



# **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)**

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# Unit 4.1

## Sequence stratigraphy: introduction

### OUTLINE:

- Principles;
- Sequence stratigraphic surfaces;
- System tracts.

*Exercise throughout:  
questions*

# Definitions

**Sequence stratigraphy** (Posamentier et al., 1988; Van Wagoner, 1995): the study of rock relationships within a time-stratigraphic framework of repetitive, genetically related strata bounded by surfaces of erosion or nondeposition, or their correlative conformities.

**Sequence stratigraphy** (Galloway, 1989): the analysis of repetitive genetically related depositional units bounded in part by surfaces of nondeposition or erosion.

**Sequence stratigraphy** (Posamentier and Allen, 1999): the analysis of cyclic sedimentation patterns that are present in stratigraphic successions, as they develop in response to variations in sediment supply and space available for sediment to accumulate.

**Sequence stratigraphy** (Catuneanu, 2006): the analysis of the sedimentary response to changes in base level, and the depositional trends that emerge from the interplay of accommodation (space available for sediments to fill) and sedimentation.

**Sequence** (Mitchum, 1977): a relatively conformable succession of genetically related strata bounded by unconformities or their correlative conformities.

**Systems tract** (Brown and Fisher, 1977): a linkage of contemporaneous depositional systems, forming the subdivision of a sequence.

# Key concepts

**Relative sea-level:** sea level relative to an imaginary reference horizon called 'datum' (Posamentier et al., 1988; Catuneanu, 2002).

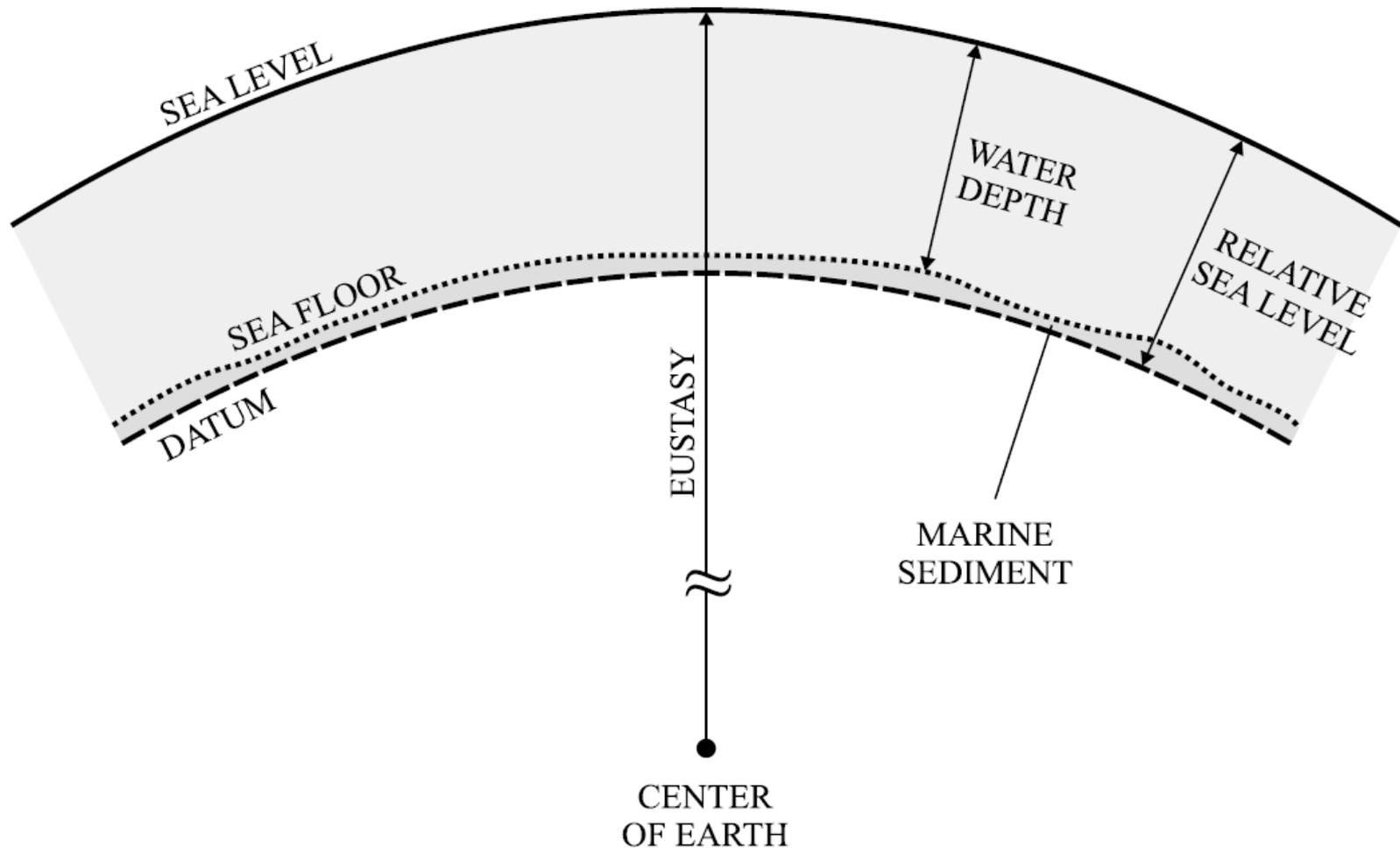
**Base level:** a surface of equilibrium which sedimentary processes strive to attain, at which neither erosion nor deposition takes place (Barrell, 1917).

Temporary base level: a surface of temporary equilibrium between sediment supply and energy (examples: seafloor, river bed)

