OGS 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 2024 - 2025

Analisi di Bacino e Stratigrafia Sequenziale (426SM)

Docente: **Michele Rebesco**

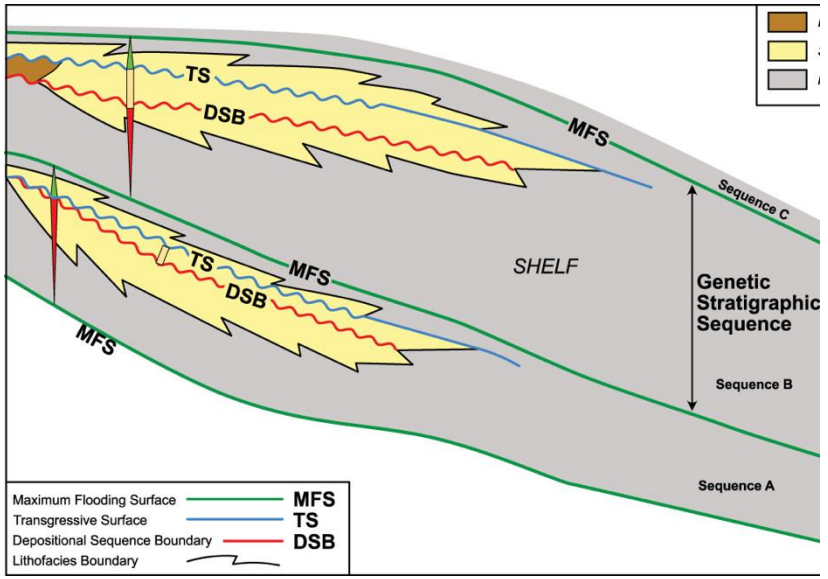
Modulo 4.2
Sequence stratigraphy – closer view

Outline:

- Your questions?
- Additional question and **First exercise**
- Stratigraphic surfaces within System Tracts (*threefold*):
  - Stratigraphic surfaces subdivided by System Tract;
  - Continuous succession of surfaces/system tracts;
  - All-in-one Stratigraphic surfaces & System Tracts
- Hiatus and Wheeler diagram
- Wheeler diagram of stratigraphic sequences
- **Second and third exercise**

First Question: Cosa si intende con il termine SEQUENZA GENETICA?

Answer: Genetic sequences are bound by maximum flooding surfaces (MFS).

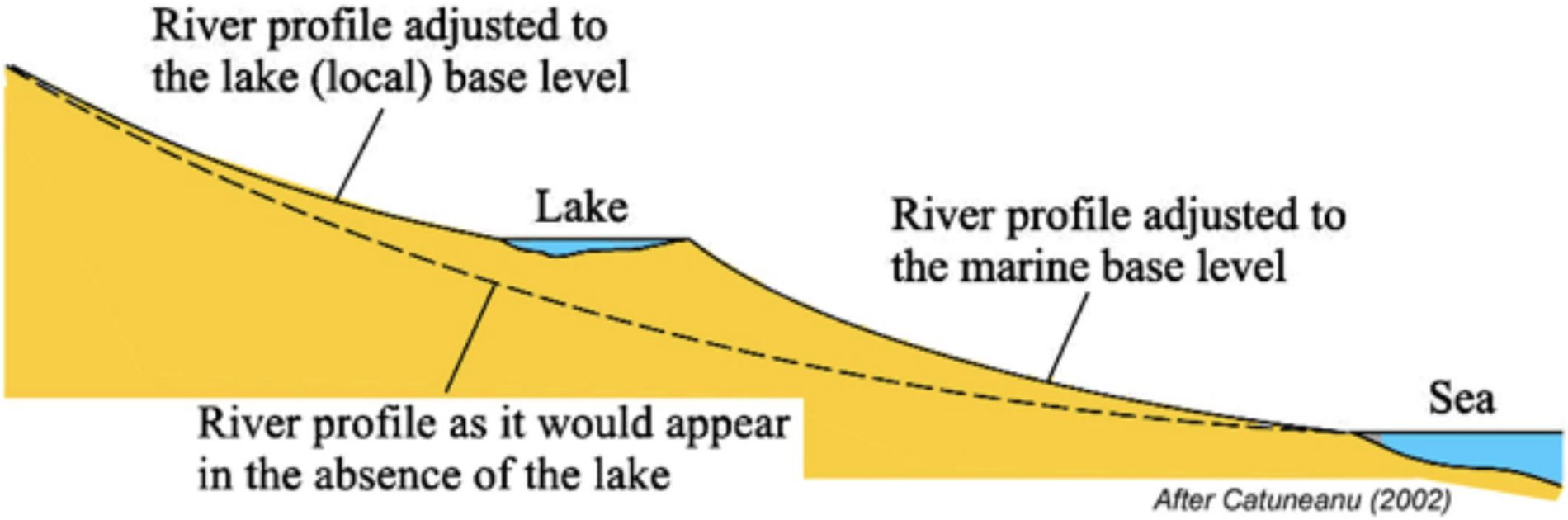


The MFS was chosen as the Genetic sequence boundary because:

- It is the surface that signals the end of transgression and landward shoreline excursion, and the beginning of regression
- It has low diachroneity.
- It is an easily recognizable and mappable surface. (Maximum flooding surfaces commonly overlie condensed sections or omission surfaces; they signal an abrupt lithological change from coarse-grained or cemented lithologies, to fine-grained beds that indicate the beginning of regression).
- The MFS is the only surface that can, in principle, be used across all parts of a basin.

Second Question: Base Level, usato da Catuneanu, si riferisce al livello del mare o quello del fondale marino?

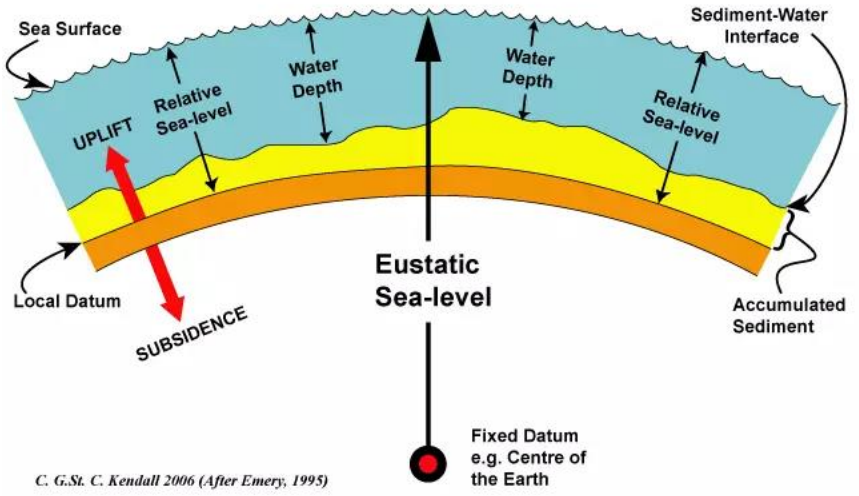
Answer: Commonly base level is equated to relative sea level position, but it can be related to the water surface of lakes and/or local equilibrium surfaces associated with river systems. Thus the base level of depositional settings is thus controlled by a combination of eustasy and tectonic movement.



Third Question: Il DATUM è sempre inferiore al Sea Floor?

Answer: while eustasy is a "worldwide sea level measured between the sea surface and a stationary-datum at the center of the Earth», relative sea level, is any change in sea level relative to a local datum point.

For example, if a region experienced tectonic uplift, the relative sea level would be the elevation difference between the surface of the sea and the bedrock surface. The local datum is determined based on the elevation of the local bedrock, not including the loose sediment above the bedrock

