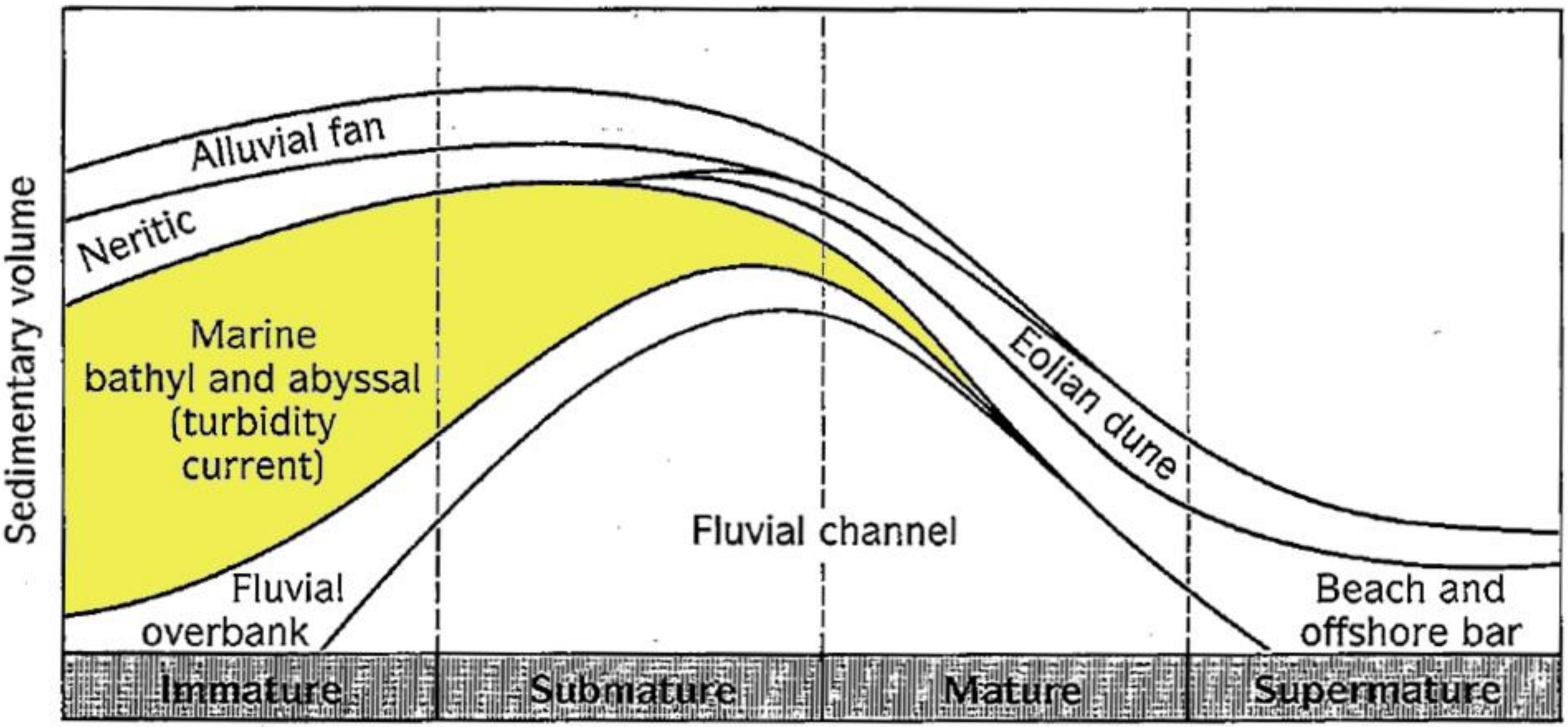
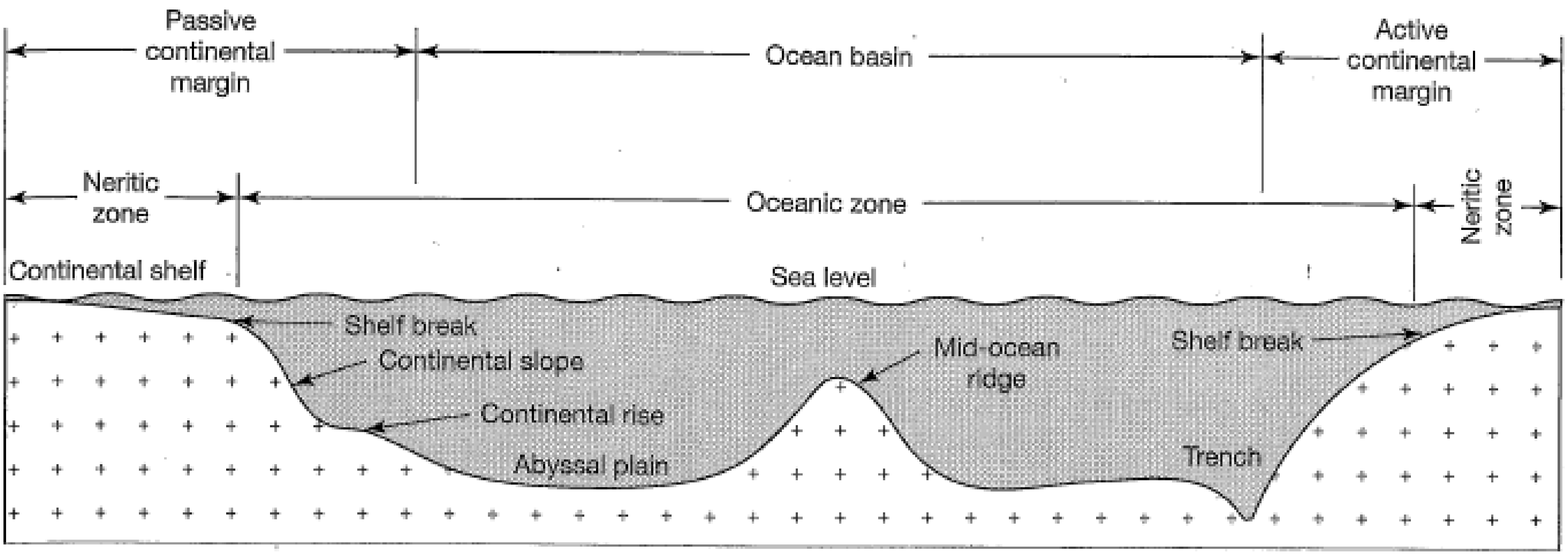
GEOL-201
Marginal to Deep Marine Depositional Environments

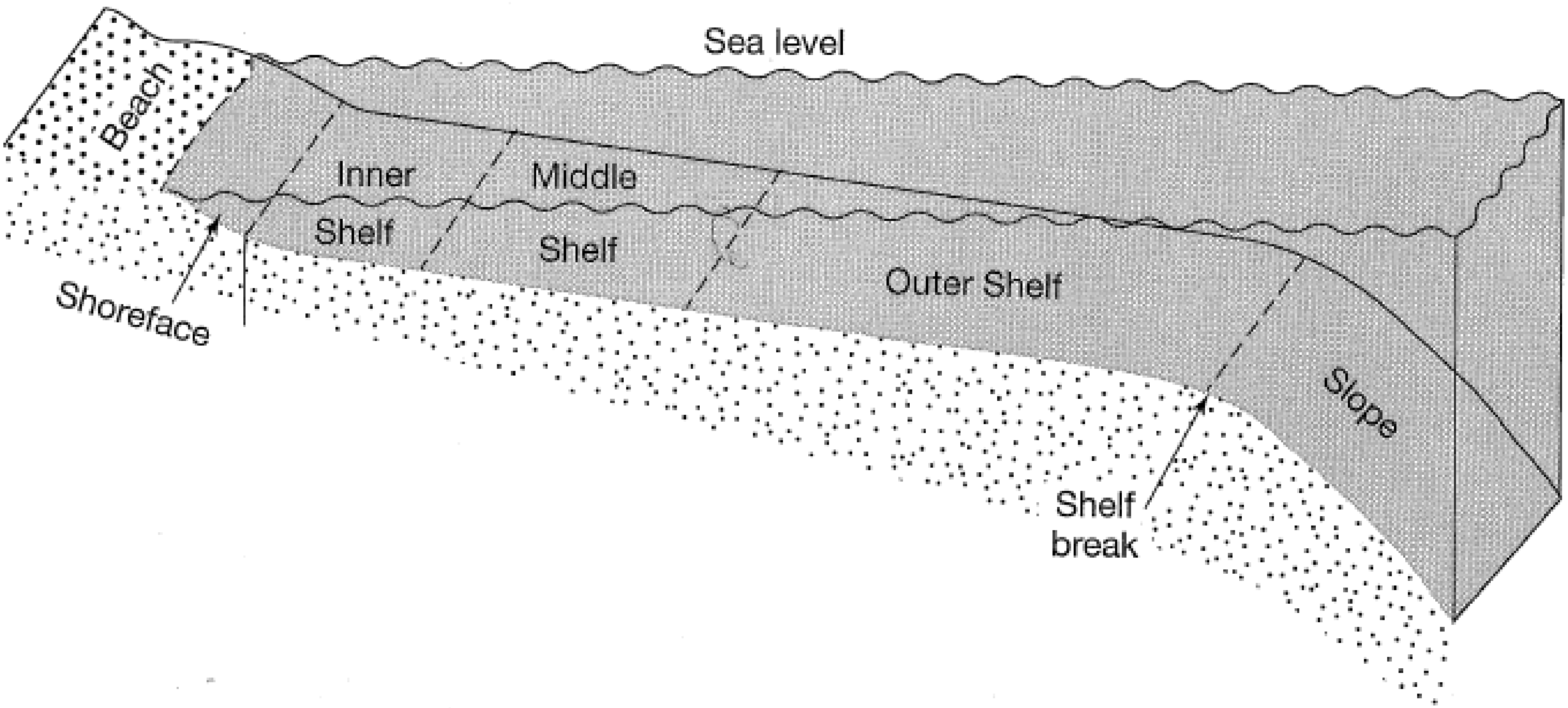
Sandstones


Alluvial fan
Neritic
Marine
bathyl and abyssal
(turbidity
current)
Fluvial
overbank
Fluvial channel
Eolian dune
Beach and
offshore bar
Sedimentary volume
Immature
Submature
Mature
Supermature

