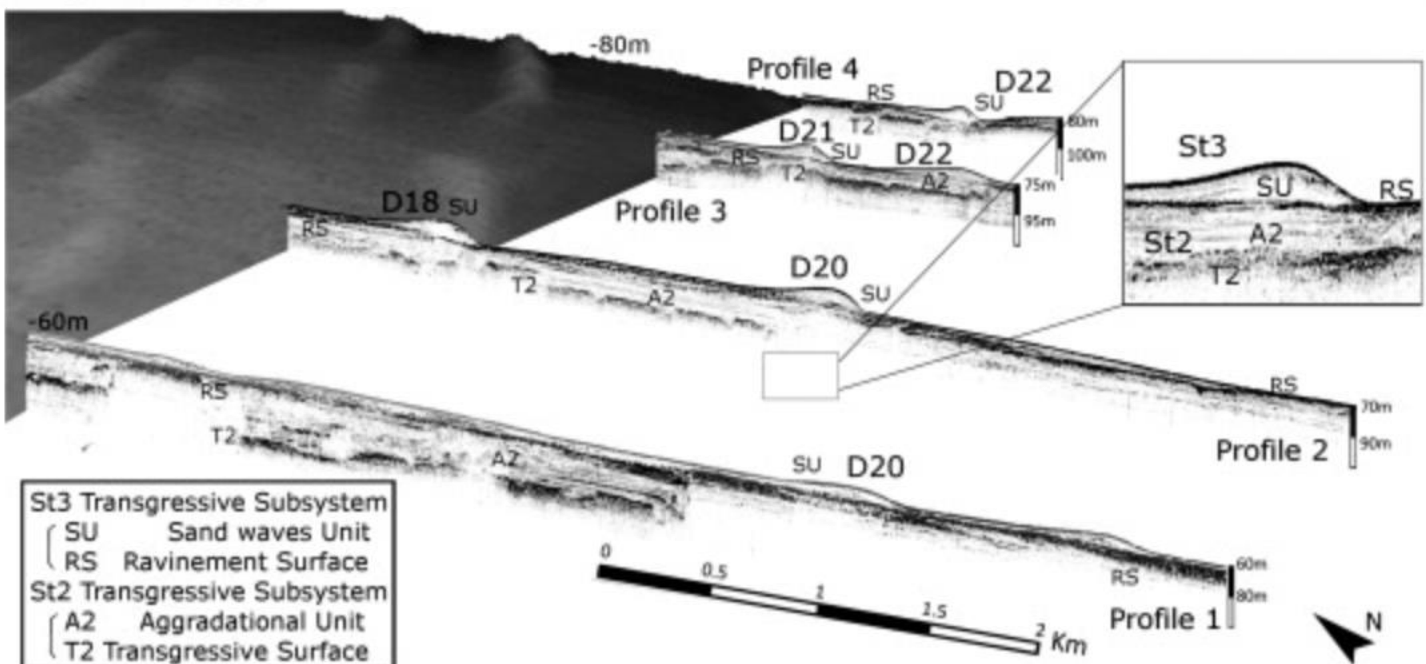
Modified by Shanmugam (2017) after Flemming (1980)

Sediment transport by the Agulhas Current off the southeastern tip of Africa. Sand in the current-controlled central shelf (B) migrates under the influence of the Agulhas Current; sand-wave fields are up to 20 km long and 10 km wide, and individual sand waves are up to 17 m high. Black streaks indicate sand ribbons. The stippled pattern indicates coarse lag deposits in the sand-depleted outer shelf (C). The nearshore sediment wedge (A) is dominated by wave processes.

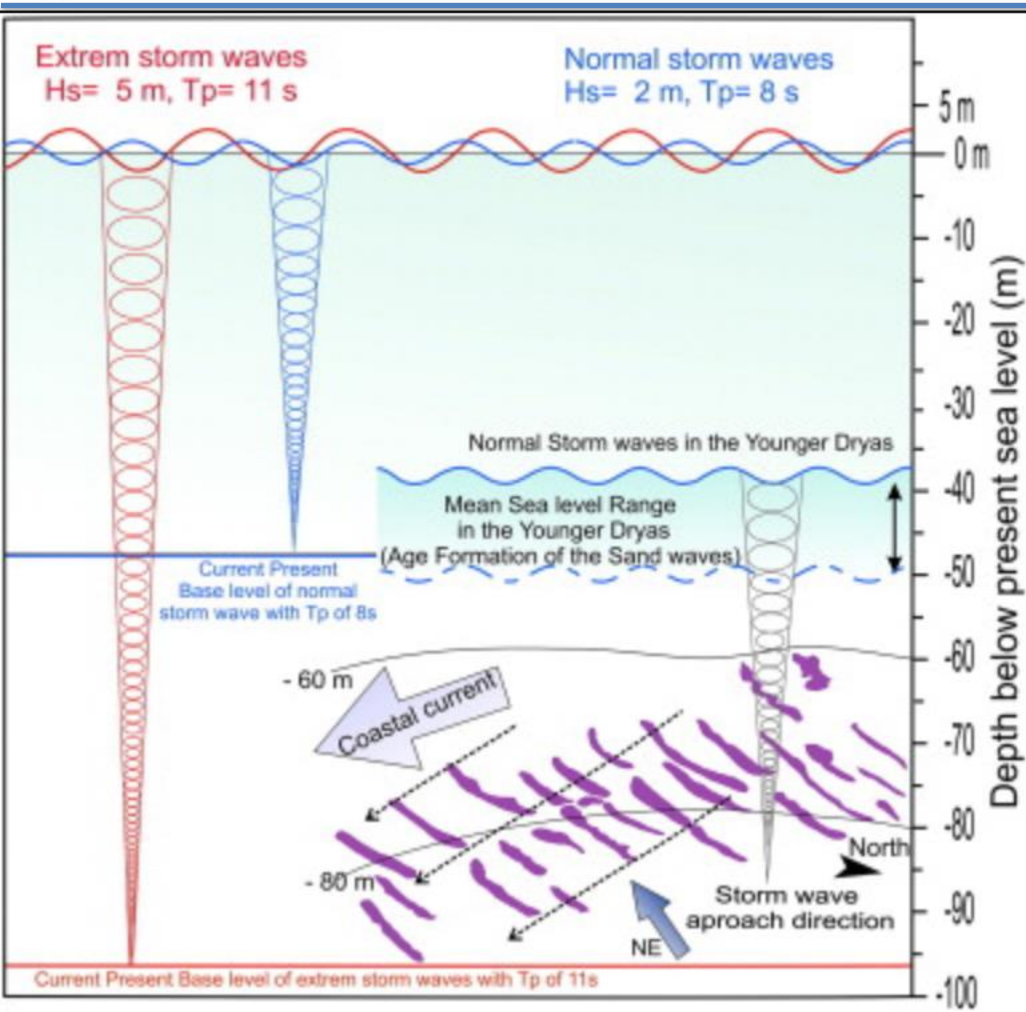
sandwaves and sand ribbons are similar to tidal shelves, but the driving current is not of tidal origin. The detailed characteristics of sands deposited on modern shelves can be determined directly only by taking shallow cores that provide a limited amount of information: indirect investigation by geophysical techniques can also yield some information about the internal structures.