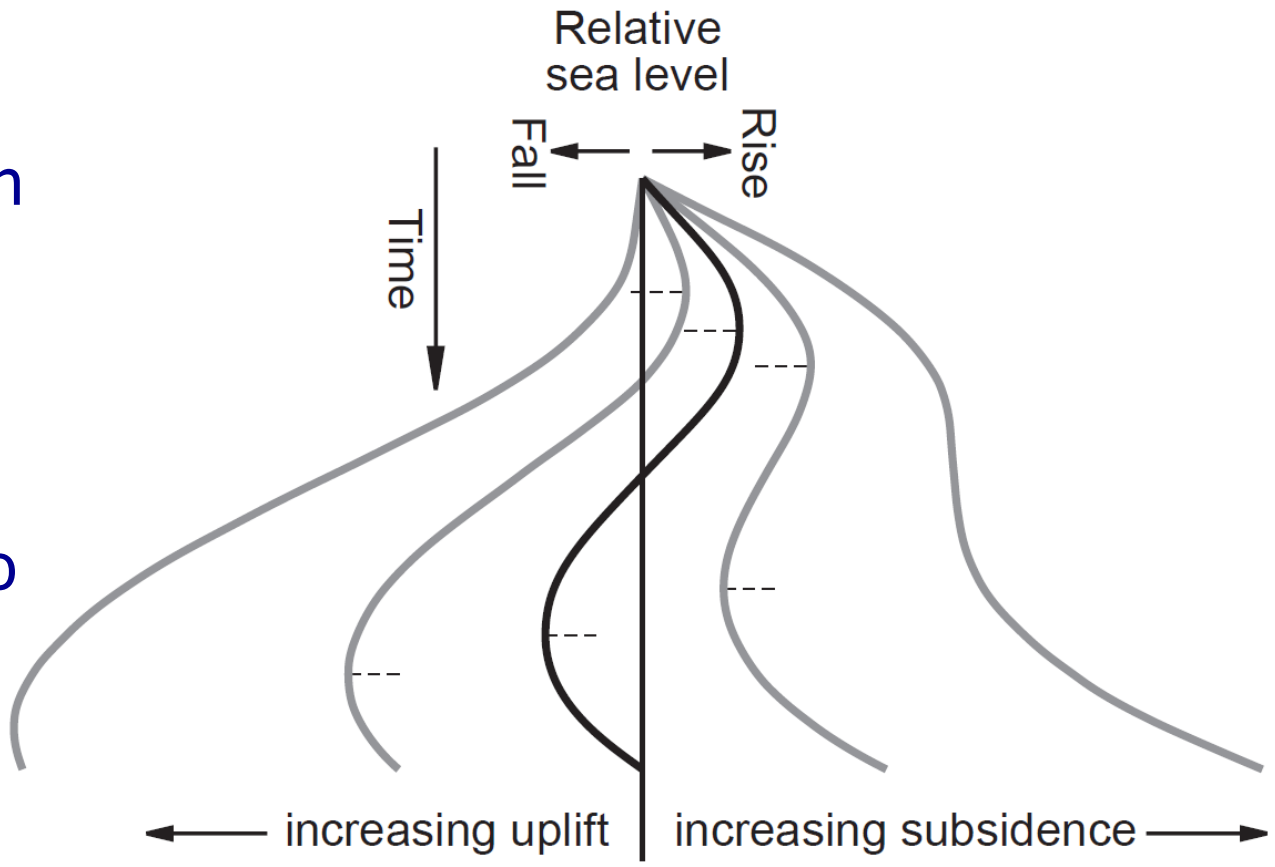


Fouth Question: Non chiaro, questa è un'ipotesi reale? Nel senso, si è visto che con l'andare del tempo ci saranno dei conitnui aumenti?

Answer: …

Fifth Question:

BSFR Basal surface of forced regression and RSME Regressive surface of marine erosion? Quando avvengono nel ciclo rise and fall, (sembra che comincino al picco massimo del rise).



Stratigraphic surfaces subdivided by System Tract

---------- basal surface of forced regression **BSFR**

is the paleo-seafloor at the onset of forced regression and lies at the base of all marine deposits accumulated during relative sea-level fall.

——— regressive surface of marine erosion **RSME**

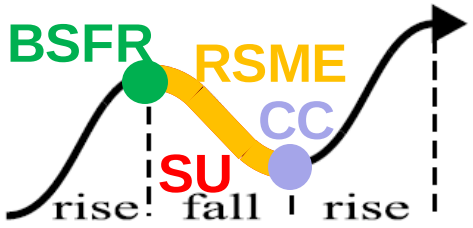
is cut by waves in the shoreface during relative sea-level fall, and marks the base of forced regressive shorefaces.

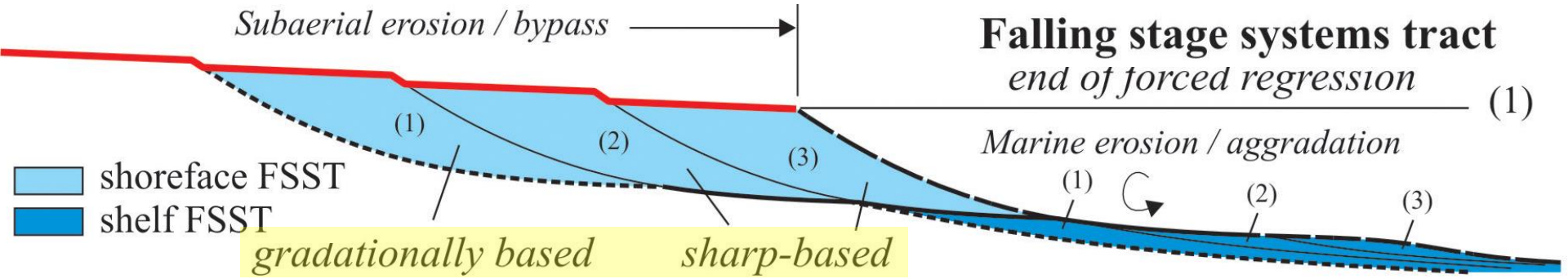
——— correlative conformity **CC**

corresponds to the seafloor at the end of relative sea-level fall and is connected to SU basinward termination.

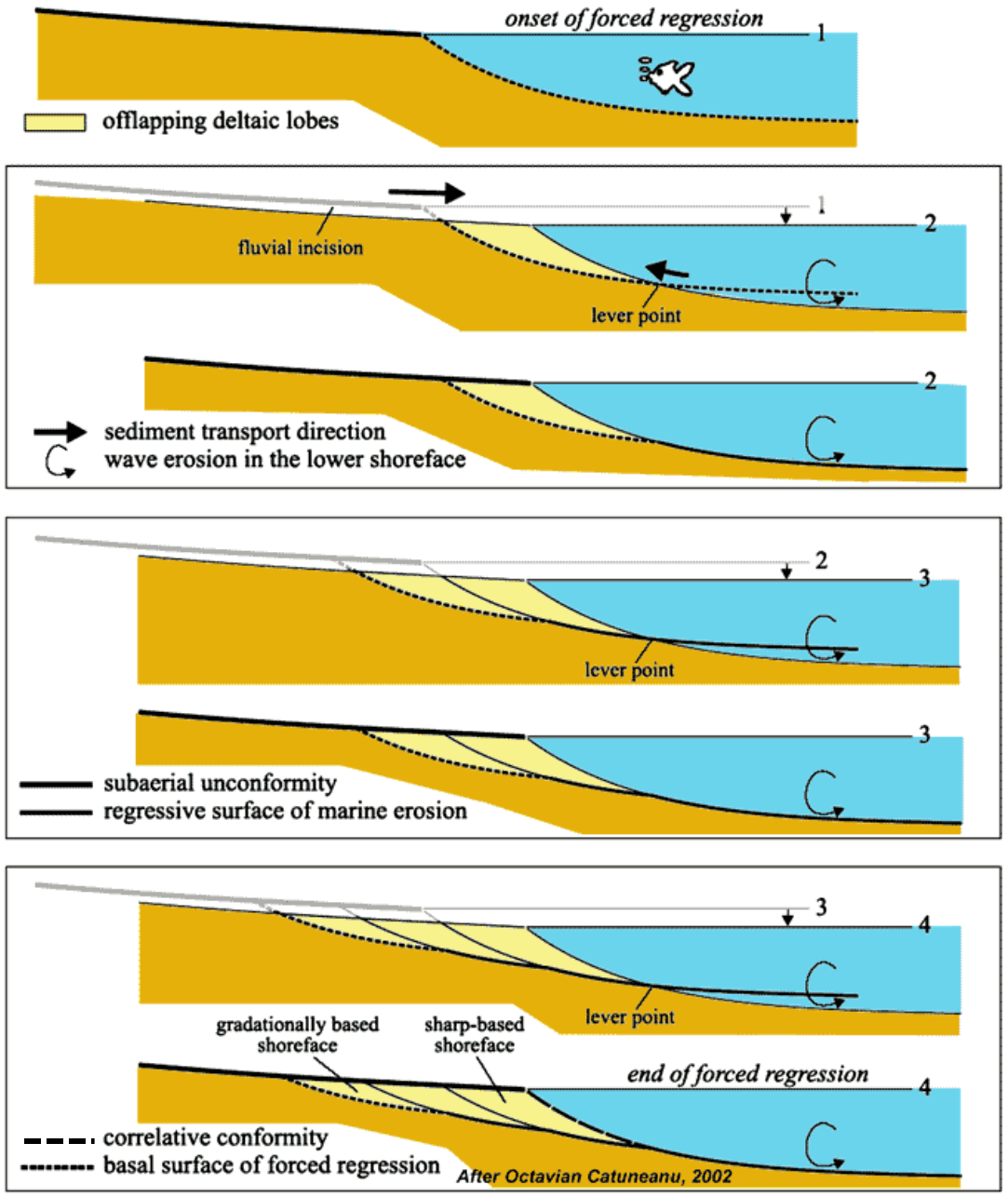
——— subaerial unconformity **SU**

develops during relative sea-level fall and progressively extends basinwards.