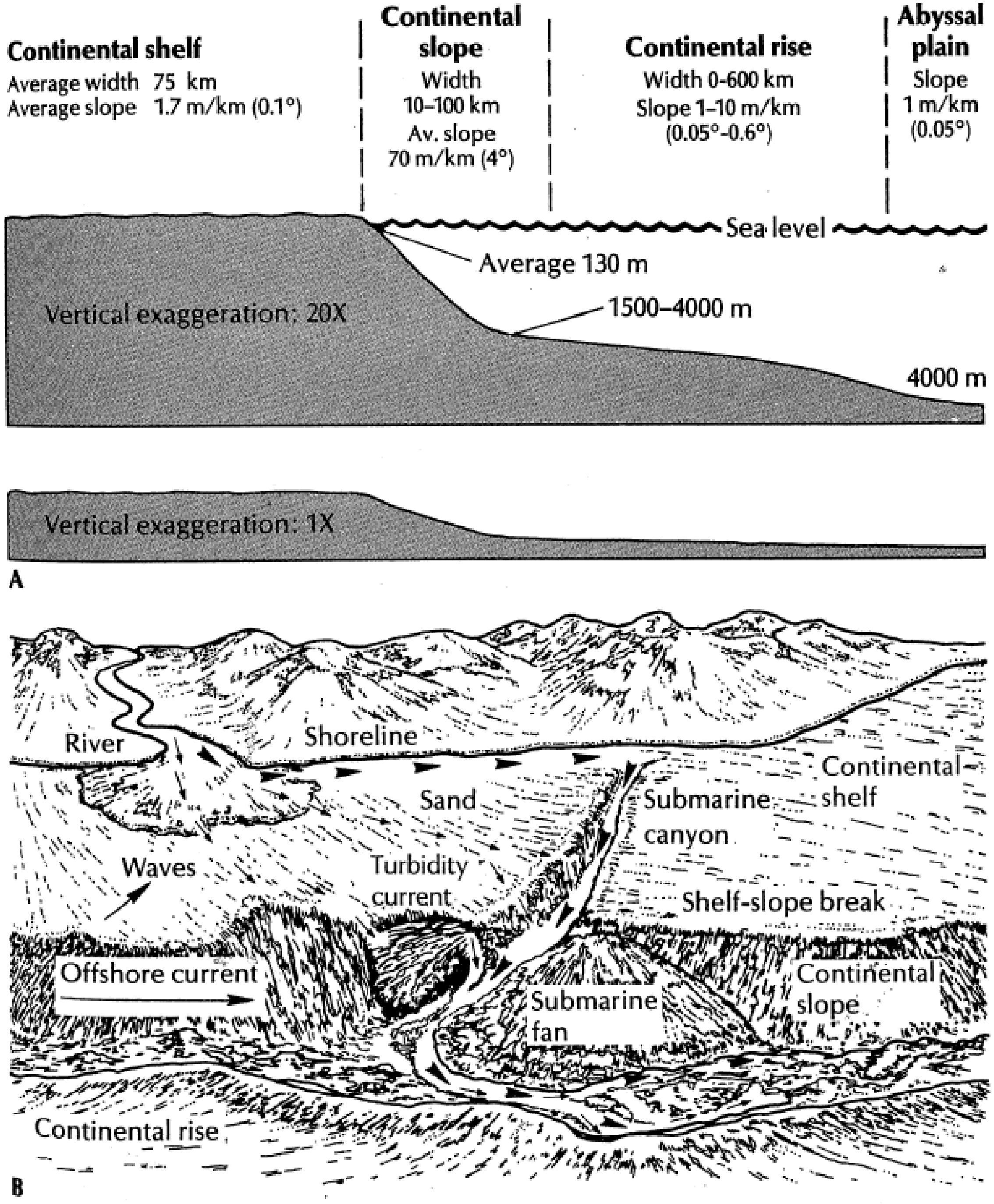
Ocean bathymetry



Boggs, 2006

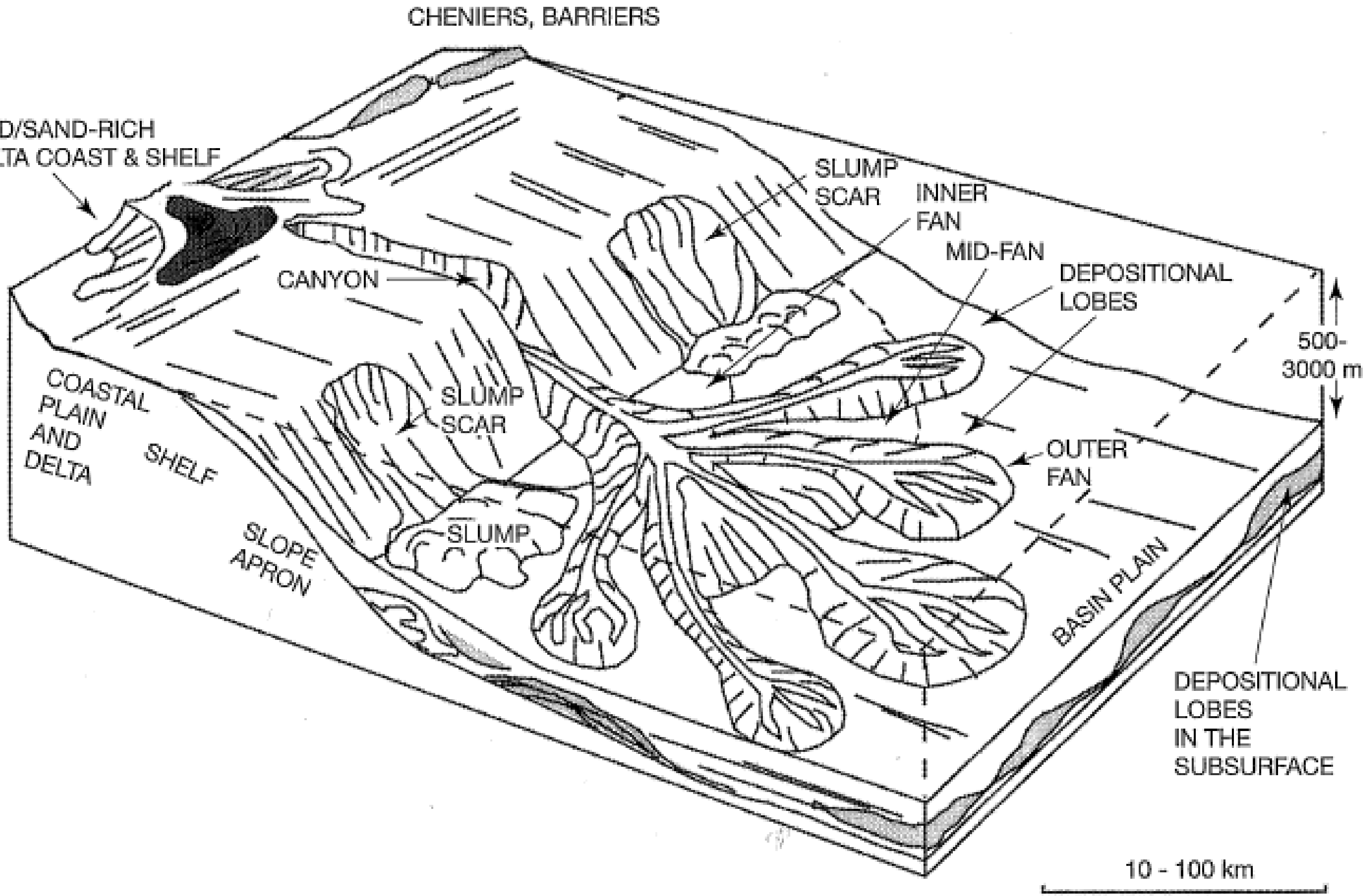

Sea level
Beach
Inner
Shelf
Middle
Shelf
Outer Shelf
Shoreface
Slope
Shelf
break

Boggs, 2006



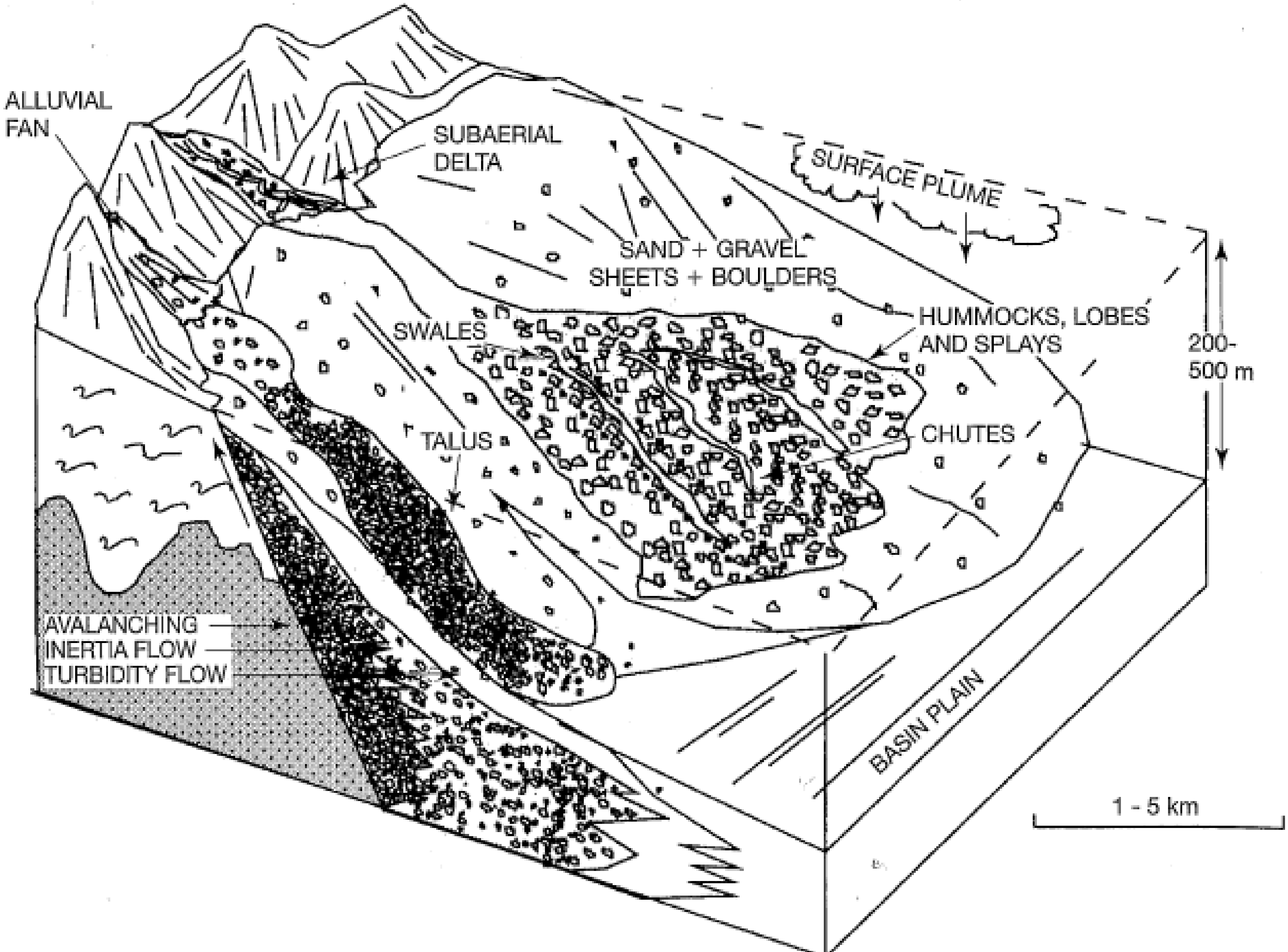
Prothero and Schwab, 2004

Sand-rich sub-marine fan



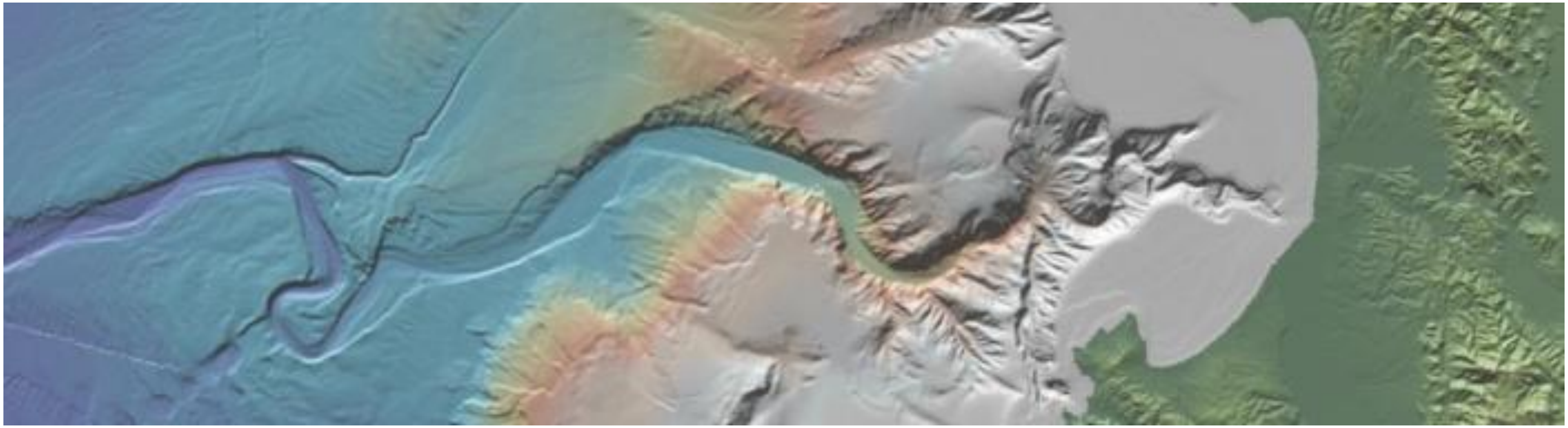
Boggs, 2006

Gravel-rich sub-marine fan



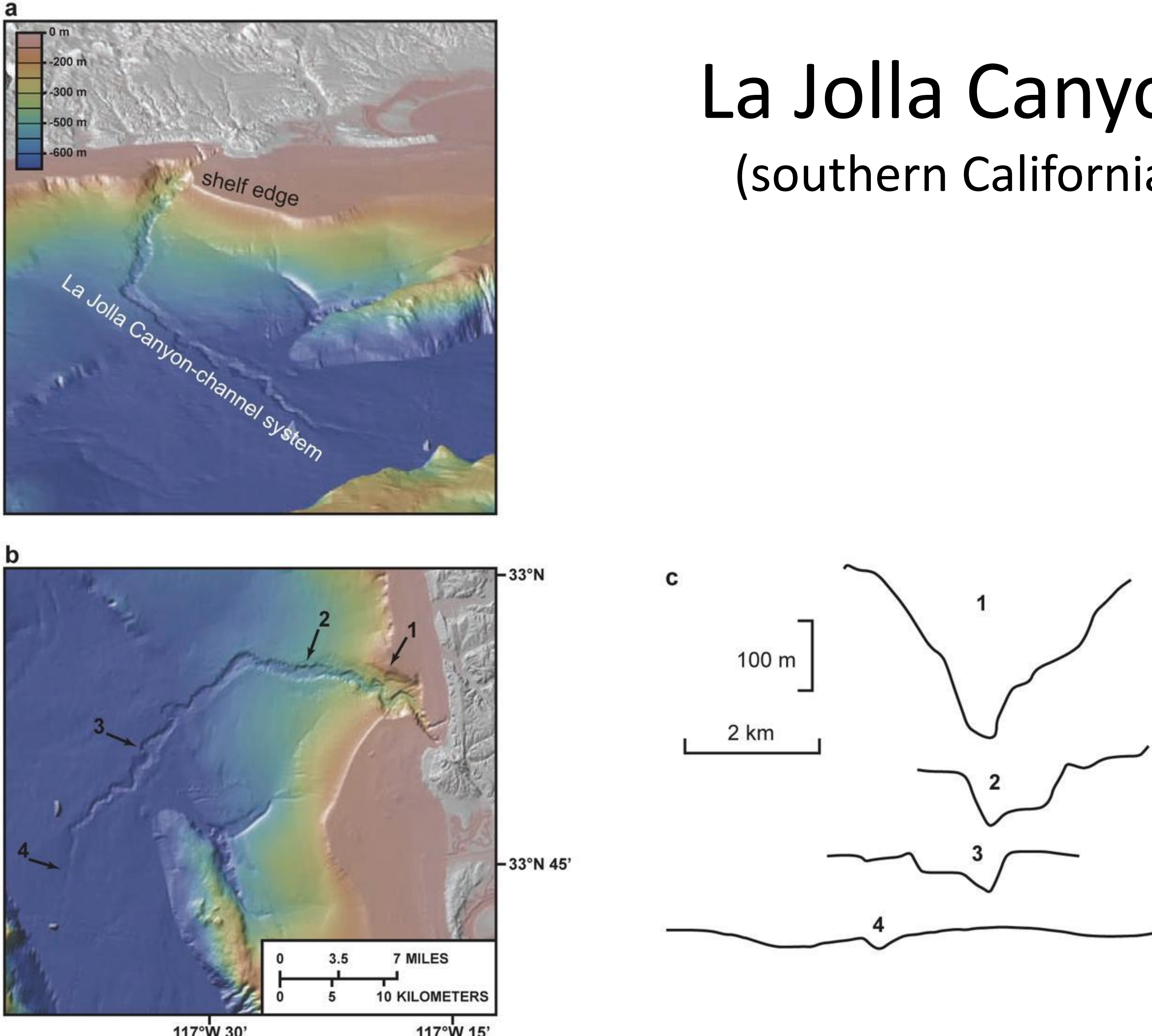
Boggs, 2006