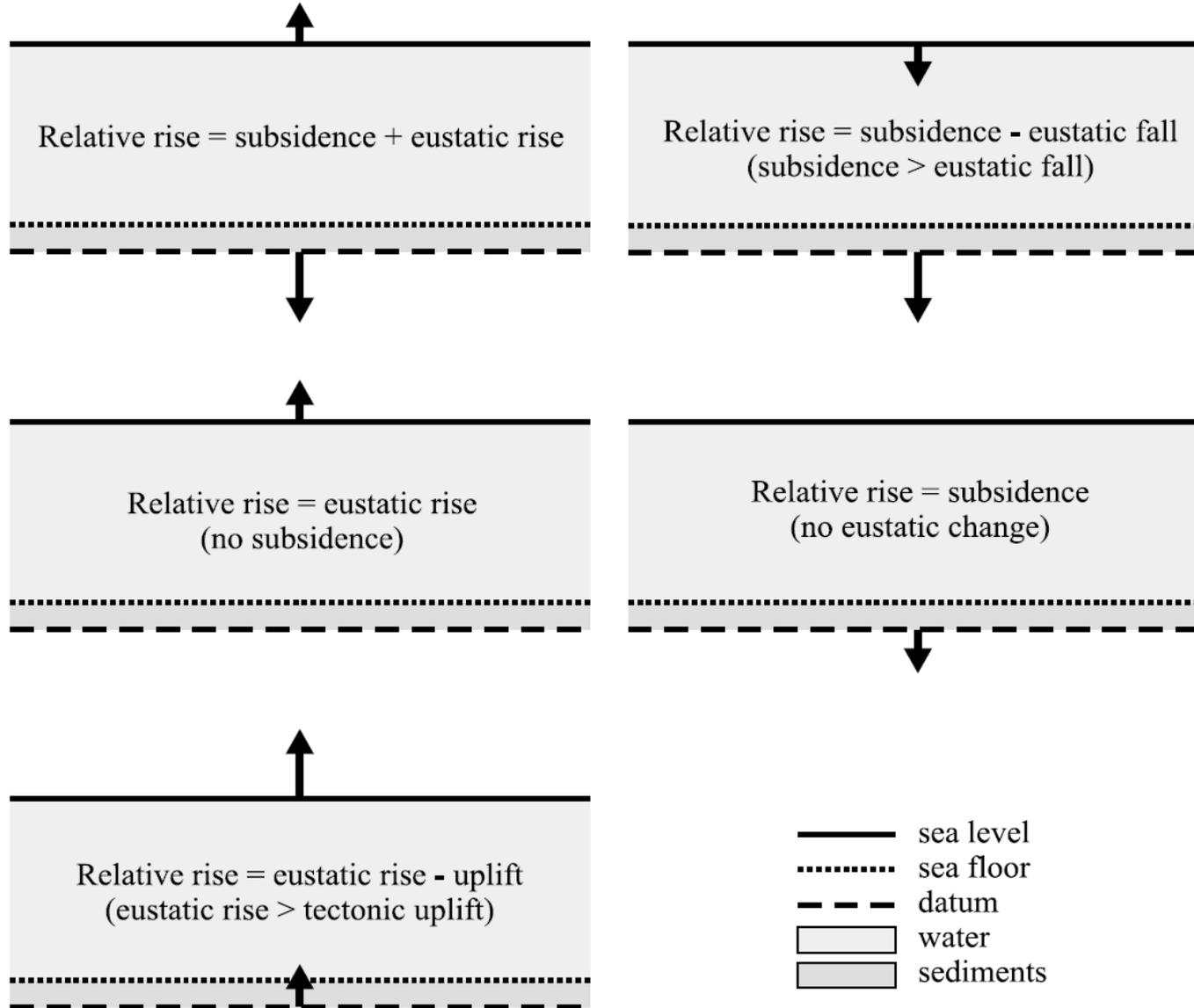
Ultimate base level = sea level

**Accommodation (space):** the space available for the accumulation of sediment (Jervey, 1988). It can be created or destroyed by variations of relative sea level.