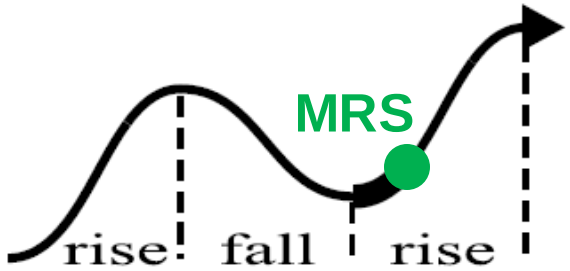


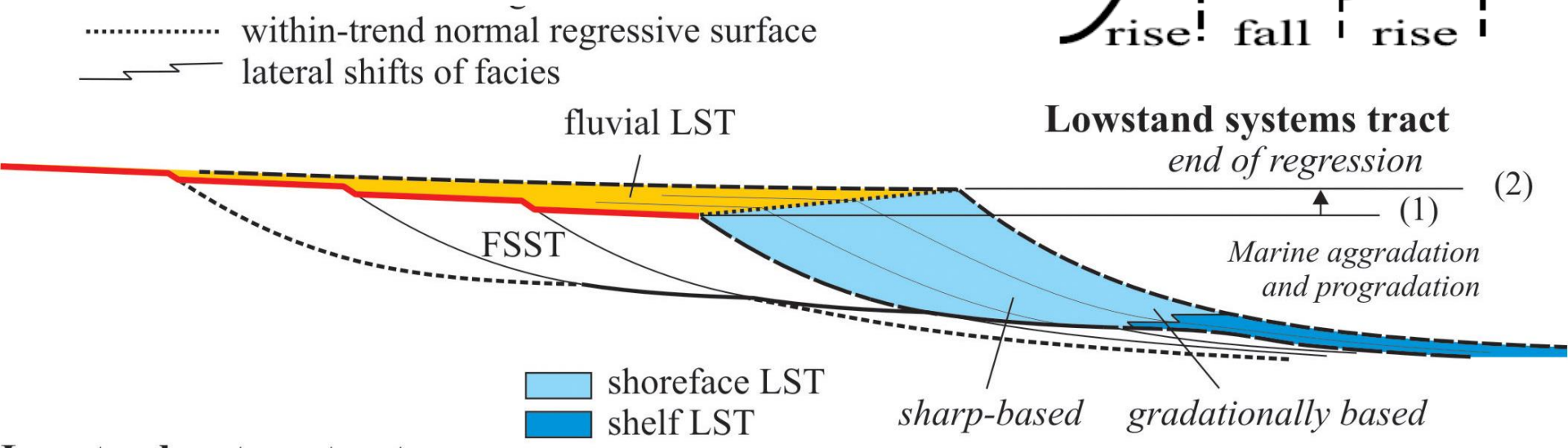
How the Regressive Surface of Marine Erosion reworks the Basal Surface of Forced Regression during the *Falling Stage System Tract*



maximum regressive surface **MRS** or Transgressive Surface, TS) marks the boundary bentween prograding (regressive) and subsequent retrograding (transgressive) deposits

It is formed when the increasing rates of accommodation creation (relative sea-level rise)
start to outpace the sedimentation rates.

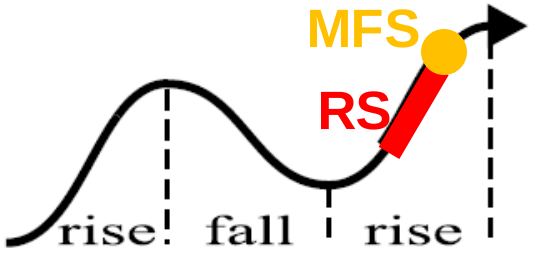


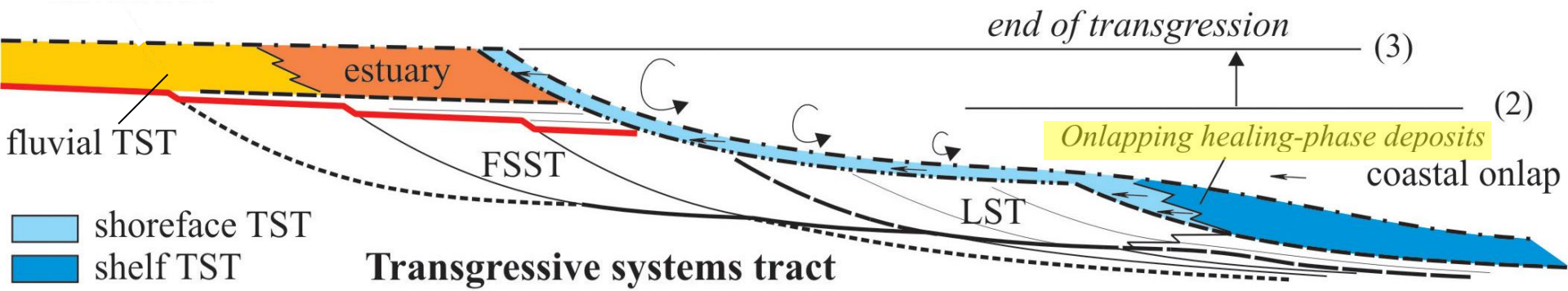


ravinement surface **RS** is a diachronous erosional surface cut by waves or tidal currents in the shoreface and coastal settings during transgression (RSL rise). It is associated with transgressive lags or condensed bioclastic deposits.

maximum flooding surface **MFS** marks the end of the shoreline transgression. It separates retrograding (transgressive) strata below from prograding (regressive) strata above. Commonly associated with a condensed section, it is a downlap surface in seismics.

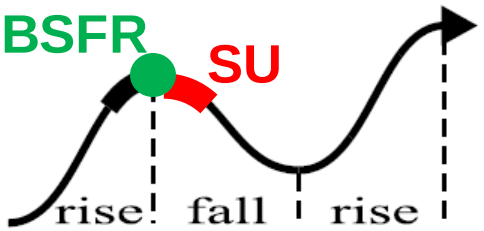
It is formed when the sedimentation rates start to outpace the rates of creation of accommodation (relative sea-level rise).

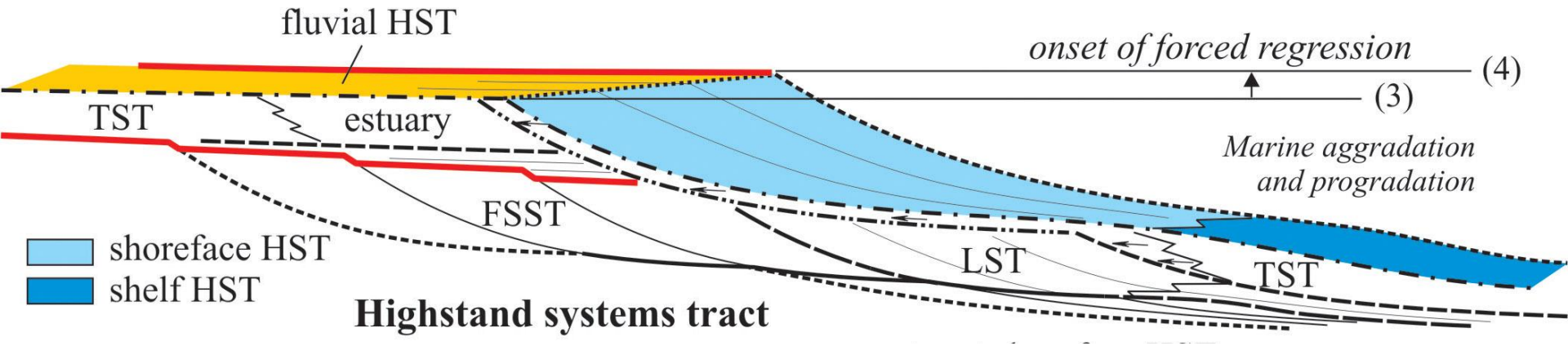




---------- basal surface of forced regression **BSFR** is to the paleo-seafloor at the onset of forced regression and lies at the base of all marine deposits accumulated during relative sea-level fall.

——— subaerial unconformity **SU** develops during relative sea-level fall and progressively extends basinwards.