Modern Submarine Fans

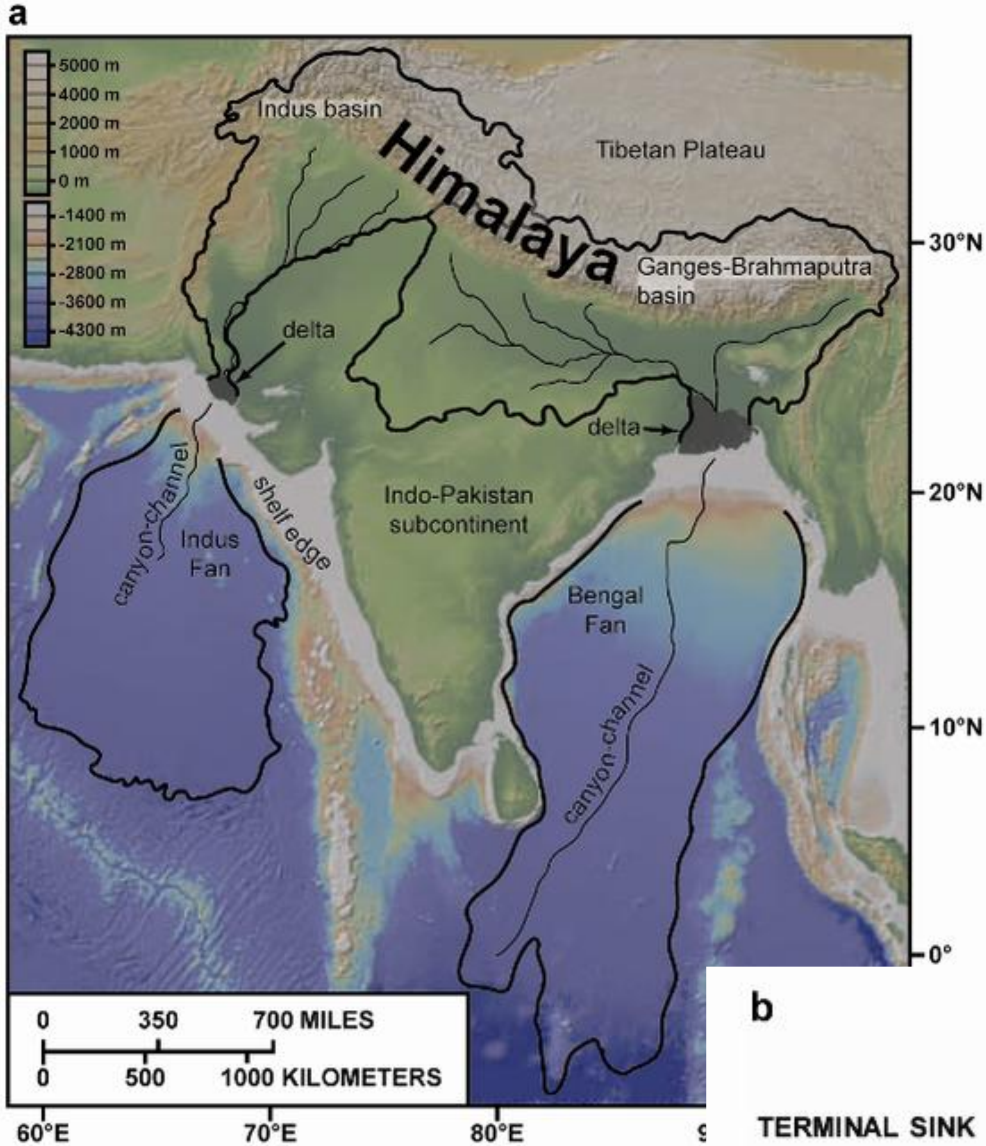


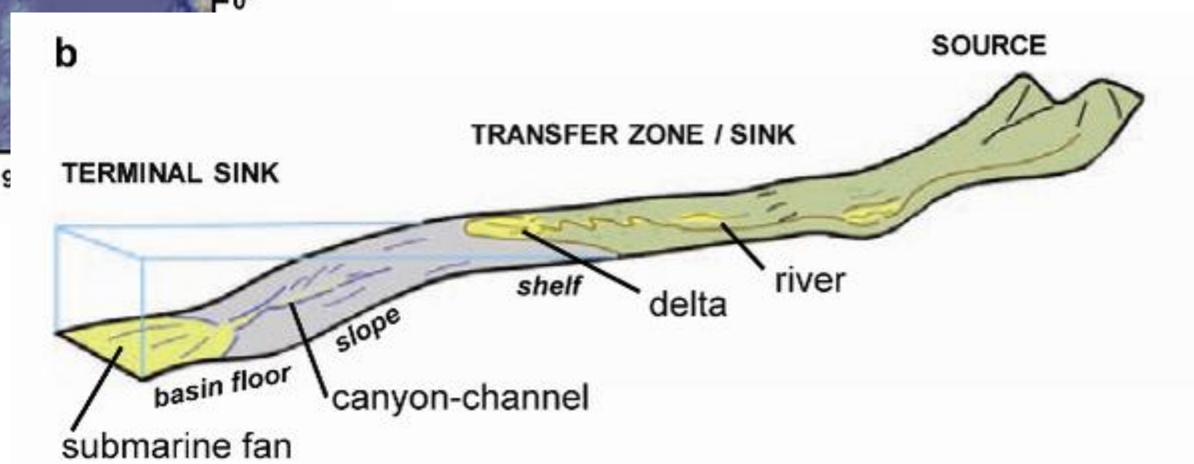
Covault, J. A. (2011) Submarine Fans and Canyon-Channel Systems: A Review of Processes, Products, and Models. Nature Education Knowledge 2(12):4
http://www.nature.com/scitable/knowledge/library/submarine-fans-and-canyon-channel-systems-a-24178428

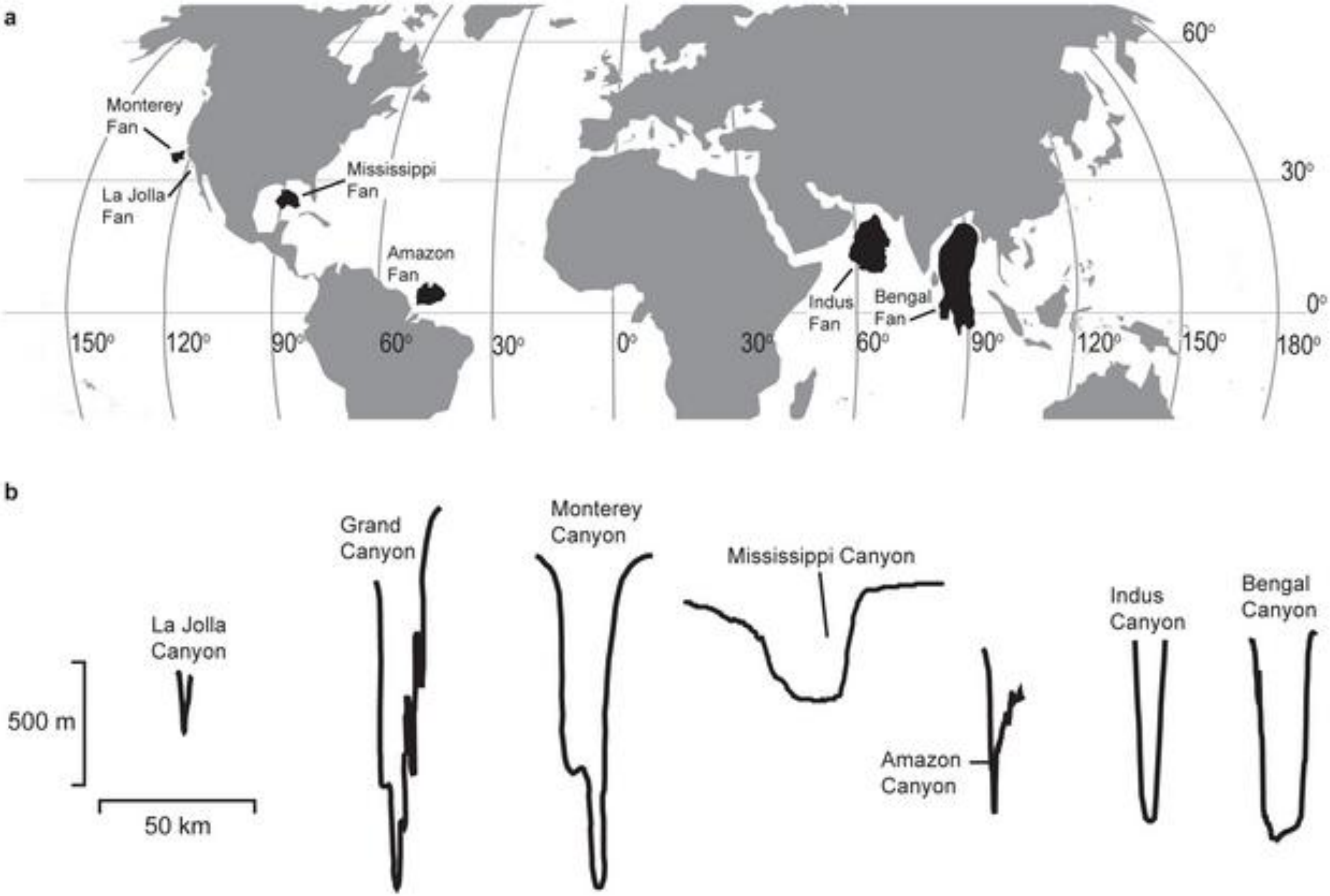
La Jolla Canyon
(southern California)