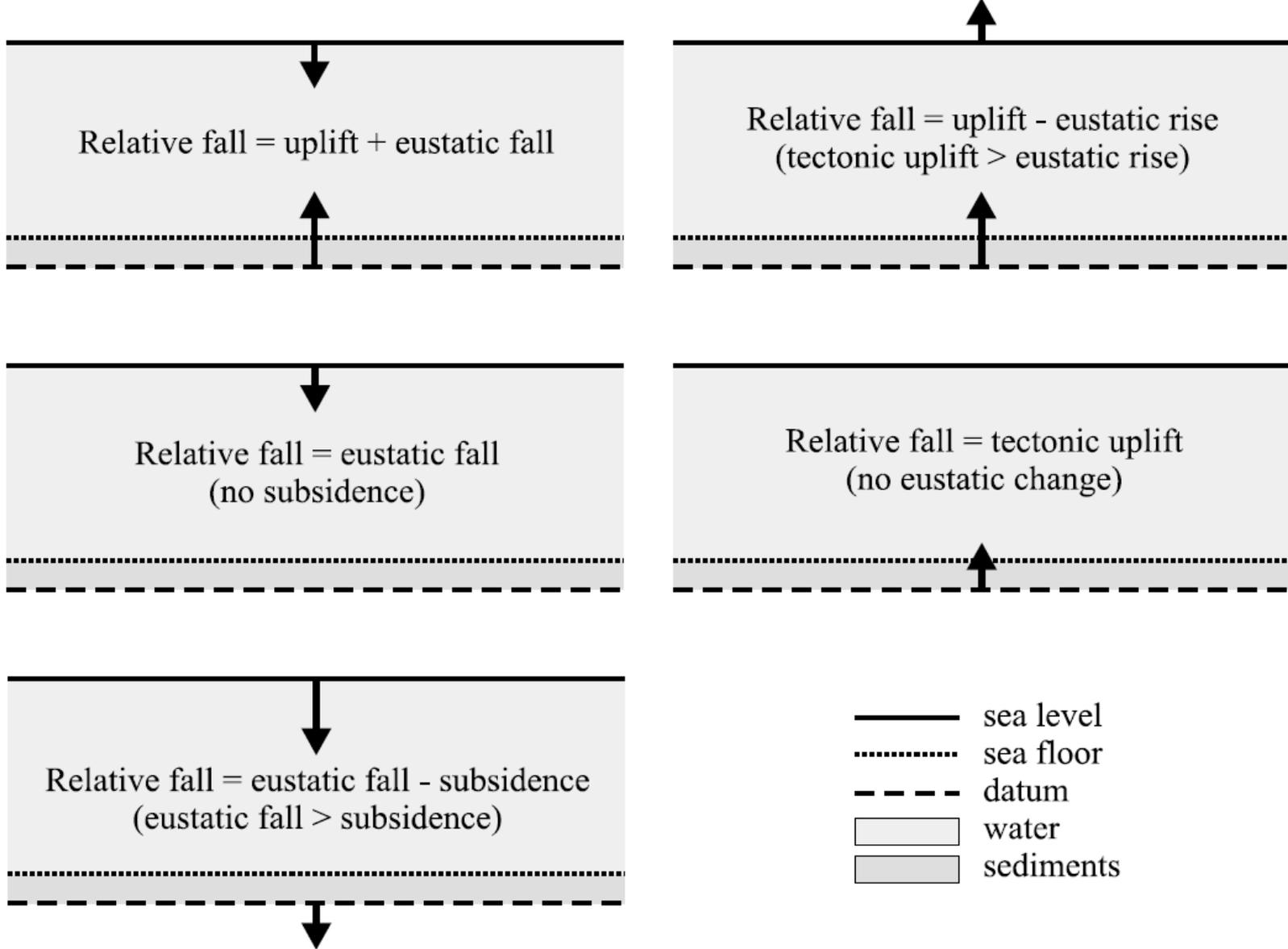
# Relative sea level



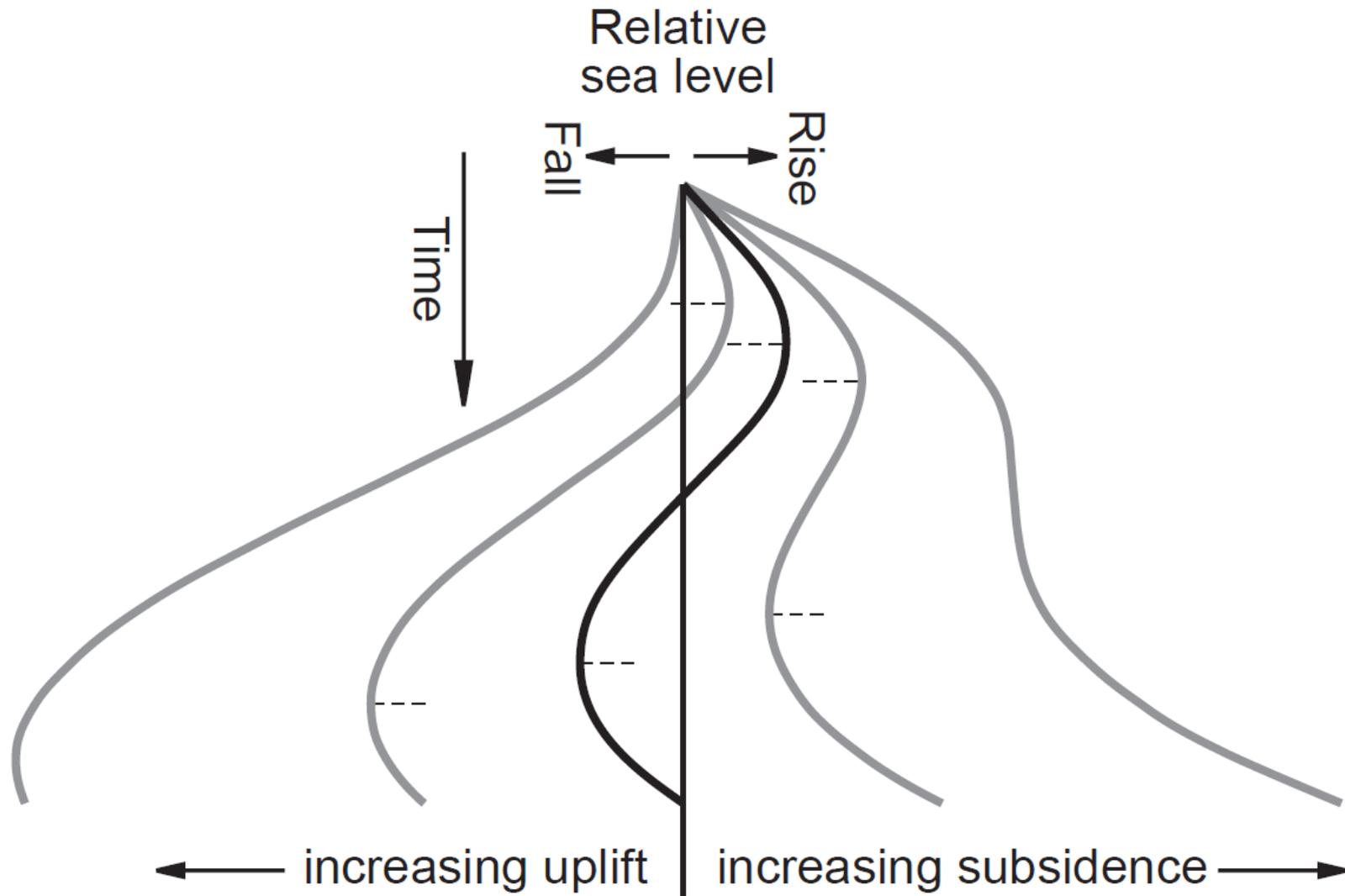
# Relative sea-level rise



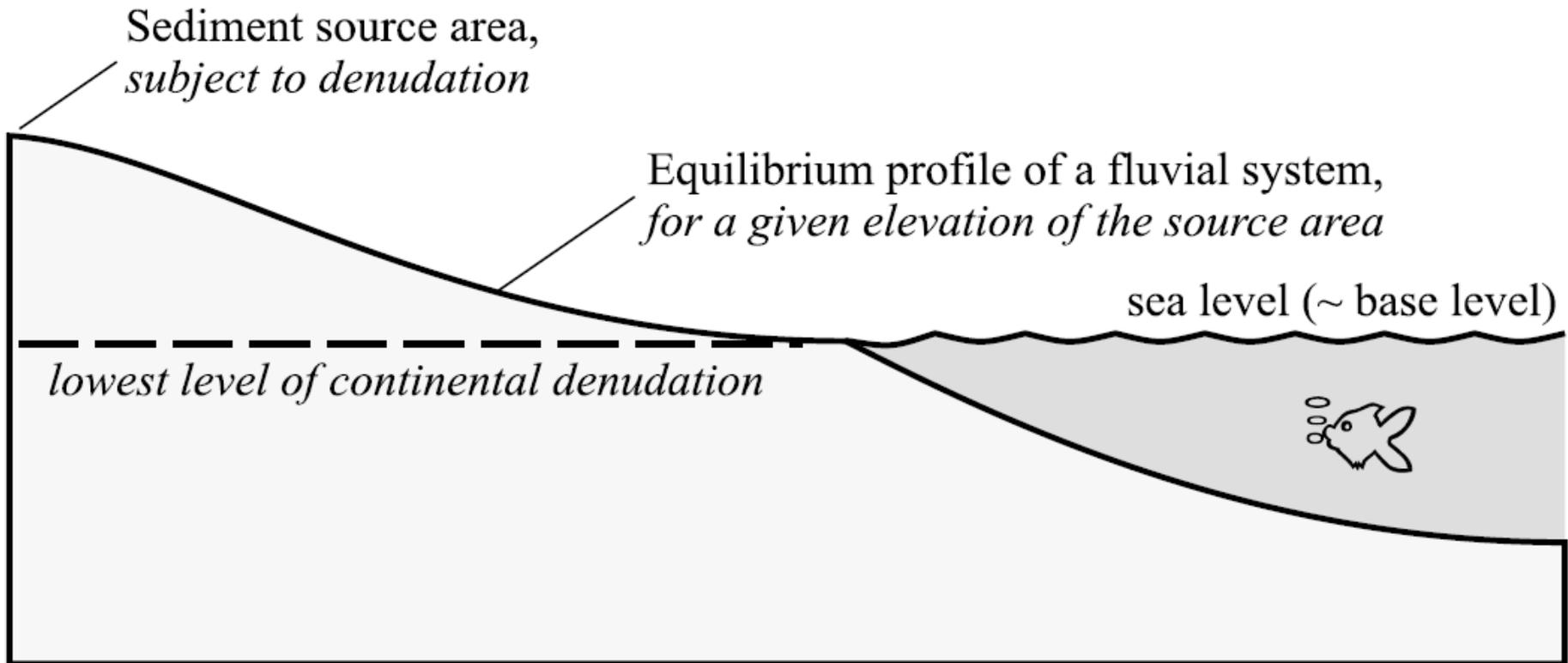
# Relative sea-level fall



# Relative sea-level changes



# Base level



# Interplay between accommodation and sedimentation

**Transgression:** the landward migration of the shoreline

It occurs if the rate of accommodation creation (relative sea-level rise) outpaces the sedimentation rate at the shoreline

