Dipartimento per le Attività Bibliotecarie,
Documentali e per l'Informazione
Servizio Educazione e Formazione Ambientale

ISPRA
Istituto Superiore per la Protezione
e la Ricerca Ambientale

Dipartimento Difesa del Suolo
Settore Rilevamento geologico e Analisi di Laboratorio

Roma **28-29 Aprile 2011**

Caratterizzazione sedimentologico-paleoambientale delle successioni carbonatiche tramite l'analisi delle facies e dei processi diagenetici: esempi evolutivi di sistemi deposizionali carbonatici mesozoici e terziari dell'area circummediterranea

lezioni curate da Flavio Jadoul

Dipartimento Scienze della Terra Università degli Studi di Milano

29 Aprile mattino ore 9,00

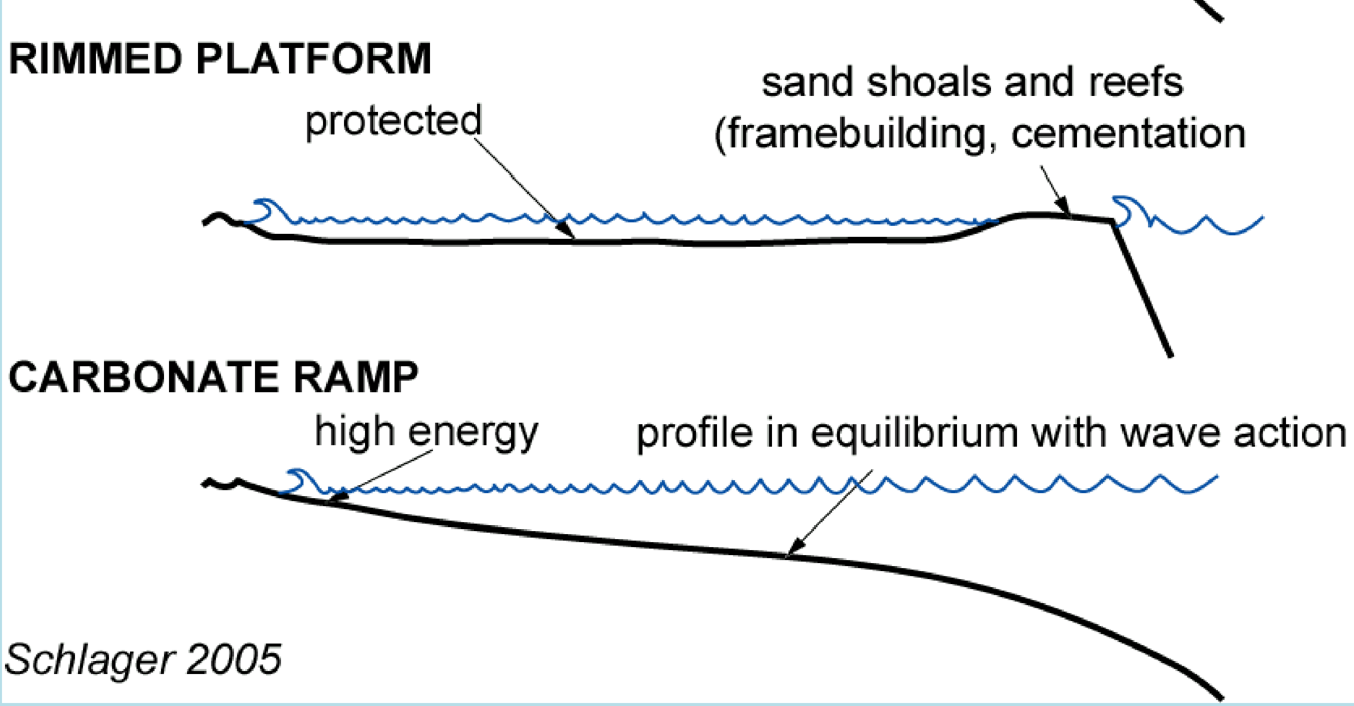
3) Le associazioni di litofacies delle rampe carbonatiche

4) Le modificazioni diagenetiche nelle piattaforme carbonatiche, metodologie di indagine

29 aprile pomeriggio ore 14,00

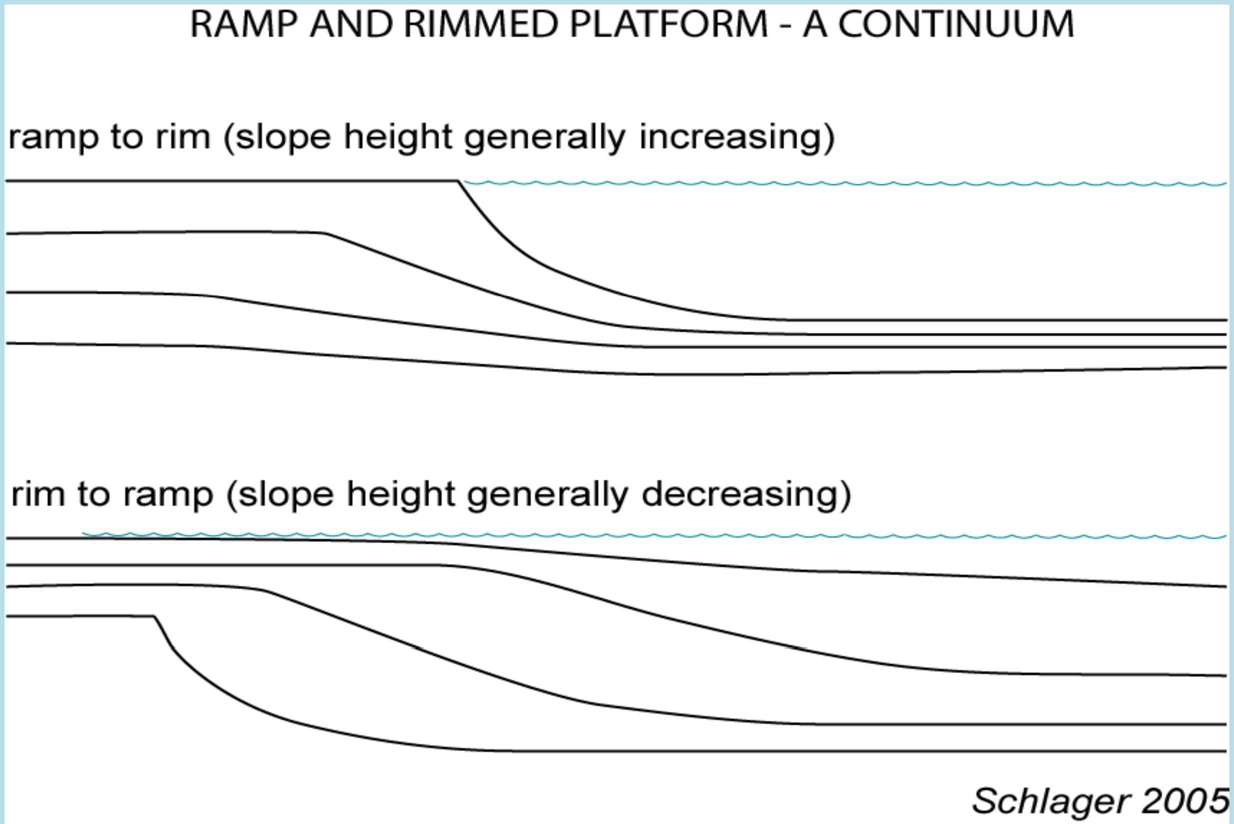
5) Esempi di studi integrati stratigrafico-sedimentologici su sistemi deposizionali carbonatici mesozoici e miocenici

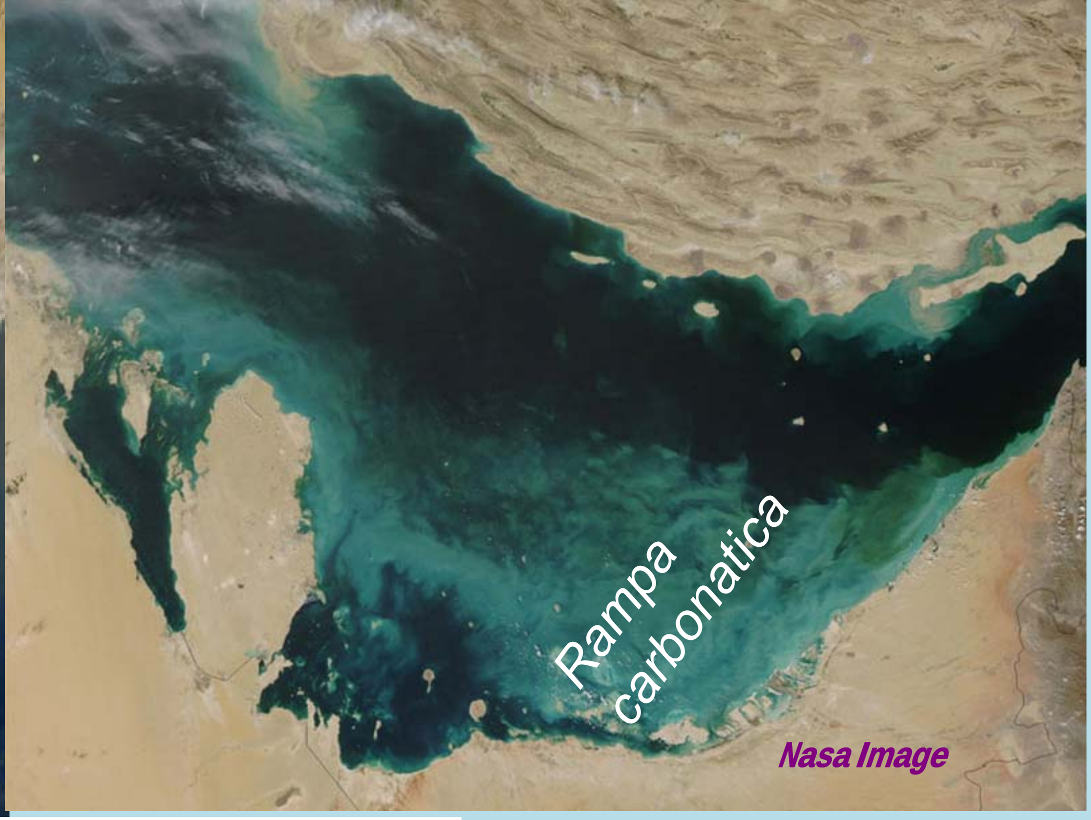
Le rampe carbonatiche e a sedimentazione mista



Costituiscono un modello deposizionale di carbonati e facies miste terrigeno carbonatiche molto diffuse in passato in diversi contesti geodinamici (in particolare nel Permiano, Giurassico-Cretacico, Terziario) .