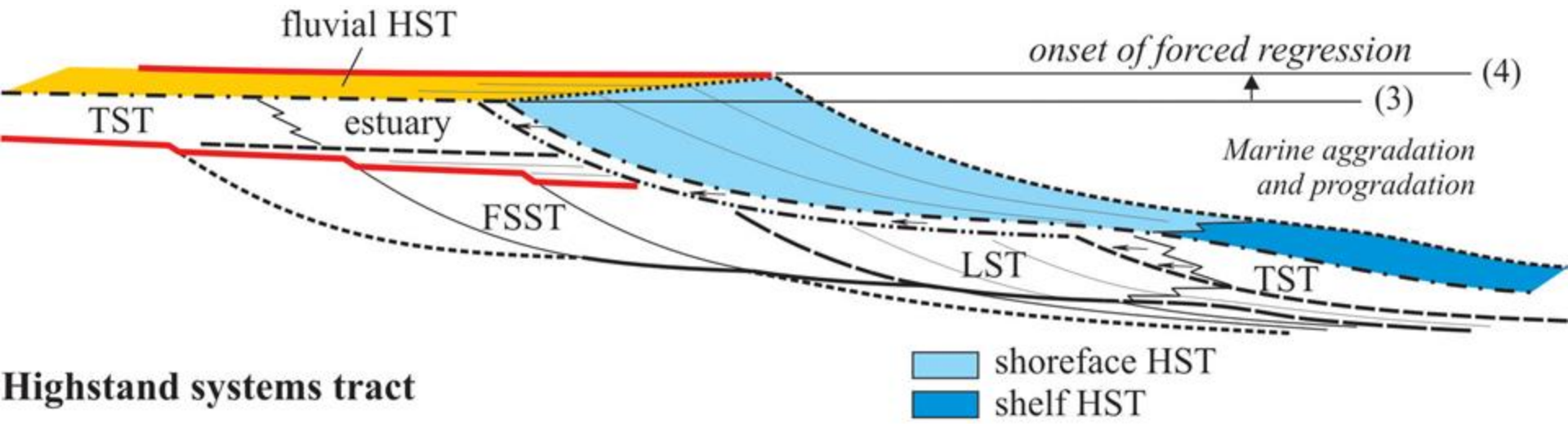




subaerial unconformity
correlative conformity
basal surface of forced regression
regressive surface of marine erosion
ravinement surface

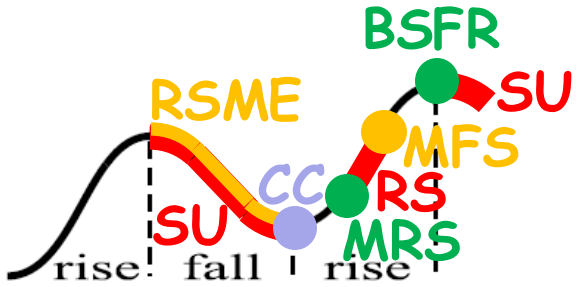
maximum regressive surface
maximum flooding surface
within-trend normal regressive surface
lateral shifts of facies
coastal onlap (healing phase deposits)

Continuous succession of stratigraphic surfaces/ system tracts



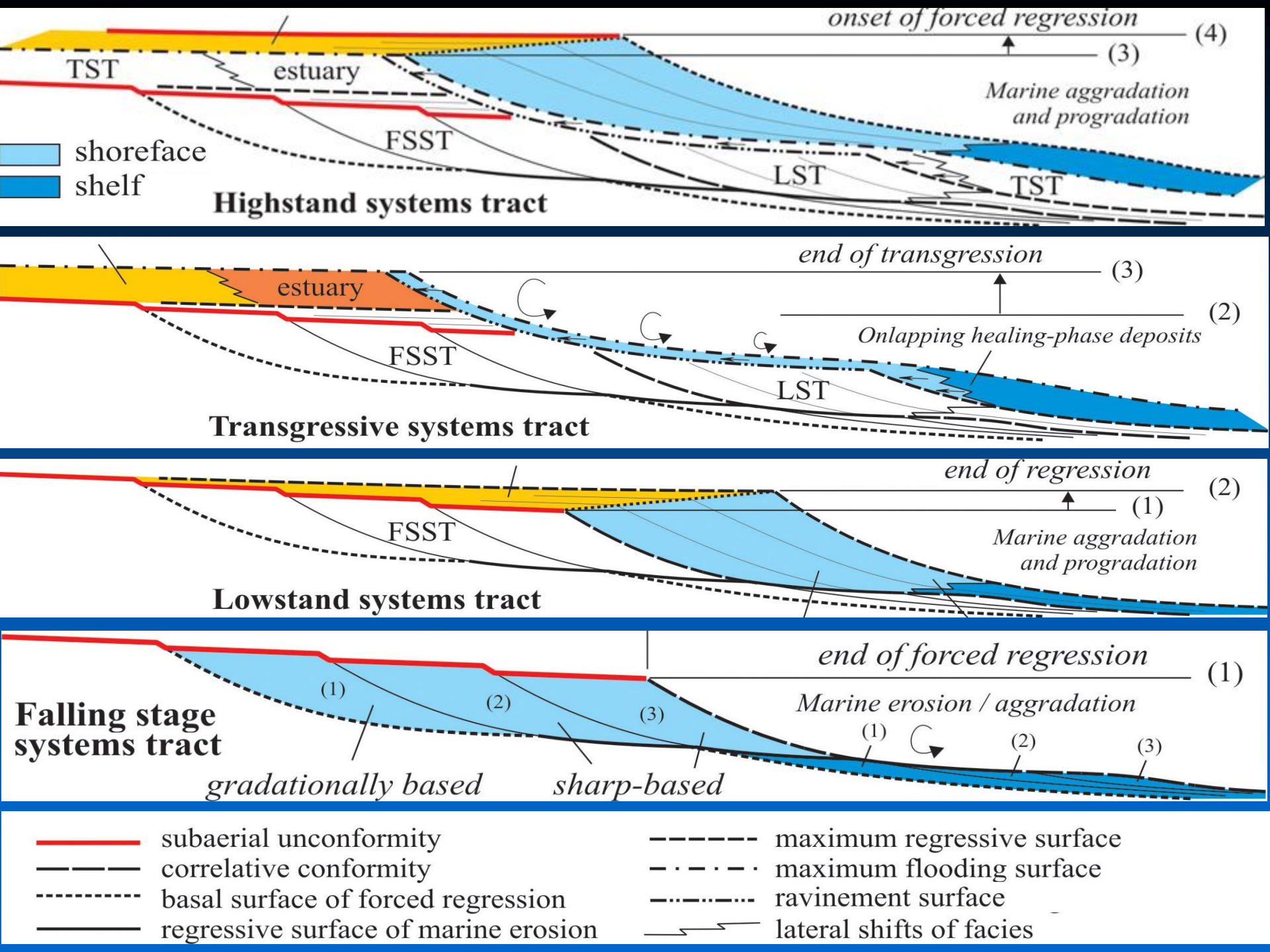
Highstand systems tract

System tracts & stratigraphic surfaces



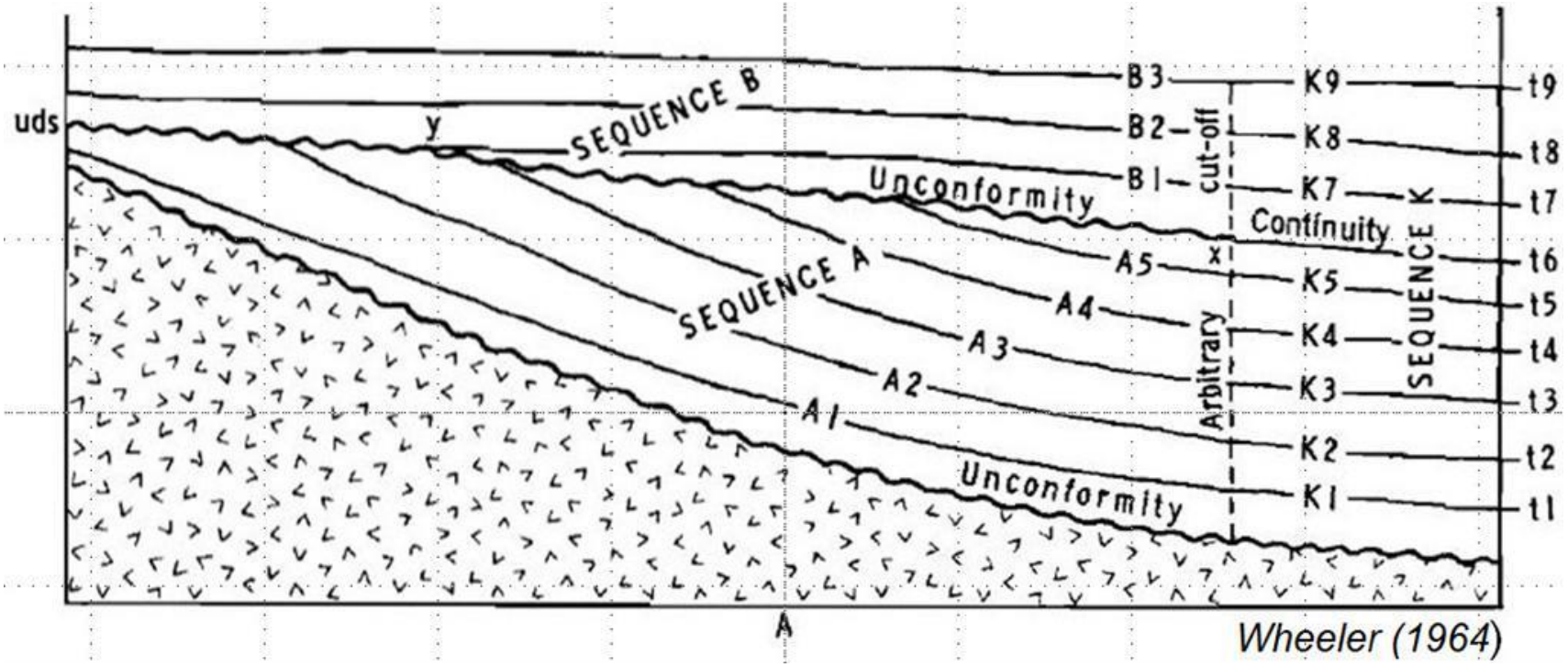
- subaerial unconformity
- correlative conformity
- basal surface of forced regression
- regressive surface of marine erosion
- ravinement surface
- maximum regressive surface
- maximum flooding surface
- within-trend normal regressive surface
- lateral shifts of facies
- coastal onlap (healing phase deposits)