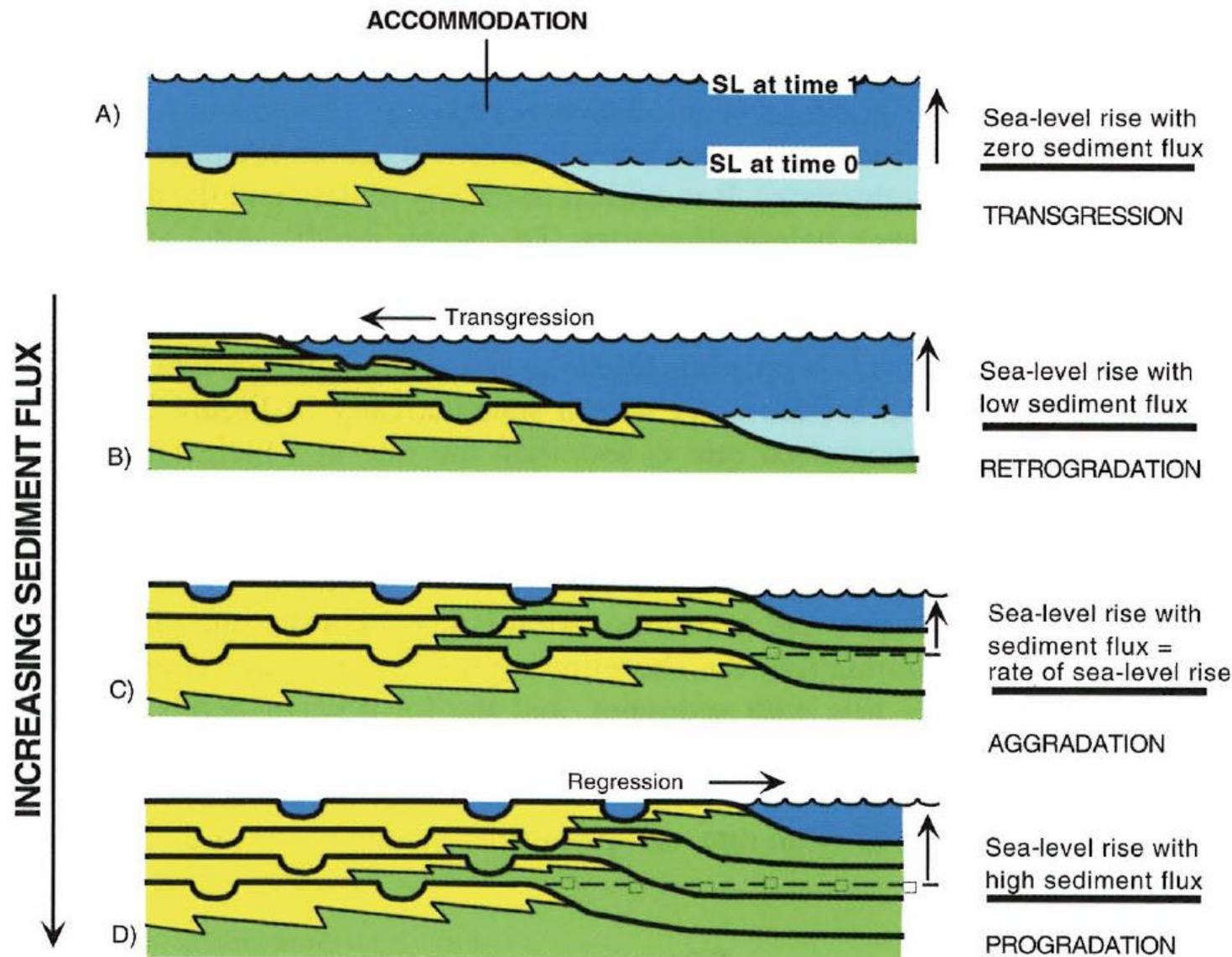
- Landward facies shift
- Deepening of the shallow-marine area
- Retrogradational stacking pattern

**Regression:** the seaward migration of the shoreline

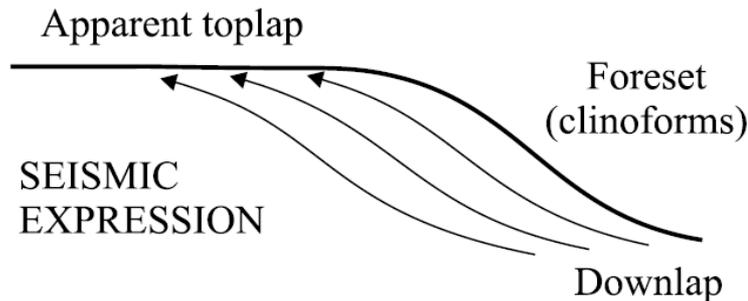
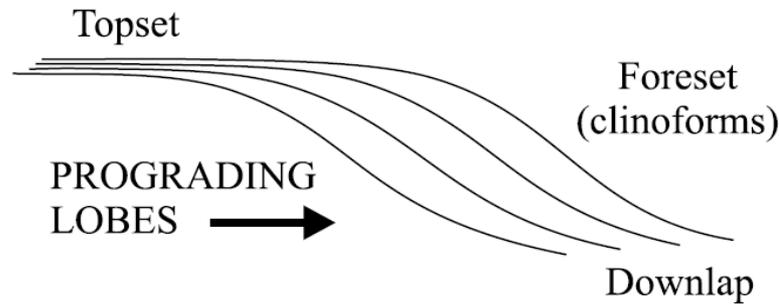
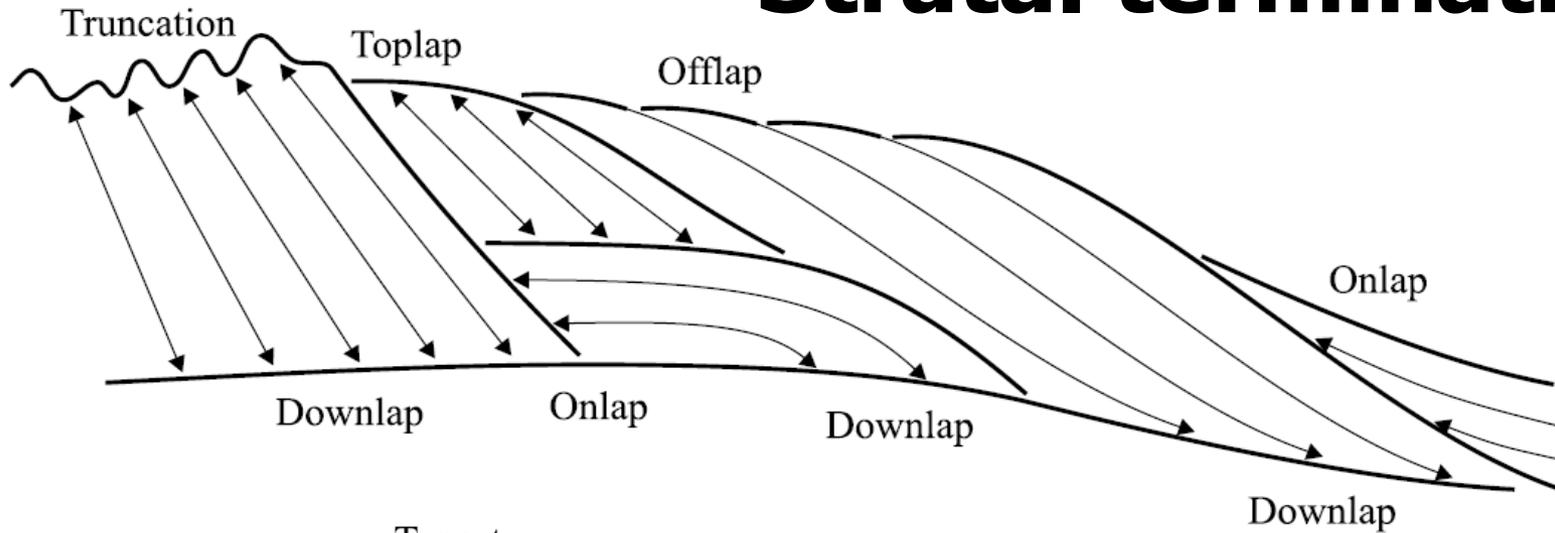
It occurs if the sedimentation rate outpaces the rate of accommodation creation at the shoreline (normal regression) or during relative sea-level fall (loss of accommodation) (forced regression)