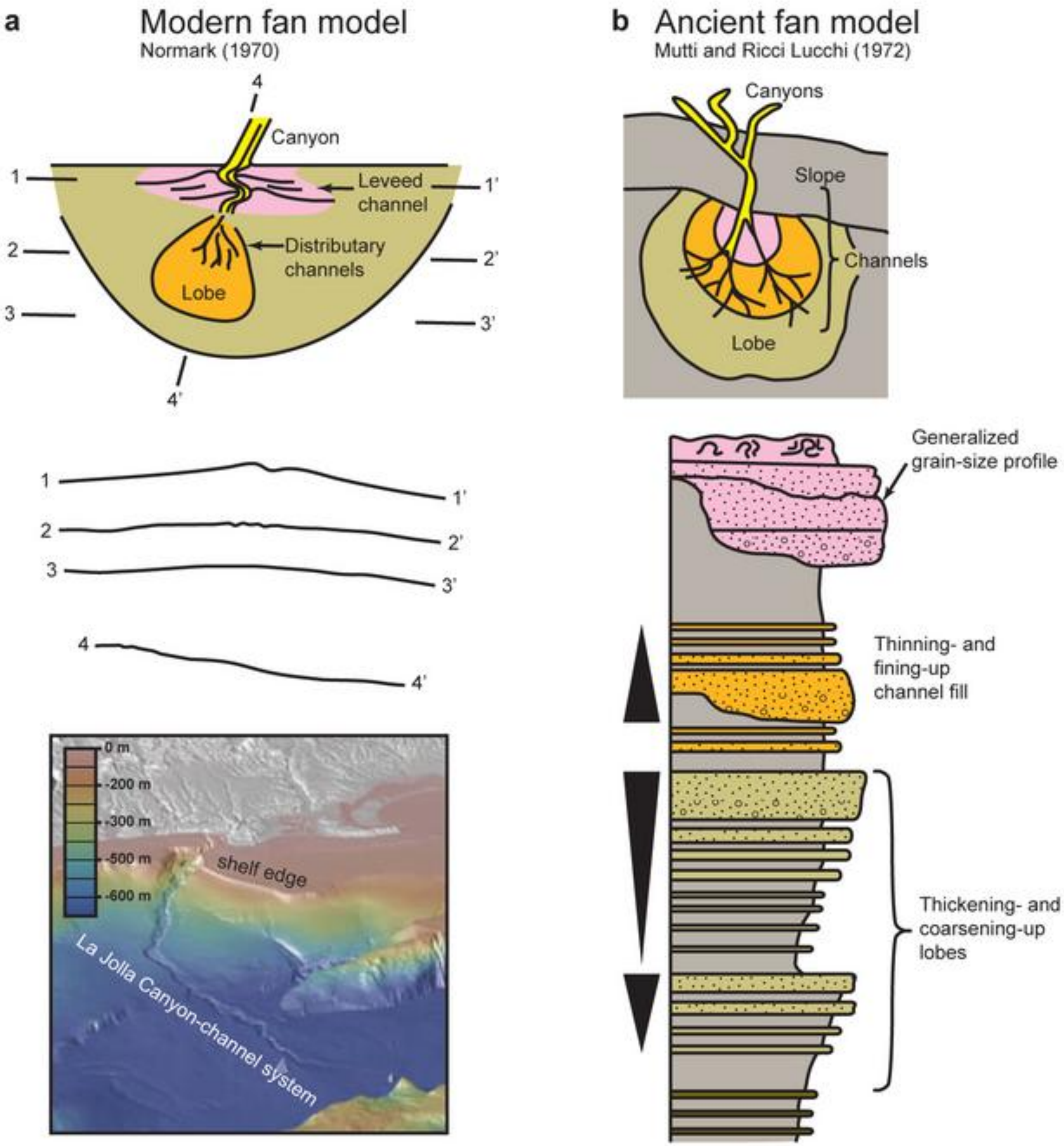


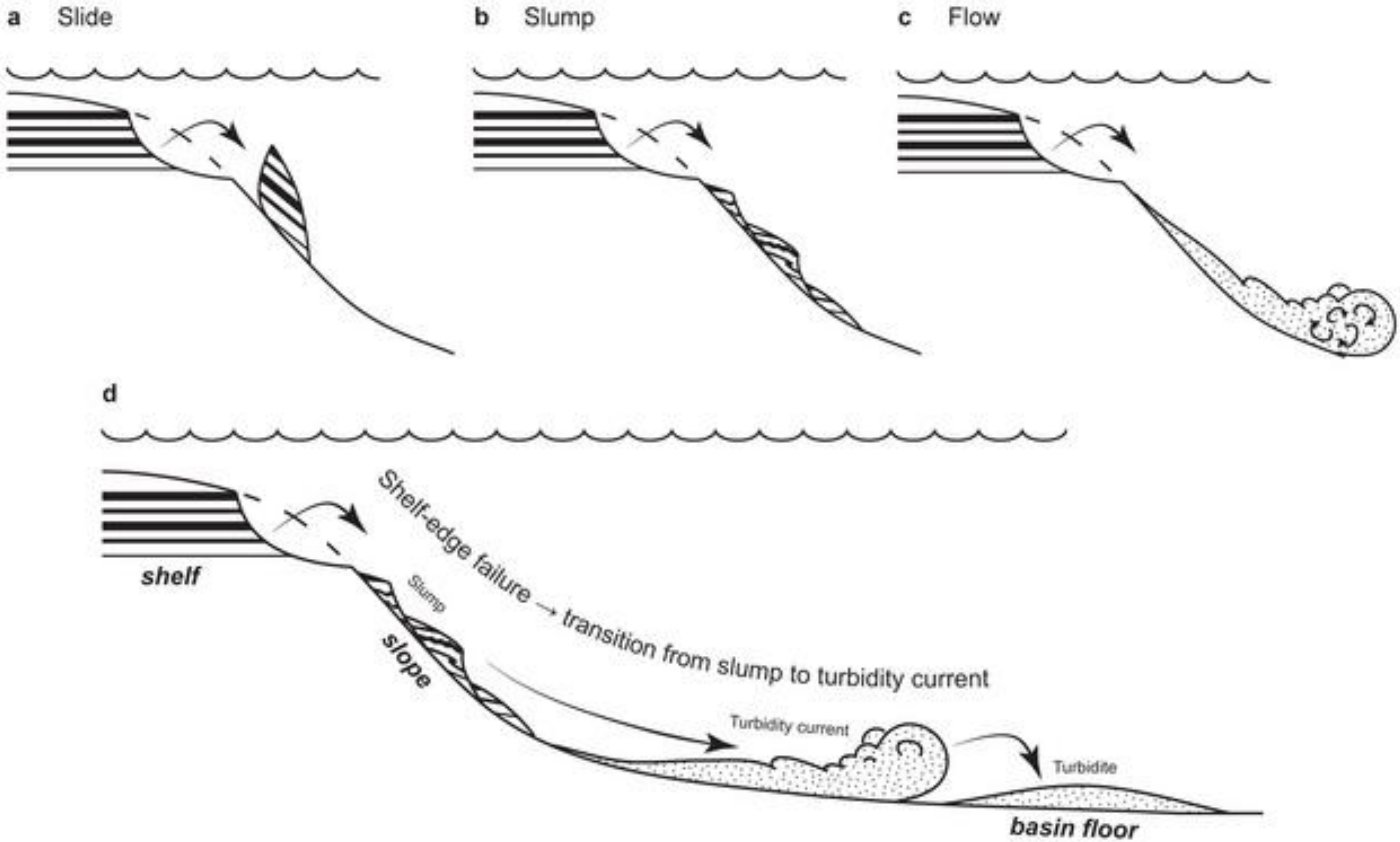
Himalayas - Indus and Bengal Fans

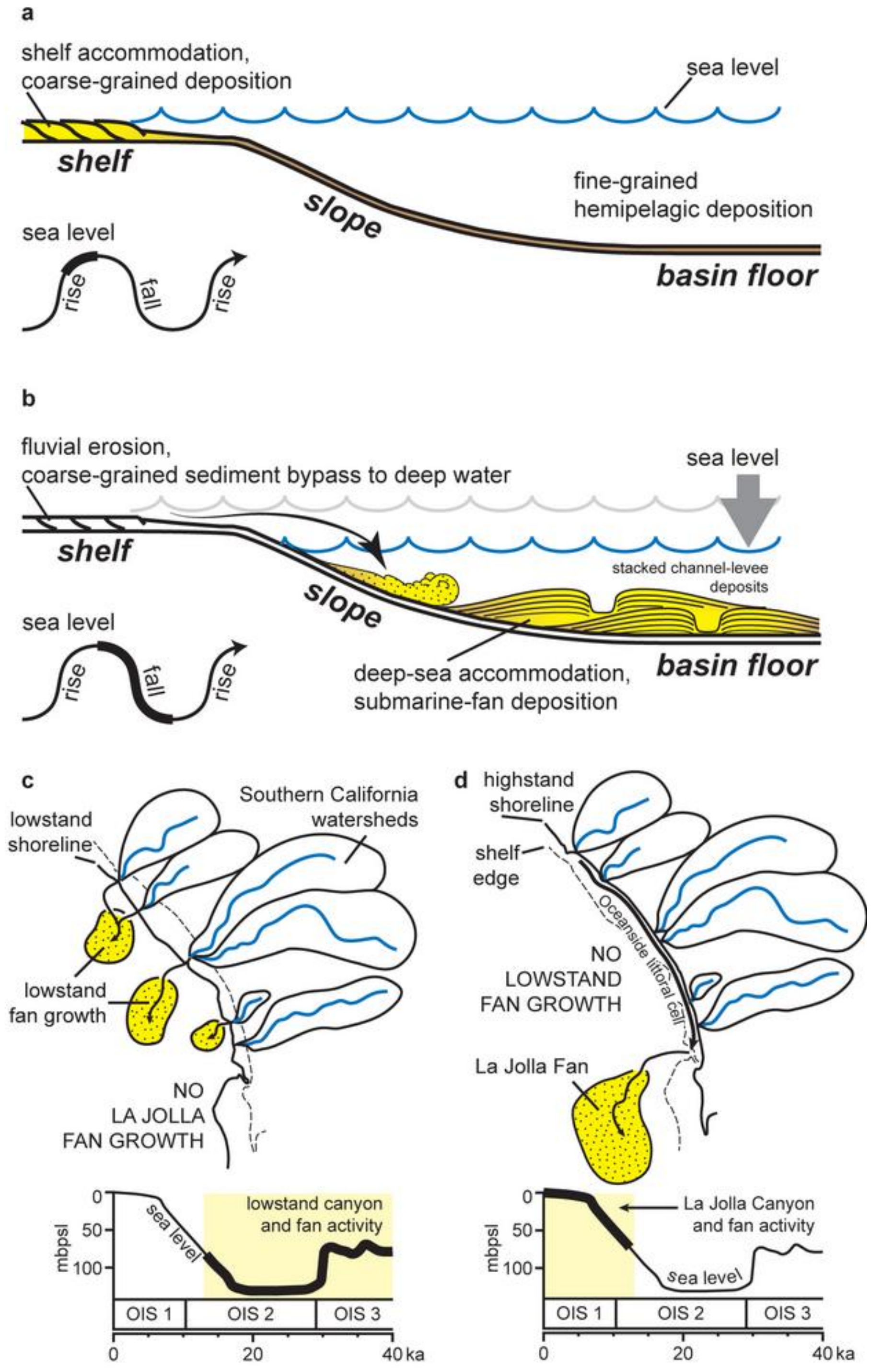





a
Monterey Fan
La Jolla Fan
Mississippi Fan
Amazon Fan
Indus Fan
Bengal Fan
60°
30°
0°
150°
120°
90°
60°
30°
0°
30°
60°
90°
120°
150°
180°
b
La Jolla Canyon
Grand Canyon
Monterey Canyon
Mississippi Canyon
Amazon Canyon
Indus Canyon
Bengal Canyon
500 m
50 km


a
Modern fan model
Normark (1970)
4
Canyon
1
Leveed channel
1'
2
Distributary channels
2'
Lobe
3
3'
4'
1
1'
2
2'
3
3'
4
4'
0 m
-200 m
-300 m
-500 m
-600 m
shelf edge
La Jolla Canyon-channel system
b
Ancient fan model
Mutti and Ricci Lucchi (1972)
Canyons
Slope
Channels
Lobe
Generalized grain-size profile
Thinning- and fining-up channel fill
Thickening- and coarsening-up lobes


a Slide
b Slump
c Flow
d
Shelf-edge failure → transition from slump to turbidity current
Slump
shelf
slope
Turbidity current
Turbidite
basin floor


a
shelf accommodation,
coarse-grained deposition
sea level
shelf
slope
fine-grained
hemipelagic deposition
basin floor
sea level
rise
fall
rise
b
fluvial erosion,
coarse-grained sediment bypass to deep water
sea level
shelf
slope
stacked channel-levee
deposits
sea level
rise
fall
rise
deep-sea accommodation,
submarine-fan deposition
basin floor
c
lowstand
shoreline
Southern California
watersheds
lowstand
fan growth
NO
LA JOLLA
FAN GROWTH
sea level
lowstand canyon
and fan activity
mbpsl
OIS 1
OIS 2
OIS 3
0
20
40 ka
d
highstand
shoreline
shelf
edge
Oceanside littoral cell
NO
LOWSTAND
FAN GROWTH
La Jolla Fan
La Jolla Canyon
and fan activity
sea level
mbpsl
OIS 1
OIS 2
OIS 3
0
20
40 ka

Christian Hiibscher , Volkhard Spiel, Monika Breitzke , Michael E. Weber

The youngest channel-levee system of the Bengal Fan: results from digital sediment echosounder data

Marine Geology 141 (1997) 125-145

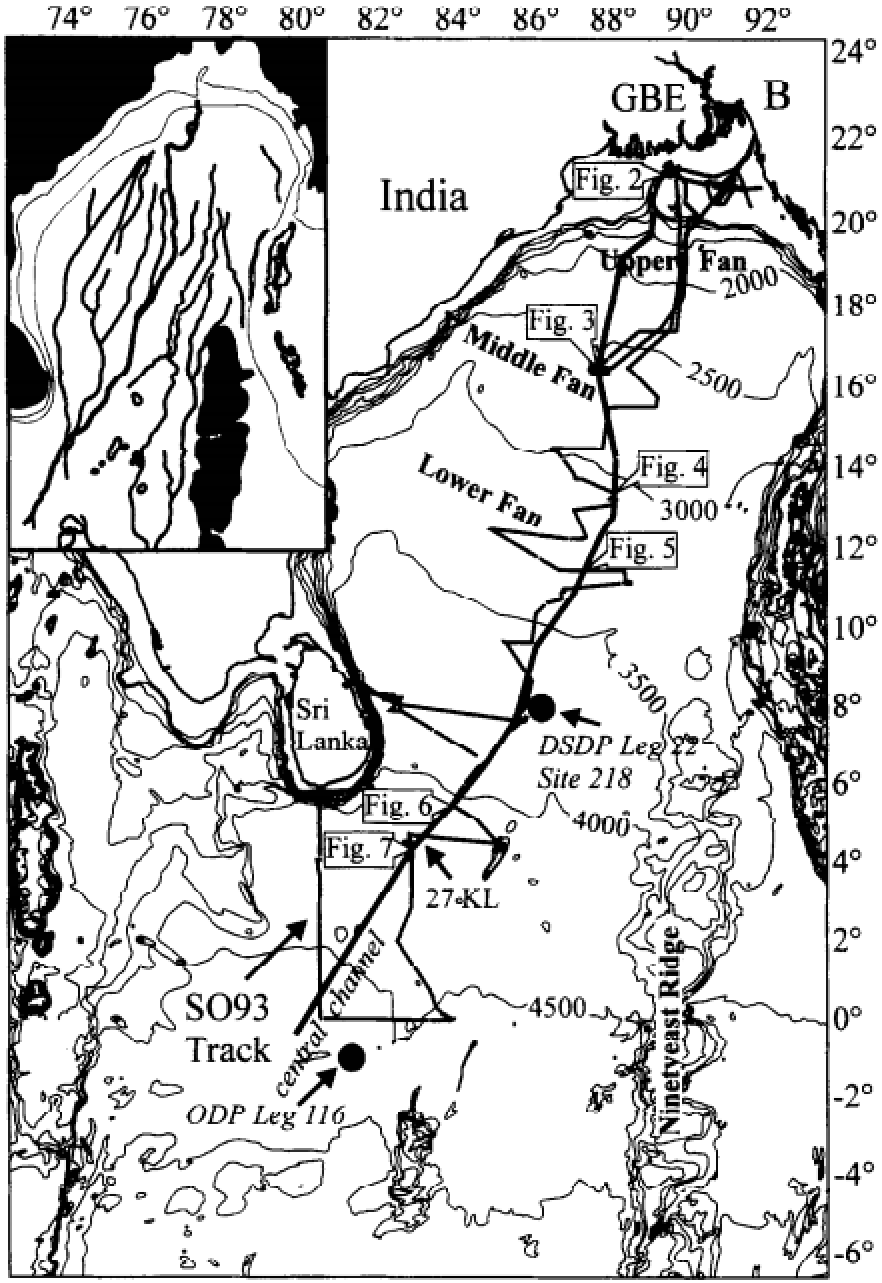
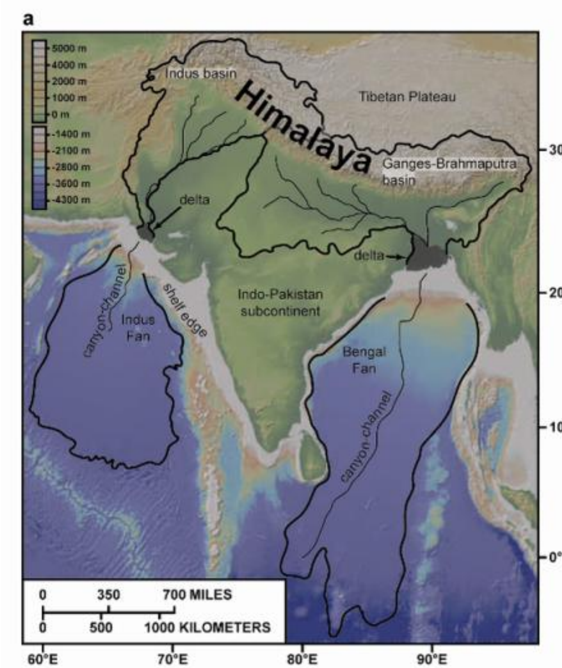


Fig. 1. Map of the Bengal Fan with SO 93 cruise track. PARASOUND data have been obtained along the entire cruise track. The inset map shows correlated channels (redrawn from Emmel and Curray, 1985). The active channel is marked by the thicker black line. *B* = Bangladesh, *GBE* = Ganges–Brahmaputra Estuary.



