



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

Unit	Topic	Teacher	Date
1.1	Introduction to the course	Rebesco	23-set
6.1	Visit to the icebreaker Laura Bassi (along with Geologia Marina)	Rebesco/Camerl.	24-set
1.2	Methods (geophysics, but not only)	Geletti/Rebesco	30-set
1.3	Mechanisms of basin formation (geodynamics, tectonics...)	Lodolo	01-ott
1.4	Energy storage & CCUS	Volpi/Barison	07-ott
1.5	Seismic interpretation, facies and primary structures	Rebesco	08-ott
2.1	Sedimentary processes in river & deltas	Rebesco	14-ott
2.2	Gravity-driven transport and bottom currents	Lucchi/Rebesco	15-ott
2.3	Action of tides and waves, wind and ice	Rebesco	21-ott
6.2	Drilling Down the Data: A Deep Learning Dive into IODP Cores	Cédric M. John	22-ott
3.1	Alluvial deposits, lakes and deserts	Rebesco	04-nov
3.2	Barrier systems and incised valleys	Rebesco	04-nov
3.3	Continental shelves (waves, storms, tsunamis)	Rebesco	05-nov
3.4	Continental slope and submarine fans	Lucchi	05-nov
3.5	Sediment drifts and contourites	Rebesco	11-nov
3.6	Abyssal plains and continental margins	Rebesco	12-nov
3.7	Carbonatic environments, faults, volcanoes	Rebesco	18-Nov
3.8	Glacial depositional systems	De Santis	19-nov
4.1	Sequence stratigraphy: introduction	Rebesco	25-nov
4.2	Sequence stratigraphy: closer view	Rebesco	26-nov
6.3	Visit to CoreLoggingLAB (along with Geologia Marina)	Rebesco/Camerl.	02-dic
4.3	Sequence stratigraphy: applications (e.g. hydrocarbon reservoirs)	Rebesco	03-dic
5.1	Excercise (part 1)	Rebesco	09-dic
5.2	Excercise (part 2)	Rebesco	10-dic
6.4	Visit to OGS (SeisLab)	Rebesco/Camerl.	16-dic

Modulo 3.6

Abyssal plains and (hemi)pelagites

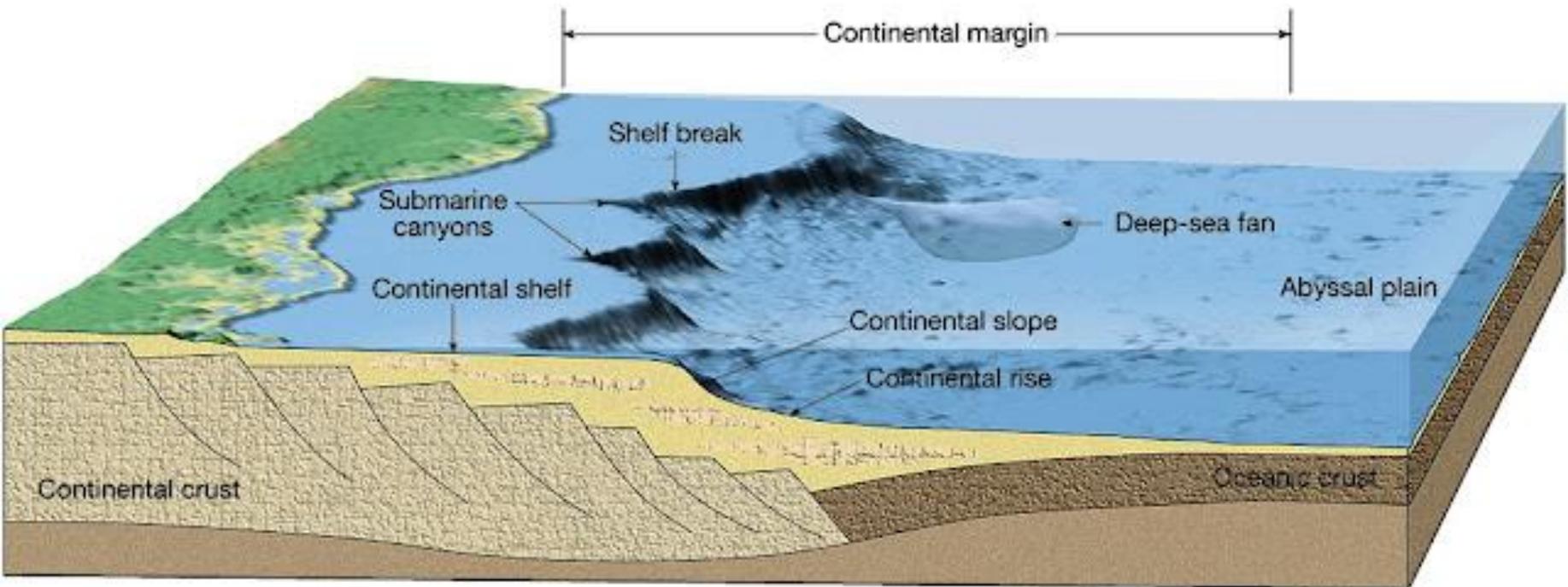
Outline:

- Basin physiography
- Deep sea interacting processes
- Pelagic sediments
- Hemipelagic facies model
- Echo and seismic facies

Physiographic provinces

Continental shelf > November 24
Shelf break
Continental slope > November 16
Continental rise > November 17
Abyssal plain > Today

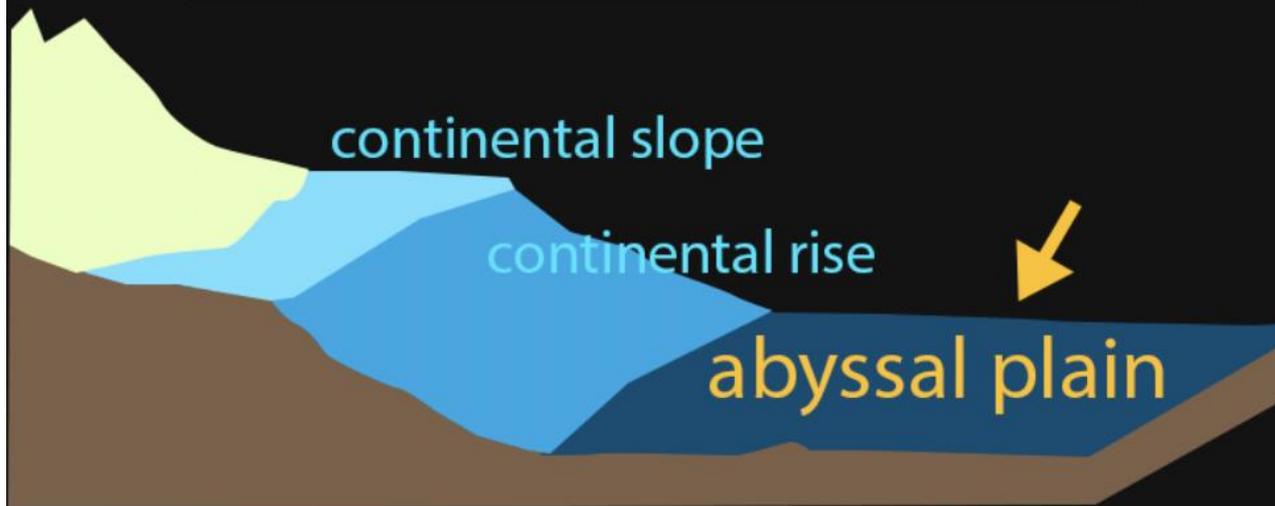
Abyssal hill province
Mid-ocean ridge
Hydrothermal vents
Polymetallic nodules
Mud volcanoes



Abyssal Plain

The term 'abyssal plain' refers to a flat region of the ocean floor, usually at the base of a continental rise, where slope is less than 1:1000. It covers more than half of the Earth's surface and represents the deepest part of the ocean floor lying between 4000 and 6500 m deep.

a large, flat area of the deep ocean floor

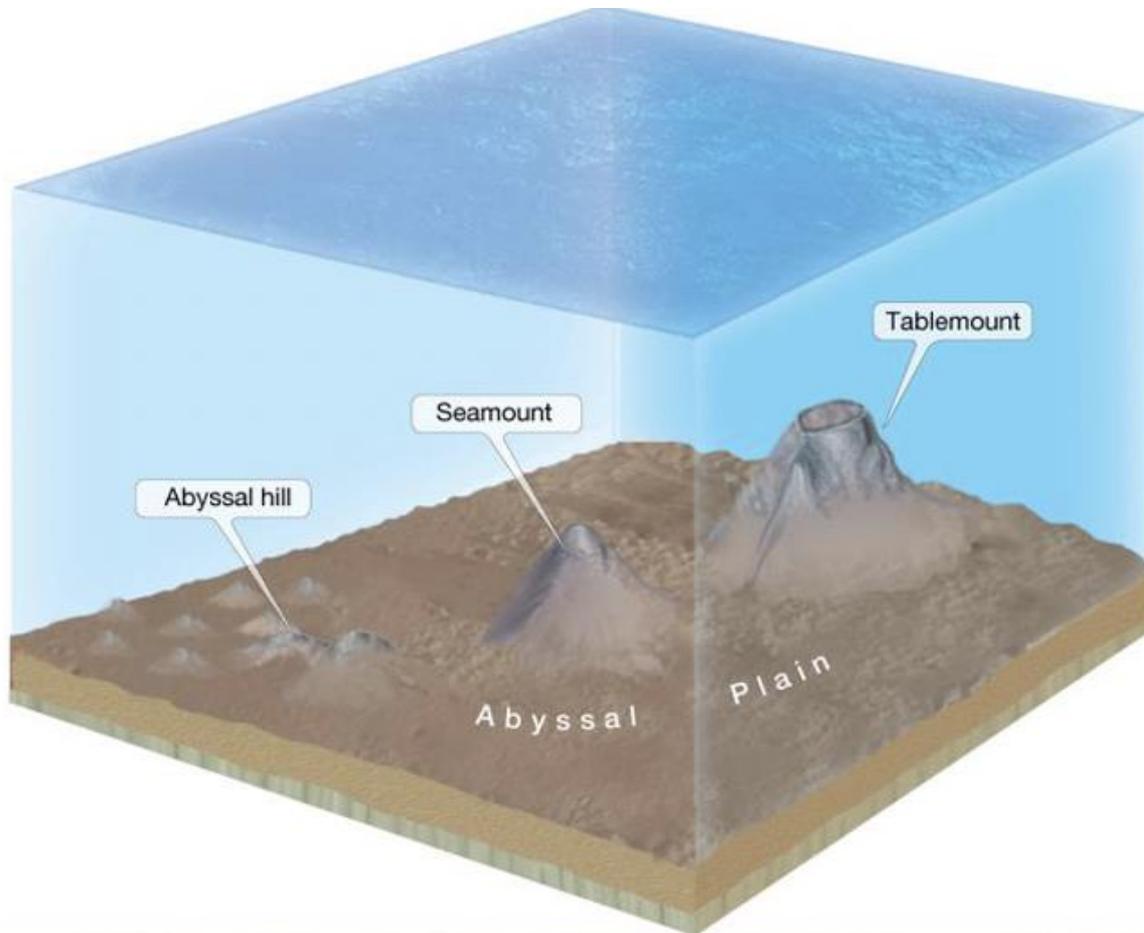


abyssal plain

A more general term 'basin plain' is commonly used in referring to ancient examples. Being adjacent to continental rises, they act frequently as the terminus of turbidity currents, which deposit thin turbidites with usually very fine grains interbedded with the most common **pelagites and hemipelagites.**