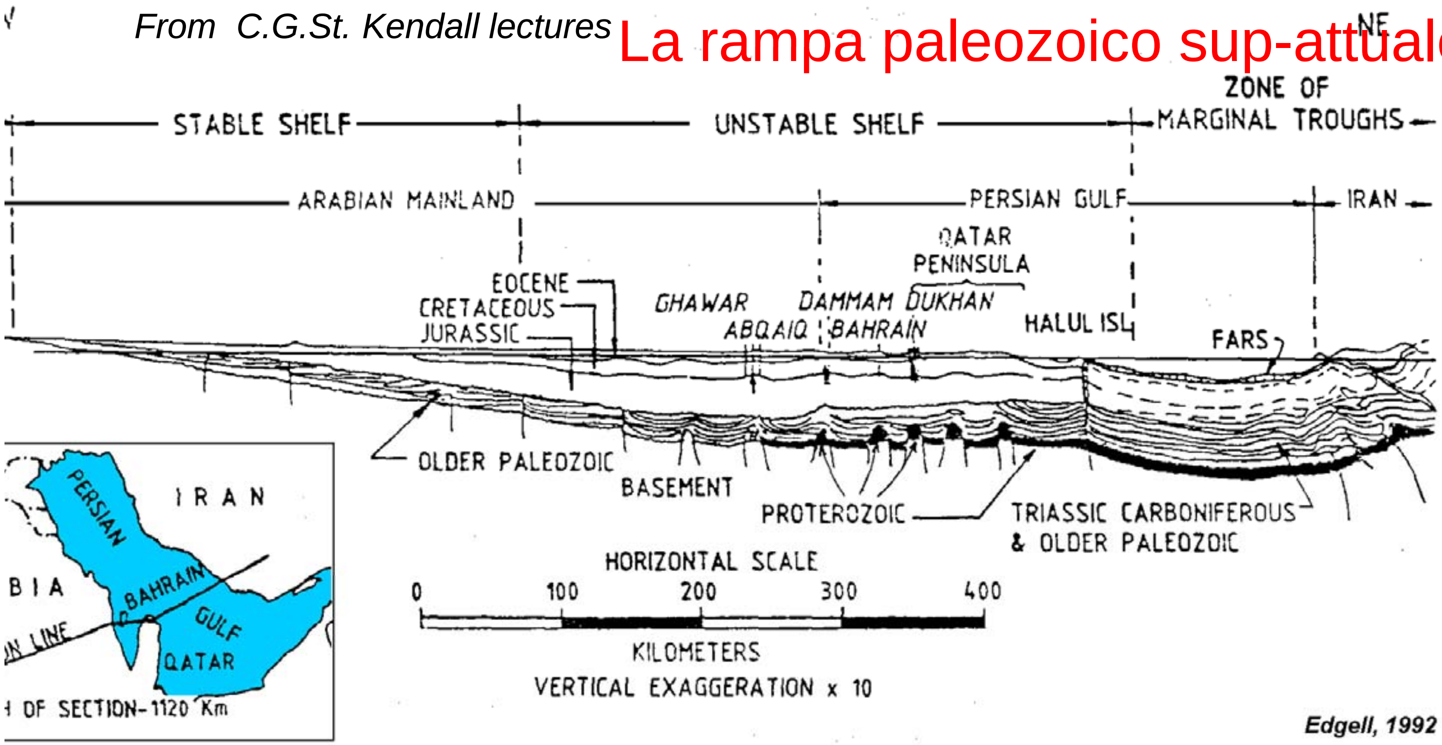
Le rampe possono anche rappresentare l'evoluzione di piattaforme carbonatiche durante importanti eventi di progradazione connessi a abbassamenti relativi del livallo marino





From C.G.St. Kendall lectures

La rampa paleozoico sup-attuale del Golfo Persico



Edgell, 1992

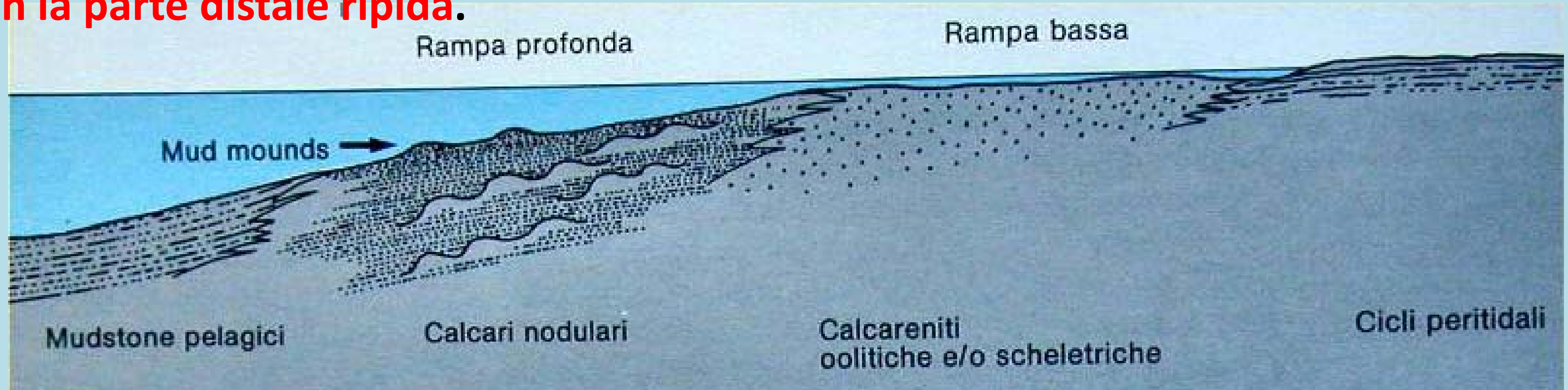
Attualmente il lato arabico del Golfo Persico costituisce il più tipico modello attualistico di rampa a sedimentazione carbonatico-evaporitica

Anche la sottostante successione . permo-terziaria ha sempre mantenuto le caratteristiche delle rampe con sedimentazione da silicoclastica a carbonatica.

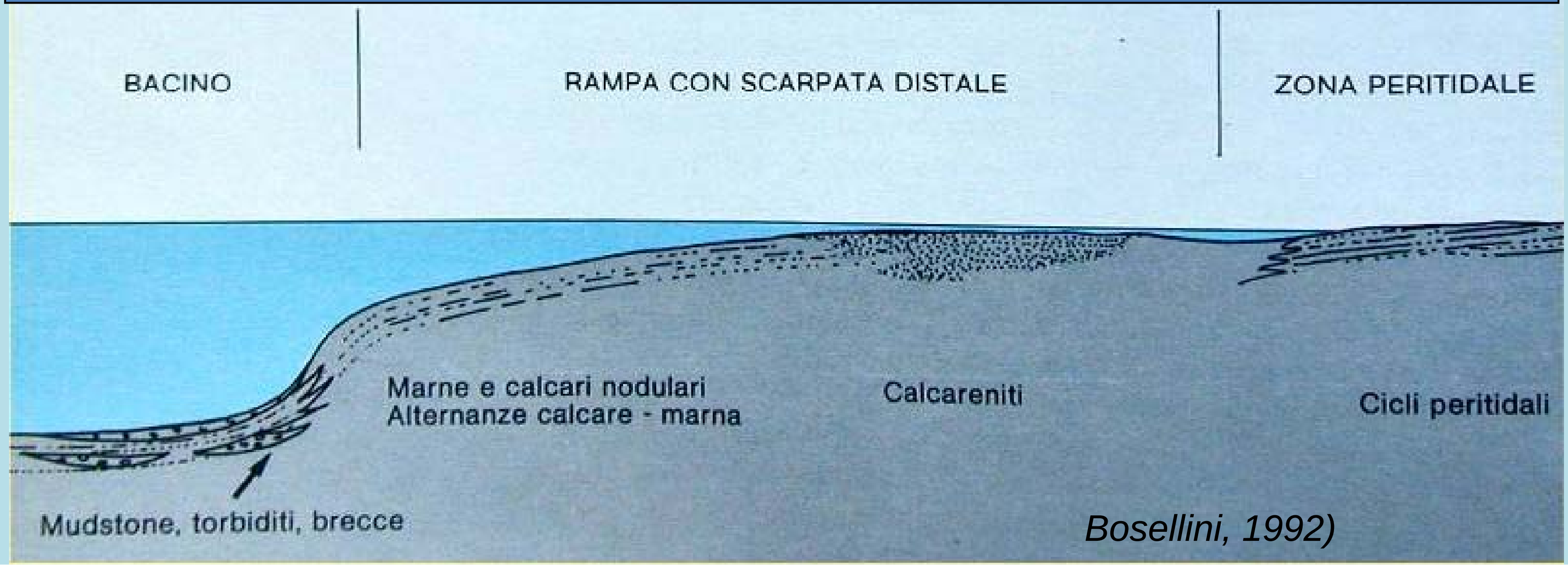
I pendii a basso angolo (1-3°) sono la caratteristica morfologica tipica delle rampe.

Dal punto di vista morfologico si distinguono due tipi di rampa:

- **omoclinalica**
- **rampa con la parte distale ripida**.



Le facies di rampa sono spesso maggiormente influenzate dalle variazioni del livello che possono determinare un'organizzazione ciclica delle facies (calcari fini ben stratificati di rampa distale a calcareniti e calcari oolitici o con fossili (mound, patch reef) della prossimale. In molte rampe si realizza anche una sedimentazione mista pelitico carbonatica.



Bosellini, 1992)

Le rampe carbonatiche e a sedimentazione mista

Gli ambienti deposizionali costieri sviluppati su rampa costituiscono il modello di facies di riferimento per interpretare le successioni miste pelitico-carbonatiche di mare basso.