All-in-one
Stratigraphic surfaces & System Tracts

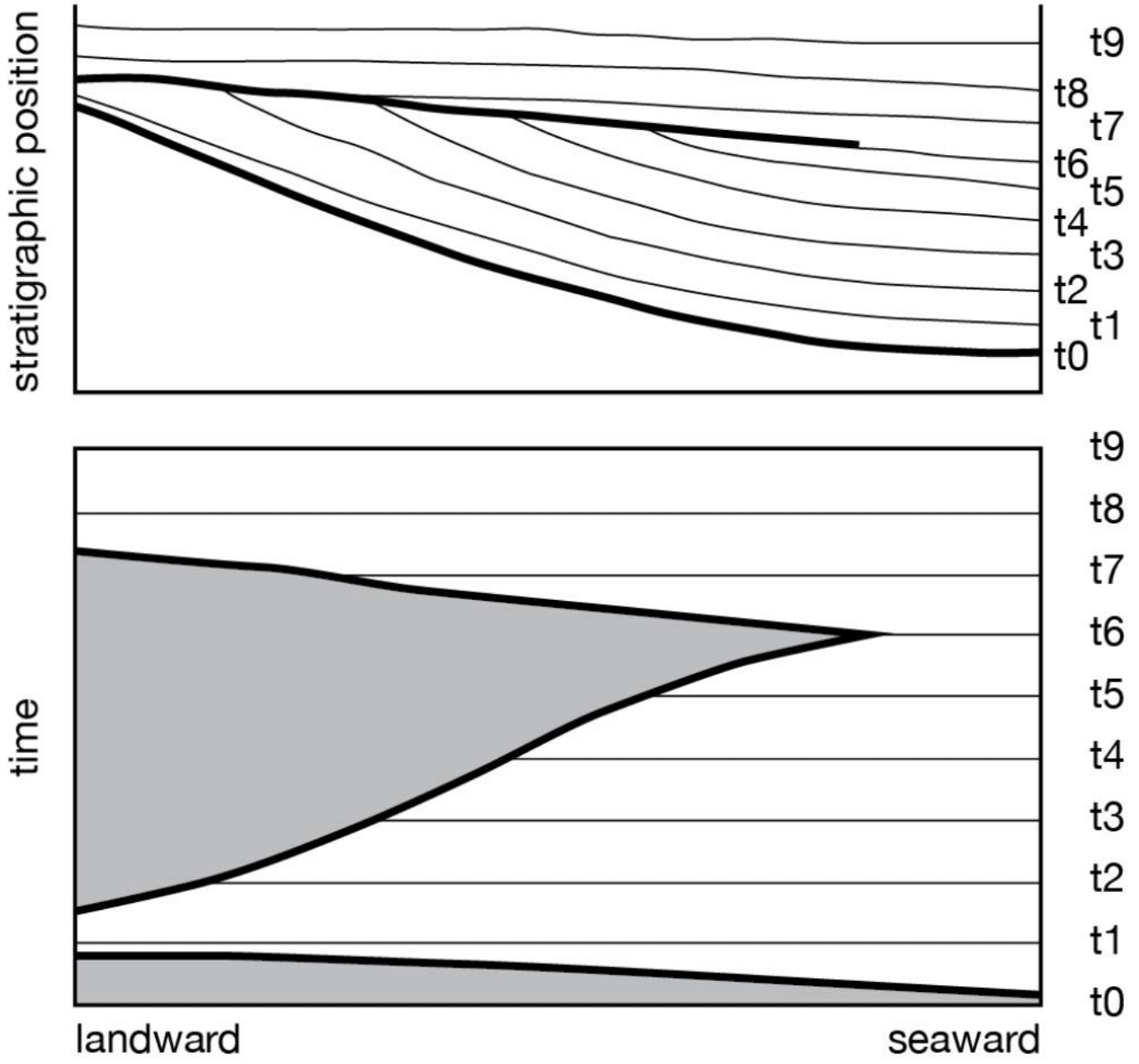

onset of forced regression
(4)
(3)
TST
estuary
Marine aggradation
and progradation
FSST
shoreface
shelf
LST
TST
Highstand systems tract
end of transgression
(3)
estuary
(2)
Onlapping healing-phase deposits
FSST
LST
Transgressive systems tract
end of regression
(2)
(1)
FSST
Marine aggradation
and progradation
Lowstand systems tract
end of forced regression
(1)
Marine erosion / aggradation
Falling stage
systems tract
(1)
(2)
(3)
(1)
(2)
(3)
gradationally based
sharp-based
subaerial unconformity
correlative conformity
basal surface of forced regression
regressive surface of marine erosion
maximum regressive surface
maximum flooding surface
ravinement surface
lateral shifts of facies

Hiatus

A cessation in deposition of sediments during which no strata form or an erosional surface forms on the underlying strata; a **gap in the rock record**. This period might be marked by development of a lithified sediment (hardground) or burrowed surface. A disconformity (surface that represents a time of nondeposition, possibly combined with erosion) can result from a hiatus.