Abyssal hill

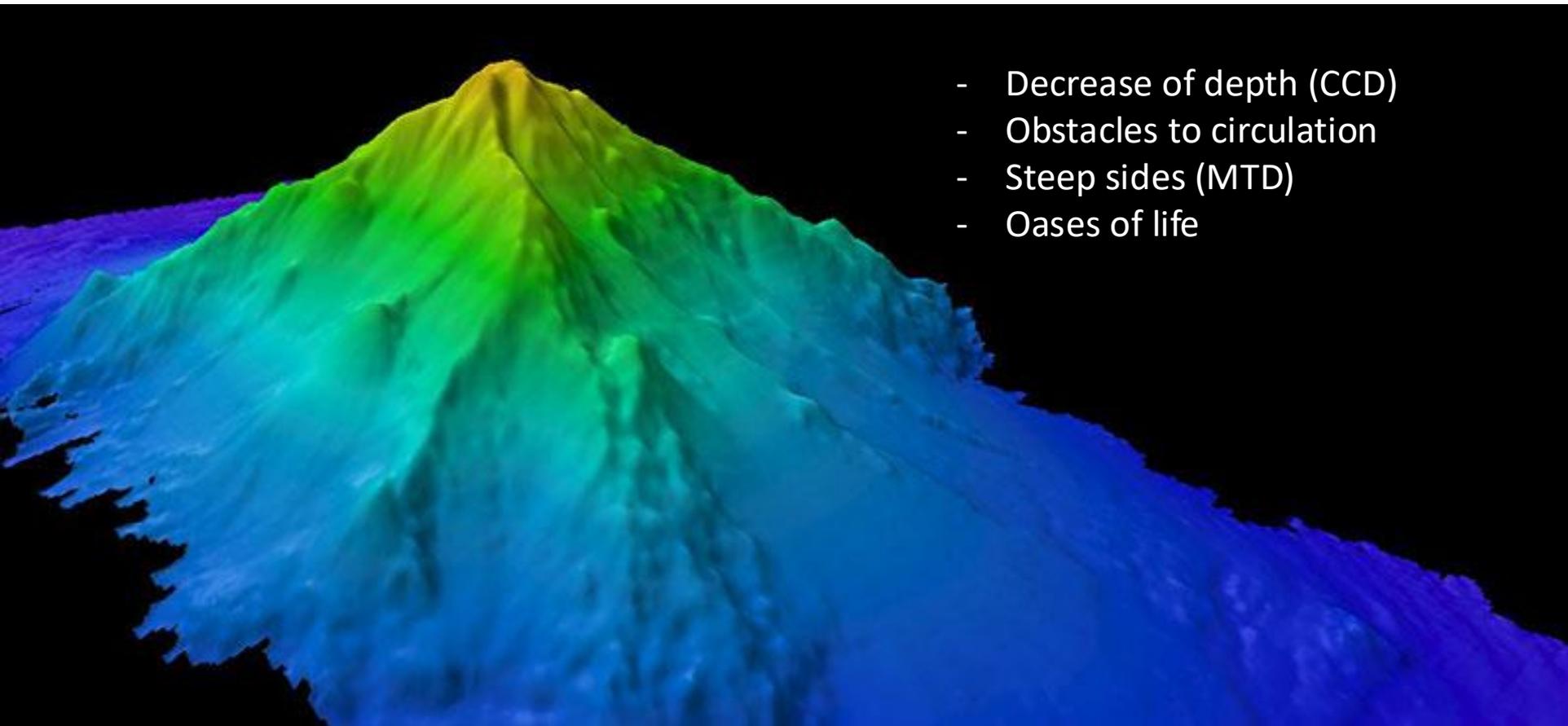
An abyssal hill is a small hill that rises from the floor of an abyssal plain. They are the most abundant geomorphic structures on the planet Earth, covering more than 30% of the ocean floors.



Abyssal hills have relatively sharply defined edges and climb to heights of no more than a few hundred meters. They can be from a few hundred meters to kilometers in width. A region of the abyssal plain that is covered in such hill structures is termed an "abyssal-hills province". However, abyssal hills can also appear in small groups or in isolation

Seamounts

A seamount is an underwater mountain with steep sides rising from the seafloor.

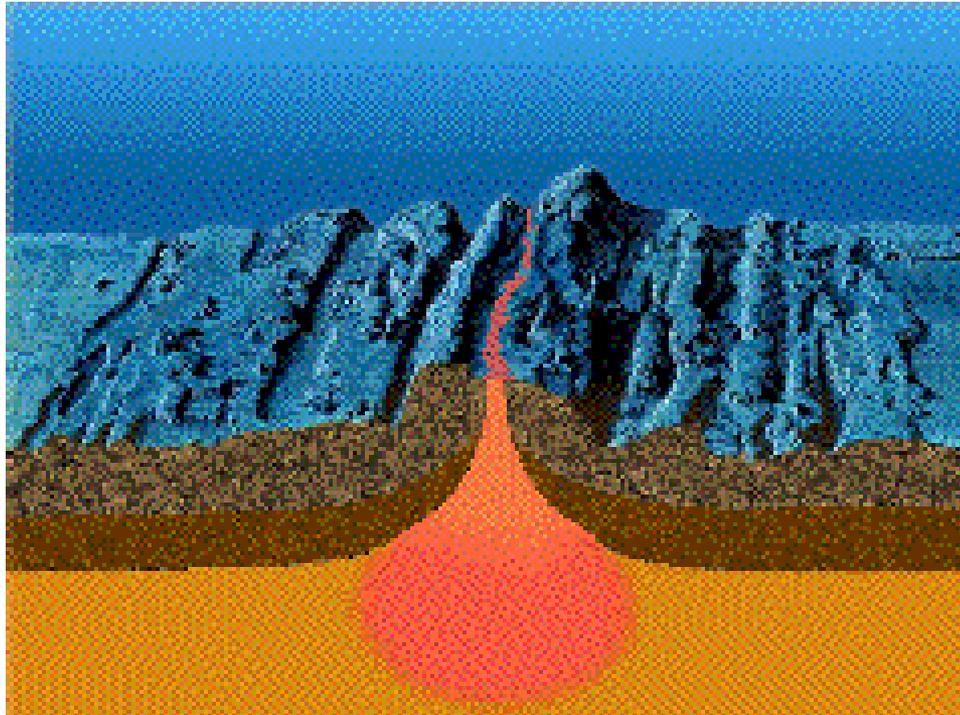


- Decrease of depth (CCD)
- Obstacles to circulation
- Steep sides (MTD)
- Oases of life

A ~4,200-meter high seamount mapped during the Mountains in the Deep:
Exploring the Central Pacific Basin expedition
(Image courtesy of the NOAA Office of Ocean Exploration and Research)

Mid-ocean ridges

A mid-ocean ridge (MOR) is a seafloor mountain system formed by plate tectonics.



Sediment on ridge flanks commonly thicken with distance from the spreading axes, reflecting the increasing age of the volcanic seafloor. Complications to this simple picture occur where there is substantial sediment transport or varied dissolution of carbonate.

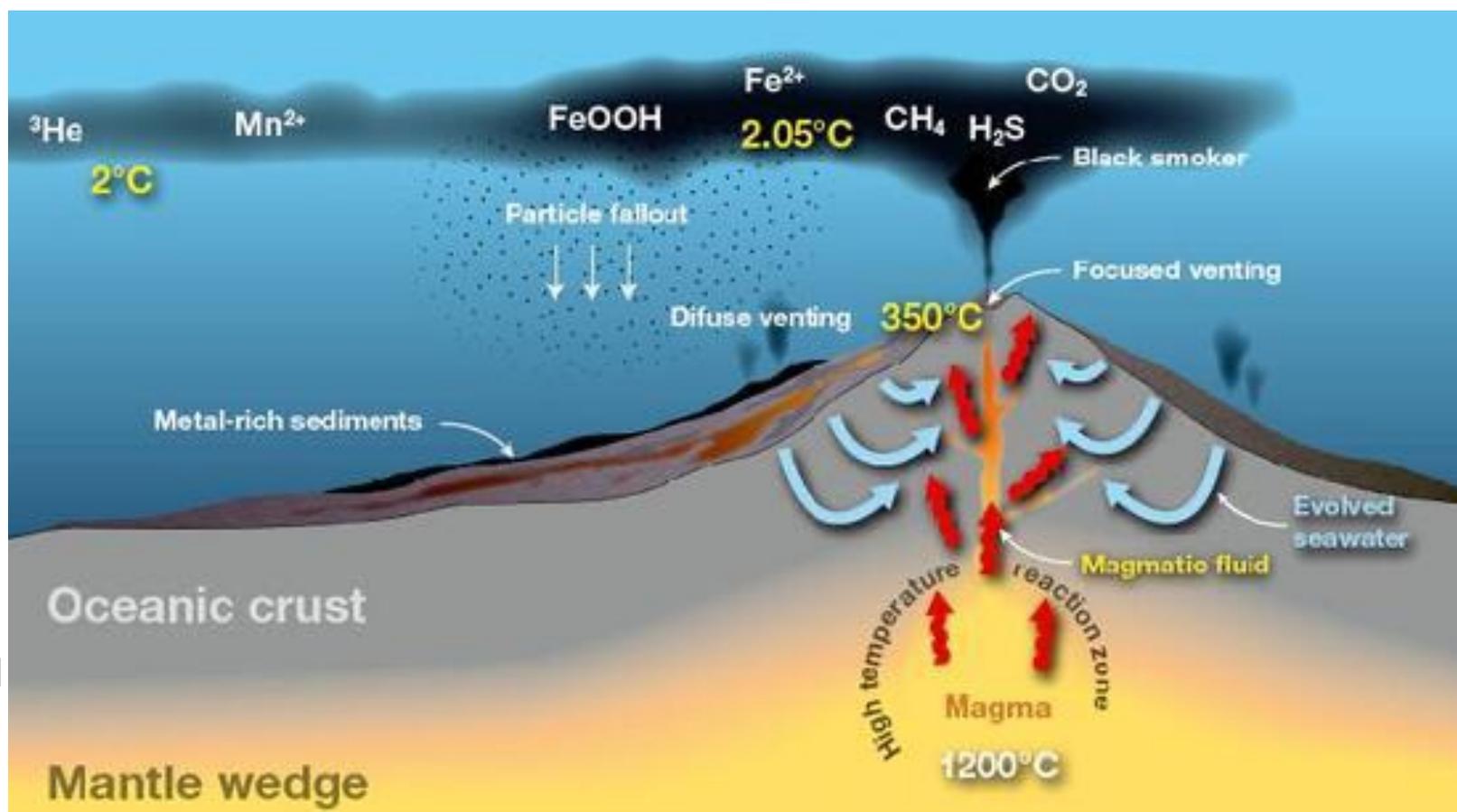


Hydrothermal vents

A hydrothermal vent is an underwater hot spring found on the ocean floor

>100 vent fields documented along the 60,000-km global mid-ocean ridge system.