# Relict sand waves in the continental shelf of the Gulf of Valencia

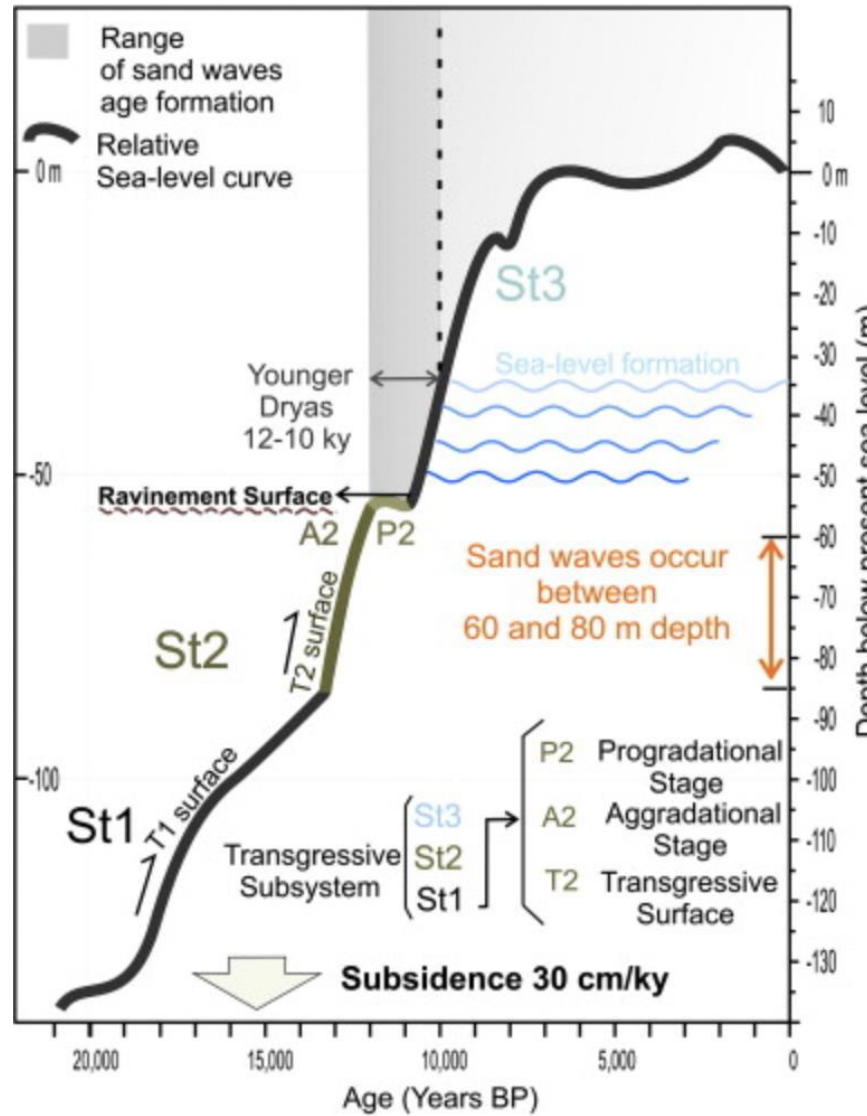



Albarracín et al., 2014 Journal of Sea Research 93, 33-46



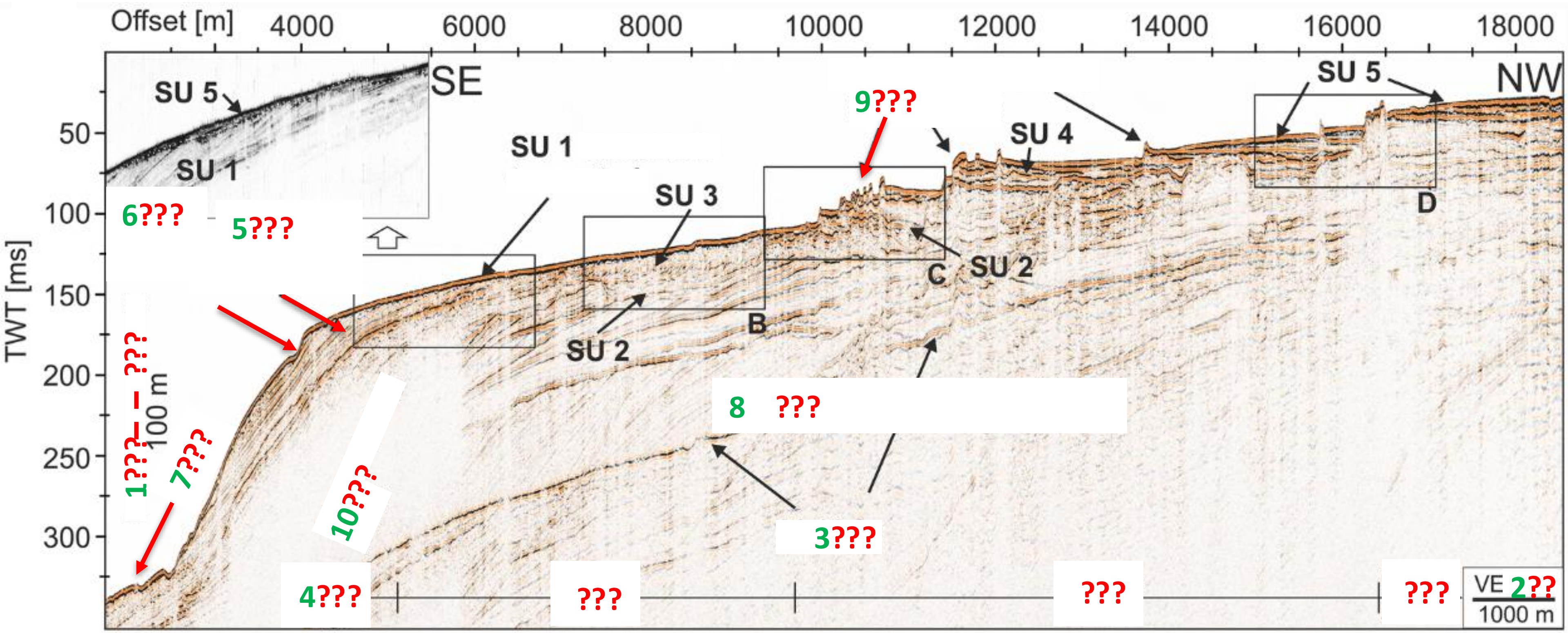

The sand waves were formed longshore littoral drift and affected by the influence of storm waves