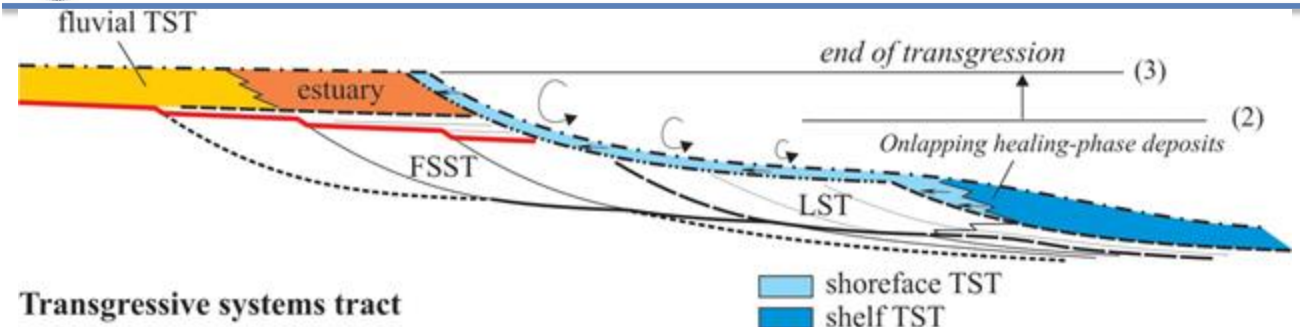


Wheeler diagram

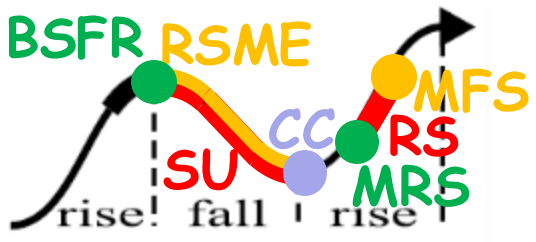


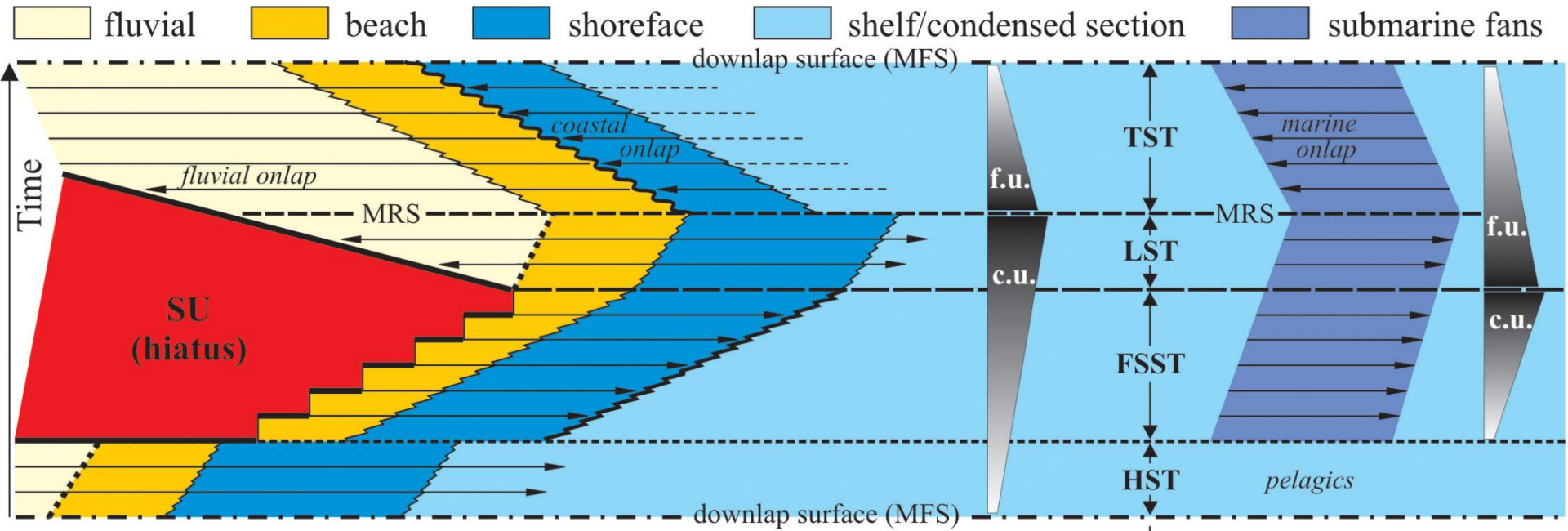
Stratigraphic cross-section (upper) and chrono-stratigraphic (Wheeler) diagram lower, illustrating the chrono-stratigraphic potential of a subaerial unconformity

Wheeler diagram of stratigraphic sequences



Transgressive systems tract

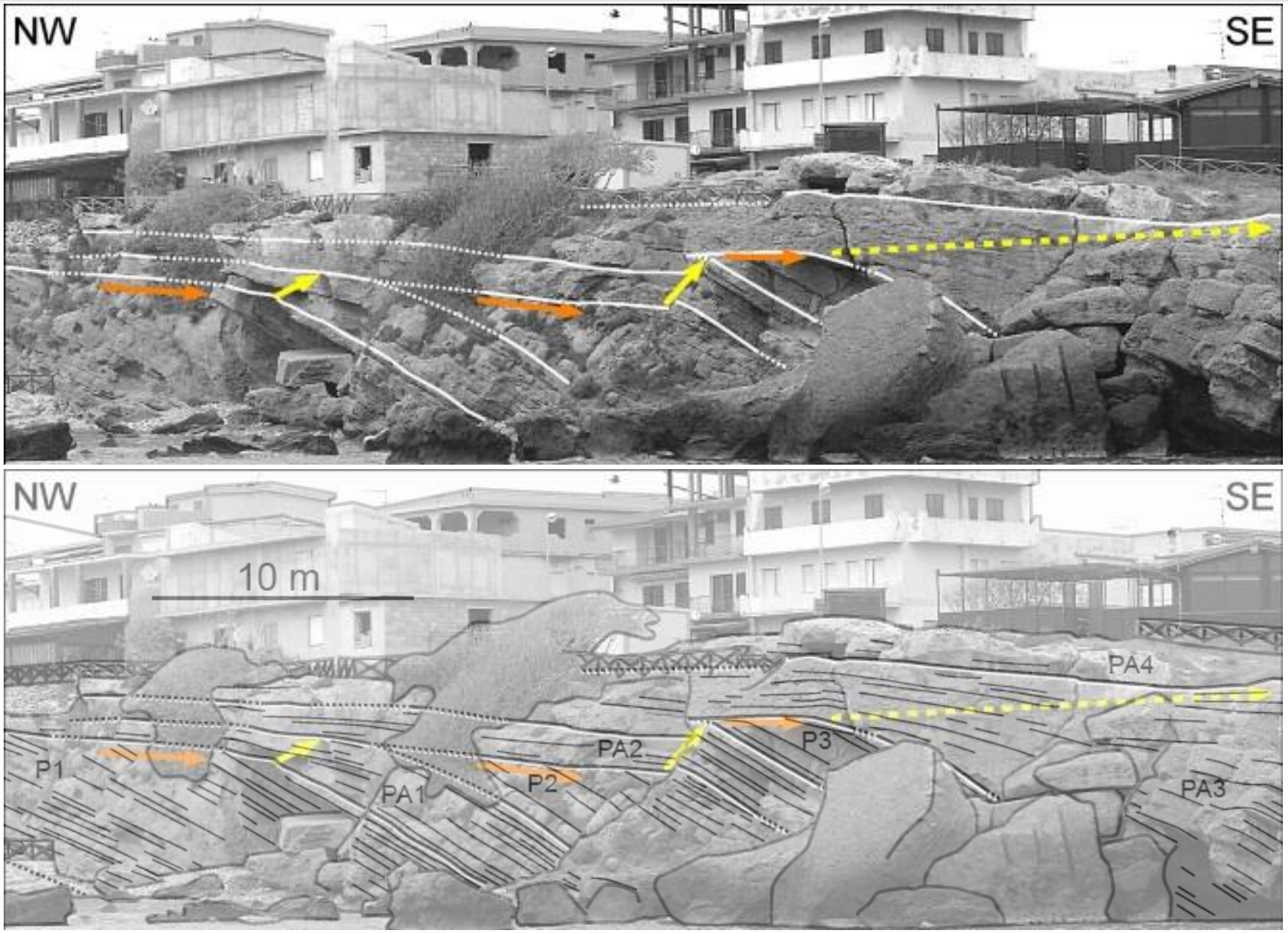




- subaerial unconformity
- correlative conformity
- regressive surface of marine erosion
- basal surface of forced regression
- onlap
- maximum regressive surface
- maximum flooding surface
- transgressive ravinement surface
- within-trend normal regressive surface
- downlap

First exercise

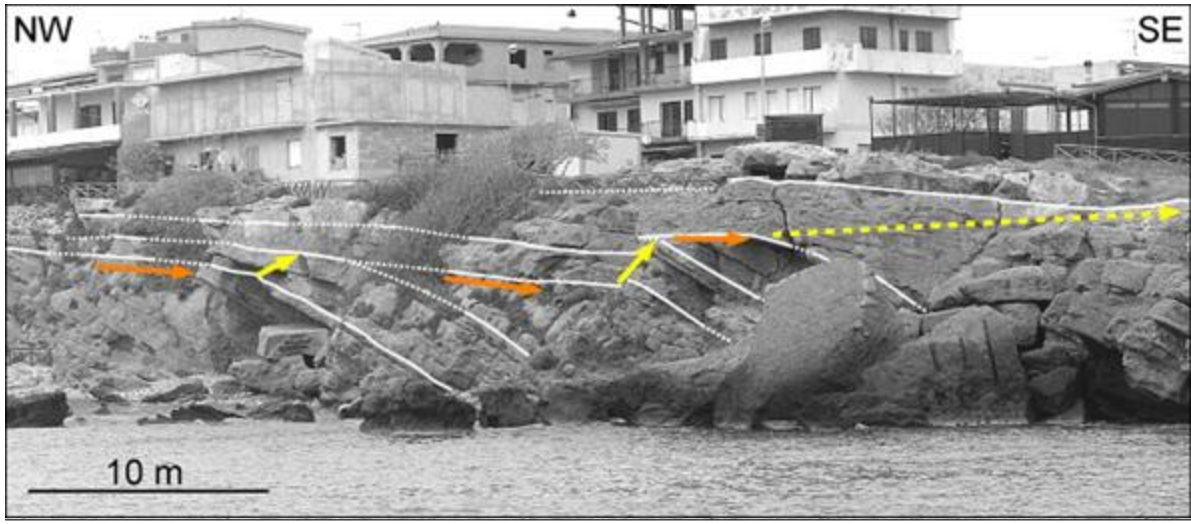
Natural example (exception)

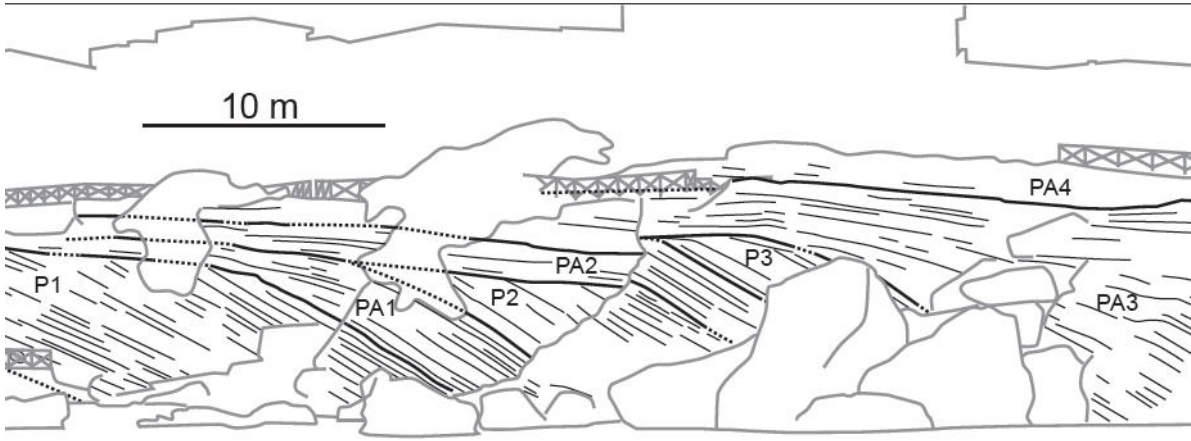


Normal and forced regressive deposits

Relative sea-level changes may be erratic/poorly predictable. The expected complete succession of systems tracts doesn't form in all cases.