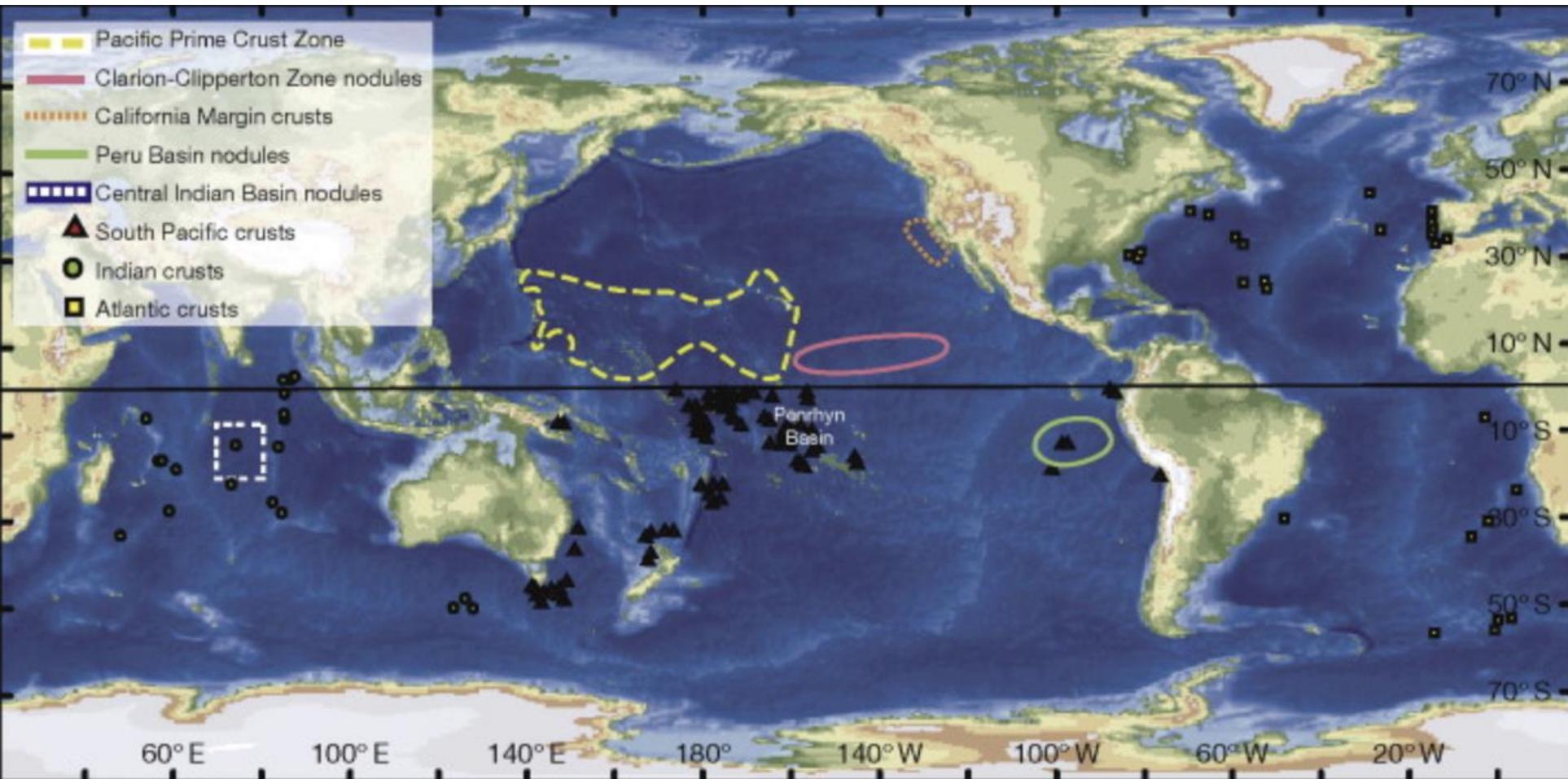
Commonly found near volcanically active places, areas where tectonic plates are moving apart, ocean basins, and hotspots, hydrothermal vents produce metal-rich chimneys, of interest in undersea prospecting, and provide an important environmental niche for life in the deep.



Nodules

Hein & Koschinsky, Geochemistry of Mineral Deposits, 2014

Fe–Mn nodules typically occur on sediment-covered abyssal plains where sediment accumulation rates are low (<10 mm/ky). Nodule coverage is more than 50% over large areas of the Pacific and Central Indian Ocean Basin. Although nodules are known to occur on abyssal plains in the Atlantic and polar oceans, their distribution is not well known.

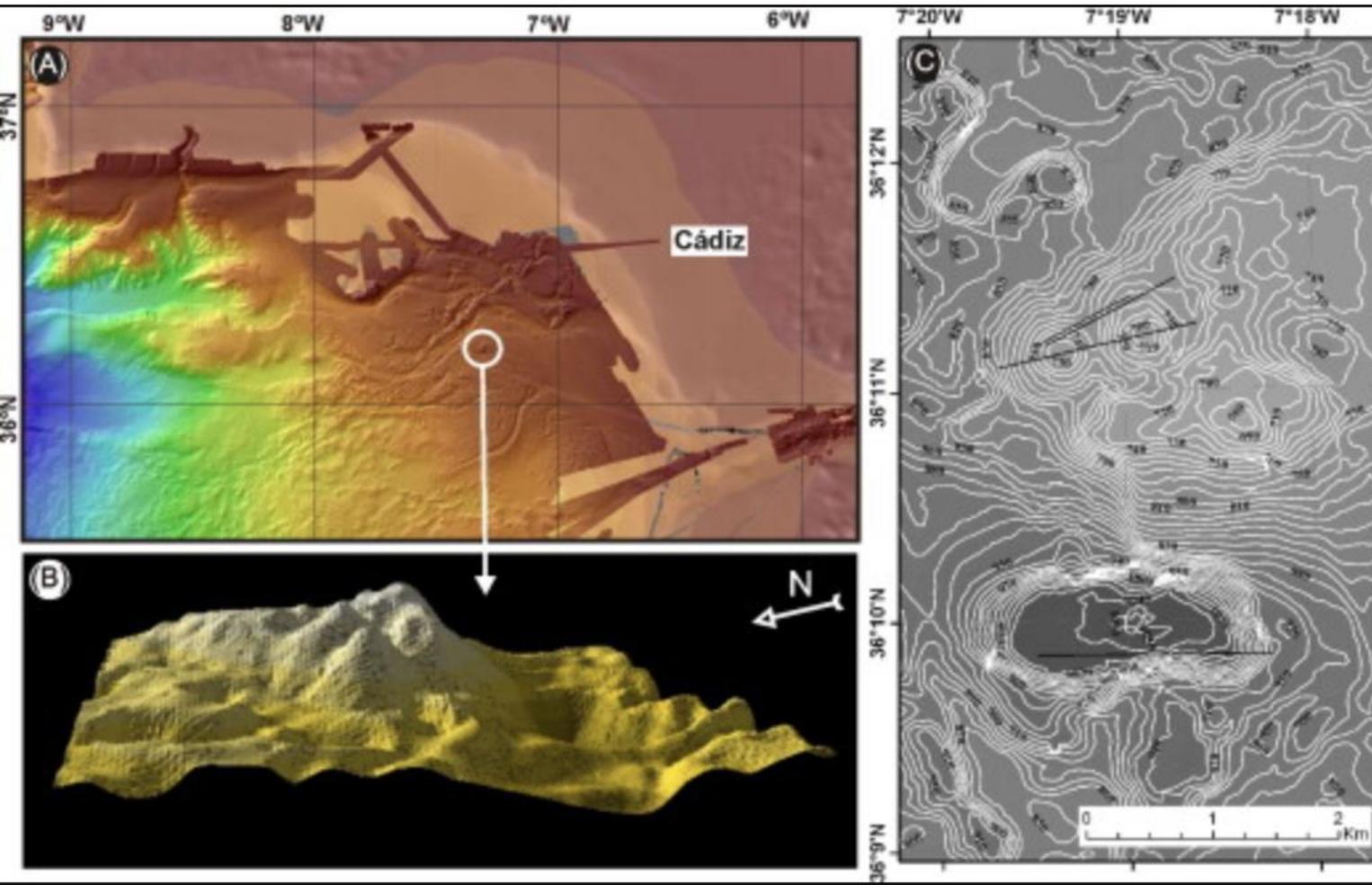


Mud volcanoes

Mud volcanoes are conduits for fluid venting and consequent carbonate precipitation within the sediments or at the seafloor.

Around 1100 mud volcanoes have so far been found on land and in shallow water. It is believed that more than 10,000 mud volcanoes may exist on continental slopes and abyssal plains.

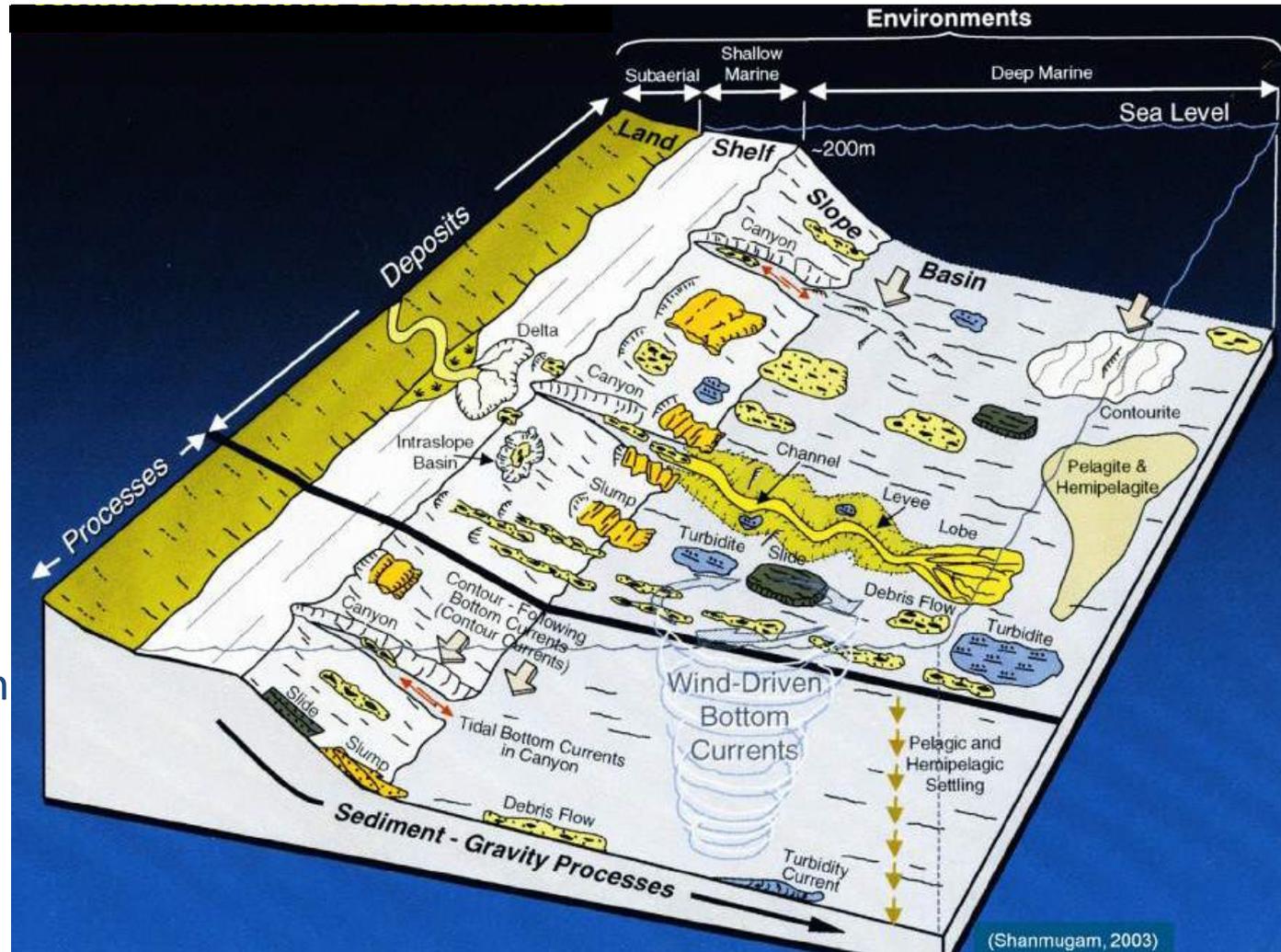
Rueda et al., 2012, in *Seafloor Geomorphology as Benthic Habitat*



Deep sea depositional processes

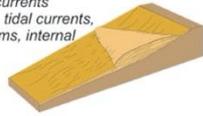
Sediment transport in deep-marine (slope and basin) environments is characterized by gravity-driven downslope processes, such as mass transport (i.e., slides, slumps, and debris flows), and turbidity currents.