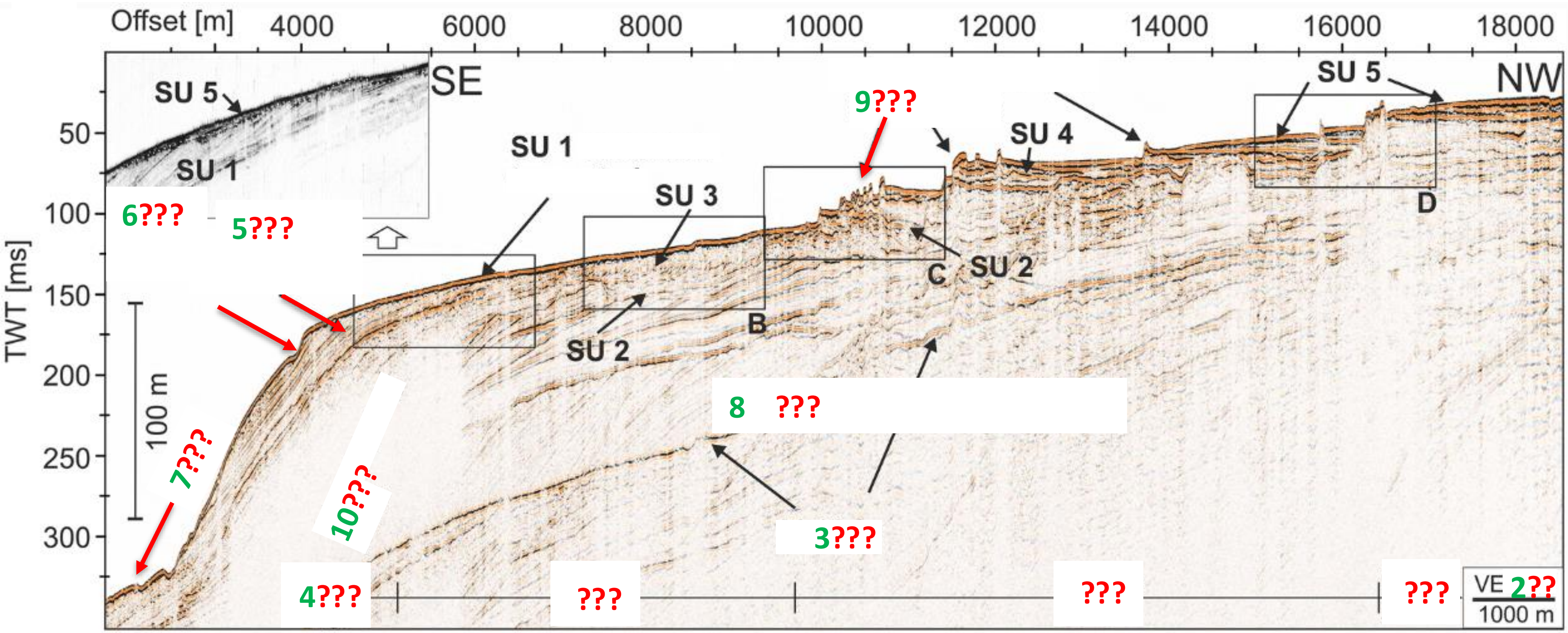

According to seismostratigraphic and relative sea level curve reconstructions, the sand waves formed during the Younger Dryas with the sea level located 30 to 50 m below the present-day