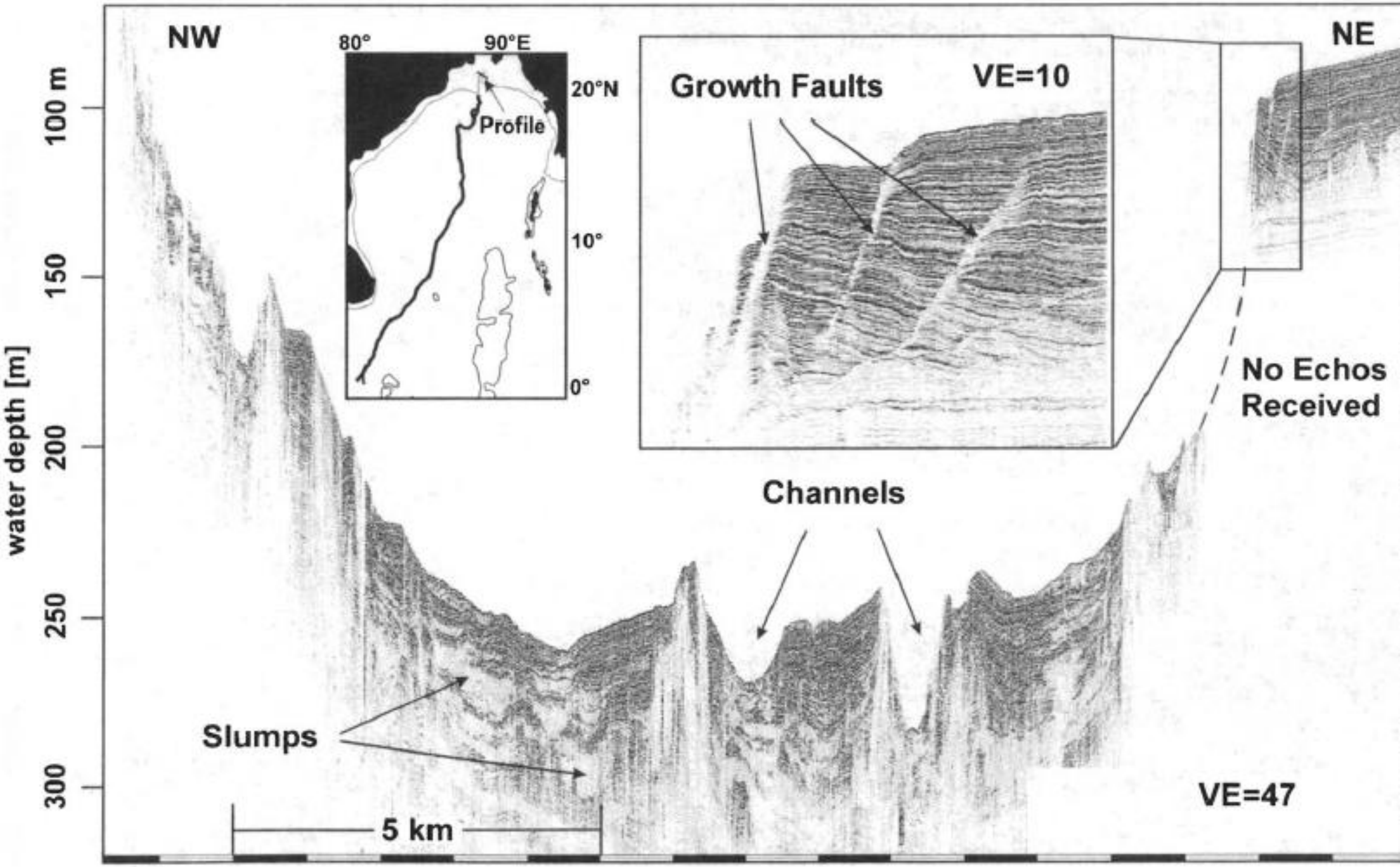


Fig. 2. PARASOUND section of the Swatch of No Ground. For location, refer to Fig. 1. The data gap at the eastern flank of the canyon is caused by the steep slope angle. Channels are incised into the bottom of the canyon. *VE* = vertical exaggeration.

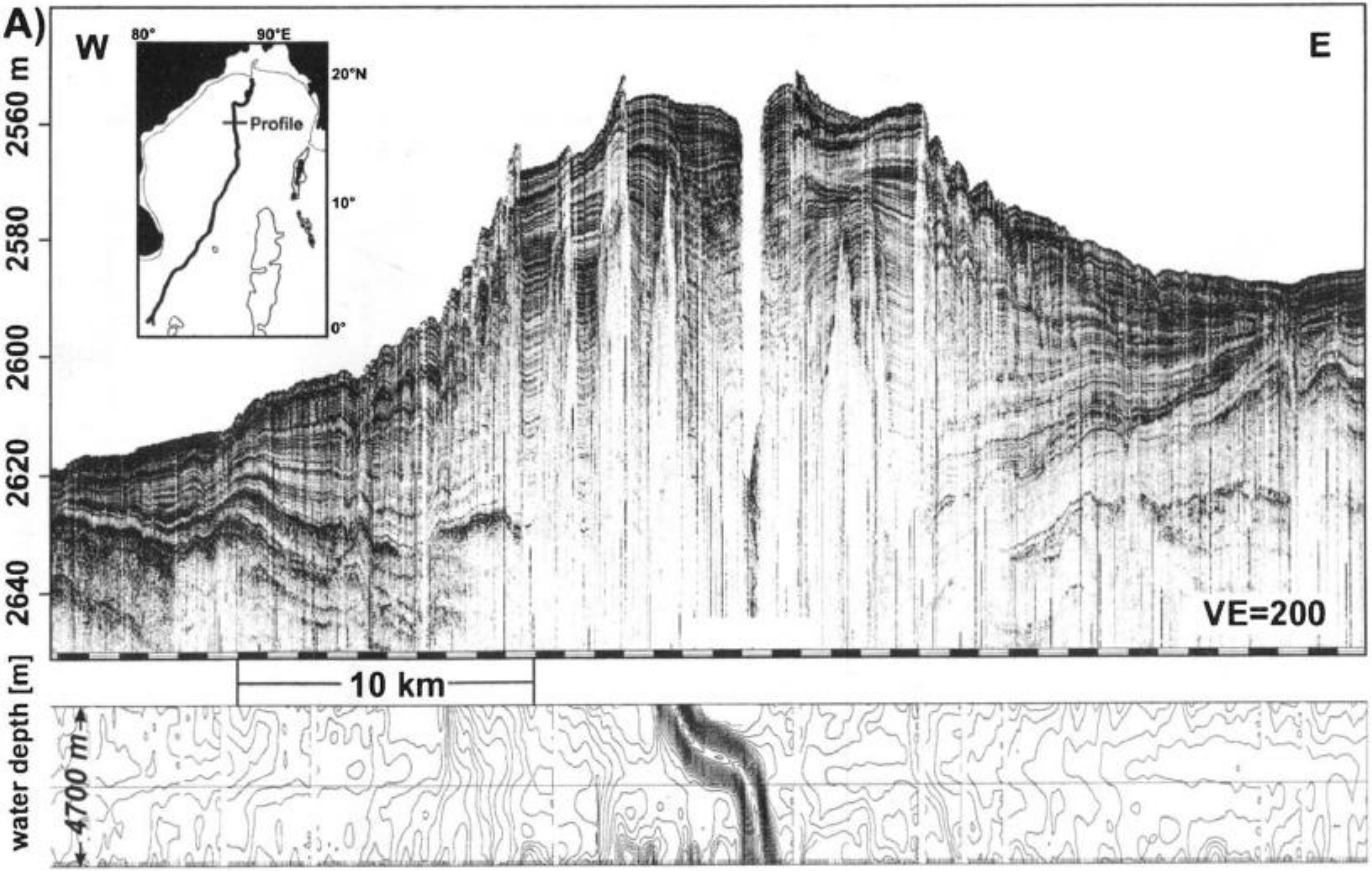


Fig. 3. (A) PARASOUND section of the youngest channel–levee system in the middle fan at 16°30'N with HYDROSWEEP data. (B) Interpreted section. For location, refer to Fig. 1. Italic number refers to swath width. Piston cores 117–120 KL are marked with arrows. The locations of 119–120 KL are projected onto the levees, which have been collected outside the profile. See text for discussion. *aCLS* = abandoned channel–levee system, *dl* = di use layer, *ich* = intra-channel highs, *VE* = vertical exaggeration.

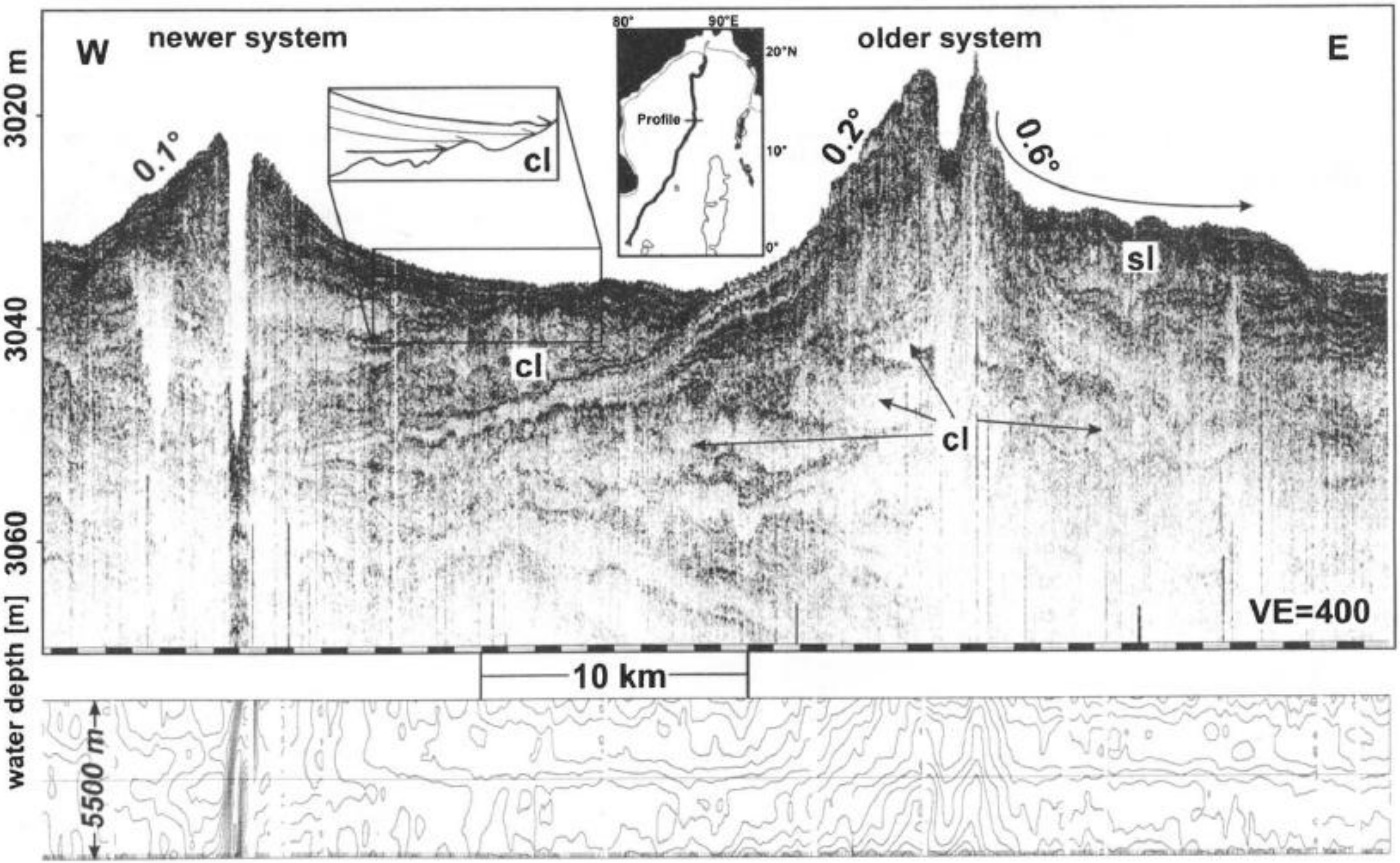


Fig. 4. PARASOUND section and HYDROSWEEP data of the youngest channel–levee system in the lower fan at 13 30́N. For location, refer to Fig. 1. Italic number refers to swath width. The westernmost of the two observed channels represents the recent channel; *cl* = chaotic layer, *sl* = slump. *VE* = vertical exaggeration.