Successioni carbonatiche o miste di rampa sono anche diffuse in contesti geodinamici tettonicamente instabili (es blocchi di margine passivo tiltati durante una fase del rifting e in fase di progressivo annegamento)

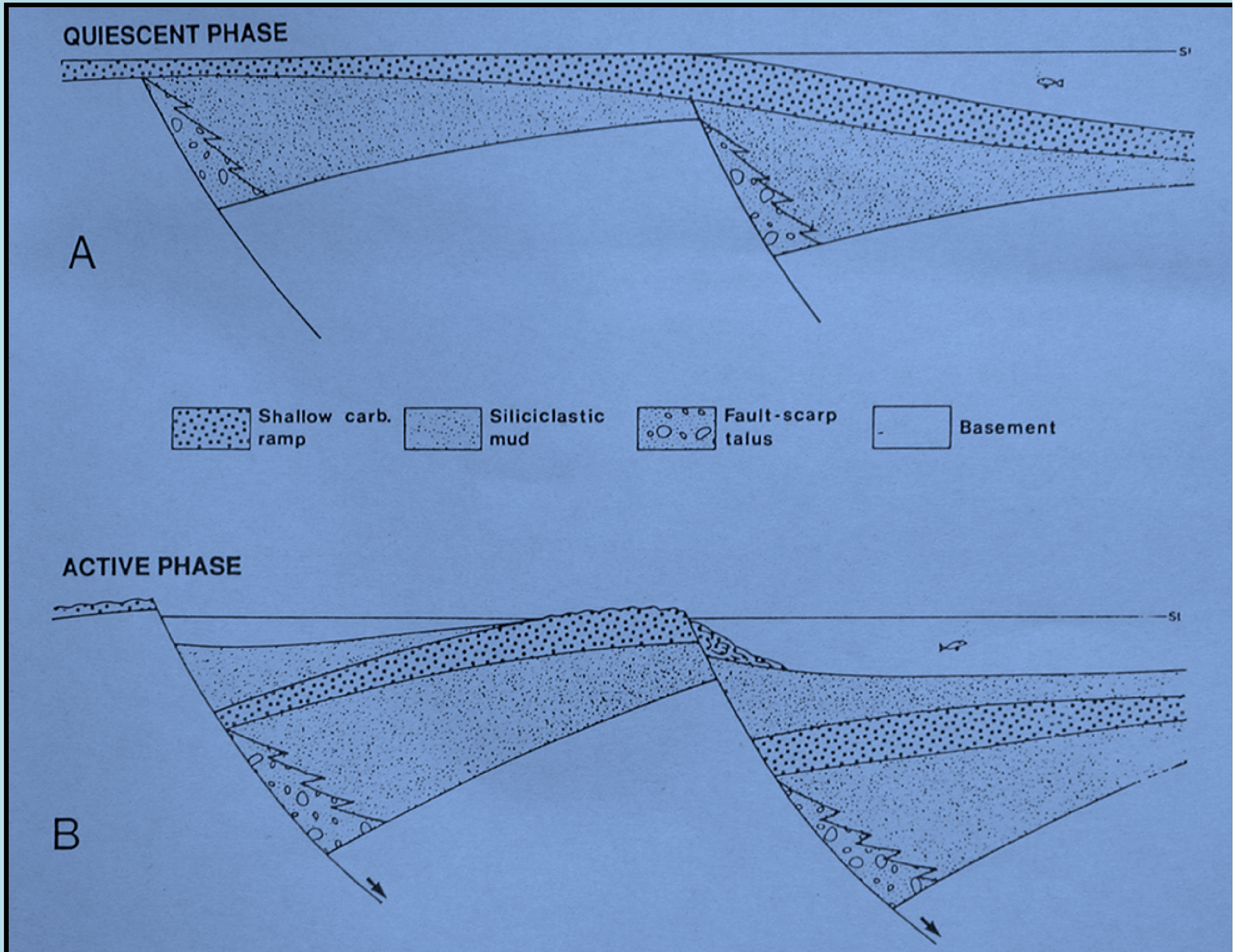


Fig. 8. (A) Example of a ramp in an extensional basin which has prograded over infilled half-graben topography. This is only possible where siliciclastic or carbonate basinal sediments reduce the amount of accommodation space available in the basin and generate a suitably low-gradient substrate for carbonate ramp growth. (B) Subsequent reactivation of faults disrupts the ramp, creating local steep scarps from which material is reworked into debris and turbiditic deposits. Footwall uplift locally exposes the ramp carbonates to karstification. Disruption in this example was accompanied by renewed influx of siliciclastic sediment which contributed to the extinction of the platform. Based on Mississippian examples in Ebdon et al. (1990).

Classificazione delle rampe in funzione dell'energia ambientale prevalente da tempeste, onde o tidale

(Burchette e Wright 1992)

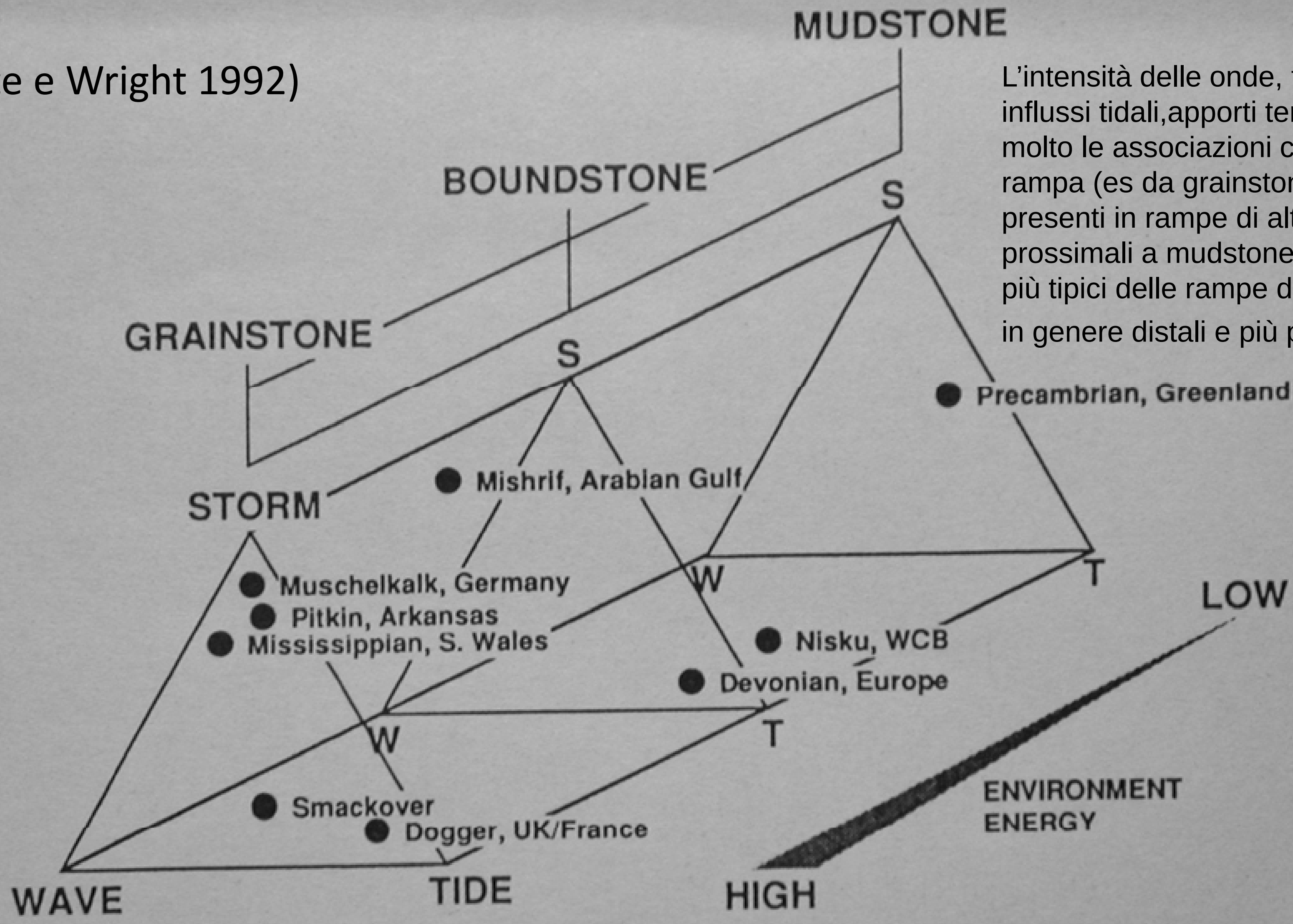


Fig. 2. Ternary diagram showing suggested classification for carbonate ramps based on the degree of storm, wave, or tidal influence which they exhibit in the mid- and inner-ramp zones. An additional axis accommodates the various lithologies which dominate ramp sediments and seem to reflect the level of environmental energy (see arrow). Several representative ramps have been entered. See text for source references on the characteristics of individual ramps.