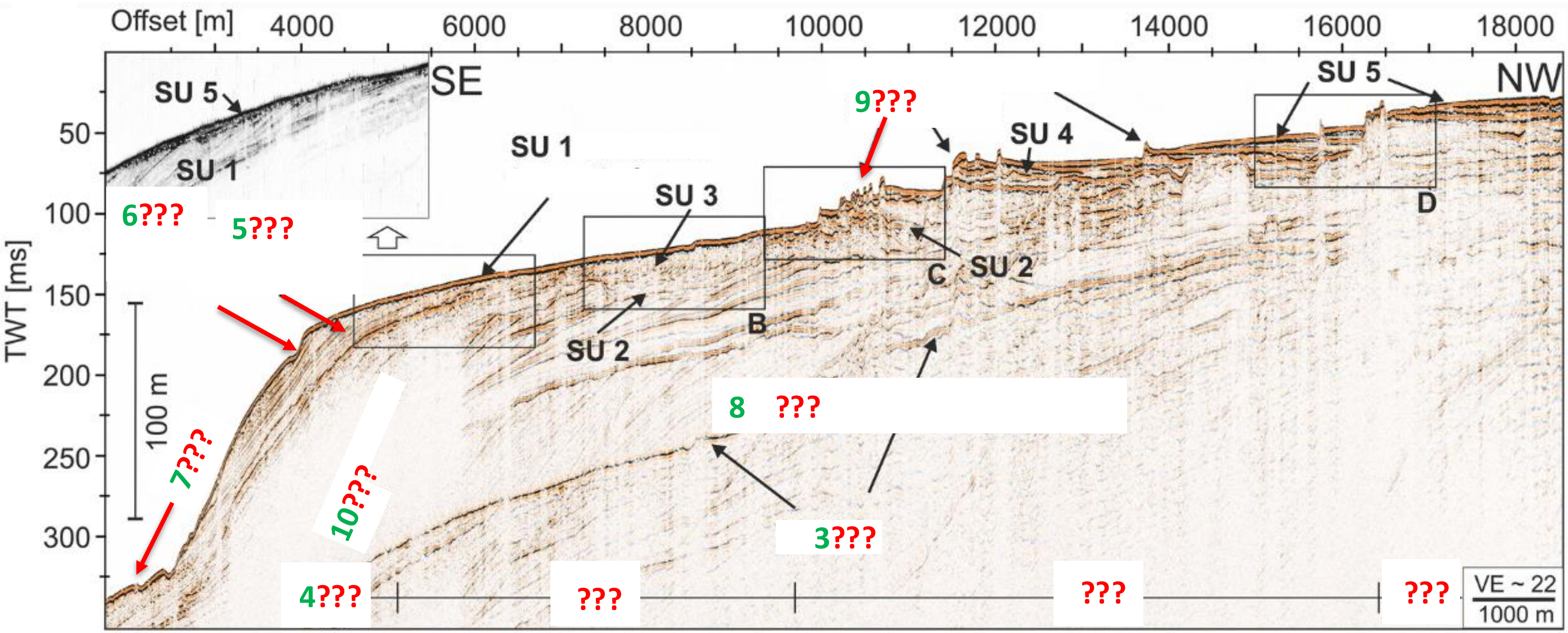
*Albarracín et al., 2014*

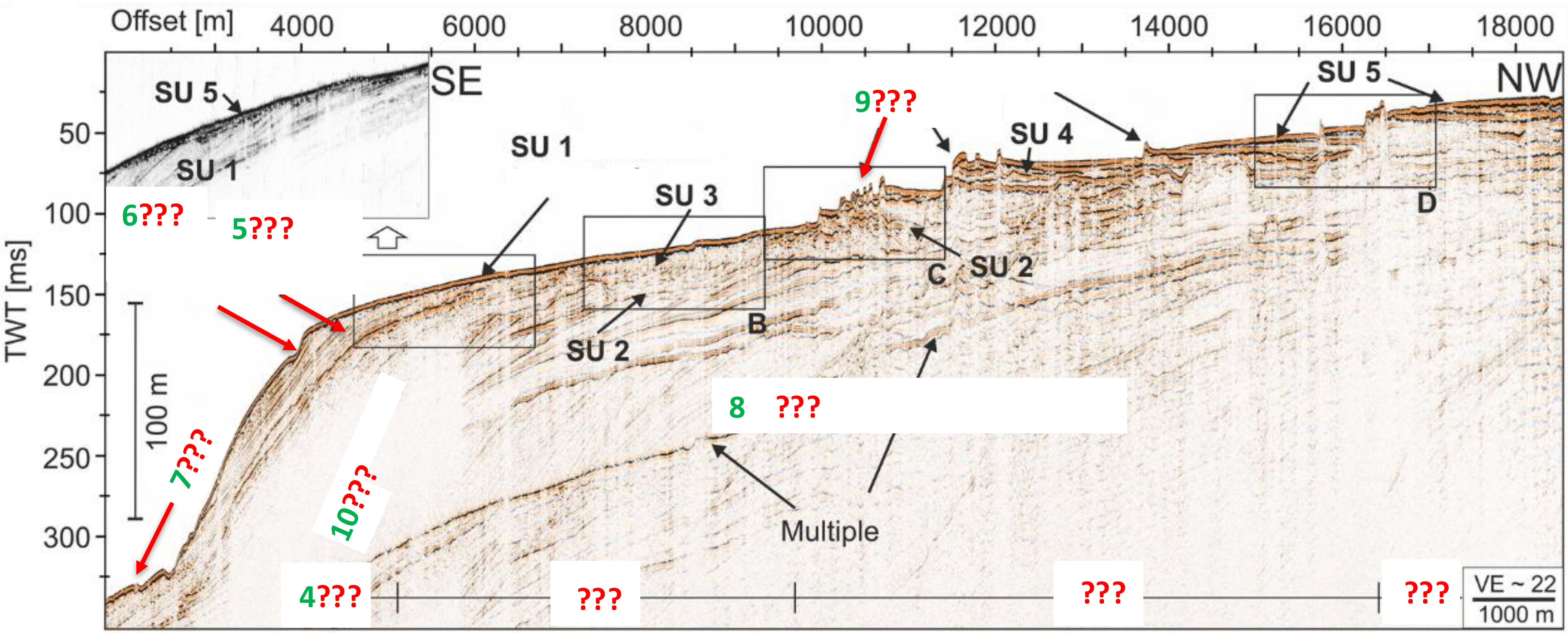
# Exercise

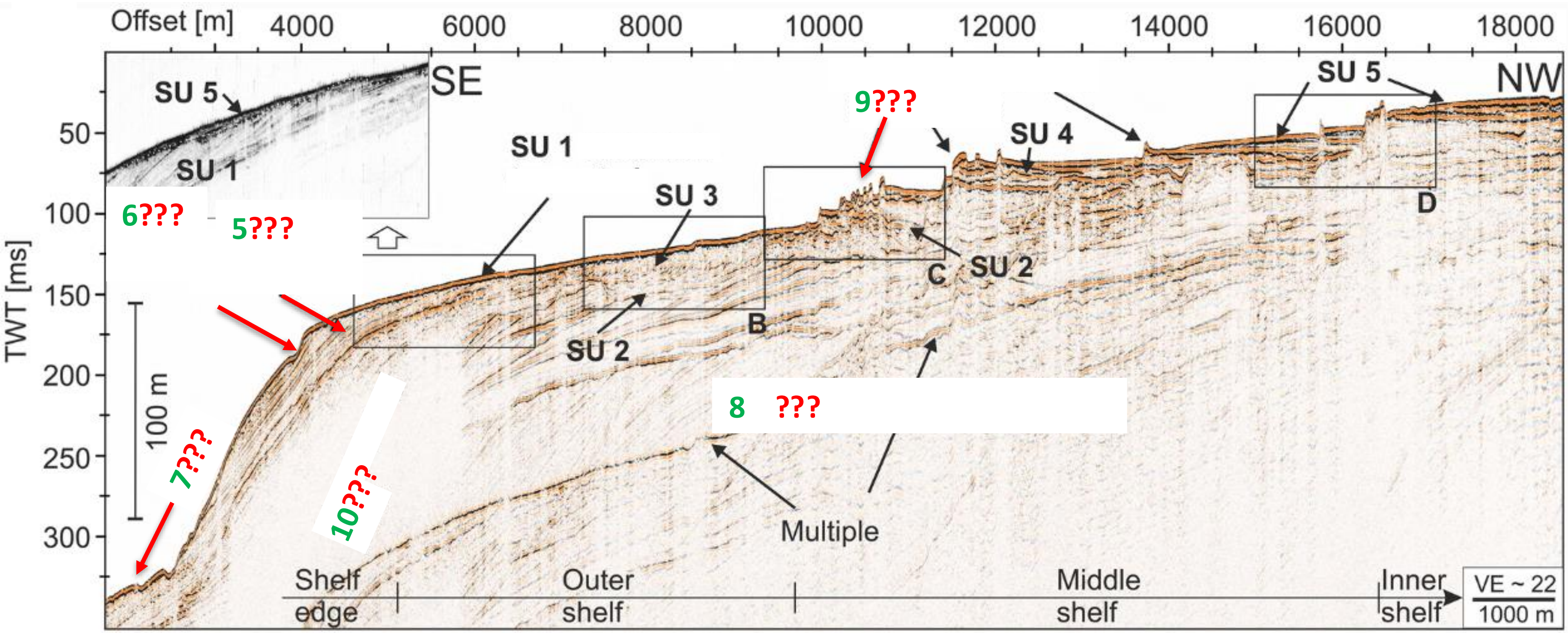


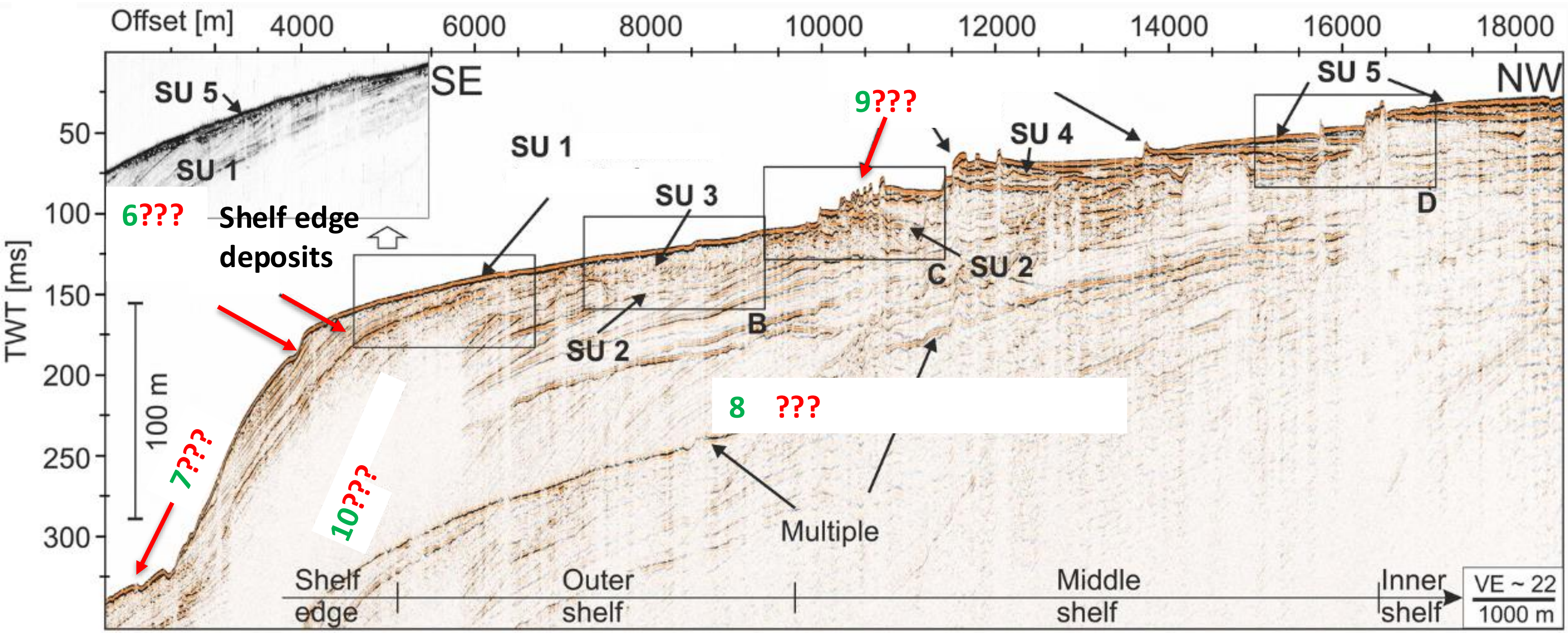
Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
TWT [ms]
50
100
150
200
250
300
SE
NW
SU 5
SU 1
SU 1
SU 3
SU 2
SU 2