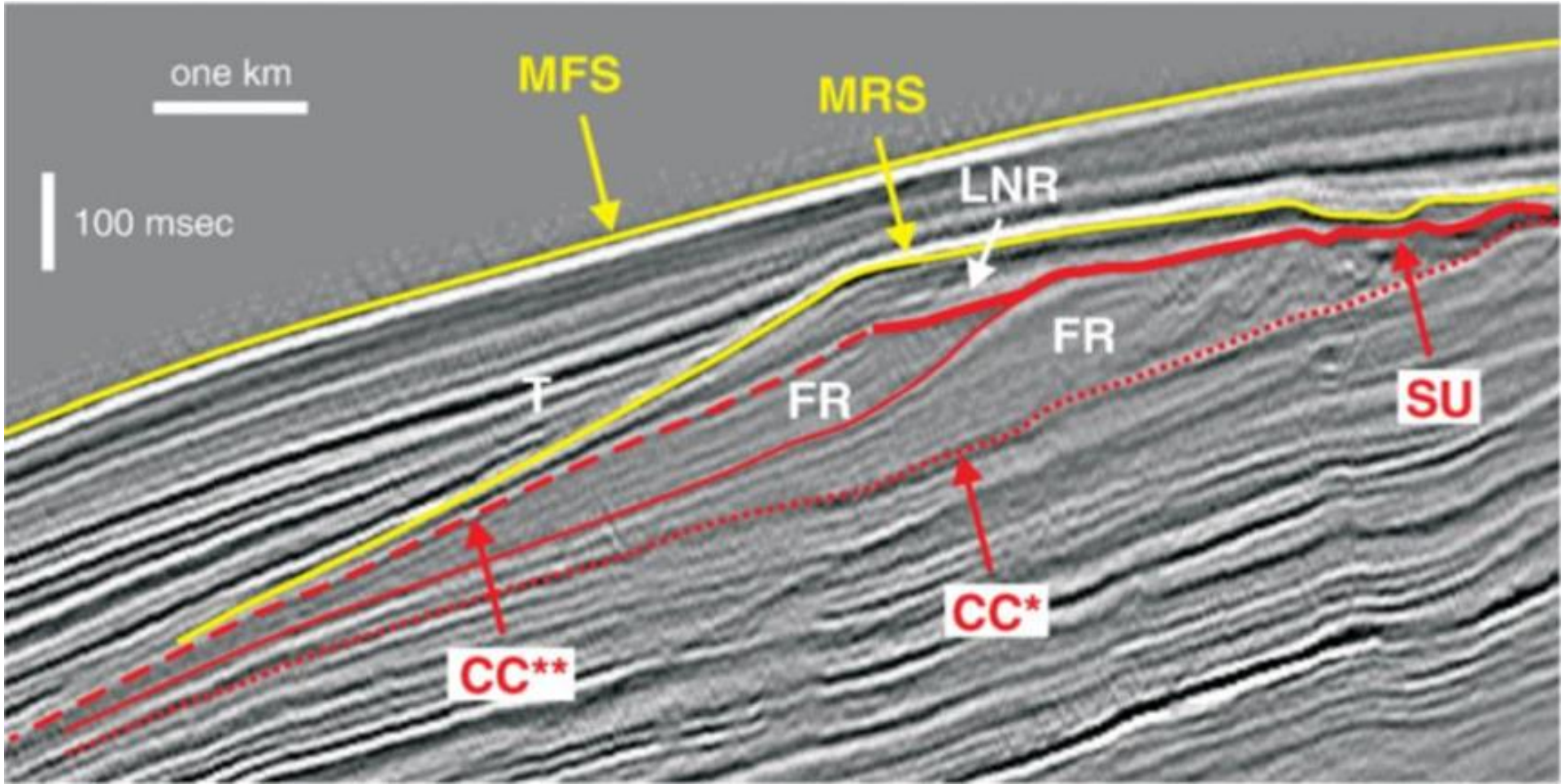
Zecchin et al., 2010. Le Castella clinoform. Sedimentary Geology. Alternating prograding and prograding/ aggrading elementary units, thought to be linked to high-frequency base-level changes during overall forced regressive conditions





Second exercise

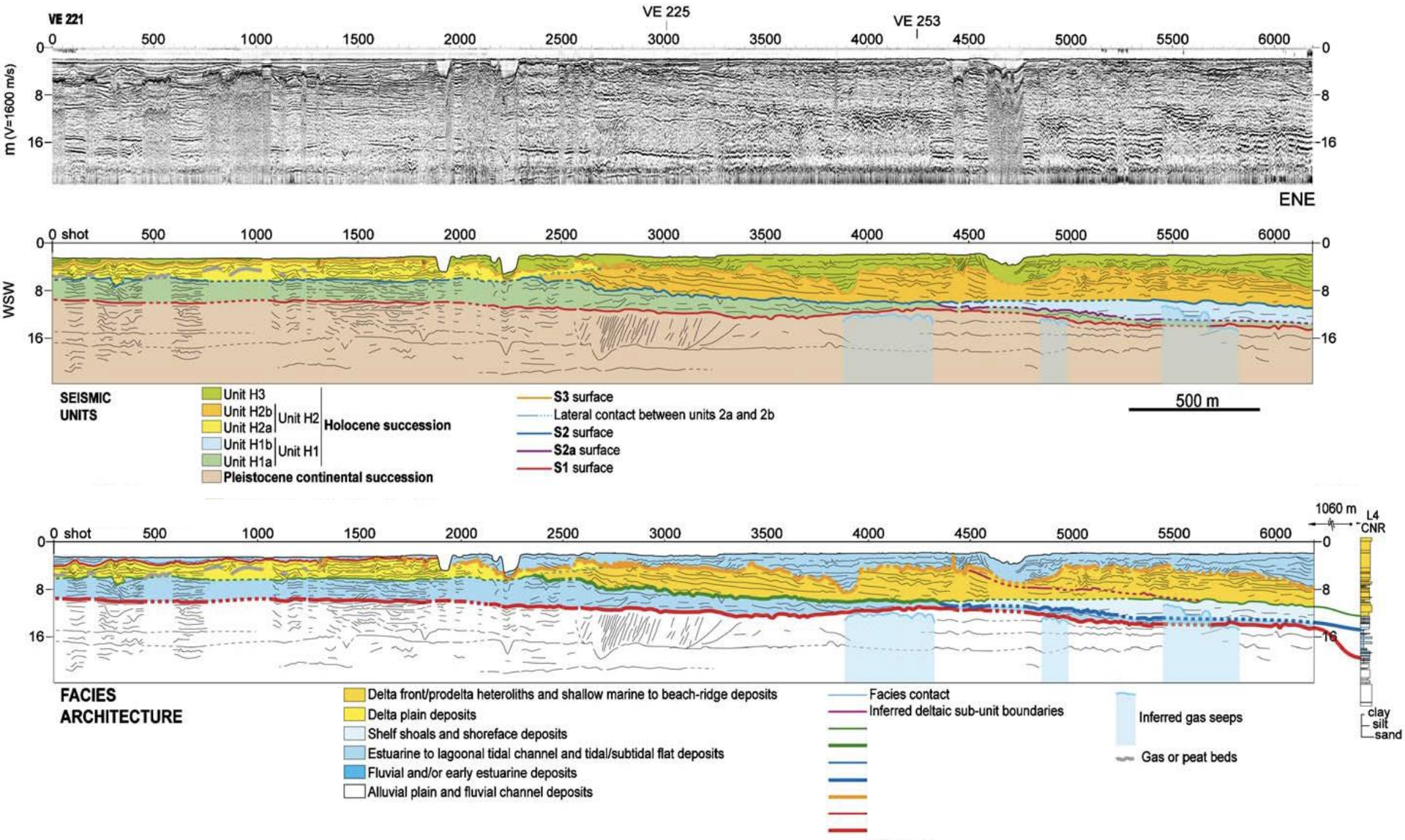
Exercise: try to identify the system tracts and to mark the stratigraphic surfaces