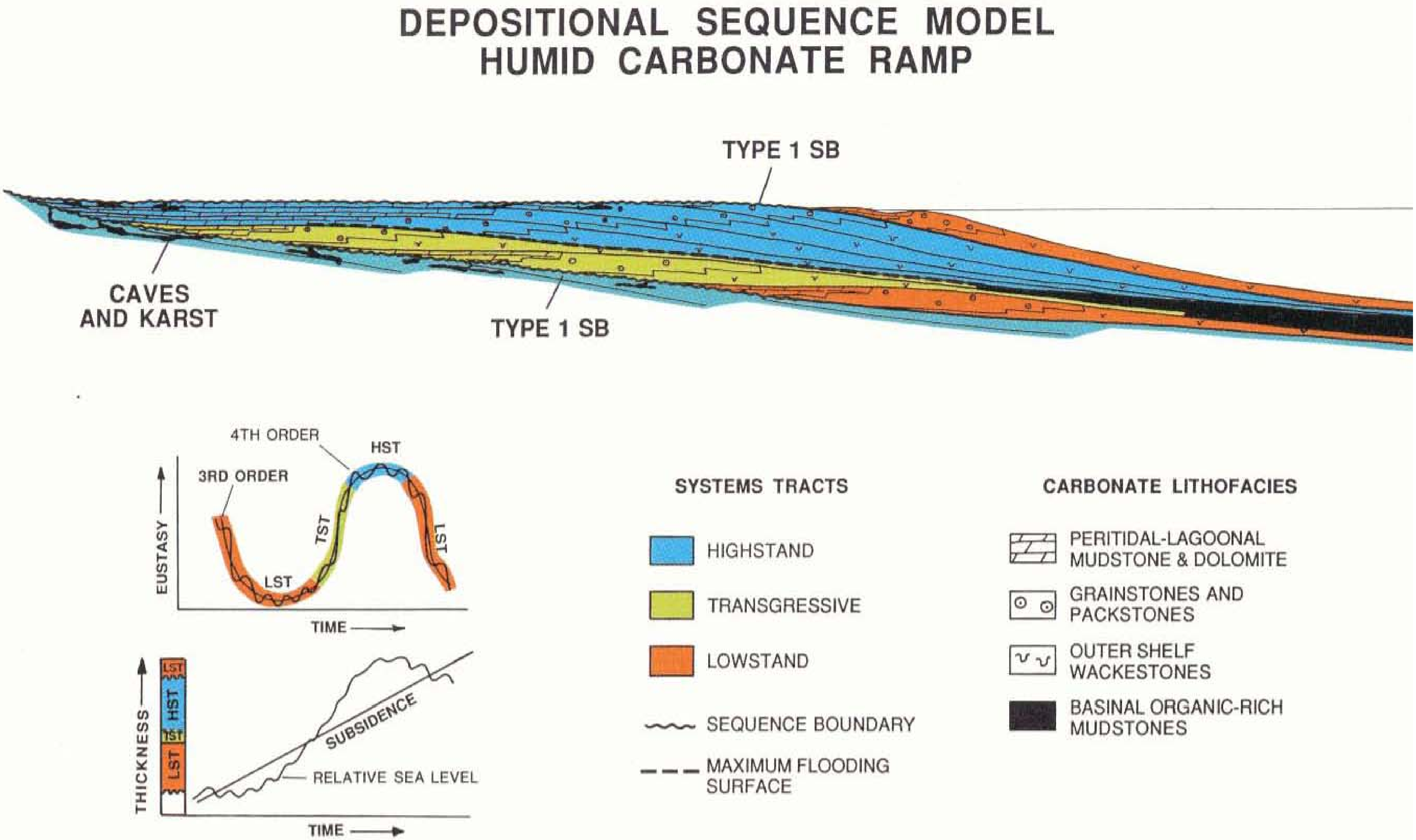
L'intensità delle onde, tempeste, influssi tidali,apporti terrigeni influenza molto le associazioni carbonatiche di rampa (es da grainstones-packstones presenti in rampe di alta energia e più prossimali a mudstones-wackestones più tipici delle rampe di bassa energia, in genere distali e più profonde.

Major controls on the development of carbonate ramp systems

Control	Expression	Significance
Antecedent slope	Low-gradient slope inherited from preceding tectonic or depositional regime.	Important in all settings. Evidenced by the tectonic locations in which ramps occur; exclusively those which generate low gradient slopes and relatively slow subsidence rates, such as orogenic forelands and passive margins.
Water depth	Basinal water depth or basinal sedimentation rate.	Shallow basins are commonly characterized by gentle depositional slopes and moderate to high *basinal* sedimentation rates (sediment production can comfortably fill all available accommodation space). Shallow basin margins promote ramp development by limiting accommodation space.
Sediment production	Rate of *in situ* sediment generation. Biogenic vs. inorganic sediment.	Ramps are low productivity carbonate systems and may therefore drown readily. Ramp sediment production rates show lower shore to basin differential than in rimmed shelves. Sediment production and redistribution on ramps is still poorly understood.
Base-level changes	Rates of relative sea-level rise/fall due to subsidence or eustacy.	Ramps drown readily even without ecological "inhibition". Rapid base-level rises cause incipient drowning whereas high-productivity rimmed shelves can continue to accrete vertically or may evolve from ramp. Many ramps are thin and "stacked", reflecting such incipient drowing events.
Presence/absence framebuilders	Evolutionary or environmental trends which determine presence/absence of major shallow-water carbonate producing organisms.	Ramps have been common in all periods but *dominant* when reef-constructors were rare or inhibited. High rates of sediment production associated with reefs enable "keep-up" sedimentation during rapid base-level rises. Framework construction promotes the development of rimmed shelves.
Oceanographic regime	Windward/leewardness, tides, storms, wave energy, oceanic currents, etc.	Windward ramps are wave- and storm-dominated and grainy sediment is maintained at the shoreline. Wind-entrained sediment may form aeolian dunes. Leeward ramps seem to be low energy and muddy with low grainstone content. Tidal ramps have not been widely documented.

Interpretazione sequenziale di una rampa carbonatica di con clima umido

C. Robertson Handford Robert G. Loucks AAPG mem 57



igure 7. Idealized depositional sequence model for a humid carbonate ramp, associated with type 1 sequence boundaries, showing systems trac acies, and stratal patterns.

Interpretazione sequenziale di una rampa carbonatica di con clima arido

La sedimentazione che può comprendere anche silicoclastici e/o evaporiti.

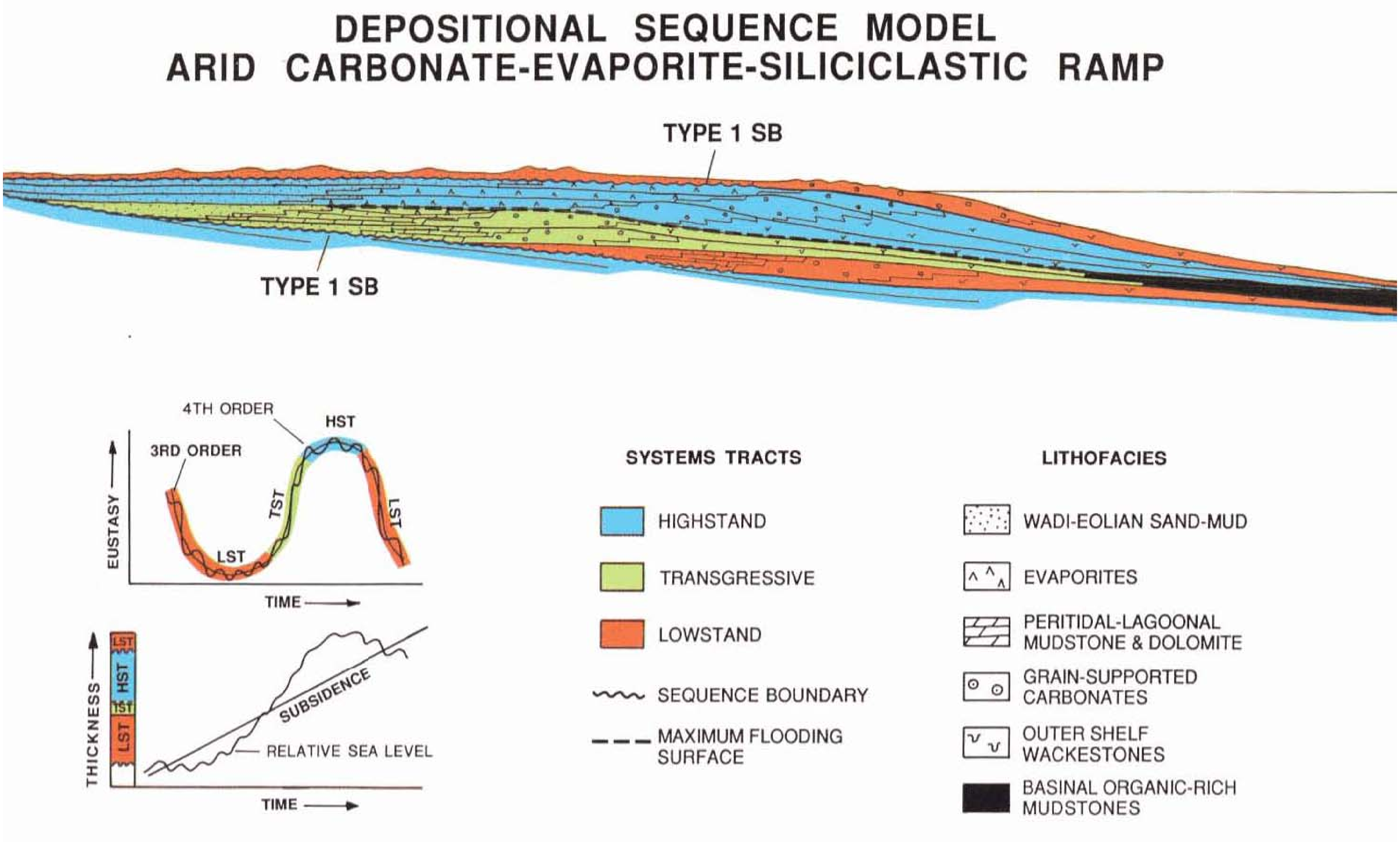


Figure 10. Idealized depositional sequence and systems tract models for an arid carbonate-evaporite-siliciclastic ramp associated with type 1 sequence boun aries. Figure 10 continues on page 25.

C. Robertson Handford Robert G. Loucks AAPG mem 57

La stratigrafia sequenziale nelle successioni di rampa.