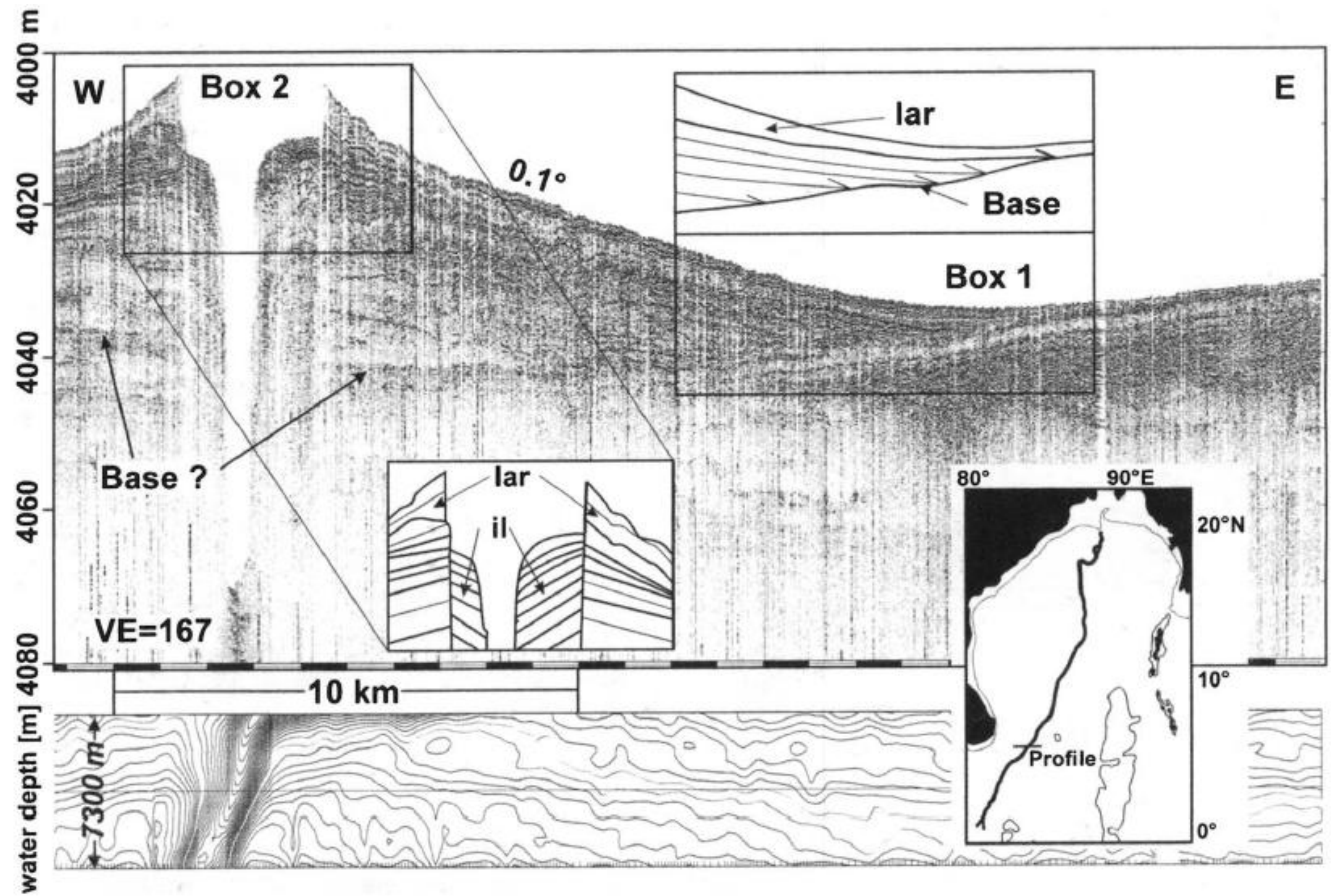


Fig. 6. Parasound section with Hydrosweep data of the youngest channel–levee system in the lower fan at 5°30′N. For location, refer to Fig. 1. Italic number refers to swath width. The interpreted base of the levees is marked by arrows. The channel has been constricted by the deposition of sediment at the inner levee flank; *lar* = low amplitude reflections, *il* = inner levees, *VE* = vertical exaggeration.

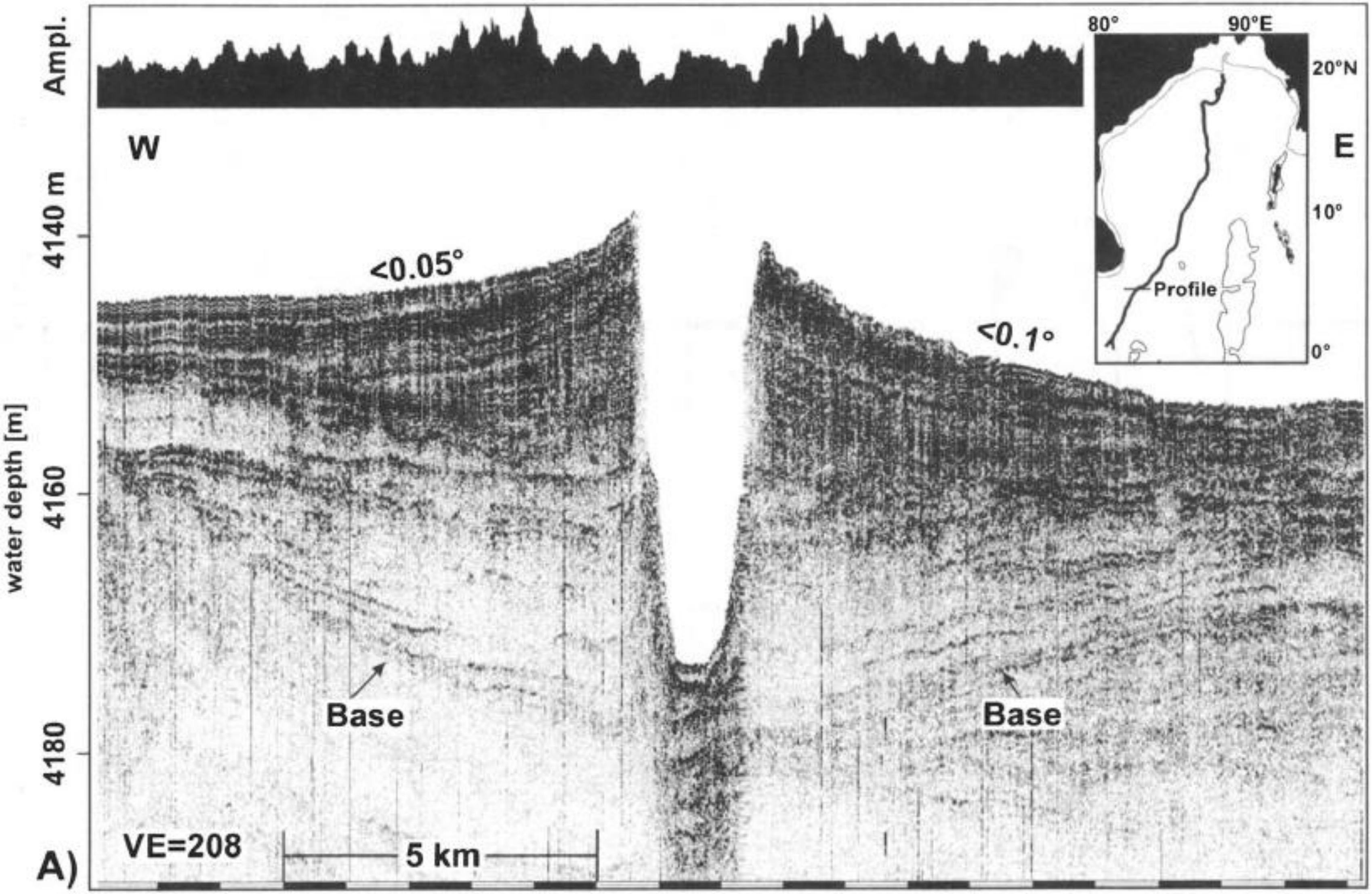


Fig. 7. (A) PARASOUND section of the youngest channel-levee system in the lower fan at 4°30'N, (B) line drawing. For location, refer to Fig. 1. The entire system is separated into two vertical units. The lower unit generally exhibits a di use reflection pattern with some divergent reflections onlapping at the convex shaped base. Distinct dipping reflections of the outer side of the upper unit terminate as a downlap on to the surface which separates the two units. The maximum reflection amplitudes are plotted at the top: *VE* = vertical exaggeration.

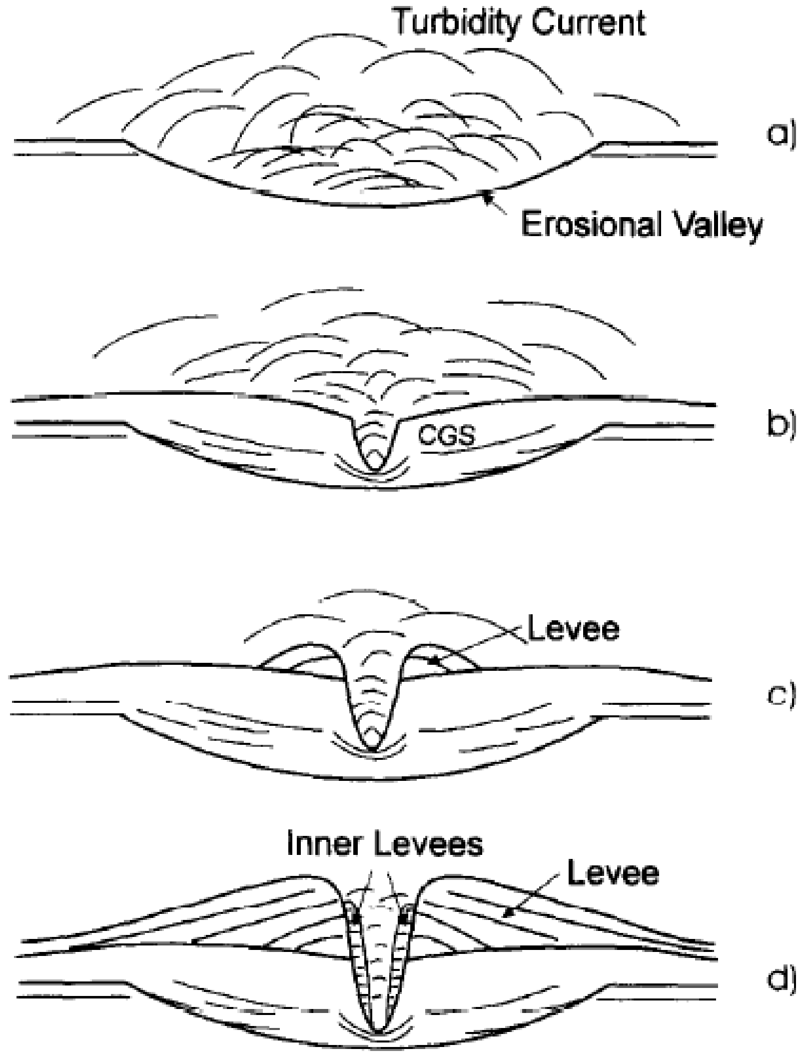
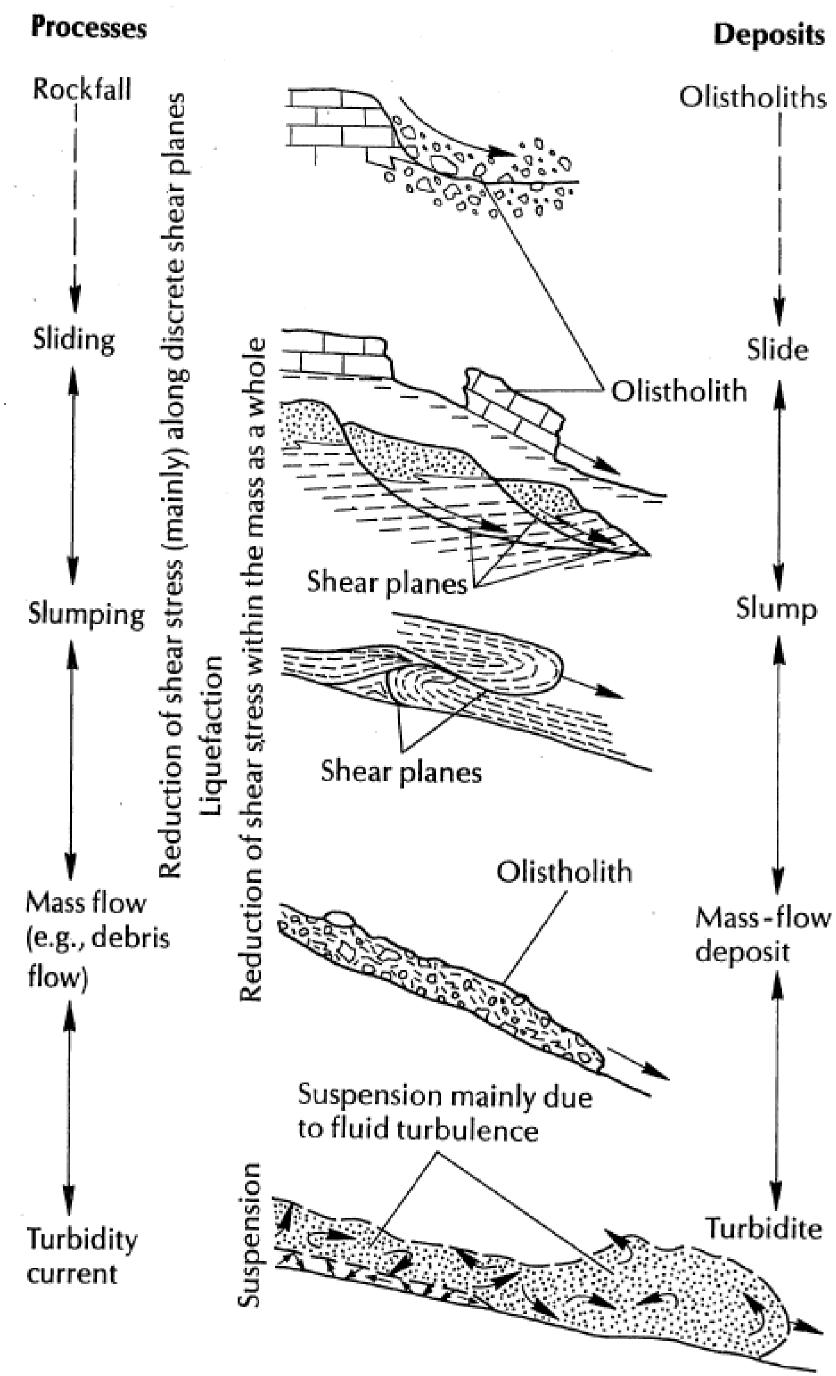


Fig. 10. Allocyclic model of the evolution of a channel–levee system in the lower fan. (A) Phase I: erosion of an elongated valley (Clark and Pickering, 1996). (B) Phase II: relatively coarse-grained sediments (CGS) are deposited within the valley and a narrow channel emerges near the centre. (C) Phase III: depositional process changes from valley-filling to overbanking. (D) Phase IV: decrease in sediment input leads to channel constriction, when inner levees develop. *CGS* = coarse-grained sediments.