Bottom currents, composed of thermohaline contour-following currents, wind-driven currents and up and down tidal bottom currents in submarine canyons.



Clastic sedimentary processes on continental margins and morphotypes

includes geostrophic currents influenced by Coriolis, tidal currents, eddies, deep-sea storms, internal waves and tsunamis



CONTOUR CURRENT

constructional or erosional oversteepening and contoured weak layers
morphology promotes deposition

nourishment by dilute turbidity current plumes
geostrophic currents reworking

Increasing liquification

erosional undercutting

Rebesco et al. (2017)

SEDIMENT MASS FAILURE

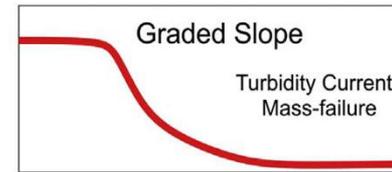
TURBIDITY CURRENT



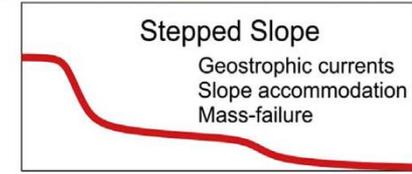
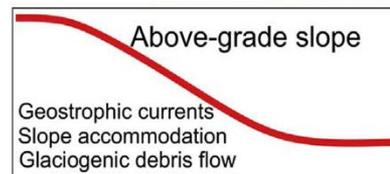
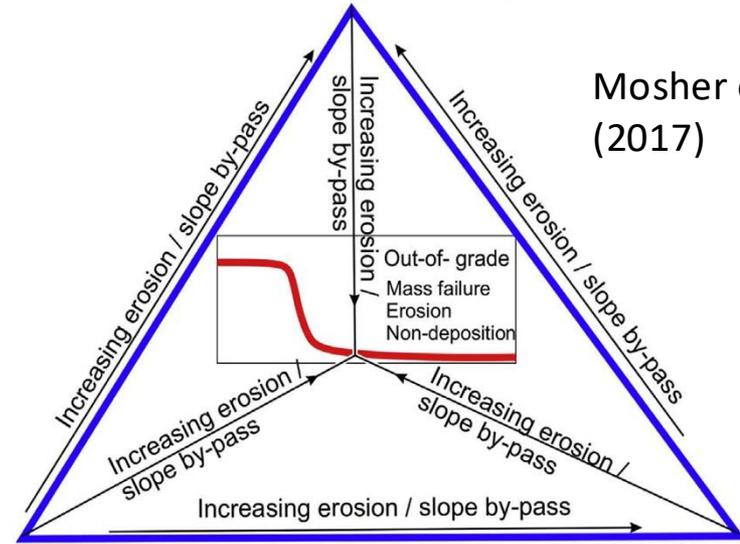
includes true debris flows, debris avalanches, slumps, slides, spreads and complex landslides



includes confined and unconfined density flows, hyperpycnal flows, and flows from oceanographic currents including tsunamis and dense suspension plumes

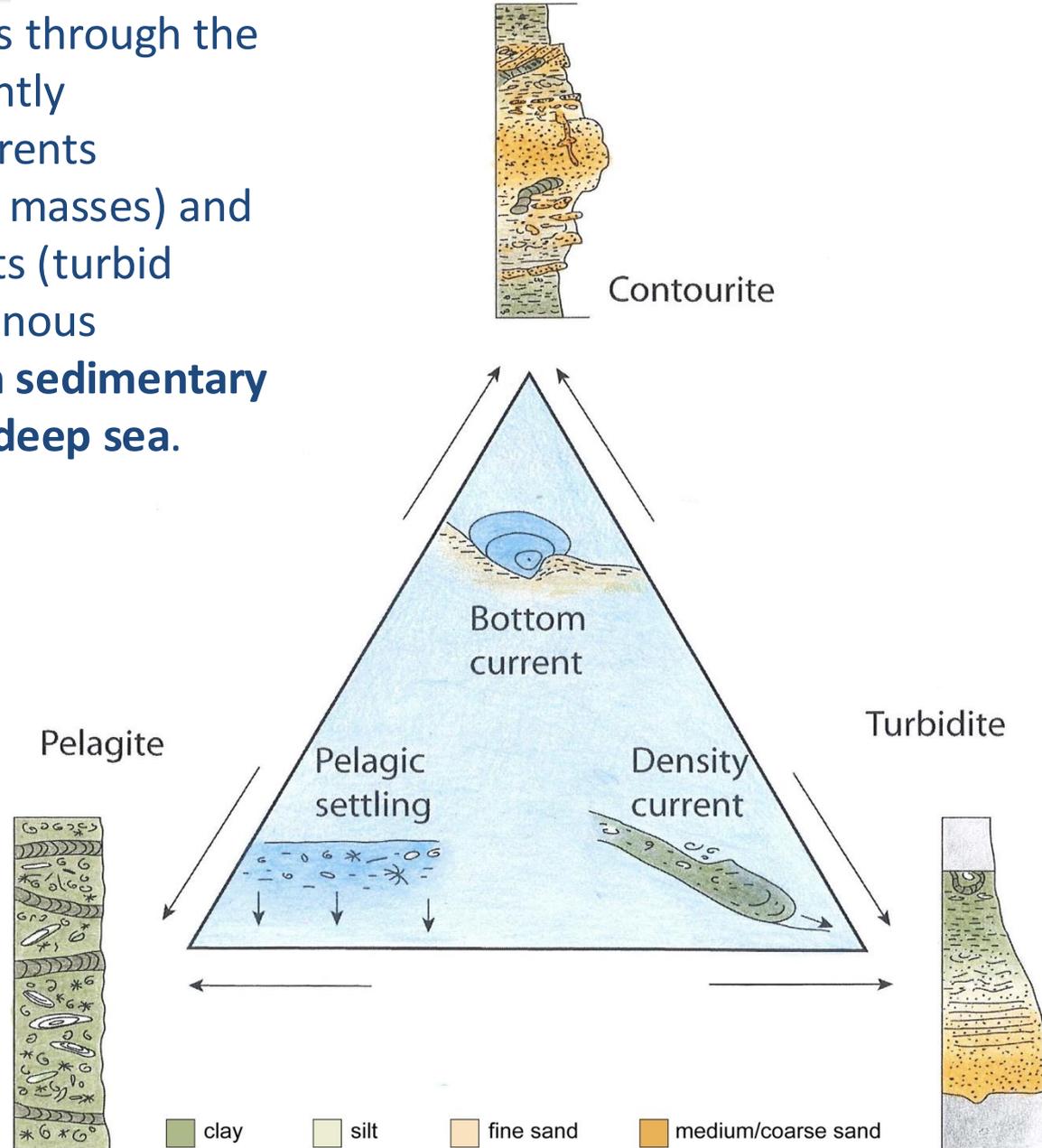


Mosher et al. (2017)



The settling of pelagic particles through the water column, the predominantly alongslope flow of bottom currents (relatively clean bottom water masses) and the downslope density currents (turbid flows of predominantly terrigenous sediments) are **the three main sedimentary processes taking place in the deep sea.**

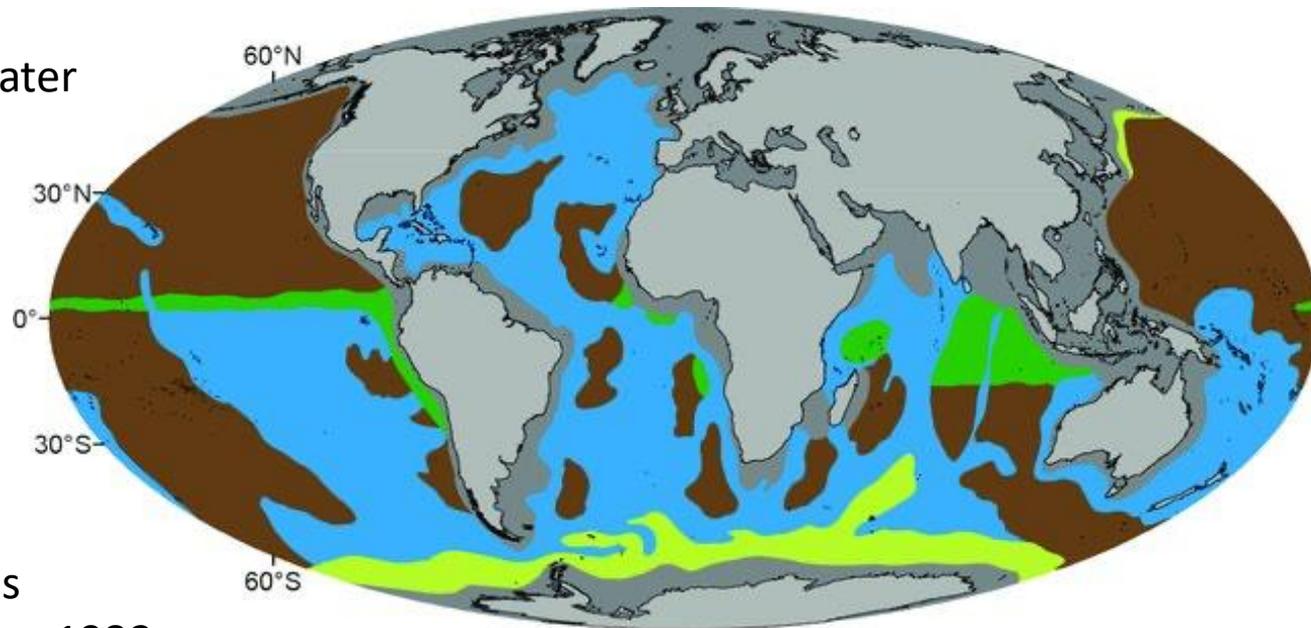
While the first two represent a “background” process that is dominant only in very remote abyssal areas, episodic, high-energy density flows are commonly superposed to the two other permanent processes on many continental margins.



Pelagic sediment

Half of the Earth's surface is covered by pelagic sediment, yet study of its sedimentology is challenging because of its slow sedimentation rates and intense bioturbation. Some 47% of the pelagic realm is floored by foraminiferal ooze, 15% by siliceous ooze (mostly diatom ooze around Antarctica), and 38% by abyssal brown clay, in areas where there is total dissolution of biogenic material.