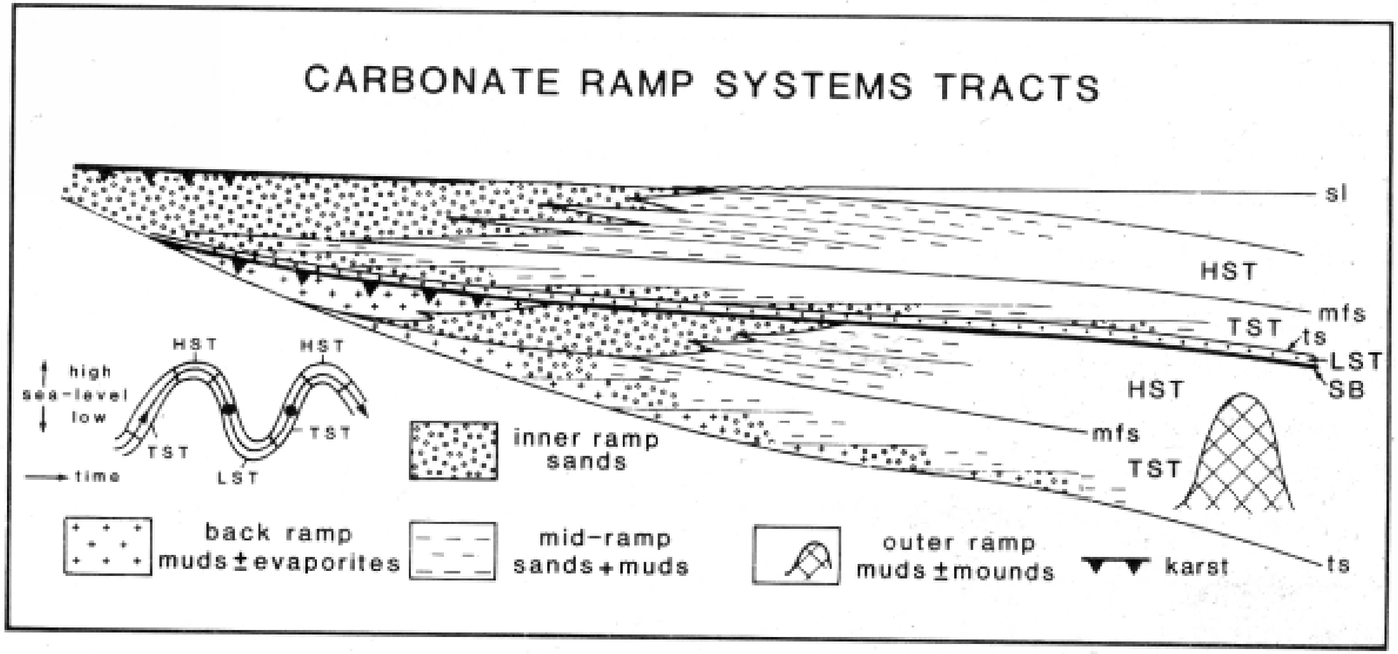


Fig. 18. Depositional systems tracts for a carbonate ramp. The rationale is that stratal patterns are controlled by relative changes of sea-level (determined by eustasy and/or tectonics; see also Fig. 25) and these also control the sediment accommodation potential. During specific time-intervals of the relative sea-level curve, particular depositional systems tracts are established: lowstand (LST), transgressive (TST), highstand (HST) and shelf-margin wedge (SMW, not appropriate here). On a carbonate ramp, deposits of the TST and HST generally form the major part of the sequence. TST strata typically consist of an onlapping, retrogradational package, which may consist of parasequences (each of which will generally be a shallowing-upward cycle). The overlying HST strata will form an aggradational–progradational package, which again may consist of a parasequence set of shallowing–upward cycles. In this figure, the TST and HST of the lower sequence are shown as the facies of a ramp with a barrier shoreline and a back-ramp lagoon, whereas in the upper sequence the TST and HST are shown as the facies of a ramp with a strandplain (see Tucker & Wright, 1990, for a review of carbonate ramp types). The lowstand systems tract may be represented by a paleokarstic surface and calcareous soils, sabkha evaporites, or fluvial-lacustrine facies, depending on the magnitude of the relative sea-level fall, hinterland relief and the climate. SB is the sequence boundary, ts is the transgressive surface, mfs is the maximum flooding surface and sl is sea-level.

Suddivisione batimetrica dei subambienti delle rampe e facies sedimentarie (Burchette e Wright 1992)

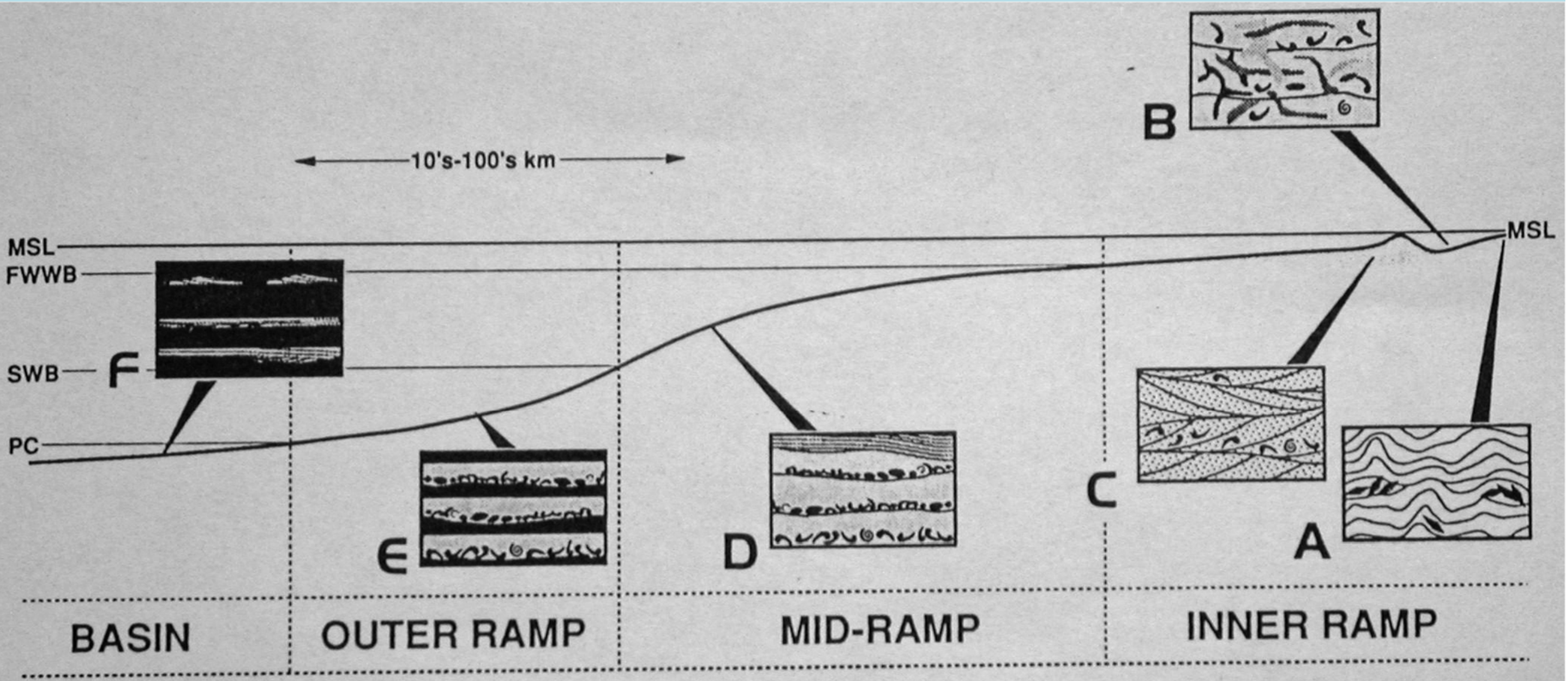
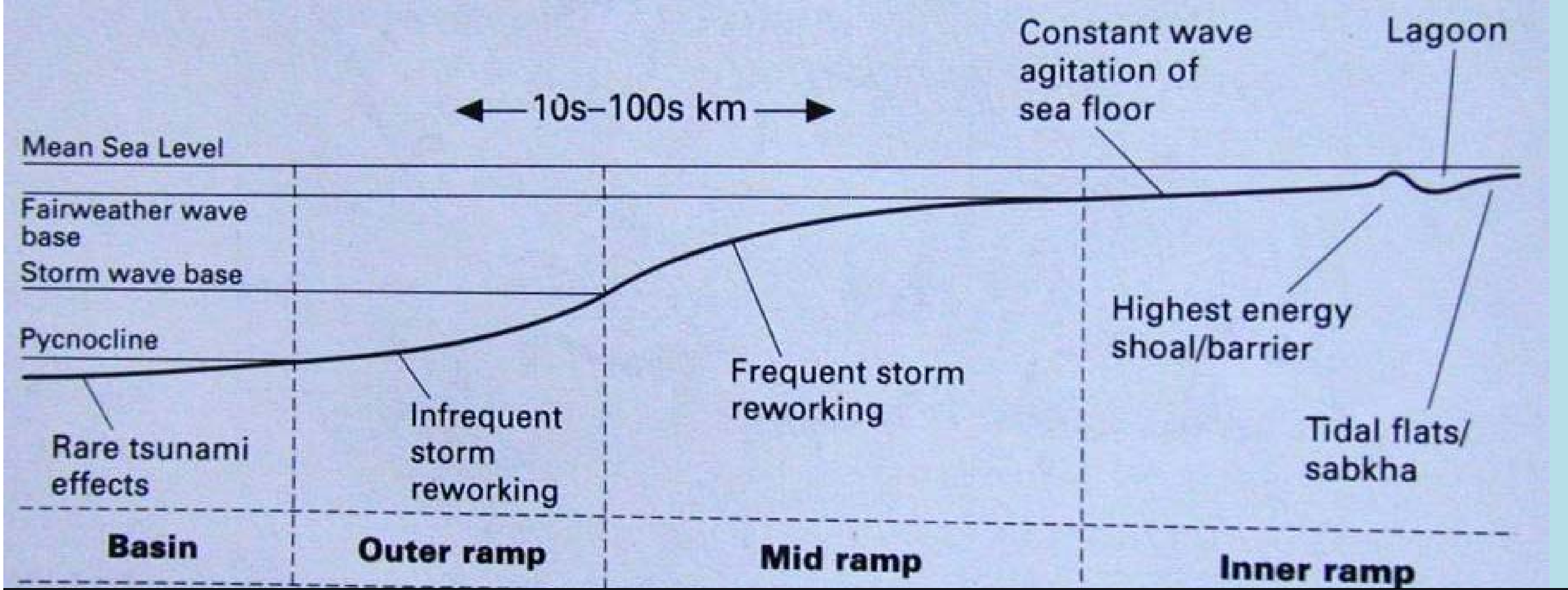
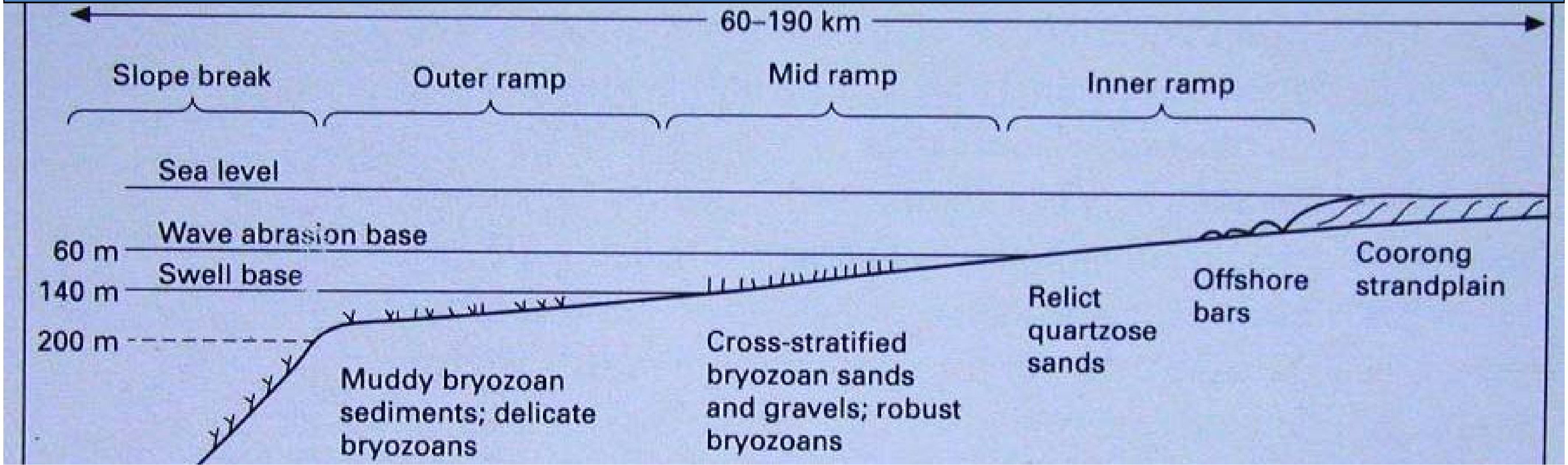