SU 4
SU 5
B
C
D
6???
5???
9???
8 ???
3???
1???
???
100 m
7???
10???
4???
???
???
???
VE 2??
1000 m

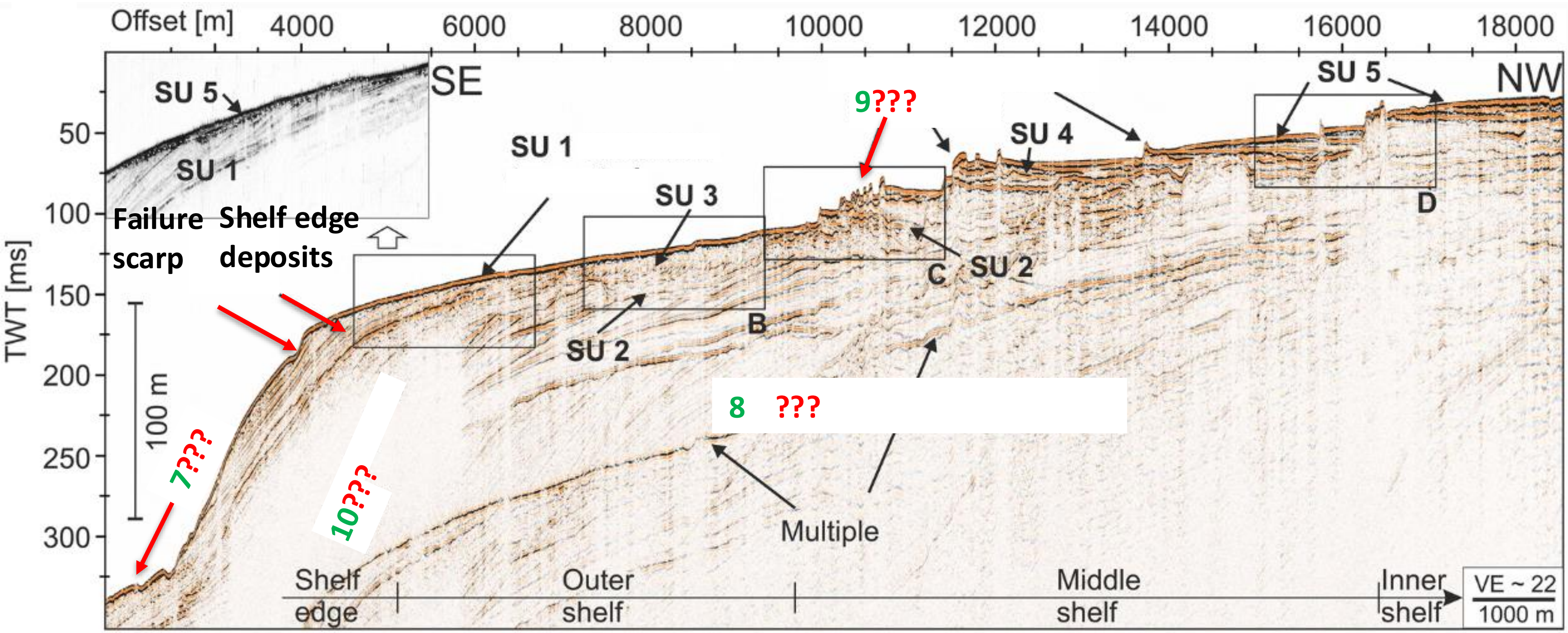

Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
SE
NW
TWT [ms]
50
100
150
200
250
300
100 m
SU 5
SU 1
SU 3
SU 2
SU 4
B
C
D
6???
5???
9???
8 ???
7???
10???
3???
4???
???
VE 2??
1000 m