Prothero and Schwab, 2004

Submarine Fan Facies

Facies A Thick to massive, channeled and amalgamated, poorly sorted coarse Ss and Cgl, with thin or no mud intervals; all gradations to facies E

Facies B Thick to massive, lenticular sorted Ss with parallel to undulating laminae, common mud clasts, and erosional bases; thin mud intervals

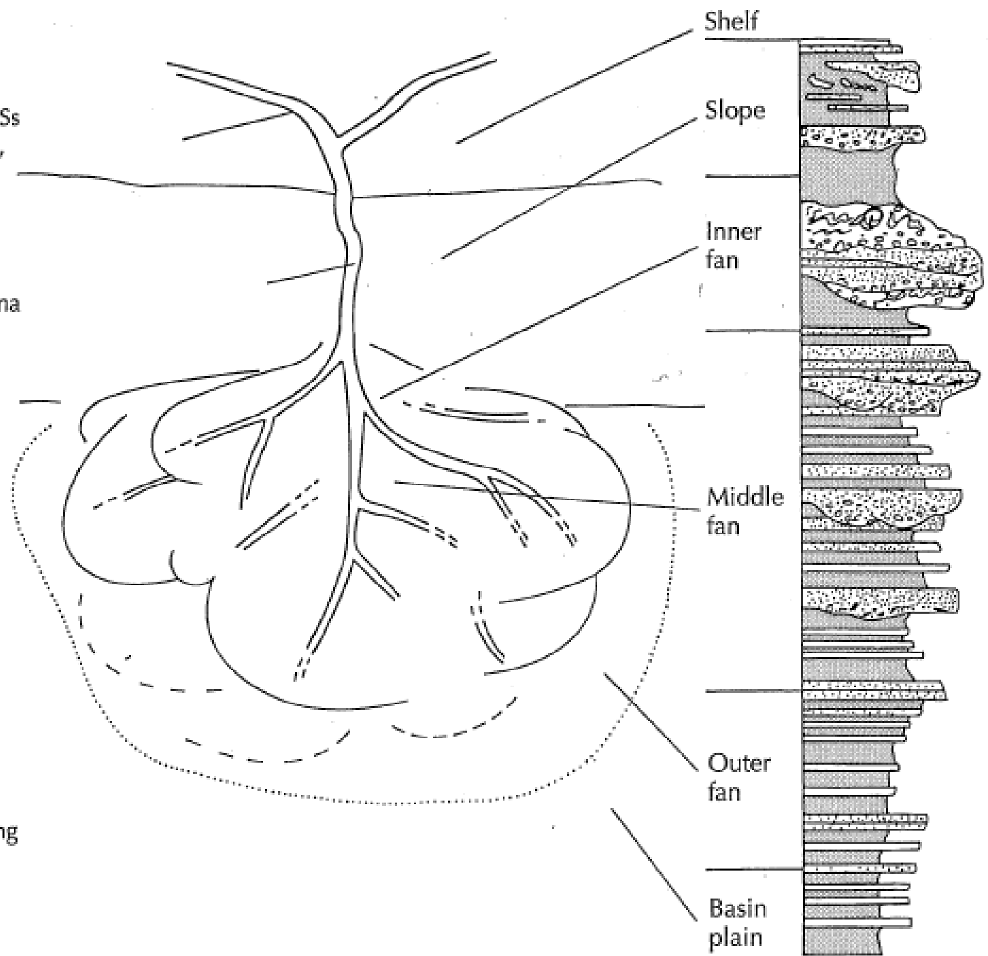
Facies C Couplets of even, parallel-bedded M-F Ss and minor homogeneous muds; Ss may show complete Bouma succession, some broad, shallow channels; common sole marks

Facies D Couplets of parallel-bedded, laterally continuous F-VF Ss/Siltst. and thicker muds. Ss with regular to convolute to ripple-drift laminations. Bouma base cutout sequences common

Facies E Thinner, irregular and discontinuous beds of slightly coarser Ss and Silst. than D; also thinner muds. Ss with basal graded and structureless intervals; sharp upper contacts with mud

Facies F Thick intervals of mildly deformed chaotic deposits derived from sliding or mass flow

Facies G Thick muds with often obscure continuous parallel bedding



Massive or stratified mudstone (facies G); discordant surfaces and facies F deposits from mass movements; lag deposits of sediment gravity flow; facies A in channels, locally succeeded by facies E

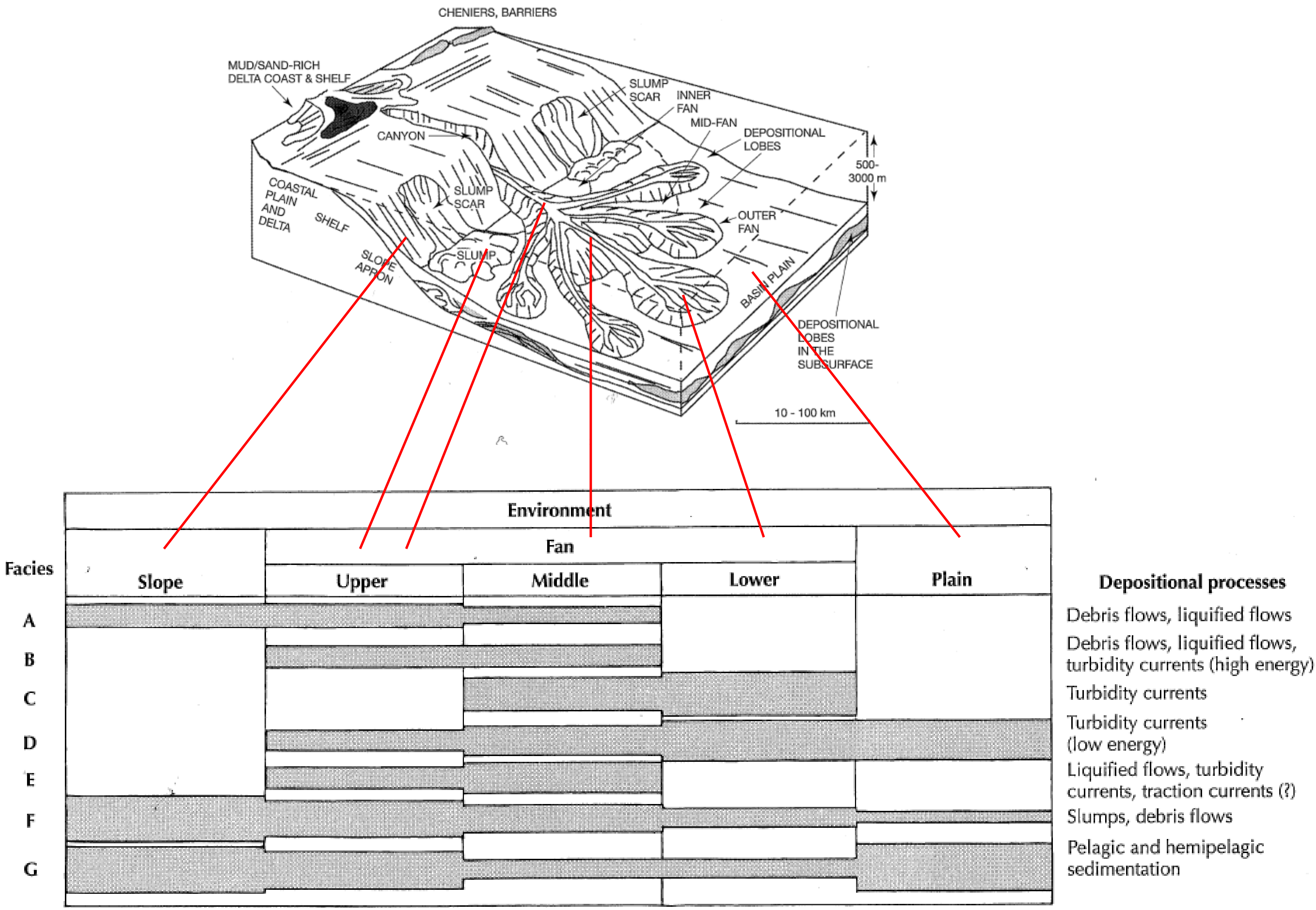
Facies G mudstones enclosing thick, broad channel-filling facies A, B, and F; facies E may be present

Essentially facies D and E; subordinate facies C; local intercalations of lenticular facies A, B, and F; typically showing thinning-and fining-upward sandy cycles; paleocurrents show dispersion of about 90°

Facies D sediments with lenticular facies C; typically showing thickening-and-coarsening-upward sandy cycles; coarser deposits usually not channelized; paleocurrents spread over 90°, transverse or longitudinal to basin axis

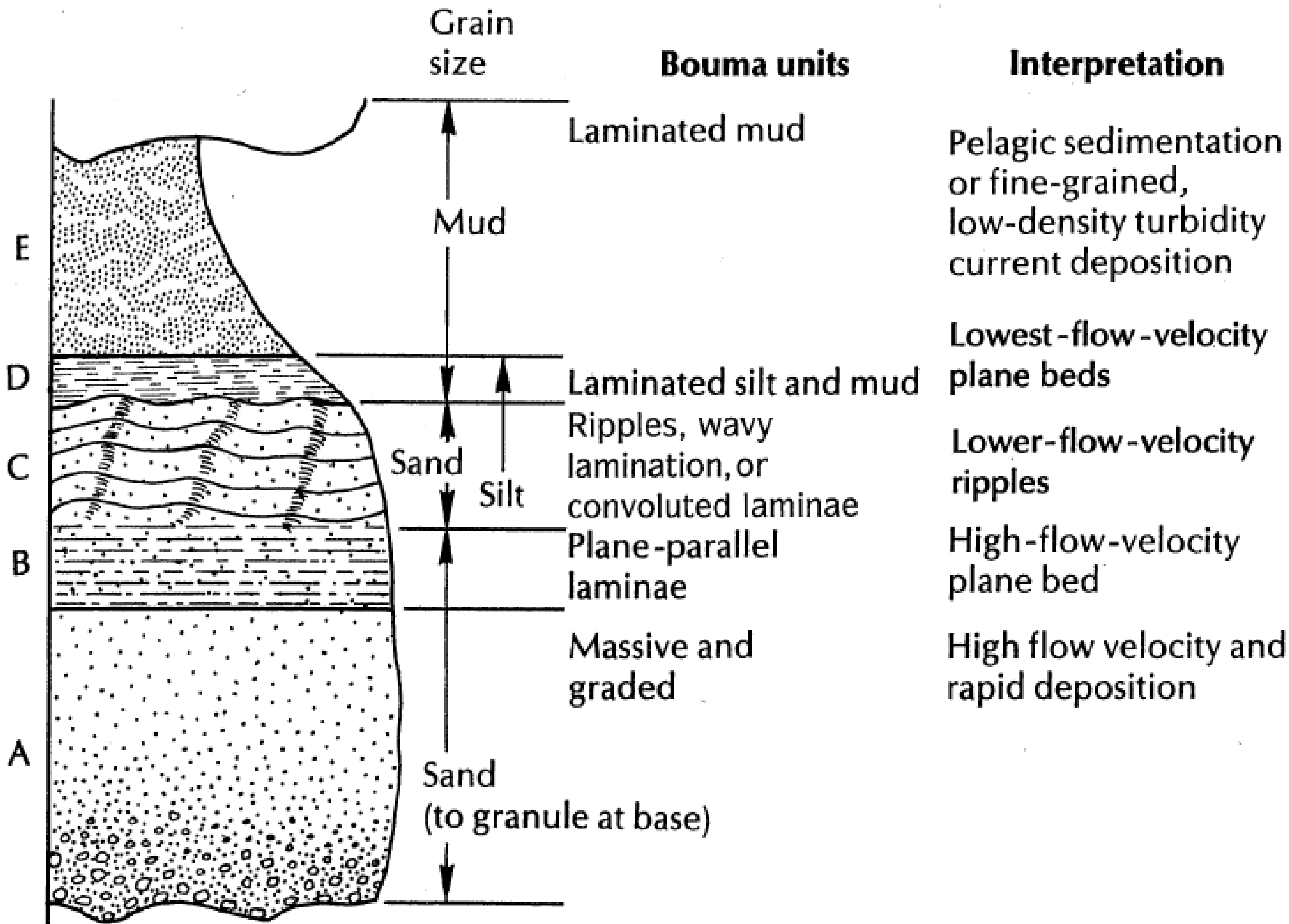
Facies D, with thin intervals of facies G mudstone sometimes detectable; paleocurrents parallel to basin axis