Fig. 3. "Homoclinal" carbonate ramp showing main sedimentary facies. Inner ramp: (A) peritidal and sabkha facies with stromatolitic algae and evaporites; (B) bioturbated and variably bedded lagoonal lime mudstone, packstone, and wackestone; (C) shoreface or shoal cross-laminated oolitic or bioclastic grainstones and packstones. Mid-ramp: (D) amalgamated coarse, graded tempestites, commonly with hummocky cross-stratification. Outer ramp: (E) fine-grained, graded tempestites interbedded with bioturbated or laminated lime or terrigenous mudstone; (F) laminated or sparsely rippled silt-grade carbonate sediment or quartz silt in a predominantly terrigenous mudstone succession. All these boundaries are gradational.



Le associazioni di facies e gli organismi che possono rappresentare le varie parti di una rampa (deep stepening).



Le successioni di rampa sono caratterizzate da una organizzazione delle facies ciclica e in genere la successione appare quasi sempre ben stratificata verso la rampa intermedia ed esterna

Esempi di organizzazione verticale delle litofacies nei cicli di rampa: alla base dominano litofacies pelitiche e/o calcari fini (in genere mudstones di rampa esterna), alla sommità i carbonati granulari (pack-grainstones di rampa interna). Questi cicli evidenziano trend: shoaling ,shallowing, coarsening e thickening upward.

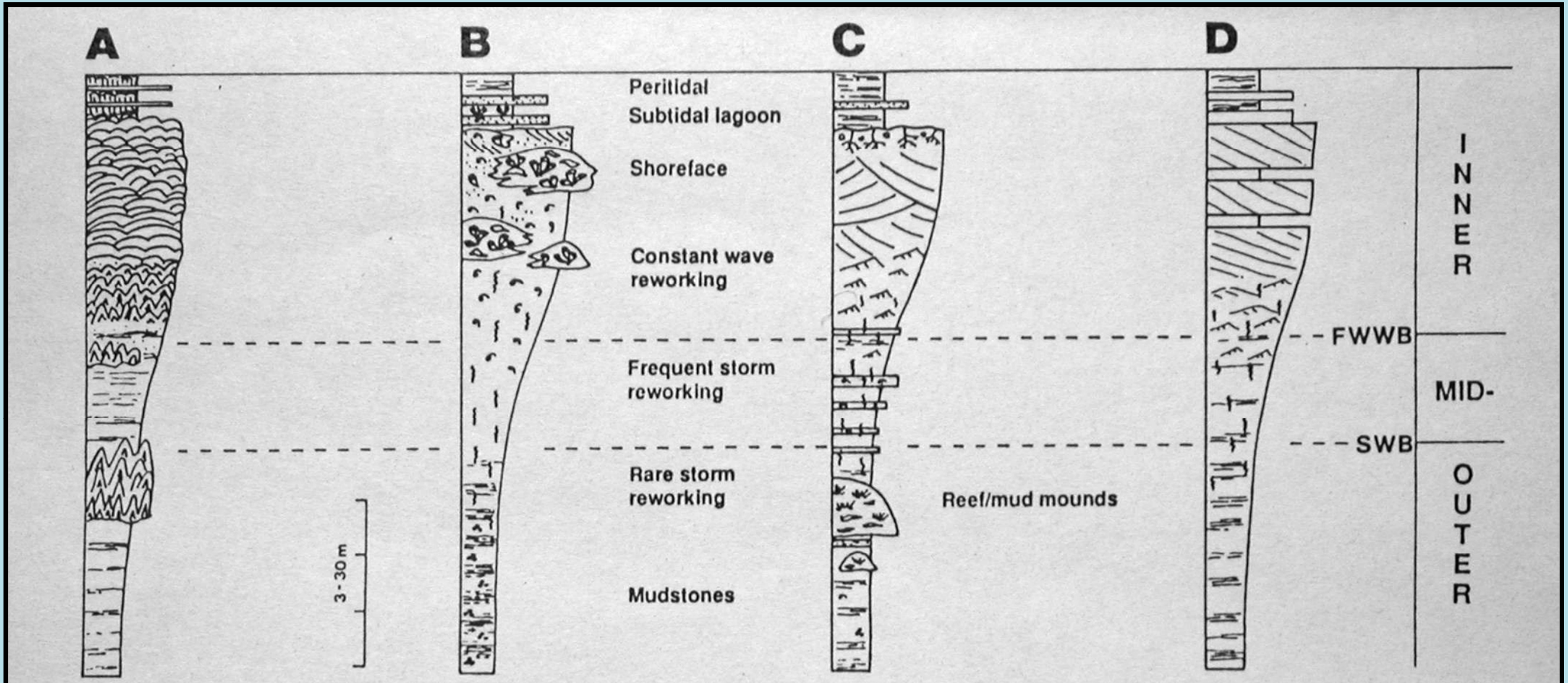


Fig. 4. Highly schematic vertical sections through several end-member ramp depositional systems, showing variation of facies within inner-, mid-, and outer-ramp depositional environments and how these are related to fair-weather wave base (*FWWB*) and storm wave base (*SWB*). (A) Proterozoic stromatolite-dominated ramp, showing variations in stromatolite morphology with depth. Based on Grotzinger (1989). (B) Skeletal boundstone-dominated ramp, typical of early Palaeozoic and later Mesozoic successions. Based on Burchette (1981) and Burchette and Britton (1985). (C) Grainstone-dominated ramp, typical of early Carboniferous and Jurassic, and some modern ramps. Based on Ahr (1973), Baria et al. (1982), and Burchette et. al. (1989). (D) Large-foraminiferan shoal-dominated ramp, characteristic of those in the Paleogene and Early Neogene. Based on Aigner (1983). Profiles are valid for