D.J.W. Piper, 2005, Deep Water Processes and Deposits. in Encyclopedia of Geology

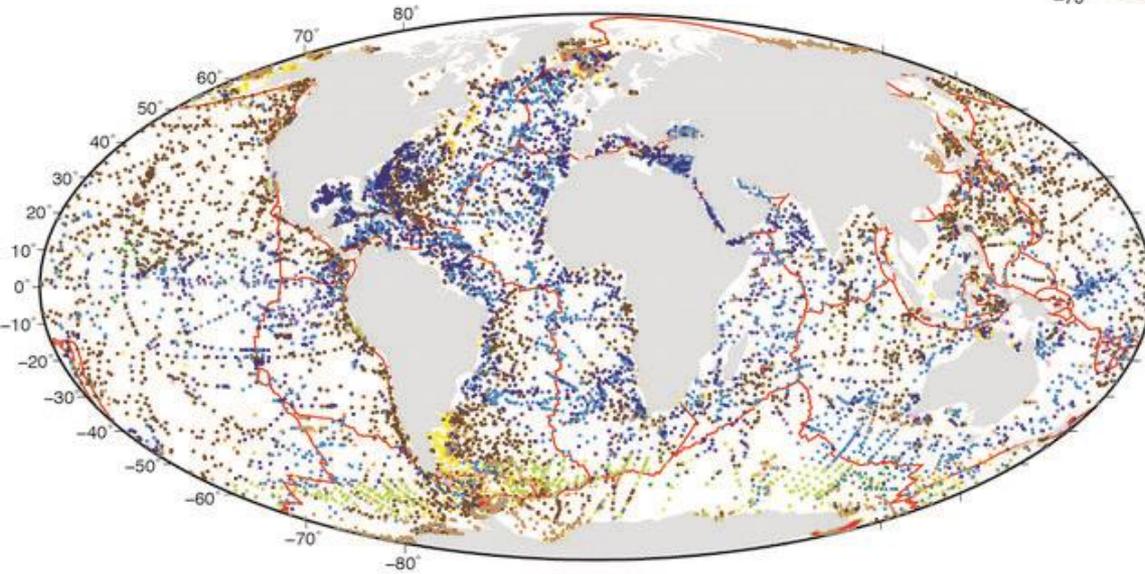
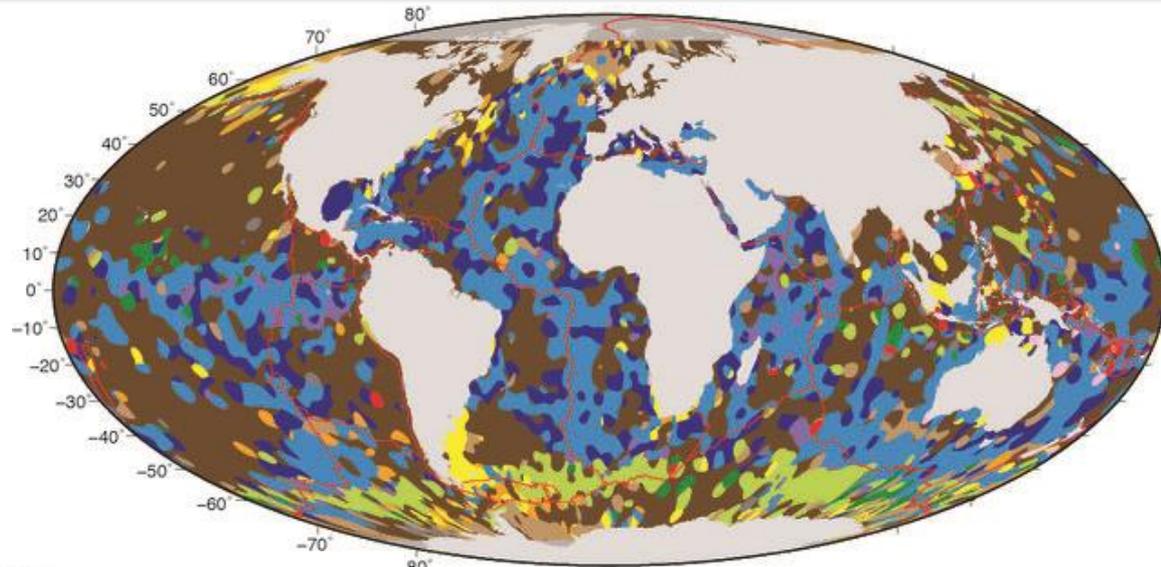


This hand-drawn map has remained unchanged since 1983 and is based on Bershad and Weiss, 1974, supplemented by ODP data

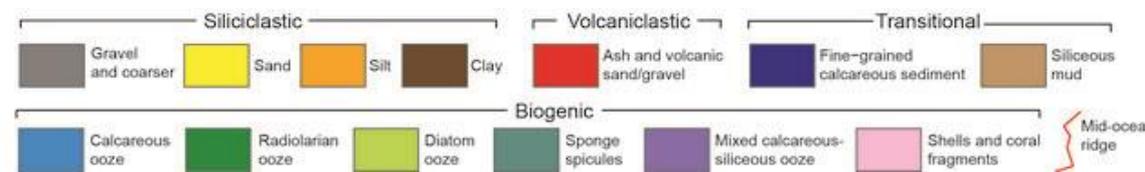


Seafloor sediments

Dutkiewicz et al., 2015.
Census of seafloor sediments in the world's ocean.
Geology 43(9):795-798



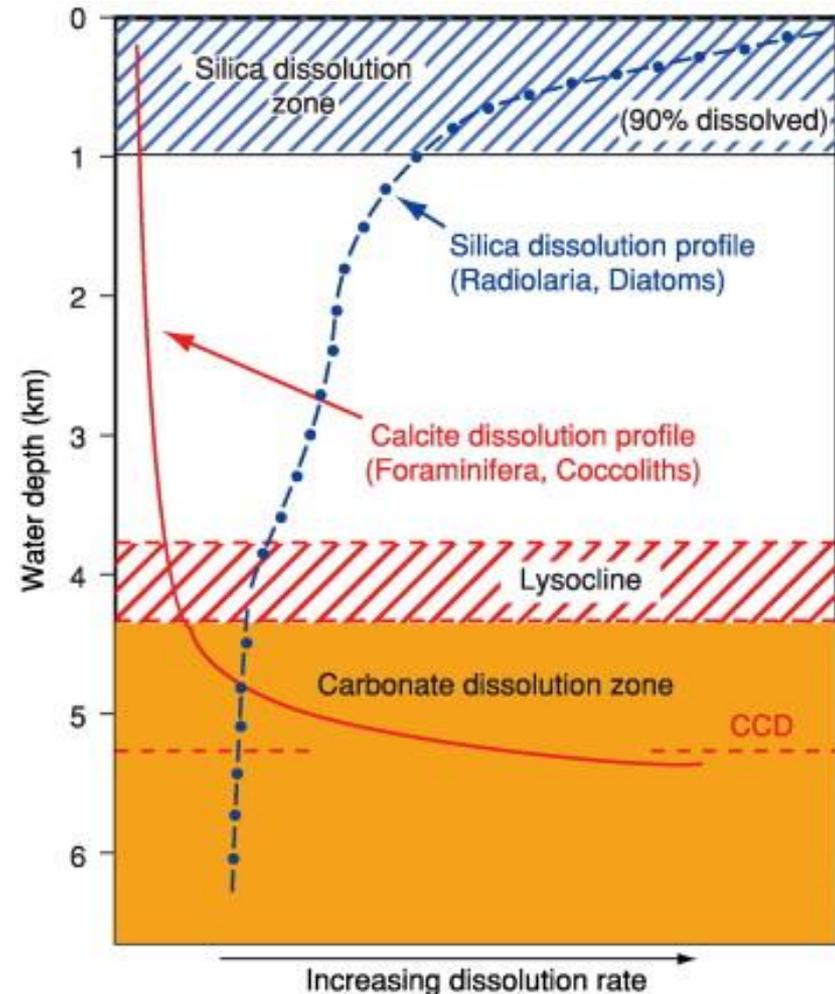
digital map of seafloor lithologies based on descriptions of nearly 14,500 samples from original cruise reports, interpolated using a support vector machine algorithm



calcite compensation depth

It controls of the distribution of pelagic deposits.

Pelagic sediments are defined as those formed of settled material that has fallen through the water column; their distribution is controlled by three main factors, distance from major landmasses, water depth, and ocean fertility. Pelagic sediments are composed largely of the calcareous or siliceous remains of planktonic micro-organisms or wind-derived material or mixtures of these. The distribution of pelagic sediment types is strongly controlled by the calcite compensation depth (CCD), which is that depth at which the rate of supply of biogenic calcite equals its rate of dissolution. Therefore, below the CCD, only carbonate-free sediments accumulate. Thus the calcite compensation depth marks a major boundary defining the deposition of pelagic clays and calcareous sediments.



R.G. Rothwell, 2005. Deep Ocean Pelagic Oozes. in Encyclopedia of Geology

Foraminiferal ooze

Calcareous foram ooze of the ocean floor viewed from the submersible Alvin in the Oceanographer Fracture Zone, central North Atlantic (~35N, 35W).

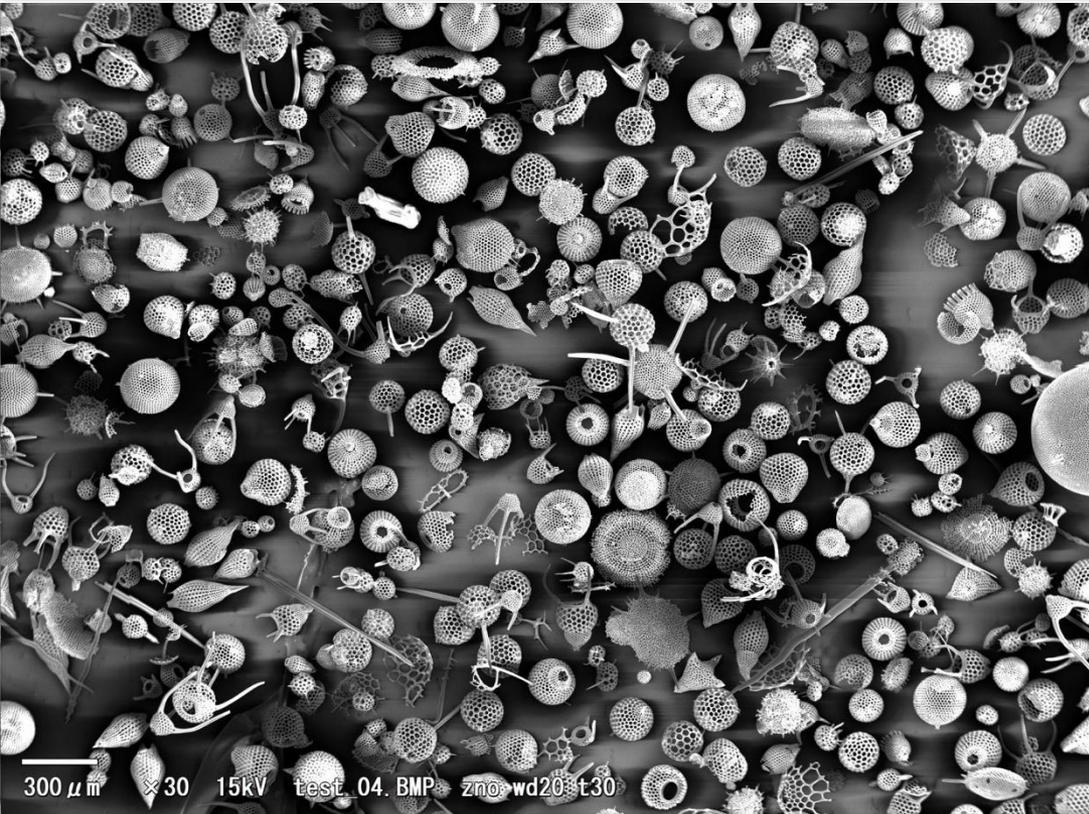


It consists almost entirely of tests (skeletons) of foraminiferans known as *Globorotalia inflata*.