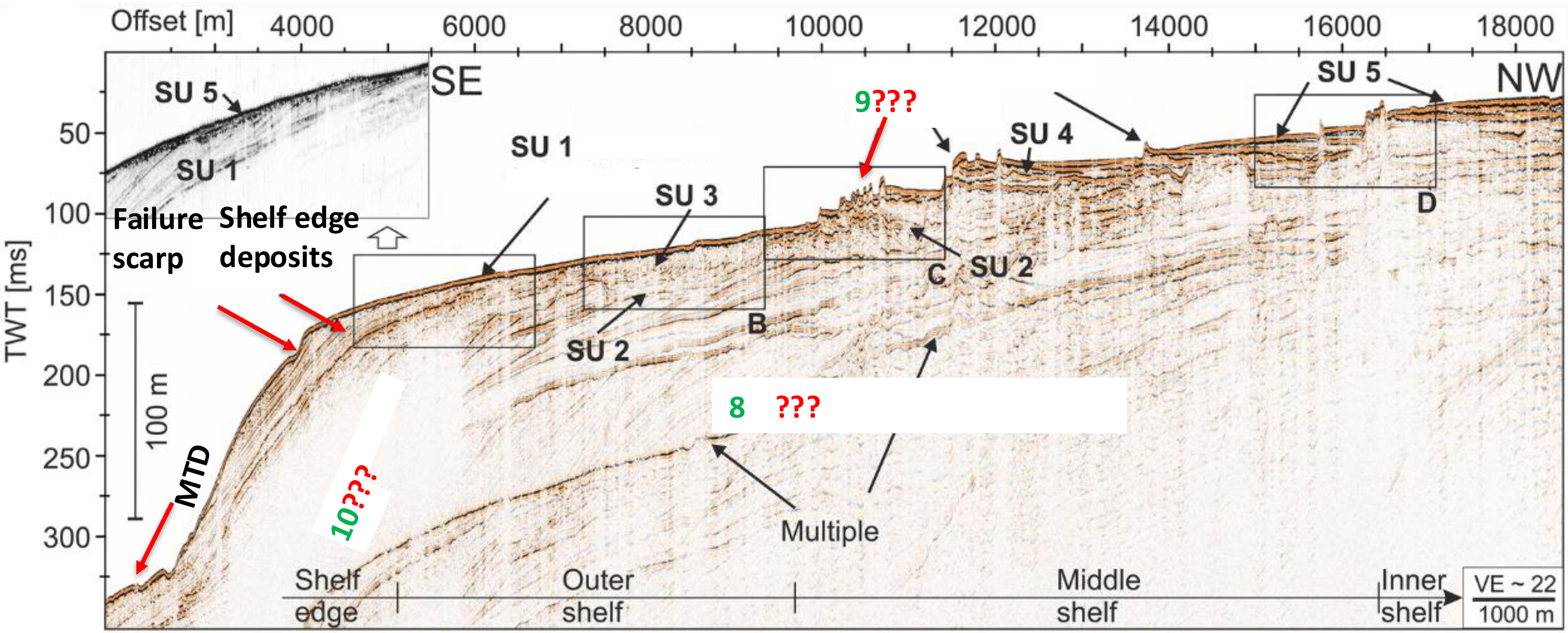

Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
TWT [ms]
50
100
150
200
250
300
SE
NW
SU 5
SU 1
SU 1
SU 3
SU 2
SU 2
SU 4
SU 5
B
C
D
100 m
6???
5???
7???
10???
9???
8 ???
3???
4???
???
???
???
VE ~ 22
1000 m

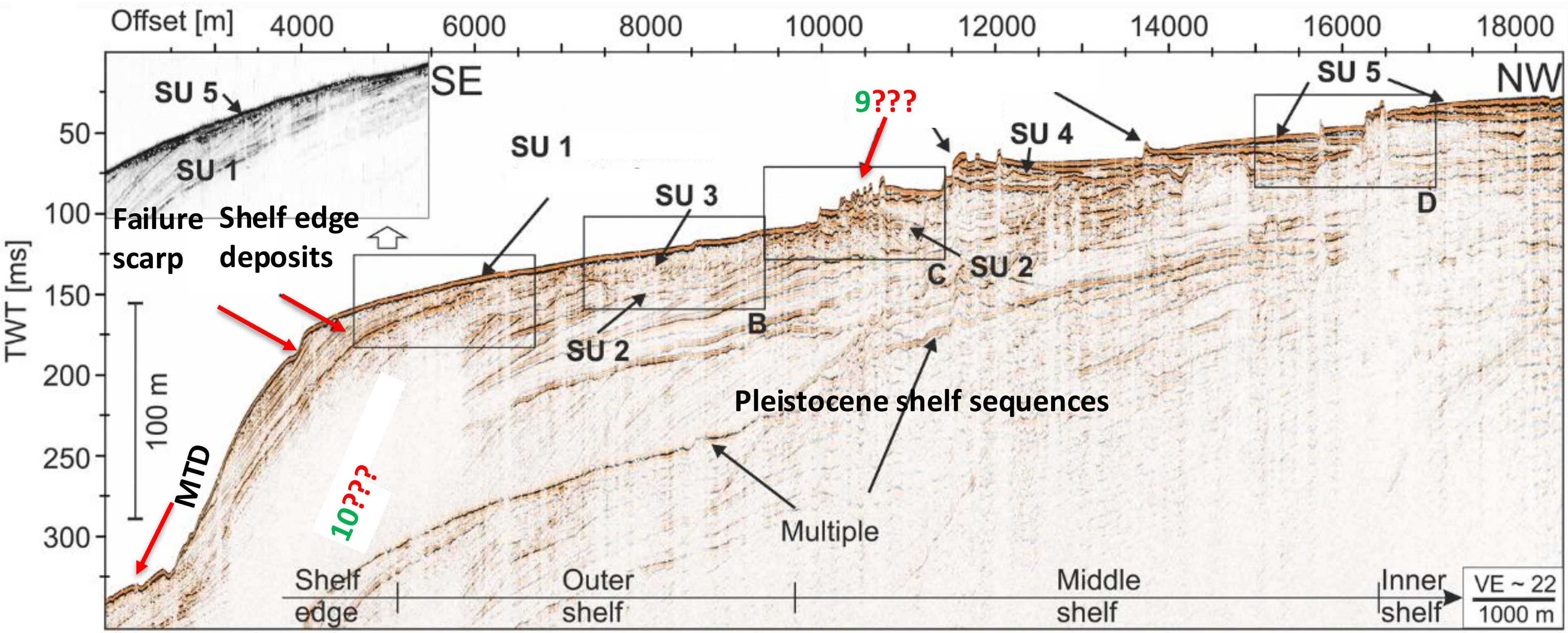

Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
SE
NW
SU 5
SU 1
SU 1
SU 3
SU 2
SU 4
SU 5
SU 2
B
C
D
TWT [ms]
50
100
150
200
250
300
100 m
6???
5???
7???
10???
4???
8 ???
9???
Multiple
???
???
???
VE ~ 22
1000 m