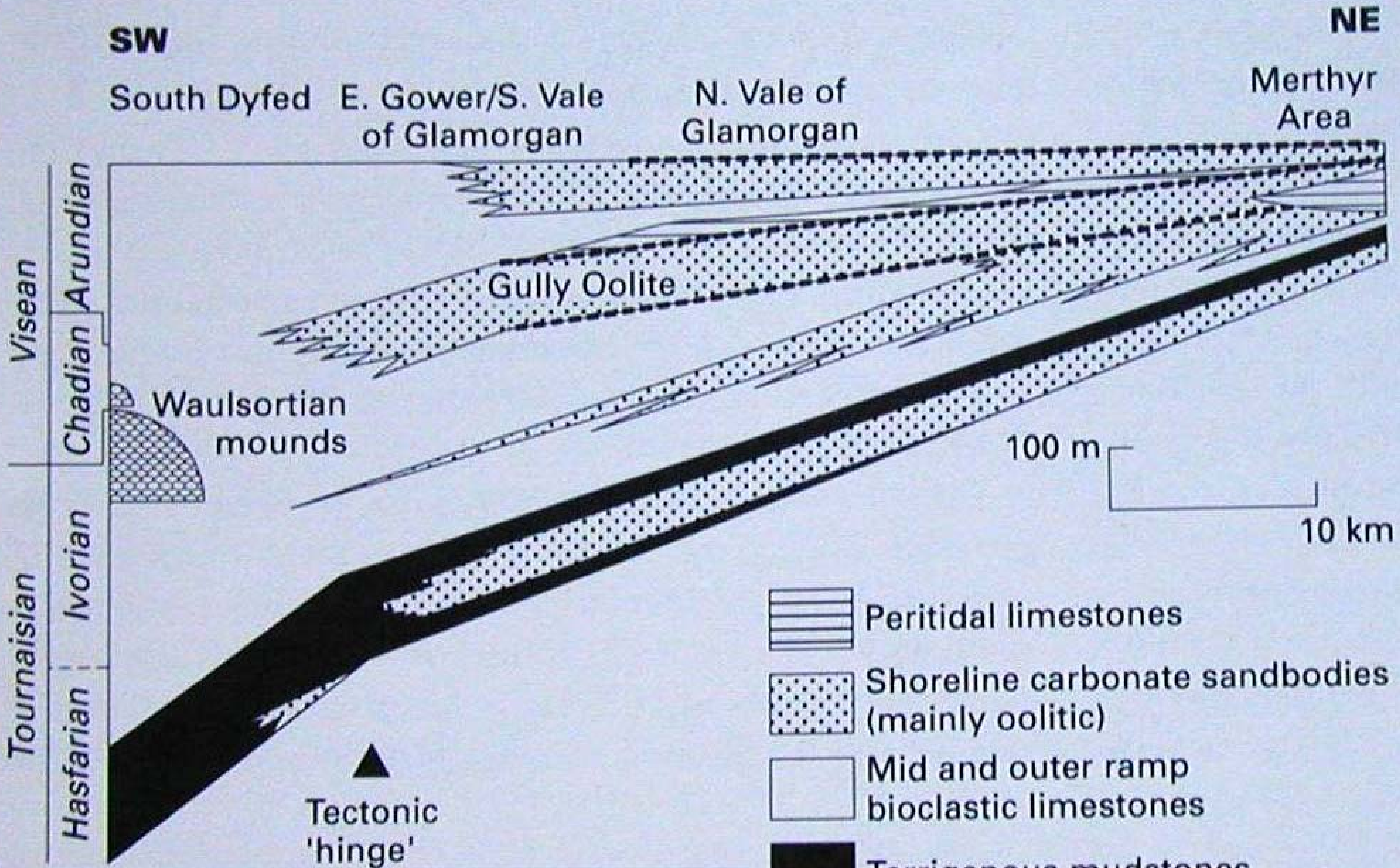
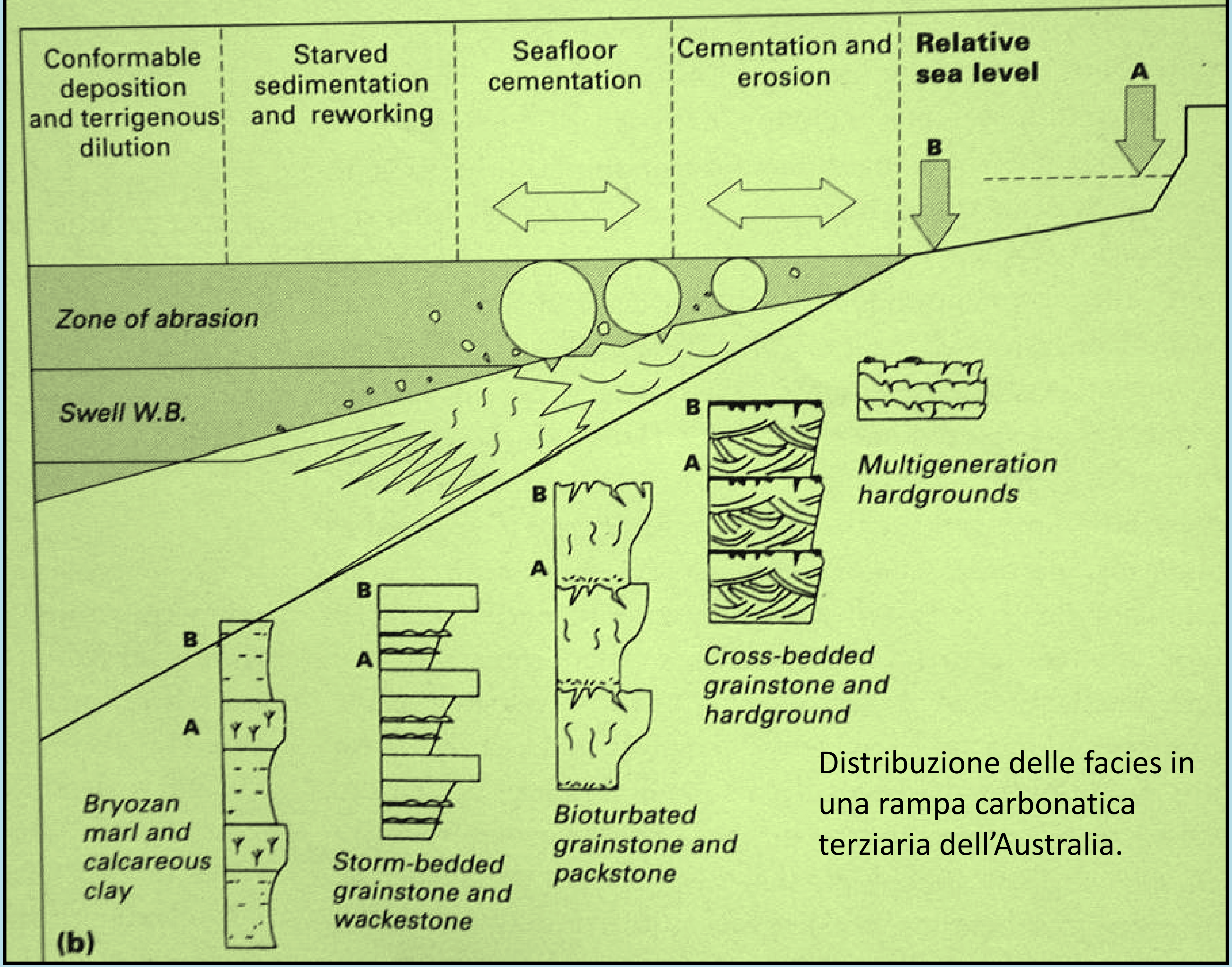
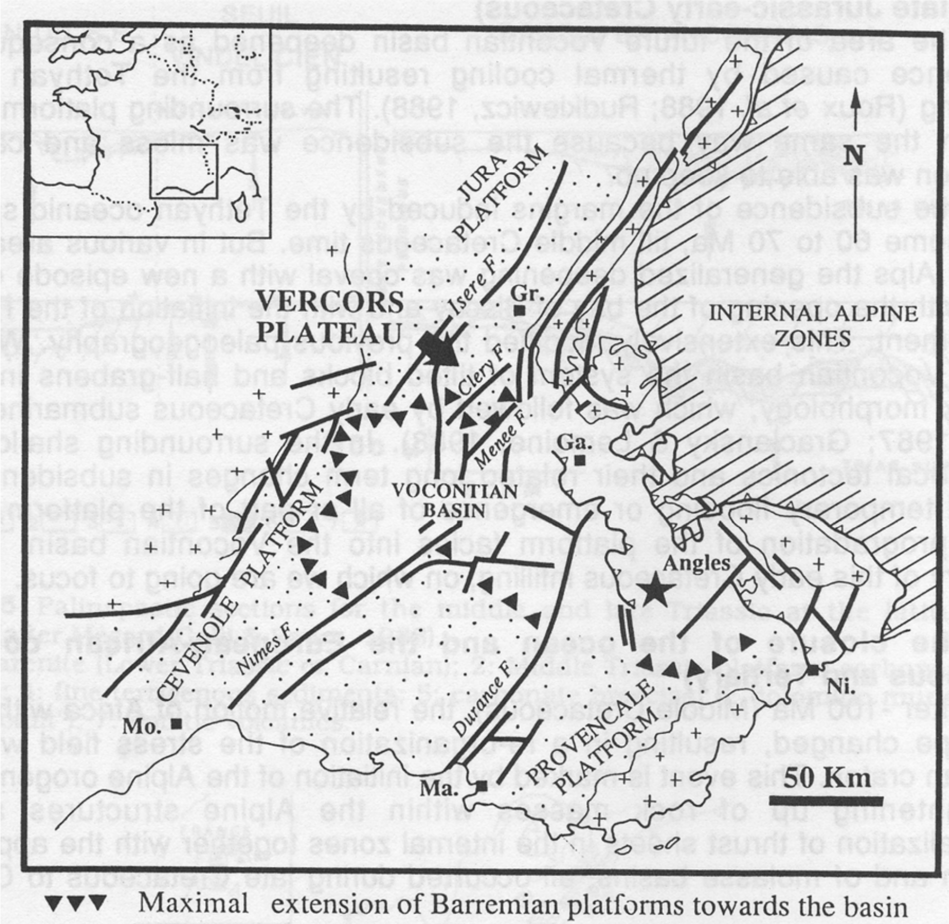


Figure 9.19 Early Carboniferous ramp stack, south Wales (after Burchette, Wright & Faulkner, 1990).



Distribuzione delle facies in una rampa carbonatica terziaria dell’Australia.

Esempi di rampe carbonatiche



La successione Cretacica sup. della Francia meridionale (Vercour)

(T. Jacquin, Arnaud Vanneau, 1992)

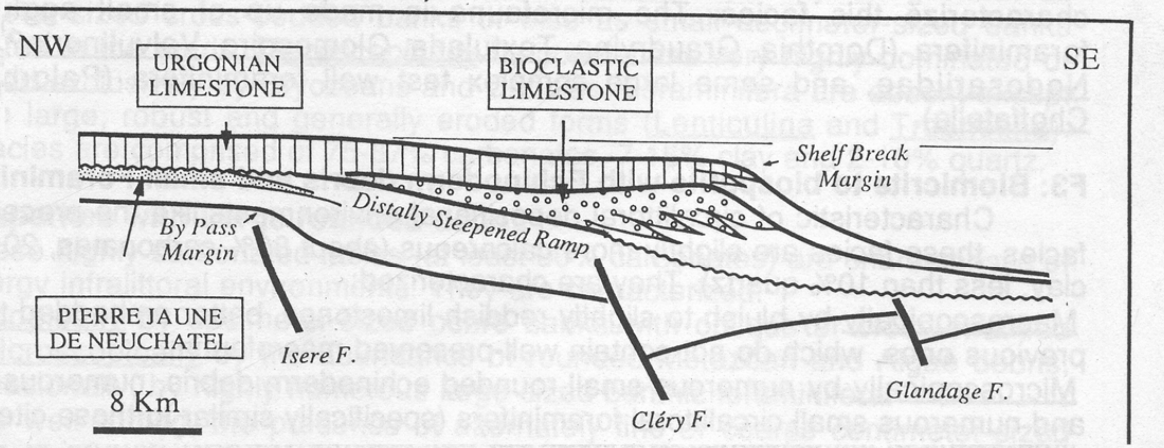


Figure 10 Composite cross-section from the Vercors Plateau (Jura platform) to the adjacent Vocontian basin. Note that the erosional truncation related to sequences boundaries H7 and B1 extends basinward and stops landward in the area of the extensional faults ("Cléry faults" on Fig. 9). These faults determine a break in slope where slope fan deposits pinch out.