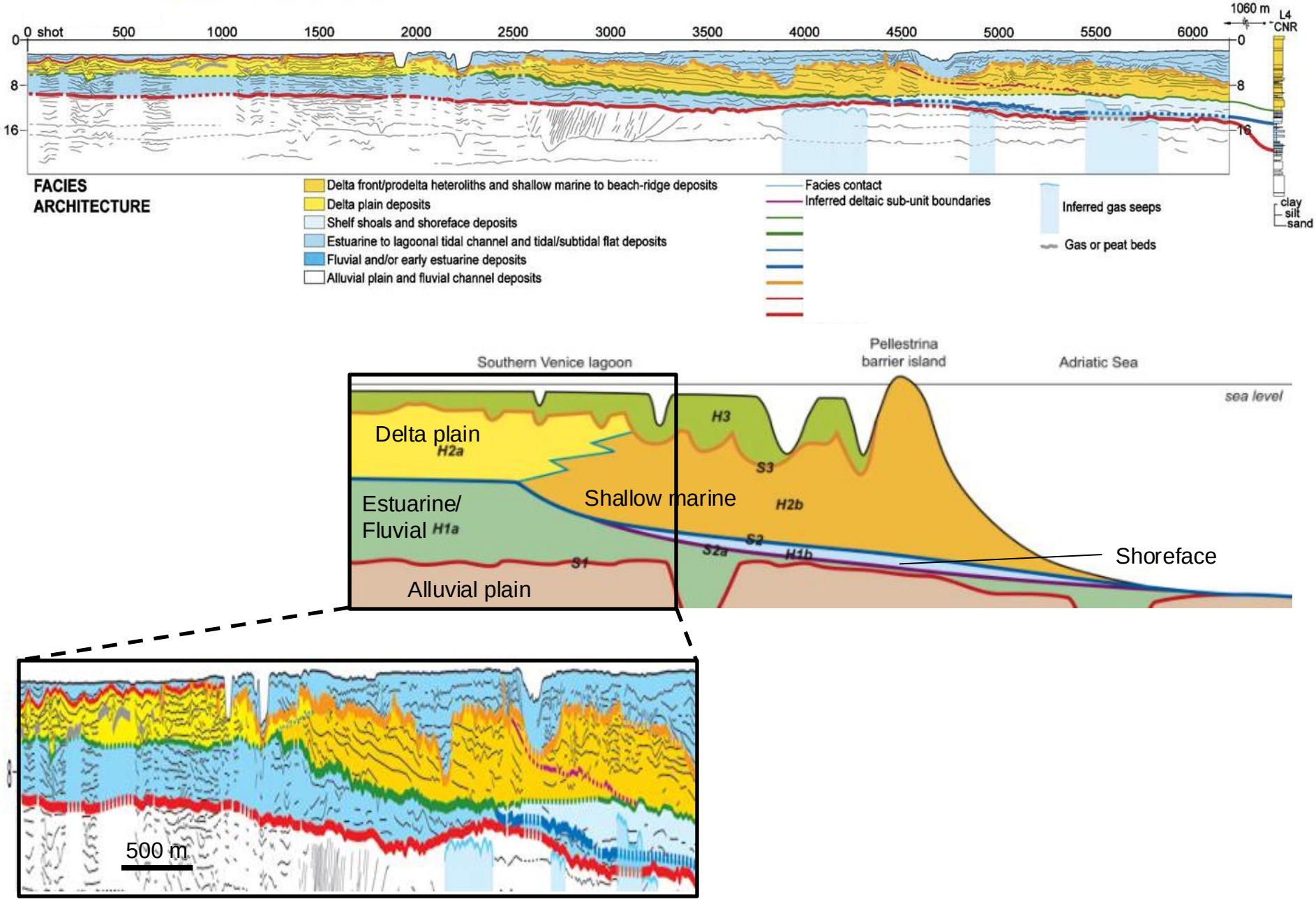


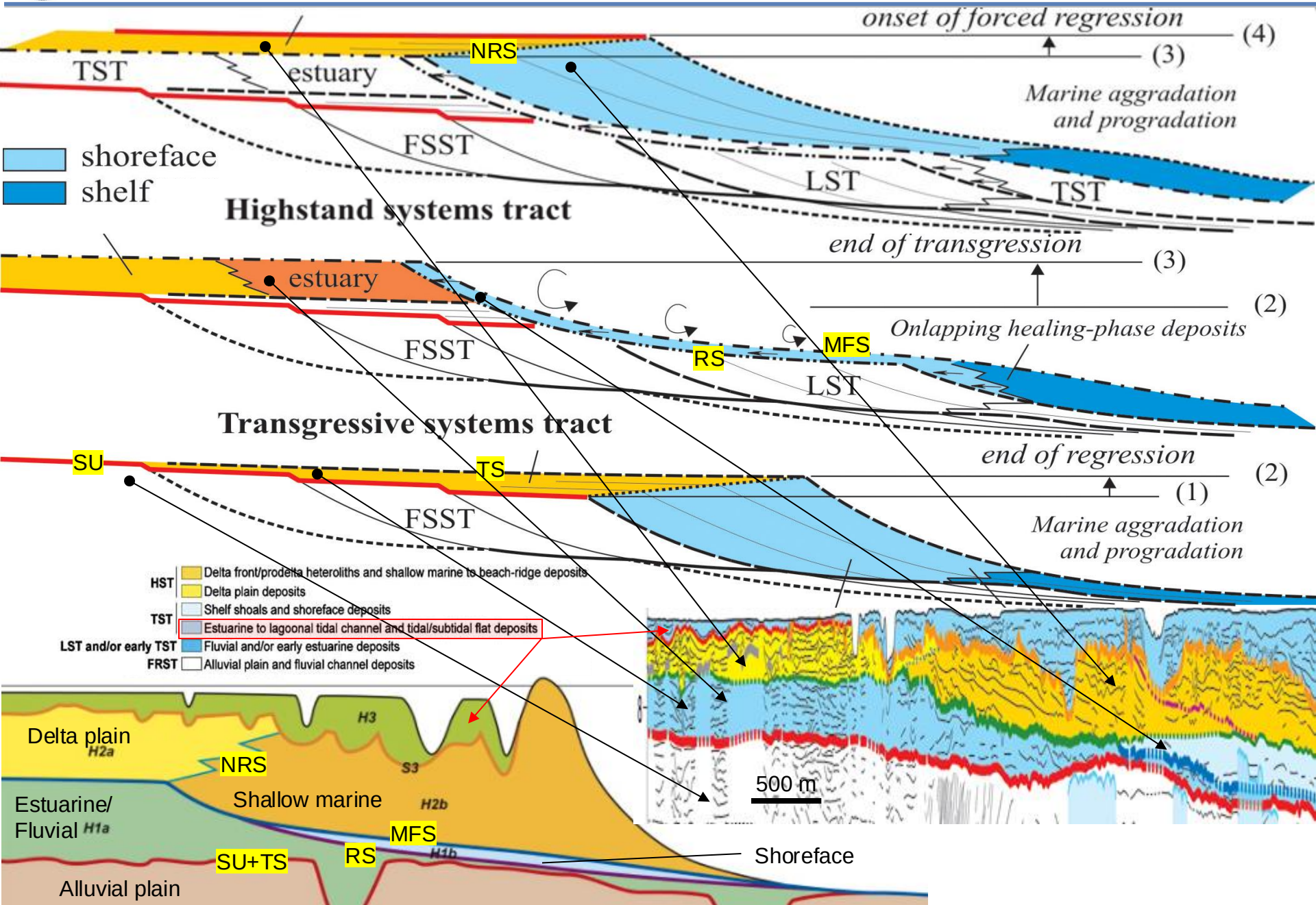
Third exercise

Guess the ST and surfaces!

From Zecchin et al. (2009) Venice lagoon. Continental Shelf Research 29, 1343-1359




0 shot
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
0
8
16
1060 m
L4 CNR
clay
silt
sand
FACIES ARCHITECTURE
Delta front/prodelta heteroliths and shallow marine to beach-ridge deposits
Delta plain deposits
Shelf shoals and shoreface deposits
Estuarine to lagoonal tidal channel and tidal/subtidal flat deposits
Fluvial and/or early estuarine deposits
Alluvial plain and fluvial channel deposits
Facies contact
Inferred deltaic sub-unit boundaries
Inferred gas seeps
Gas or peat beds
Southern Venice lagoon
Pellestrina barrier island
Adriatic Sea
sea level
Delta plain
H2a
H3
S3
Shallow marine
H2b
Estuarine/
Fluvial H1a
S2
S2a
H1b
S1
Shoreface
Alluvial plain
500 m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LST and/or early TST
Fluvial and/or early estuarine deposits
FRST
Alluvial plain and fluvial channel deposits
500 m
Delta plain
H2a
H3
NRS
S3
Shallow marine
H2b
Estuarine/
Fluvial H1a
MFS
RS
H1b
SU+TS
Shoreface
Alluvial plain