- Seaward facies shift
- Shallowing of the shallow-marine area
- Progradational stacking pattern

# Accommodation and sedimentation



# Stratal terminations



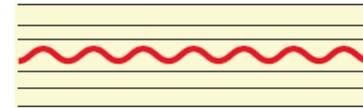
# Unconformities

**Unconformity** = hiatus ± erosion

A break in the geological record, whatever its cause and magnitude, with or without accompanying erosion.  
Types of unconformity:

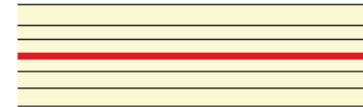
- **Disconformity** = hiatus + erosion

An unconformity in which the bedding planes above and below the break are essentially parallel, ...and usually marked by a visible and uneven erosion surface of appreciable relief.



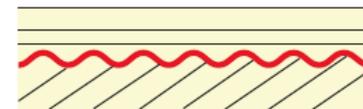
- **Paraconformity** = hiatus ± erosion

An obscure or uncertain unconformity with no discernable erosion, in which the beds above and below the break are parallel to each other. 'Minor' paraconformities are also referred to as 'diastems'.



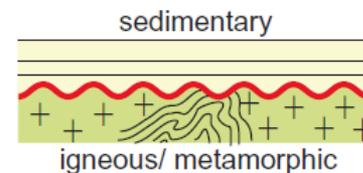
- **Angular unconformity** = hiatus, erosion, and tilt

An unconformity between two groups of rocks whose bedding planes are not parallel or in which the older, underlying rocks dip at a different angle (usually steeper) than the younger, overlying strata.



- **Nonconformity** = top of basement rocks

An unconformity developed between sedimentary rocks and older basement rocks that had been exposed to erosion before the overlying sediments covered them.

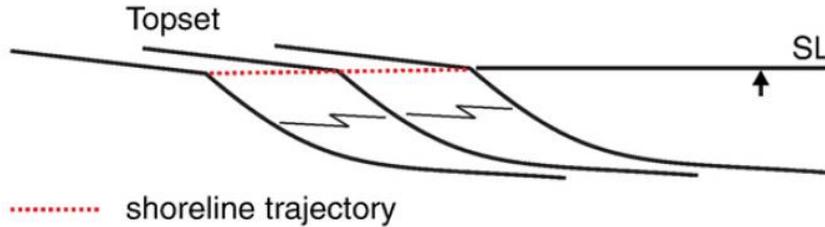


**Conformity** = no hiatus

Undisturbed relationship between adjacent sedimentary strata that have been deposited in orderly sequence.  
True stratigraphic continuity in the succession of beds.

# Genetic types of deposits

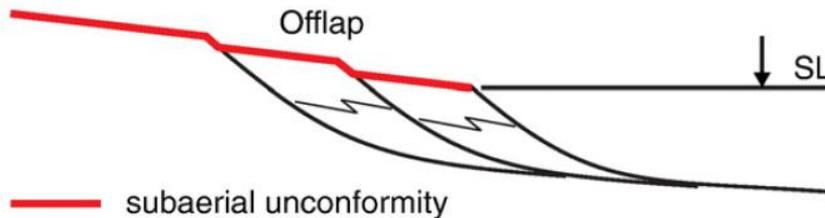
## Normal regression



Definition: progradation driven by sediment supply. Sedimentation rates outpace the rates of base-level rise at the coastline.

Depositional trend: progradation with aggradation.

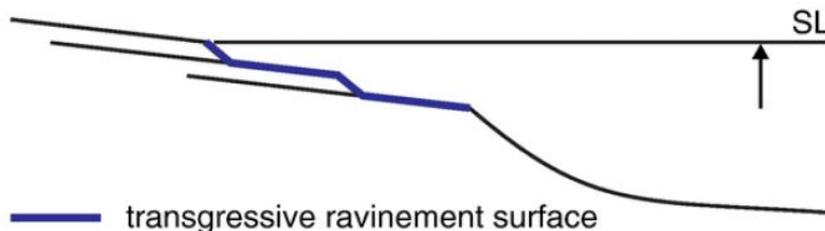
## Forced regression



Definition: progradation driven by base-level fall. The coastline is forced to regress, irrespective of sediment supply.

Depositional trend: progradation with downstepping.

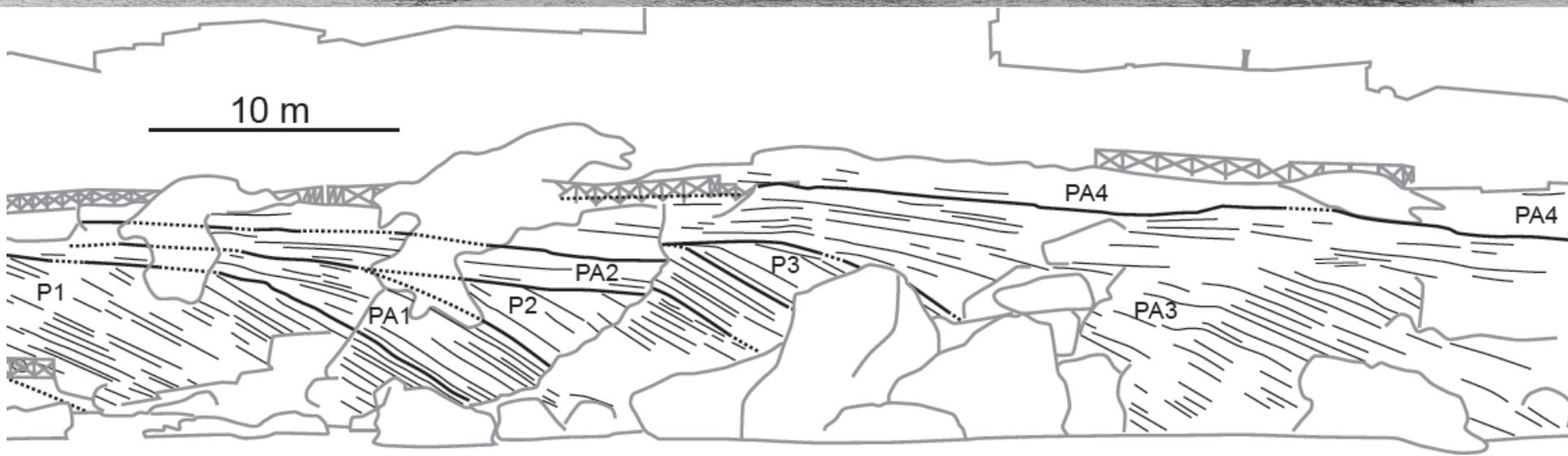
## Transgression



Definition: retrogradation (backstepping) driven by base-level rise. The rates of base-level rise outpace the sedimentation rates at the coastline.

Depositional trend: retrogradation.