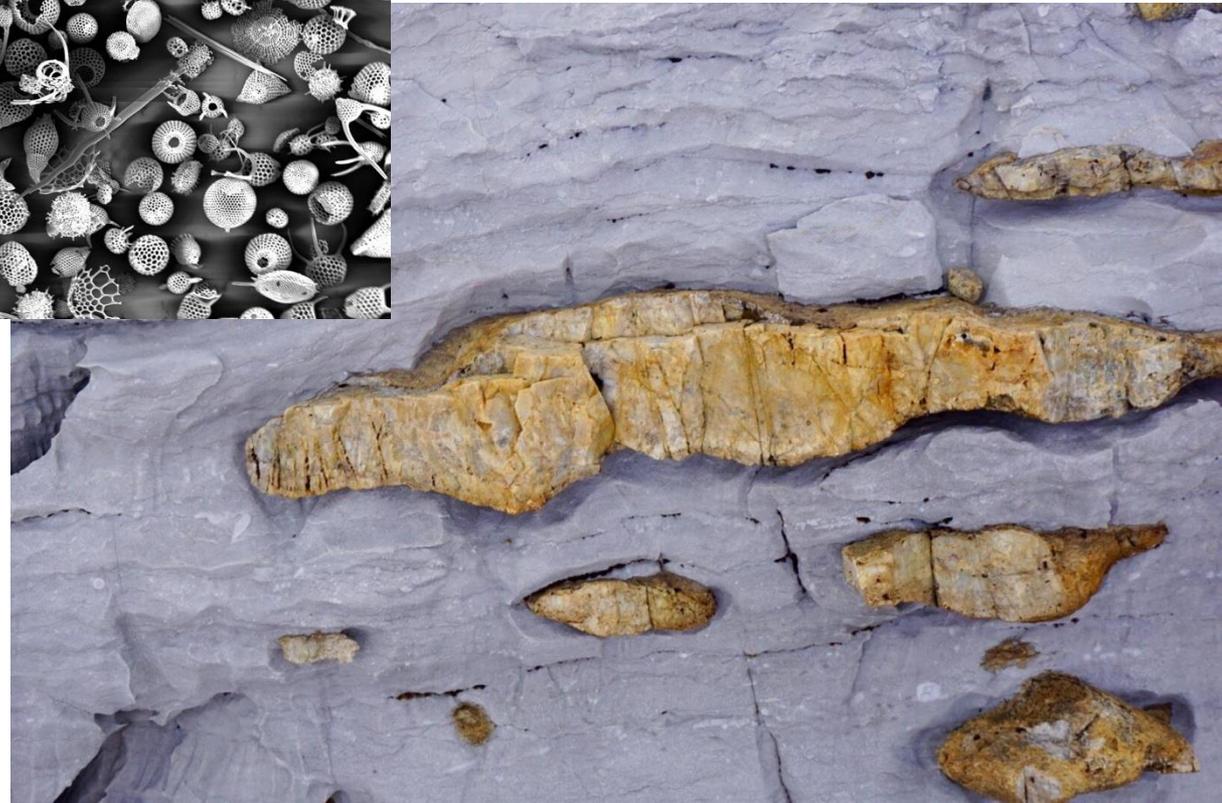
Above is the outcrop of the “Yellow Calcareous Marls” at Cala Sant’Antonino from which the left samples were collected. The rock is very soft and powdery to the touch.

Siliceous ooze

Eocene radiolarian ooze seen at the Scanning Electron Microscope. Credit: Yasuhiro Hata



Nodules of chert (yellowish, in relief) within a crinoid-bearing limestone of the Buttle Lake Group, Vancouver, Canada. Photo courtesy MarkuMark.



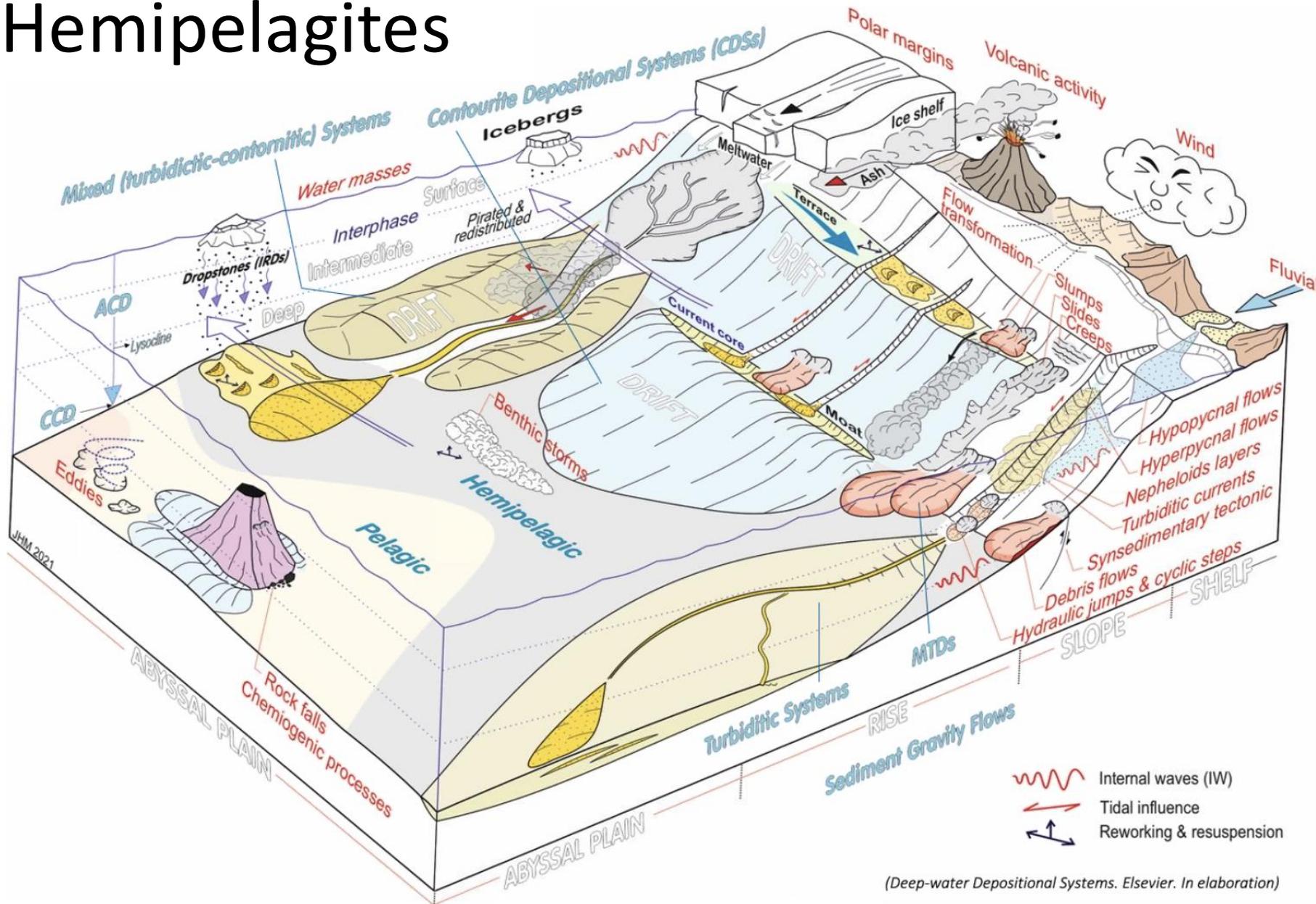
Pelagic red clays



For example
*Rosso
ammonitico*,
deposits
typical of
pelagic
highlands, in
conditions of
good
oxygenation
and therefore
water
exchange.



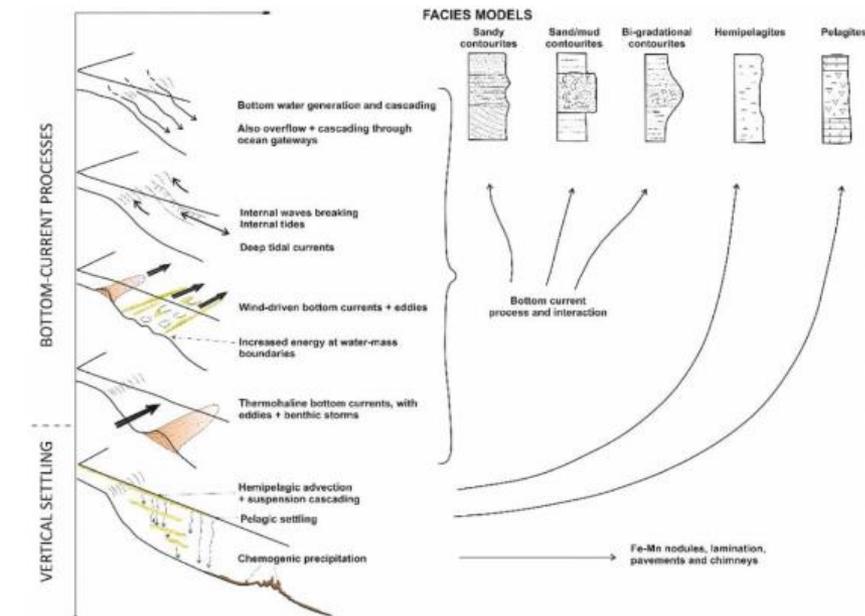
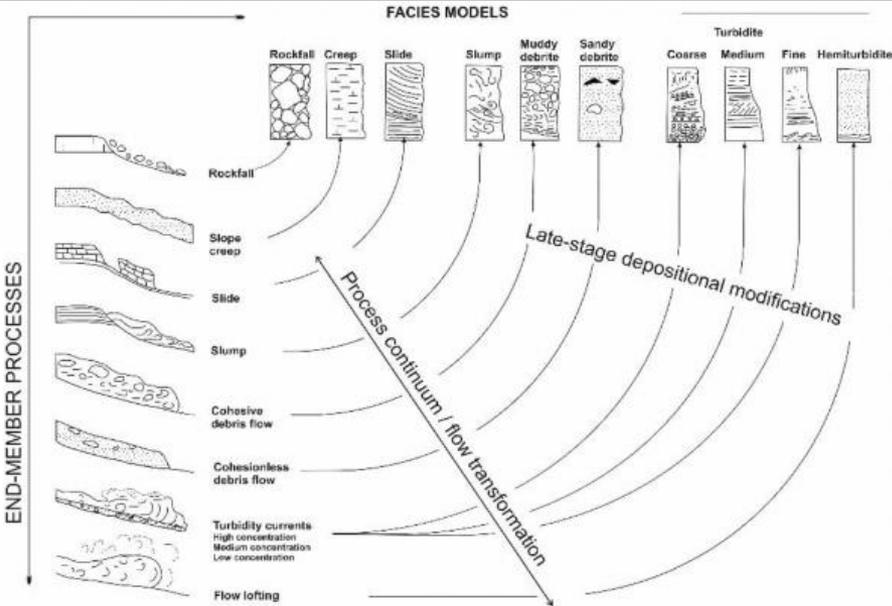
Hemipelagites