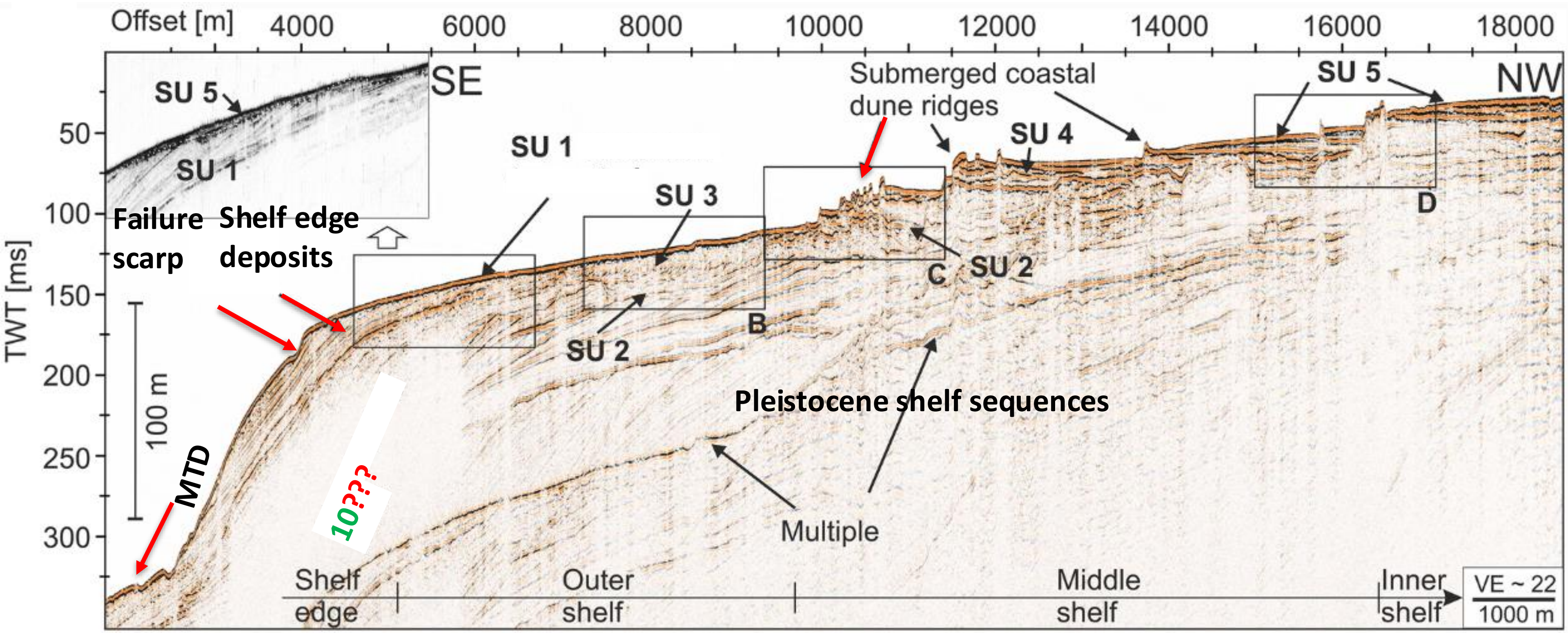

Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
TWT [ms]
50
100
150
200
250
300
100 m
SE
NW
SU 5
SU 1
SU 1
SU 3
SU 2
SU 2
SU 4
SU 5
B
C
D
6???
5???
7???
8 ???
9???
10???
Multiple
Shelf edge
Outer shelf
Middle shelf
Inner shelf
VE ~ 22
1000 m

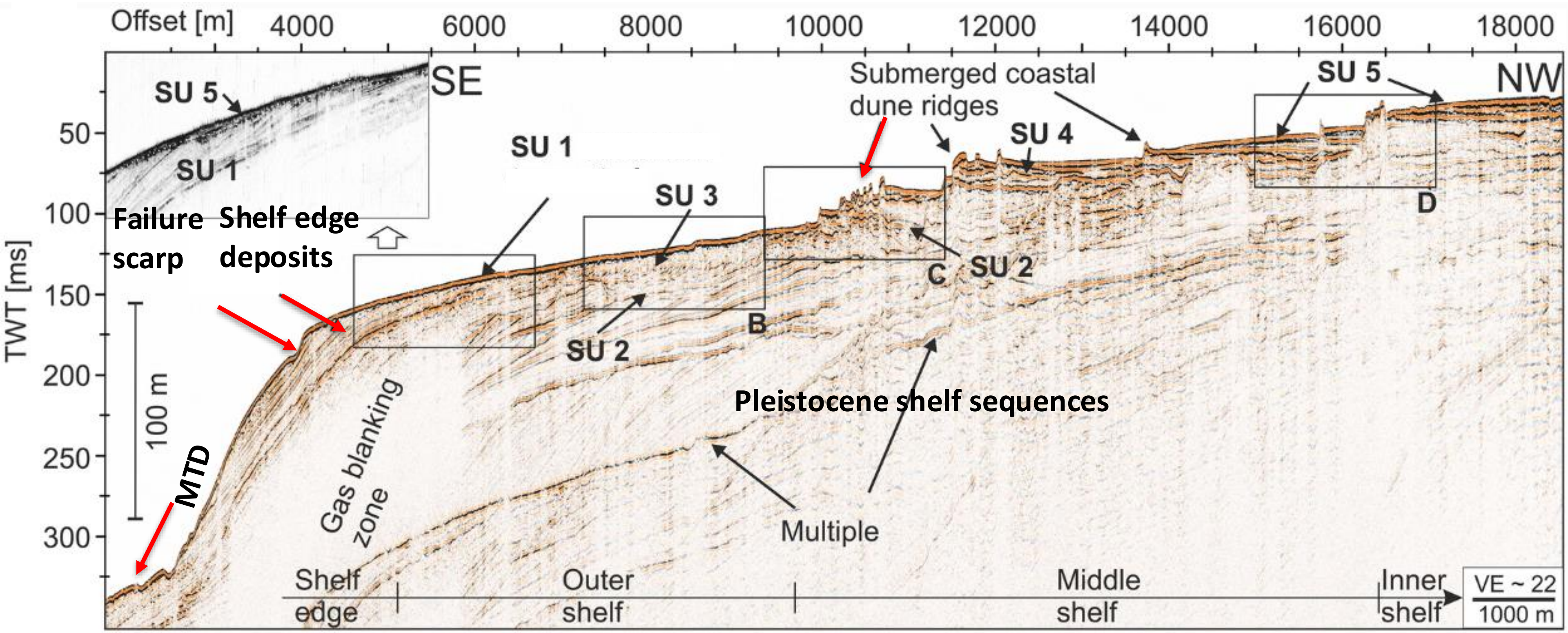

Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
SE
NW
TWT [ms]
50
100
150
200
250
300
100 m
SU 5
SU 1
SU 1
SU 3
SU 2
SU 2
SU 4
SU 5
B
C
D
6???
Shelf edge deposits
7???
10???
9???
8 ???
Multiple
Shelf edge
Outer shelf
Middle shelf
Inner shelf
VE ~ 22
1000 m