# Normal and forced regressive deposits



# Sequence stratigraphic surfaces

## *Relative sea-level fall*

- Subaerial unconformity (and correlative conformity)
- Basal surface of forced regression
- Regressive surface of marine erosion

## *Relative sea-level rise*

- Maximum regressive surface
- Maximum flooding surface
- Ravinement surface

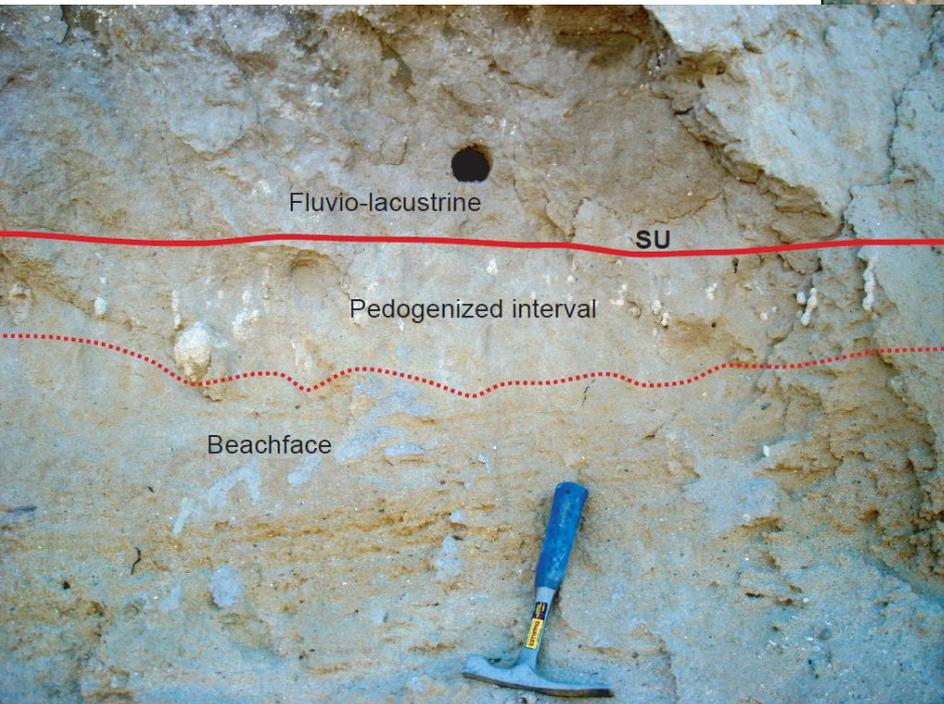


# Subaerial unconformity (SU)

Lower Cretaceous –  
Axel Heiberg Island



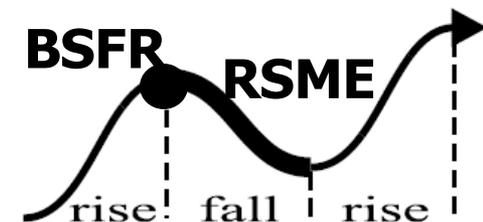
Middle Pleistocene – Crotona



# Basal surface of forced regression (BSFR) and regressive surface of marine erosion (RSME)

Cretaceous –  
Blackhawk  
Fm., Utah

- The BSFR marks the base of all marine deposits accumulated during relative sea-level fall. It corresponds to the paleo-seafloor at the onset of forced regression
- The RSME is cut by waves in the shoreface during relative sea-level fall, and marks the base of forced regressive shorefaces. It easily reworks the BSFR in proximal settings. Its formation depends on wave energy, slope, and subsidence

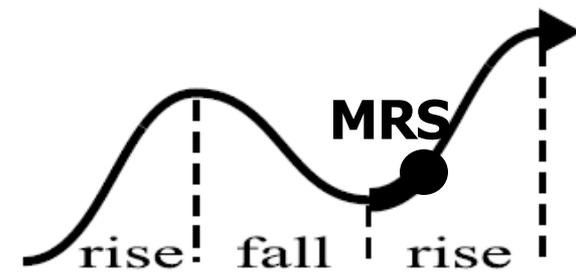


# Maximum regressive surface (MRS) or transgressive surface (TS)

- The MRS marks the boundary between 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.



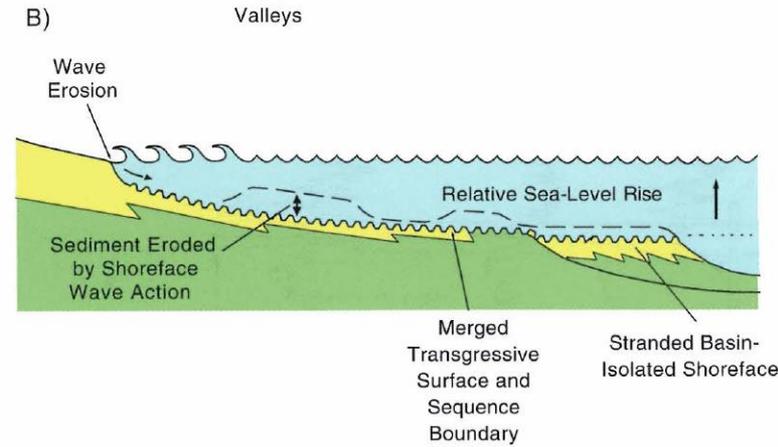
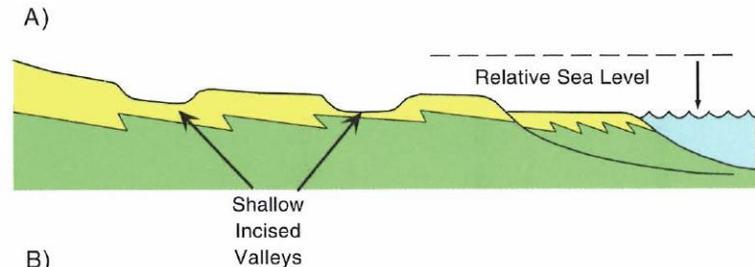
Early and Middle  
Triassic –  
Ellesmere Island



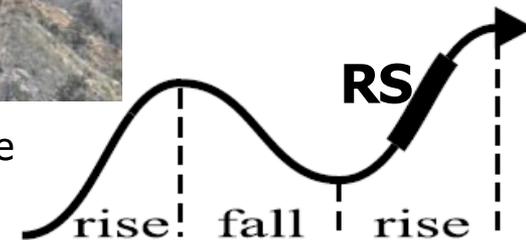
# Ravinement surface (RS)

- The RS is a diachronous erosional surface cut by waves (WRS) or tidal currents (TRS) in the shoreface and coastal settings during transgression (relative sea-level rise)
- It is associated with transgressive lags or condensed bioclastic deposits
- It climbs toward the basin margin

- Its formation depends on wave energy, slope and rates of relative sea-level rise and sediment supply