Distinguishing between Deep-Water Sediment Facies

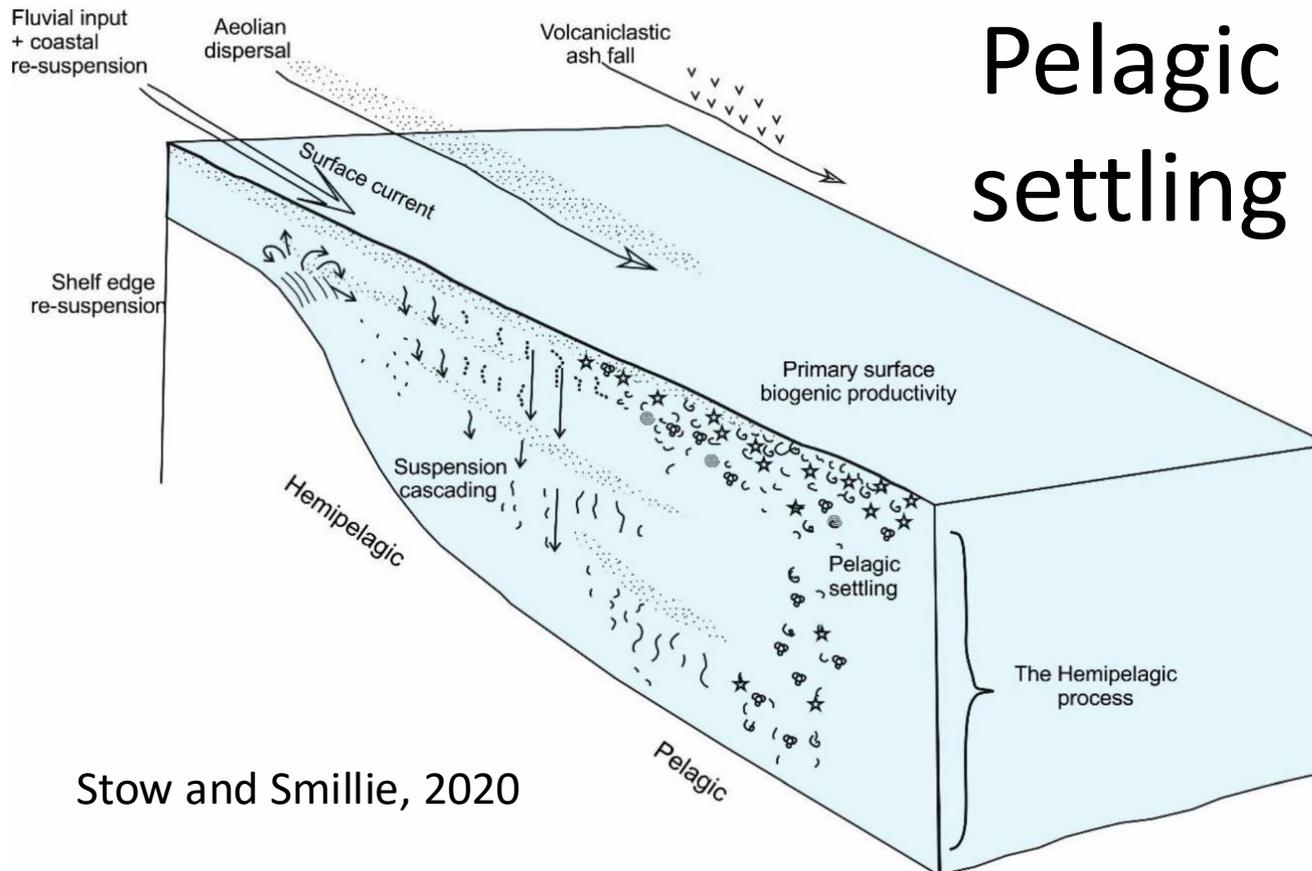
Pelagic or hemipelagic sedimentation dominates where other processes are absent or rare, but all trace of these deposits can be removed where turbidites dominate or where strong bottom currents have prevented deposition. It is in part for these reasons that the distinction between turbidites, contourites and hemipelagites has long been a matter of controversy. Anyone whose work involves deep-water systems and their sediments should be aware of these differences in opinion.

Hemiturbiditic sedimentation involves flow lofting and upward dispersion from a dilute turbidity current during its final stages of deposition. The fine-grained material carried by the turbidity current disperses beyond the final deposit of the normal turbidite, mixes with any background pelagic or hemipelagic material, and deposits slowly by vertical settling.



Pelagic settling is a process of vertical settling under the influence of gravity by which primary biogenic material and very fine-grained terrigenous or other detritus in the surface waters fall slowly to the seafloor. The rate of fall and hence of sediment accumulation is increased by both flocculation and by organic pelletisation, especially in high productive areas. In oligotrophic open-ocean systems, the process is quite continuous and accumulation is typically very slow, i.e., $< 1 \text{ cm ka}^{-1}$.

Pelagic settling

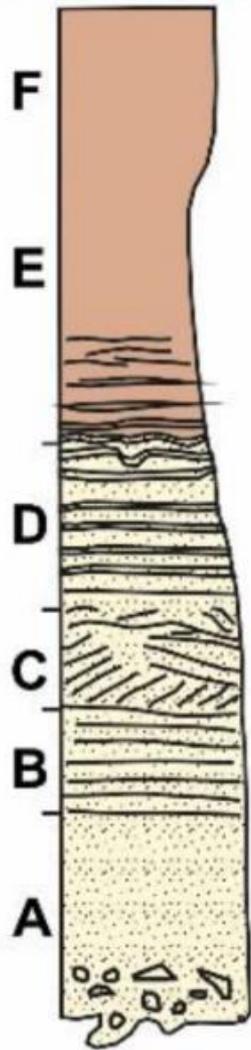


Stow and Smillie, 2020

Hemipelagic deposition is a complex process involving both vertical settling and slow lateral advection through the water column. The driving forces behind this lateral advection include the inertia of river plumes, glacial meltwater diffusion, turbid layer plumes, internal tides and waves and other slowly moving midwater currents.

Process Interaction

SAND-MUD TURBIDITE



PELAGITE

- +/- Bioturbation
- TURBIDITE MUD
- +/- Graded
- +/- Laminated
- TURBIDITE SILT-SAND
- Graded, fine-medium
- Parallel-laminated
- Graded, medium
- Cross-laminated
- +/- Convolute lamination
- +/- Graded, medium-coarse
- Parallel-Laminated
- Massive, medium-very coarse,
- Poor or no grading
- Sharp scoured base
- +/- Shale clasts
- +/- Pebbles
- +/- Scoured/loaded base

THE BOUMA MODEL

10 Cm

Close interaction between different processes is also common. Both turbidity currents and bottom currents will directly affect the slow settling of hemipelagic material, incorporating this fine-grained, often biogenic, material into their deposits. Bottom currents will similarly pirate the fine suspended load of distal turbidity currents and of the upper parts of flows that have over-spilled channel levees. The sudden introduction of turbidity current material into bottom currents will affect the nature and concentration of the flow as well as the composition of the deposit. Both interbedded and hybrid facies will result.

Stow and Smillie, 2020

Bedding

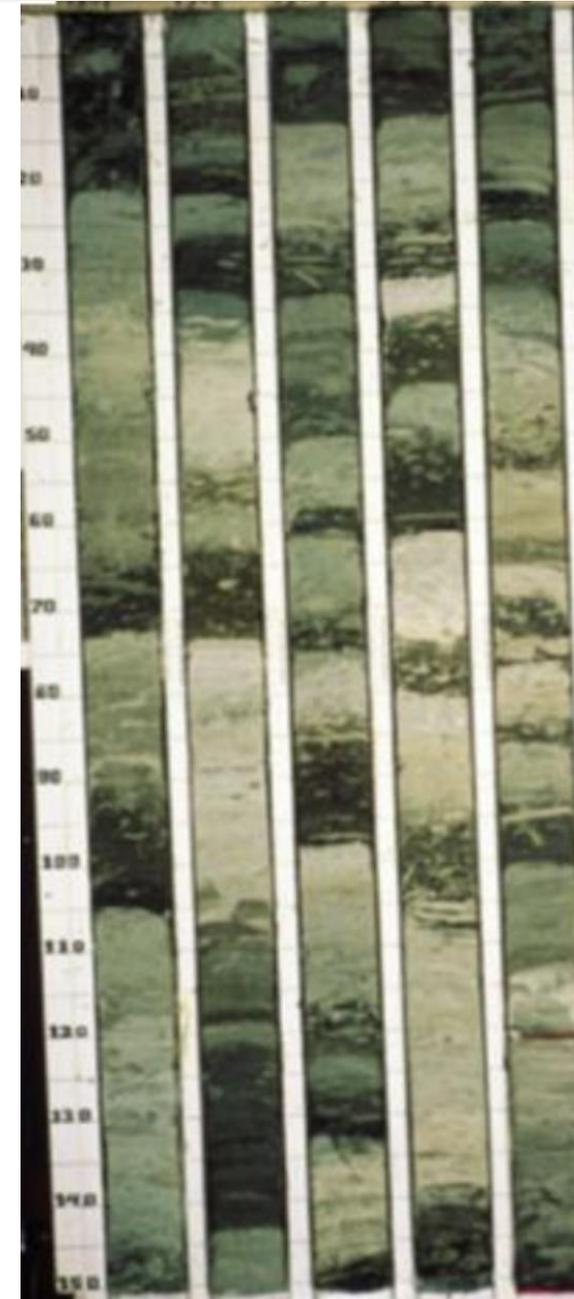


Stow and Smillie, 2020

Typical bioturbated and colour-varied hemipelagites, IODP Site 1385 (Expedition 339), offshore SW Portugal.

There is an absence or indistinctness of beds in thick successions of modern hemipelagites, where the subtle, often cyclic, variation in composition can lead to a cyclic colour bedding.

Bioturbated hemipelagites–pelagites (whitish) interbedded with graded mud turbidites (dark brown), Plio-Pleistocene, DSDP Site 530, SE Angola Basin, S Atlantic



Structures

Stow and Smillie, 2020

Primary sedimentary structures are completely absent in those hemipelagites deposited in oxygenated water. There is no current activity and a complete bioturbational overturn has served to homogenise the sediment. Where bottom waters are low in oxygen, then parallel lamination may be preserved, with low to absent bioturbation. This is most typically a fissile lamination with laminae showing a sub-parallel, wavy, anastomosing pattern.



Pelagite (micritic limestone), Eocene, Petra tou Romiou, southern Cyprus. Some evidence for interbedding with fine calcareous contourites, i.e., small bi-gradational sequence from calcilutite to calcisiltite and back to calcilutite (marked with a black line).

Bioturbation

Bioturbation. Pervasive, high-intensity and diverse bioturbation is typical for hemipelagites deposited under normal oxygenated conditions.

Trace fossil zonation, with multiple tiering, is most evident in more rapidly deposited hemipelagites, especially where they are interbedded with turbidites. Complete bioturbational mottling is more common under slow rates of deposition.

Detail from the bioturbated hemipelagites–pelagites interbedded with graded mud turbidites of DSDP Site 530 in SE Angola Basin: hemipelagite over turbidite with intense bioturbation.



Texture and fabric

Grain size characteristics of hemipelagites are strongly influenced by their composition as well as by distance from source. They are mostly fine-grained (mean 5–35 μm) and poorly sorted. Coarser grains are introduced, in particular, by ice rafting at high latitudes and by volcanoclastic activity.

Hemipelagite (pale) interbedded and interbioturbated with volcanoclastic ash layers (dark). Miocene Misaki Formation, Miura, Japan.

Hemipelagites are characterised by random to semi-random silt and clay fabrics further accentuated by the presence of isolated large grains as well as by intense bioturbation.



Composition

Hemipelagites, by definition, have a mixed composition, with biogenic components dominated by open ocean planktonic microfossils and terrigenous components depending on the source area and supply. Total organic carbon content, although generally very low, may be significantly higher (1–10%) in upwelling zones and areas of low bottom-water oxygenation.