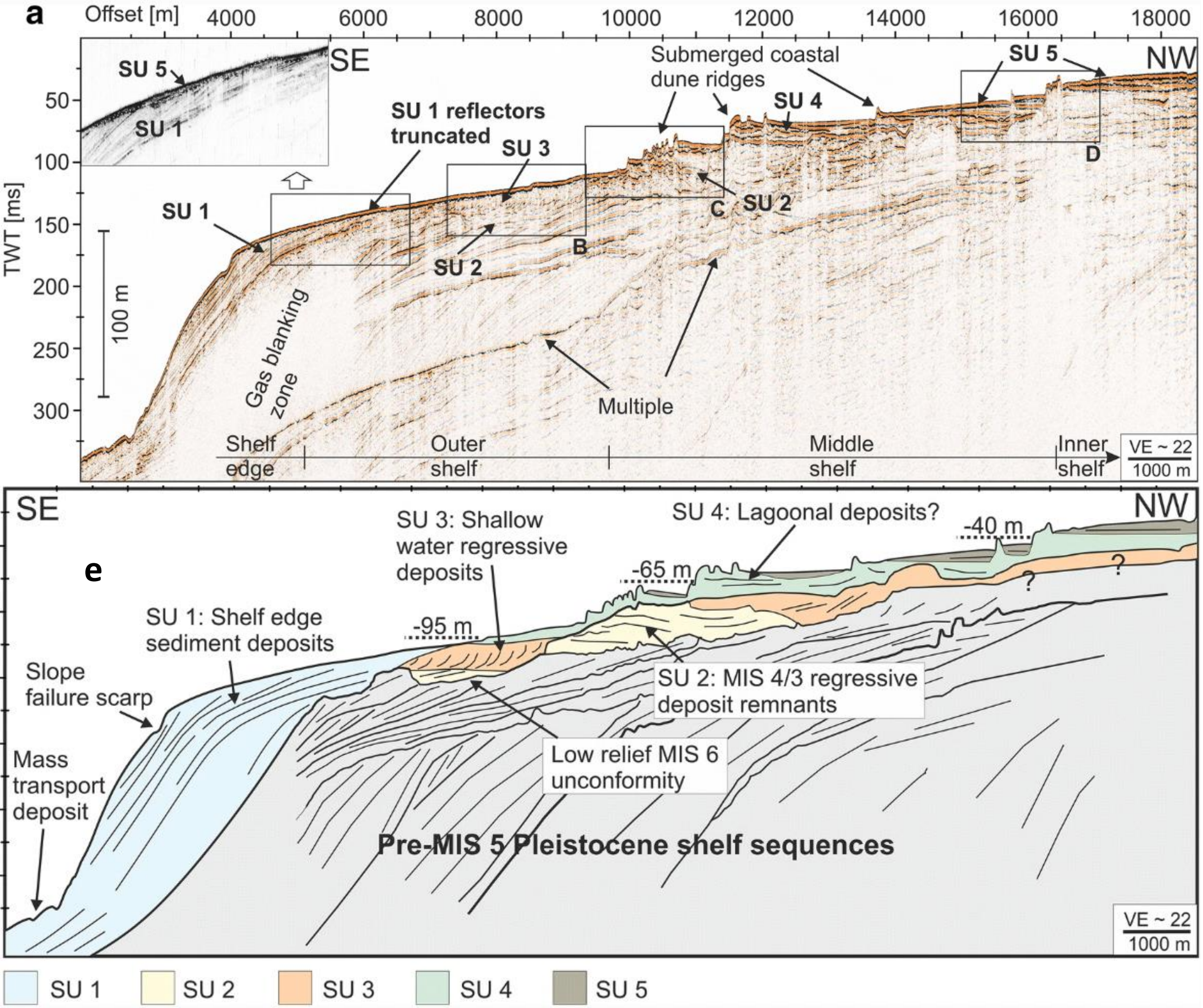

Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
SE
NW
TWT [ms]
50
100
150
200
250
300
100 m
SU 5
SU 1
SU 1
SU 3
SU 2
SU 2
SU 4
SU 5
B
C
D
9???
8 ???
7???
10???
Failure scarp
Shelf edge deposits
Multiple
Shelf edge
Outer shelf
Middle shelf
Inner shelf
VE ~ 22
1000 m


Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
SE
NW
TWT [ms]
50
100
150
200
250
300
100 m
SU 5
SU 1
SU 1
SU 3
SU 2
SU 2
SU 4
SU 5
B
C
D
9???
8 ???
10???
Failure scarp
Shelf edge deposits
MTD
Multiple
Shelf edge
Outer shelf
Middle shelf
Inner shelf
VE ~ 22
1000 m


Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
SE
NW
TWT [ms]
50
100
150
200
250
300
100 m
SU 5
SU 1
SU 3
SU 4
SU 2
9???
10???
Failure scarp
Shelf edge deposits
MTD
B
C
D
Pleistocene shelf sequences
Multiple
Shelf edge
Outer shelf
Middle shelf
Inner shelf
VE ~ 22
1000 m


Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
SE
NW
TWT [ms]
50
100
150
200
250
300
100 m
SU 5
SU 1
SU 1
SU 3
SU 2
SU 2
SU 4
SU 5
Submerged coastal dune ridges
B
C
D
Failure scarp
Shelf edge deposits
MTD
10???
Pleistocene shelf sequences
Multiple
Shelf edge
Outer shelf
Middle shelf
Inner shelf
VE ~ 22
1000 m


Offset [m]
4000
6000
8000
10000
12000
14000
16000
18000
SE
NW
SU 5
SU 1
SU 1
SU 3
SU 2
SU 2
SU 4
SU 5
Submerged coastal dune ridges
B
C
D
Failure scarp
Shelf edge deposits
TWT [ms]
50
100
150
200
250
300
100 m
MTD
Gas blanking zone
Pleistocene shelf sequences
Multiple
Shelf edge
Outer shelf
Middle shelf
Inner shelf
VE ~ 22
1000 m




Wenau, S., Preu, B., Spiess, V. (2020) Geological development of the Limpopo Shelf (southern Mozambique) during the last sealevel cycle. Geo-Marine Letters, 40 (3), pp. 363-377. DOI: 10.1007/s00367-020-00648-6

Multichannel seismic profile showing the geological development of the Limpopo Shelf (southern Mozambique) during the last sealevel cycle. Dominant features are partly buried submerged coastal dune ridges. The sedimentary shelf sequence is dominated by truncation surfaces and shelf-edge sediment accumulations, corresponding to sea-level cycles. (B–D**)** Close-ups of Parasound echosounder data showing details of identified seismic units. **(**E) Interpretative line drawing of A. SU = Seismic Unit.