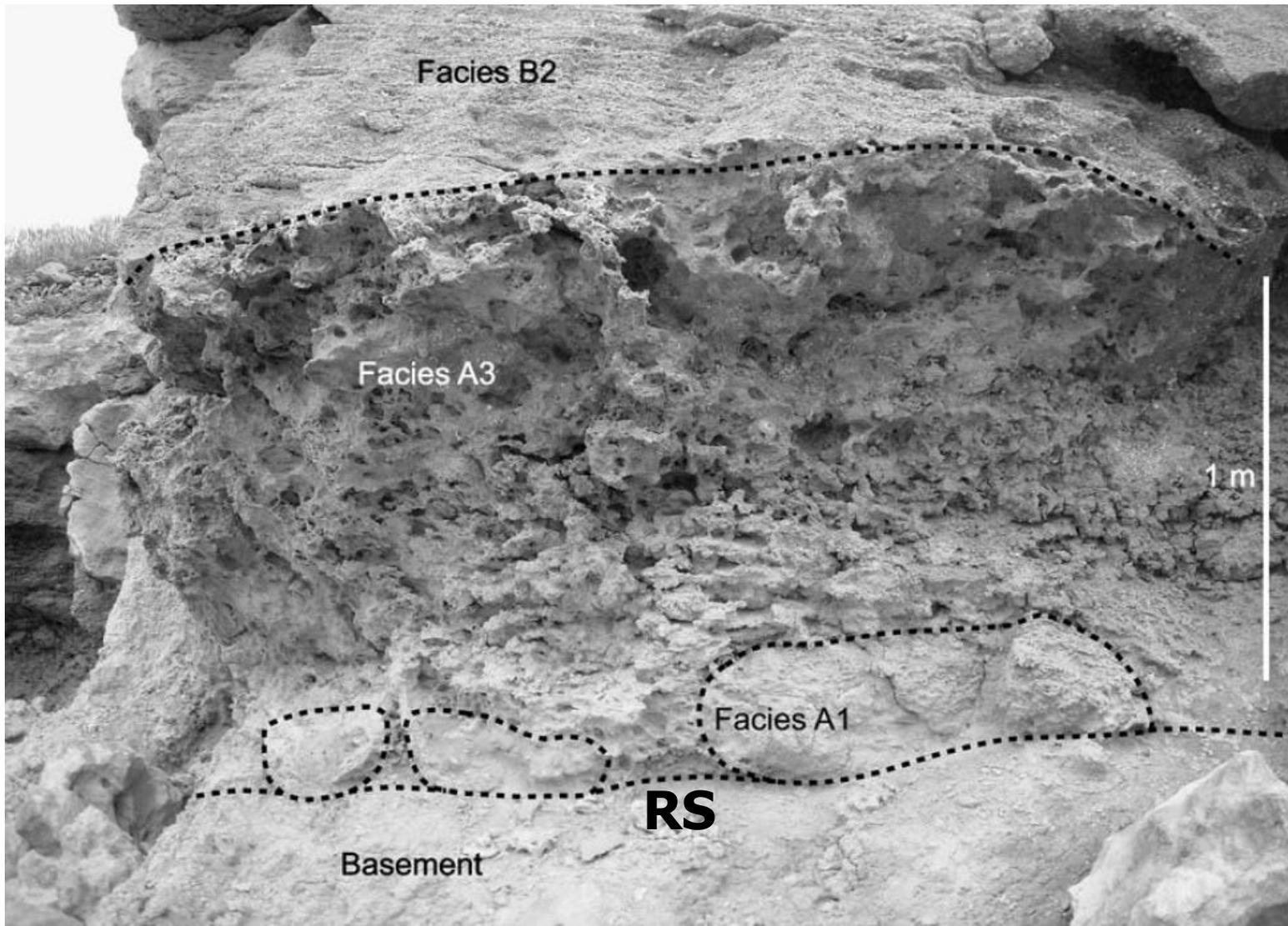


Upper Cretaceous – Panther Tongue Member, Star Point Fm., Utah



# Ravinement surface (RS)

Late Pleistocene  
– Crotona

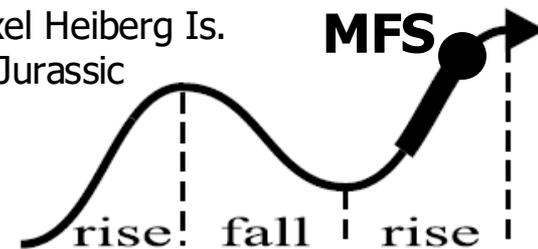


# Maximum flooding surface (MFS)

- The MFS marks the end of the shoreline transgression
- It separates retrograding (transgressive) strata below from prograding (regressive) strata above
- It is formed when the sedimentation rates start to outpace the rates of creation of accommodation (relative sea-level rise)
- It is a downlap surface (in seismics)
- It is commonly associated with a condensed section