Prothero and Schwab, 2004



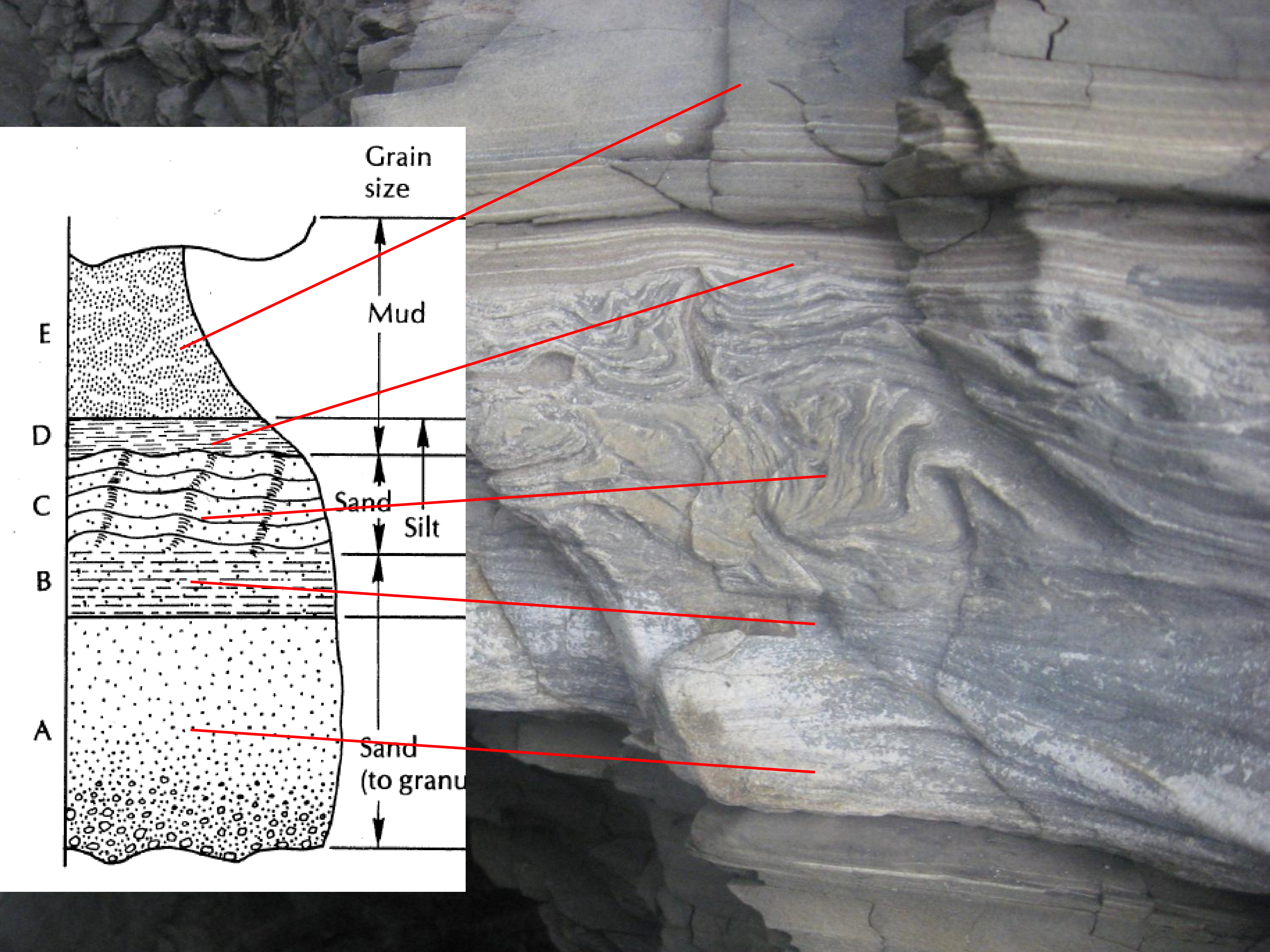
Prothero and Schwab, 2004

Bouma Sequences



Commonly scours into previous layer

Prothero and Schwab, 2004


Grain size
E
D
C
B
A
Mud
Sand
Silt
Sand
(to granu

Not all Bouma layers are likely to be visible in any one place.
The notation for turbidite layers is as follows:

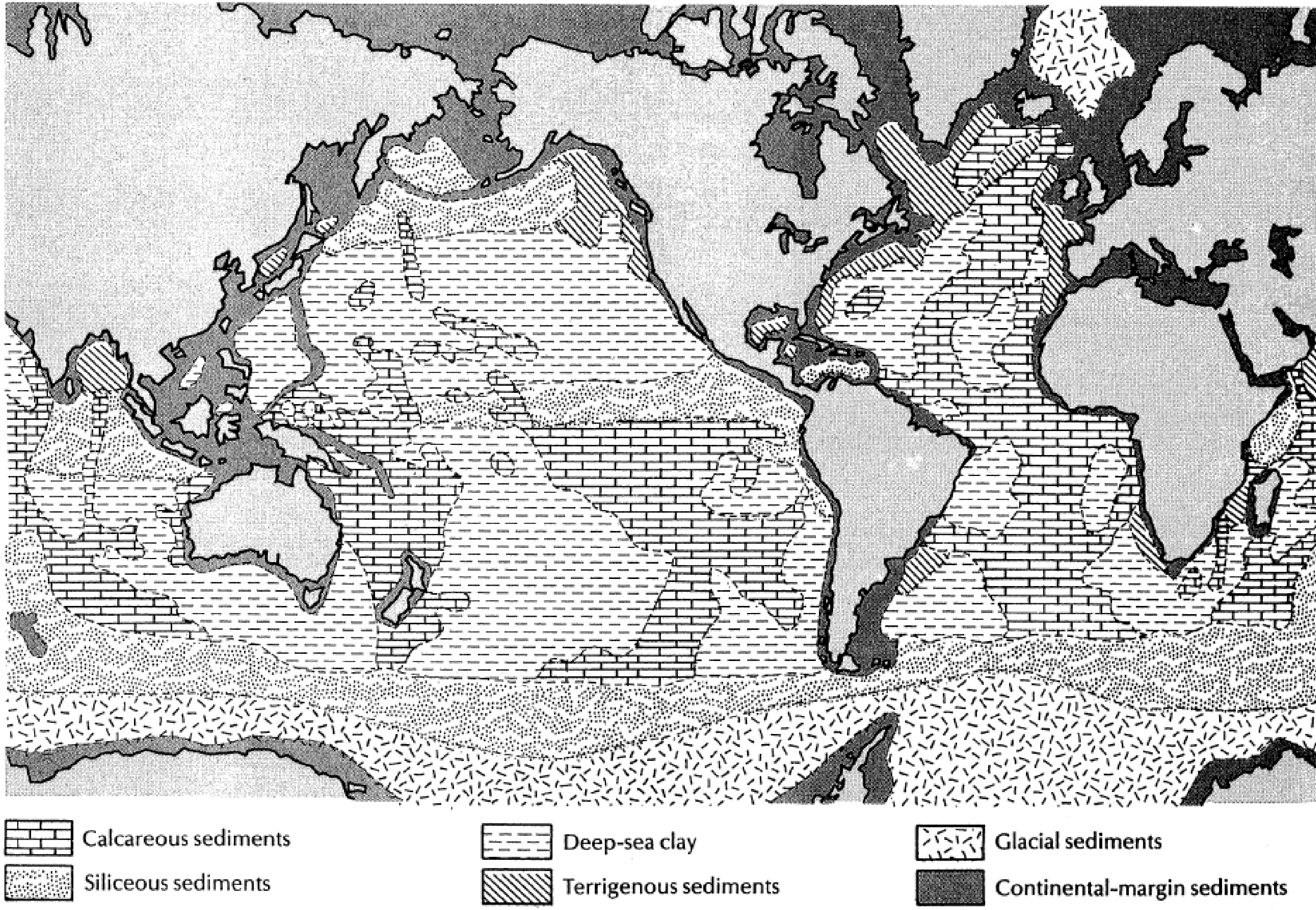
T_{abcde}: all present

T_{acd}: only a, c and d present

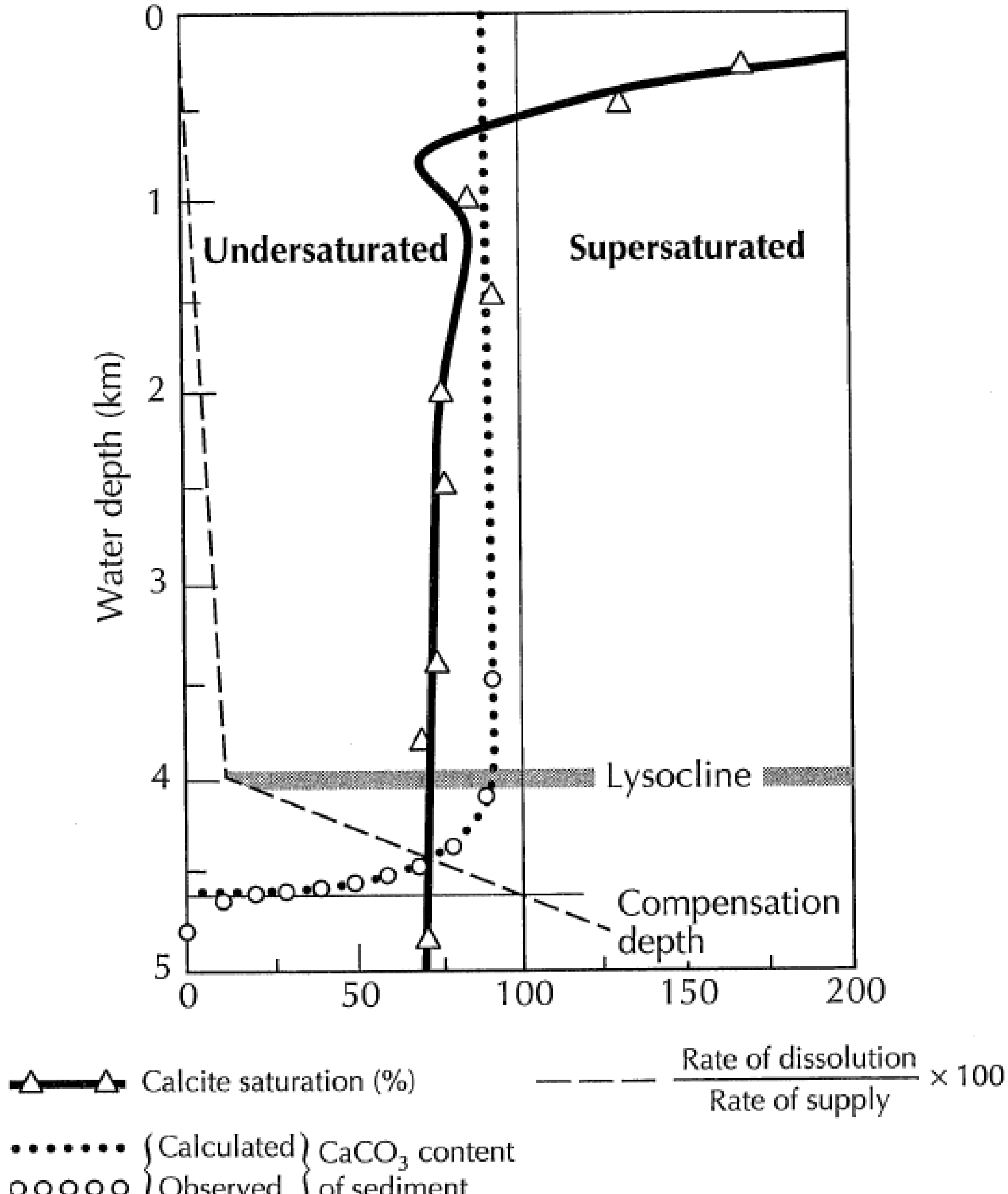
T_{e}: only e present

etc.

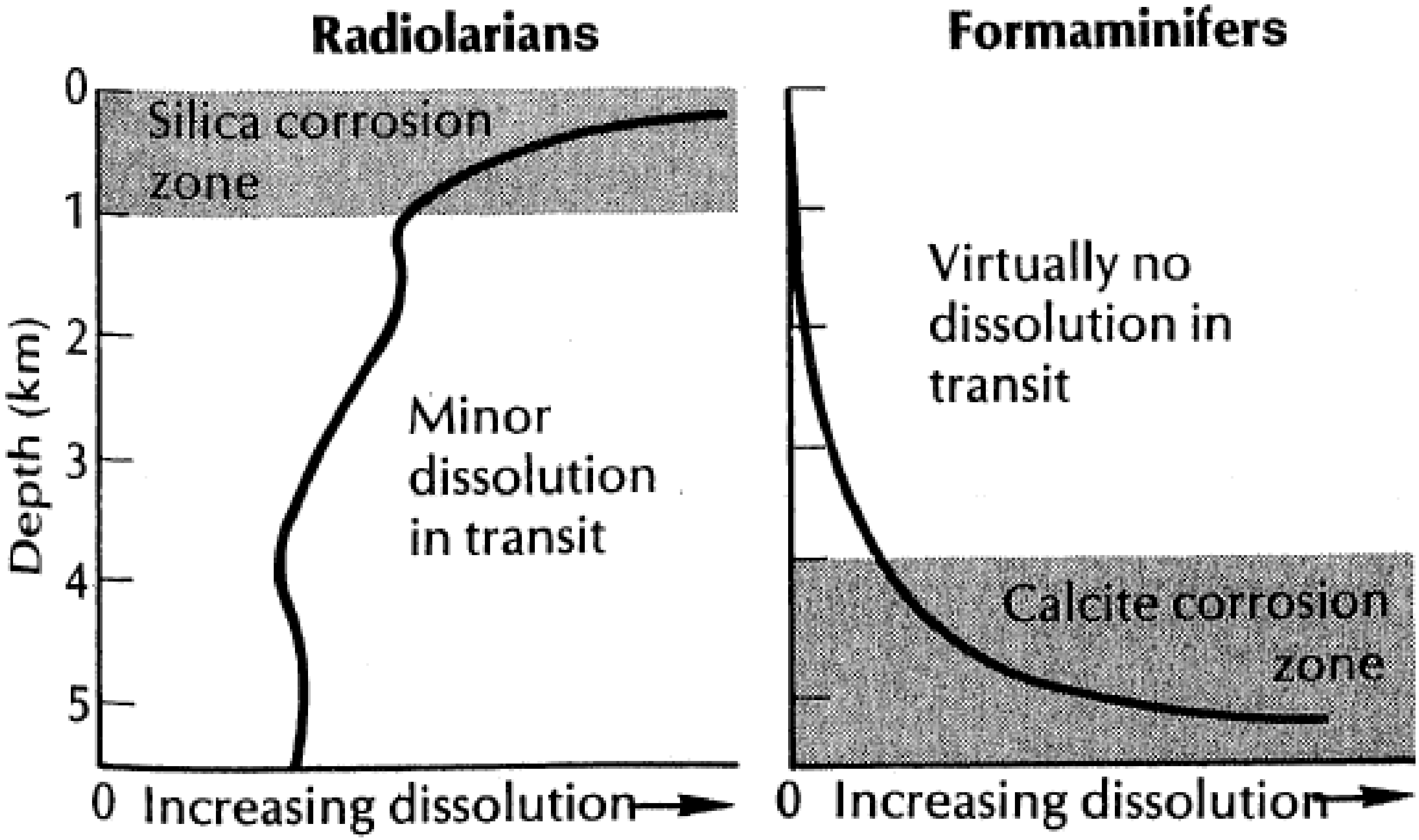
Deep Ocean Sediments



Prothero and Schwab, 2004



Prothero and Schwab, 2004


Radiolarians
Formaminifers
0
1
2
3
4
5
Depth (km)
Silica corrosion zone
Minor dissolution in transit
0 Increasing dissolution
Virtually no dissolution in transit
Calcite corrosion zone
0 Increasing dissolution