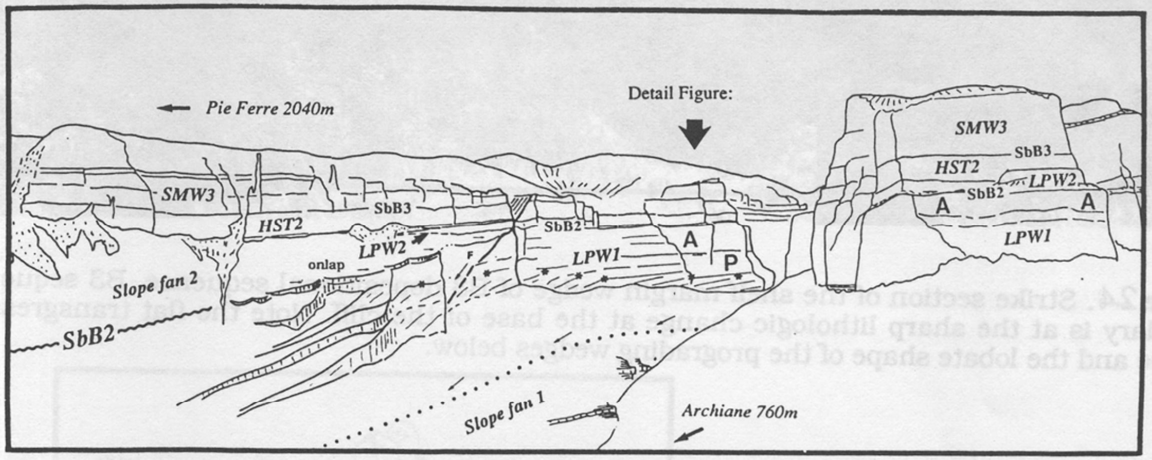
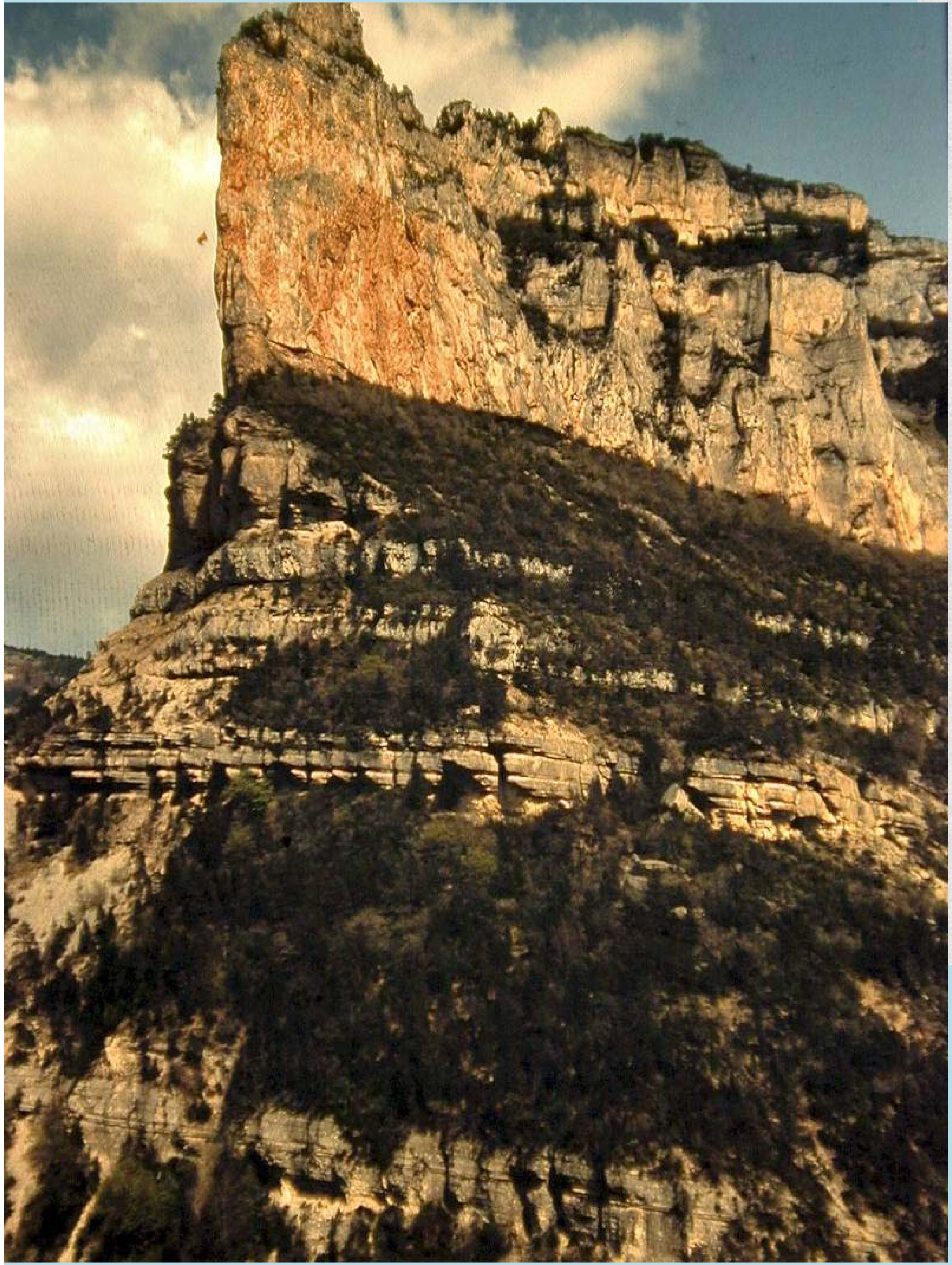


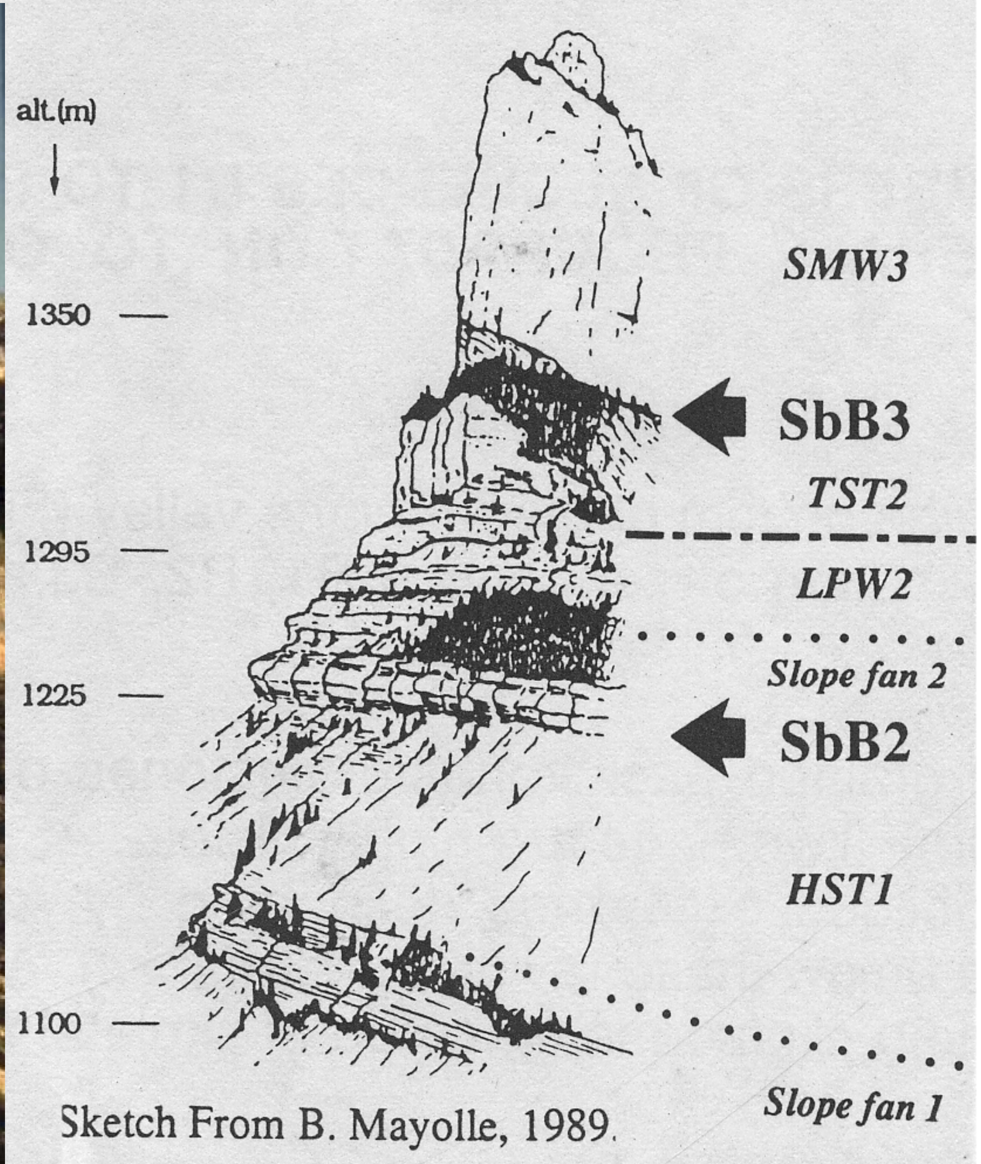
Fig 23 Geometry of the shelf margin during deposition of sequences B1 and B2 in the bottom of the Archiane Valley and along its eastern side. The small asterisks within LPW1 indicate the successive points of offlap break. They show that they prograde (P) and then aggrade (A), which is the typical signature of a lowstand prograding complex

La successione carbonatica del Cretacico (Barremiano) delle Alpi occidentali (Vercour, Provenza).

Si osservano due edifici carbonatici interpretati il superiore rappresenta una successione di rampa poco inclinata (omoclinalica), l'inferiore presenta invece a sinistra una blanda clinostratificazione e il passaggio per interdigitazione alle facies di bacino (deep steepened ramp ?) (copertura vegetale).

Dettaglio della una successione carbonatica con evidenti clinoformi nella parte centrale.





Dettaglio della successione stratificata inferiormente (bacino- rampa distale e della soprastante piattaforma progradante (le sigle evidenziano l'interpretazione sequenziale).