Axel Heiberg Is.  
– Jurassic

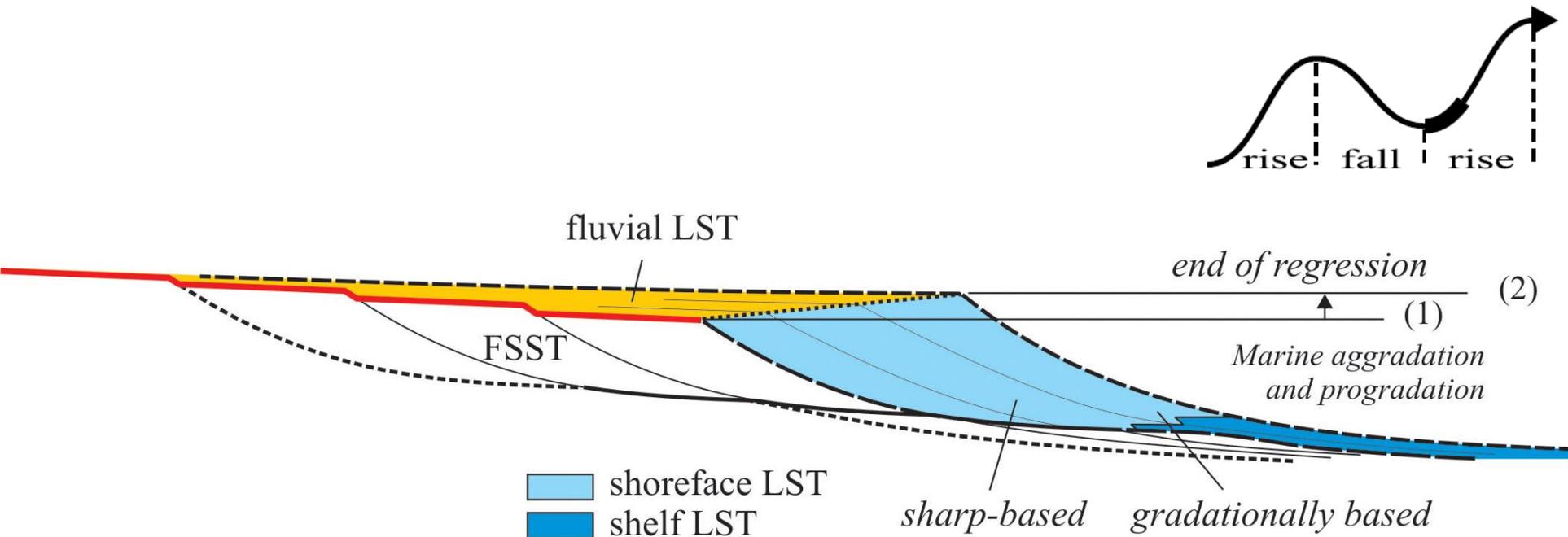




# Systems tracts



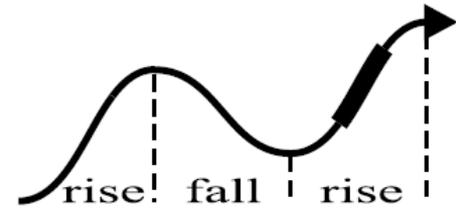
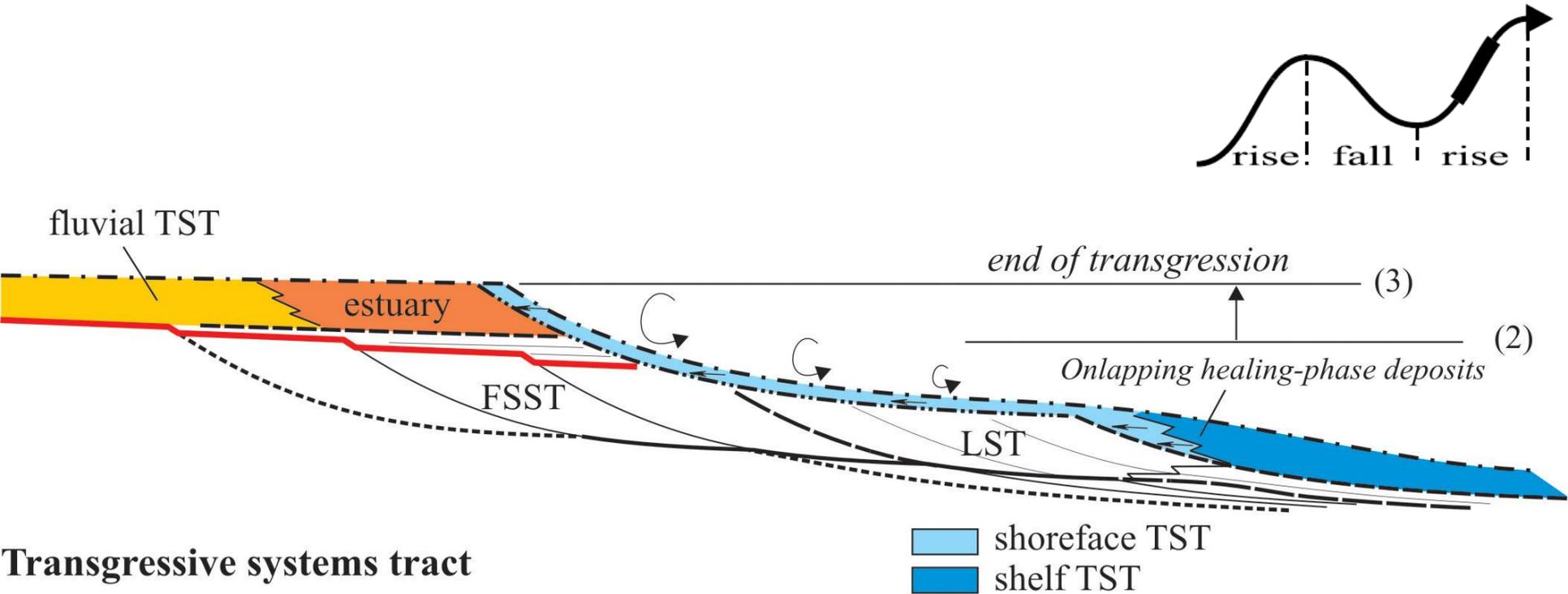
# Lowstand or late lowstand Systems tract



## Lowstand systems tract

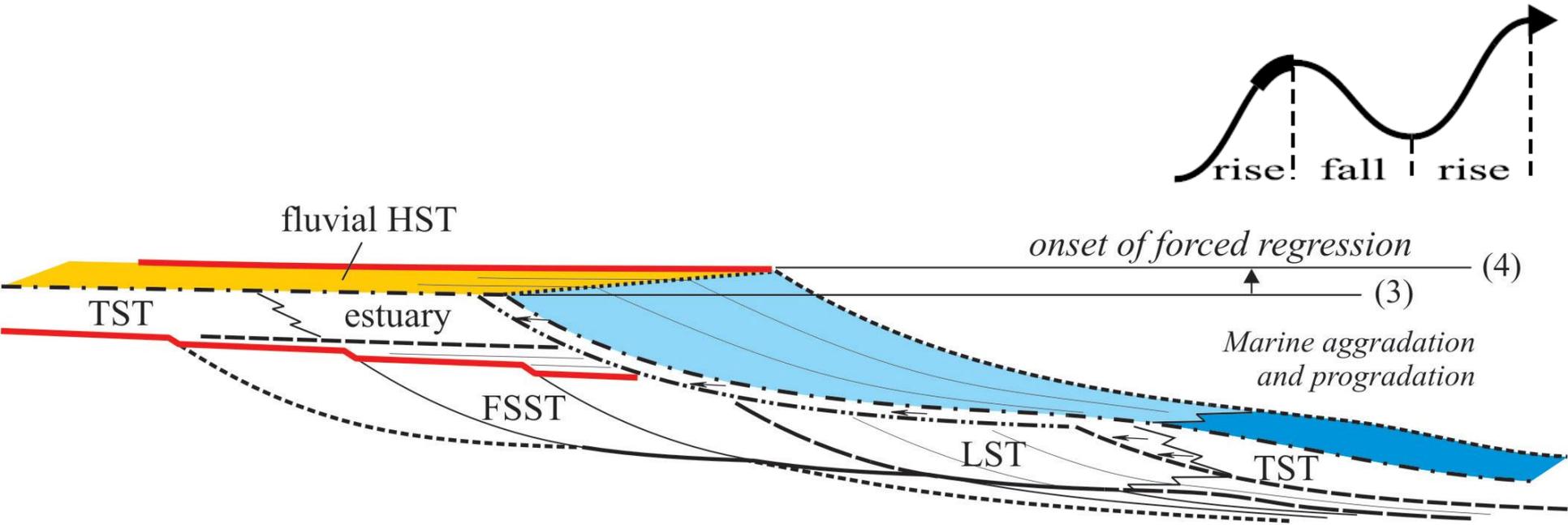
- |  |                                      |  |  |
|--|--------------------------------------|--|--|
|  | subaerial unconformity               |  | maximum regressive surface             |
|  | correlative conformity               |  | maximum flooding surface               |
|  | basal surface of forced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

# Transgressive systems tract



**Transgressive systems tract**

# Highstand systems tract



## Highstand systems tract

shoreface HST  
shelf HST

- 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)

# Sequence stratigraphic models

		Mitchum et al. (1977)	Posamentier et al. (1988)	Van Wagoner et al. (1988)	Hunt & Tucker (1992)	Galloway (1989)	Johnson & Murphy (1984)
Sequence model <i>Events and stages</i>	Depositional Sequence I	Depositional Sequence II	Depositional Sequence III	Depositional Sequence IV	Genetic Sequence	T-R Sequence	
	HNR <i>end of T</i>	Sequence	HST	early HST	HST	HST	RST
T <i>end of R</i>	TST		TST	TST	TST	TST	
LNR <i>end of RSL fall</i>	late LST (wedge)		LST	LST	late LST (wedge)	MRS	
FR <i>onset of RSL fall</i>	early LST (fan)		late HST	FSST	early LST (fan)		RST
HNR	HST		early HST	HST	HST		

— sequence boundary  
 — systems tract boundary  
 - - - within-sequence surface  
 - - - within-systems tract surface