Pelagites:
interbedded
limestone
(white) and
organic-rich
chert (black)
beds,
Cretaceous,
central Umbria,
Italy

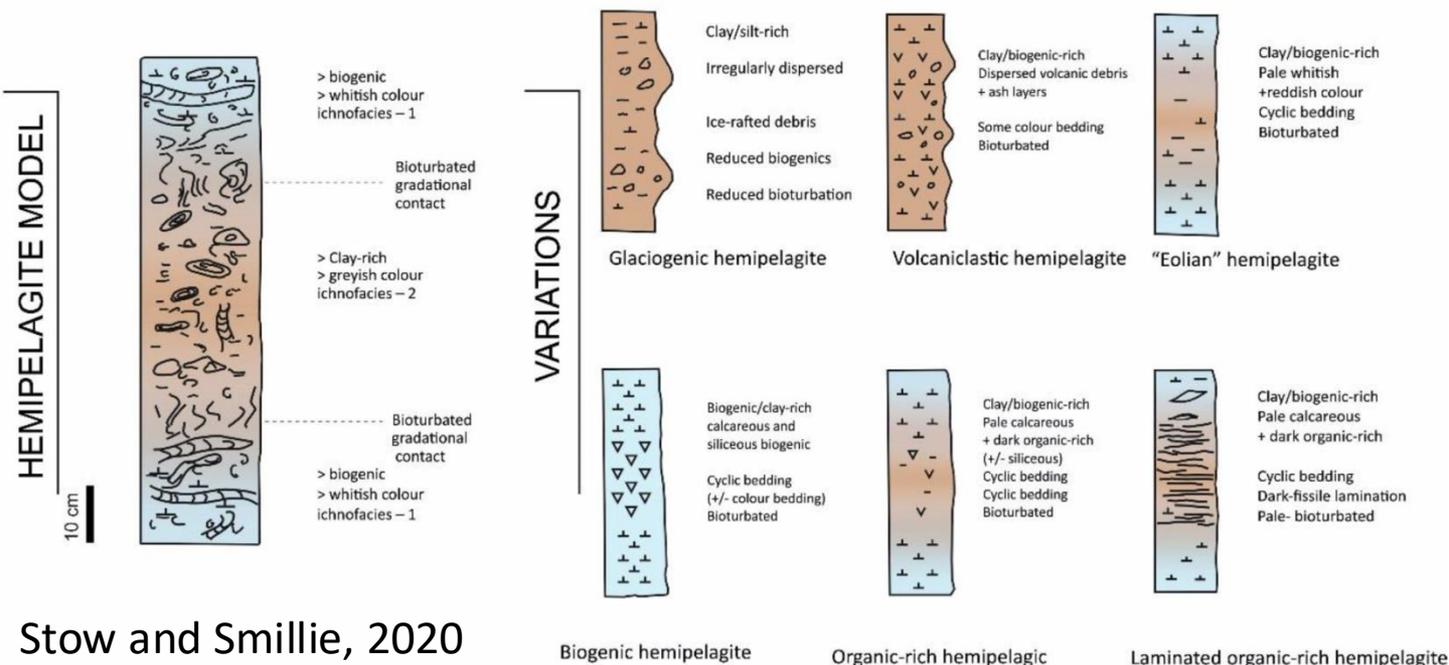
Hemipelagic Facies Models

Hemipelagite is often considered to be a rather elusive sediment facies and almost a bucket-term for a wide range of sediment types that form background deposits in many basins.

An estimated 15–20% of the present-day seafloor is composed of hemipelagites. Limestone-marl cyclic sedimentation is commonly reported from ancient successions in which the marlstone units are hemipelagic and the limestones pelagic in nature.

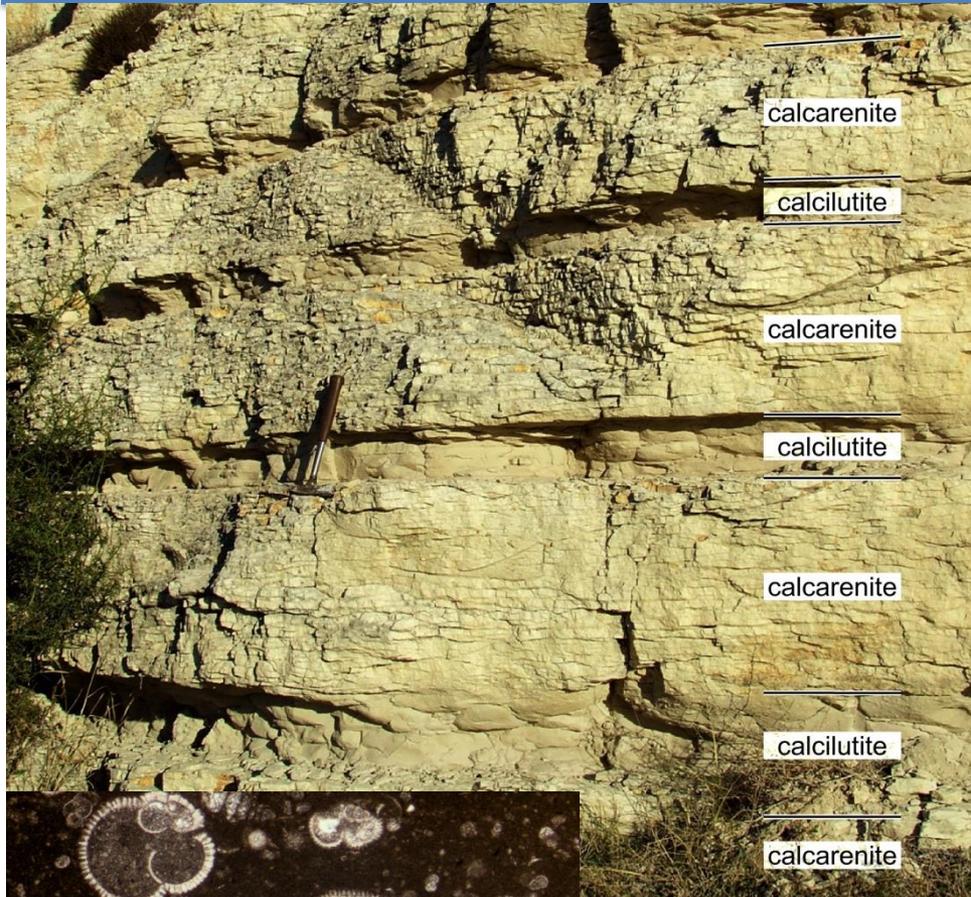
The standard facies model shows indistinct bedding. Compaction, burial and diagenesis commonly yield a more well-bedded succession. There are no primary sedimentary structures but a pervasive bioturbation. The mean size is fine (5–35 μm) and the sediment poorly sorted. The microfabric is random. Composition is mixed biogenic and terrigenous.

HEMPELAGITE FACIES MODELS: Fine-grained, mixed-composition hemipelagites

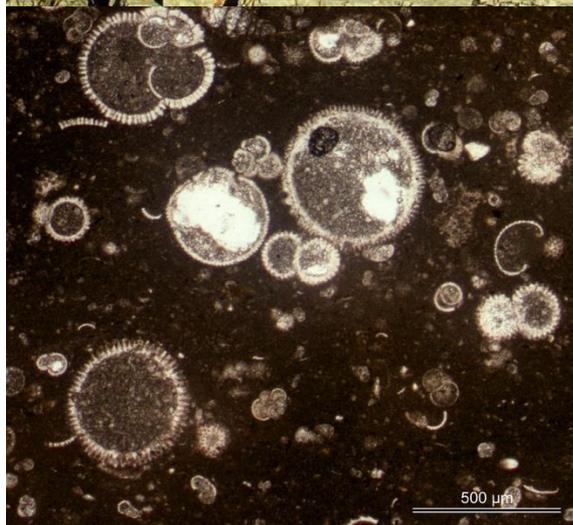


Diagnostic criteria using microfacies for calcareous contourites, turbidites and pelagites

The distinction of pelagic oozes from muddy calcareous contourites is difficult, since all of these fine-grained sediments form relatively uniform records showing indistinct bedding based on subtle compositional variation. In pelagic environments, this longer-duration compositional variation typically results from biogenic productivity fluctuations and alternating seafloor redox conditions



Hüneke et al.,2021.
Sedimentology



The key point is that sediment re-location and mixing from different sources occurs only in bottom-current controlled environments. Within pelagic sediments, by contrast, shells are empty or filled with mud that is identical to the overall matrix.

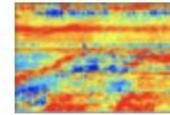
echo-character types

Llave et al., 2018, Geomorphological and sedimentary processes of the glacially influenced northwestern Iberian continental margin and abyssal plains, *Geomorphology* 312, 60-85



Irregular hyperbolae overlapping with varying vertex elevations

Continental slope and abyssal plain



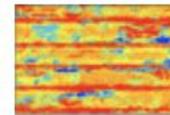
Erosion or outcrop

Erosive gravitational process or basement outcrop



Continuous echo with transparent fill

Abyssal plain



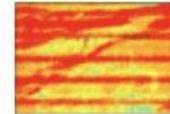
Debrite

Depositional mass flow process



Continuous echo and no sub-bottom reflectors in the first few meters followed by zones of parallel sub-bottom reflectors and intermittent transparent layers

Abyssal plain



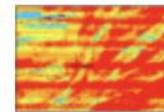
Channel Infill

Depositional pelagic/hemipelagic process



Erosive bottom surface with parallel and truncated sub-bottom reflectors

Abyssal plain



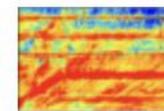
Channel

Erosive turbiditic process



Wavy echo with no parallel sub-bottom reflectors

Abyssal plain



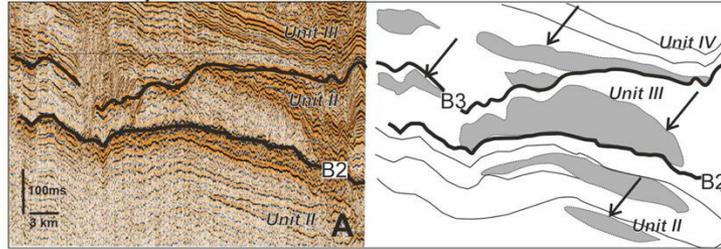
Sediment waves

Depositional turbiditic process

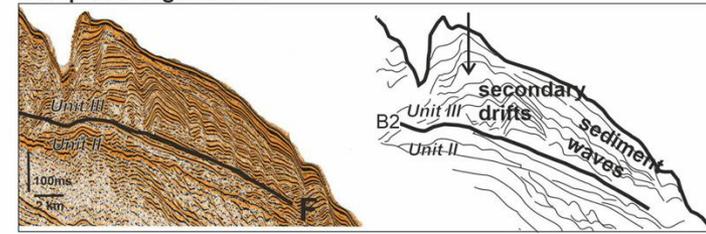
Main morphological and seismic characteristics

Ercilla et al., 2019.
 Cenozoic sedimentary history of the northern Argentine continental slope, off Bahia Blanca, the location of the Ewing Terrace: Palaeogeodynamic and palaeoceanographic implications.
 Marine Geology 417, 106028

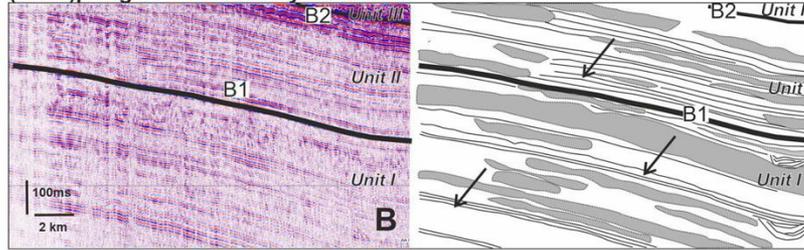
Mass-flow deposits



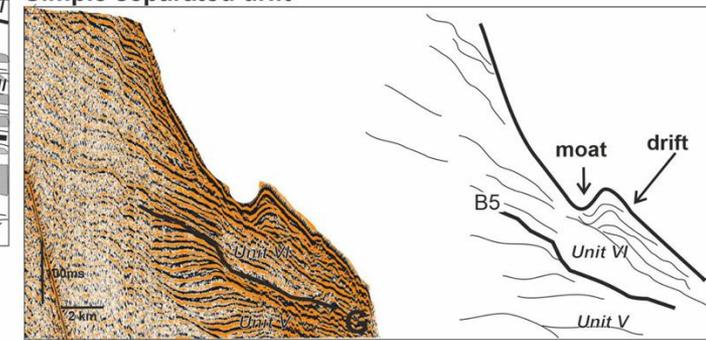
Complex elongated drift



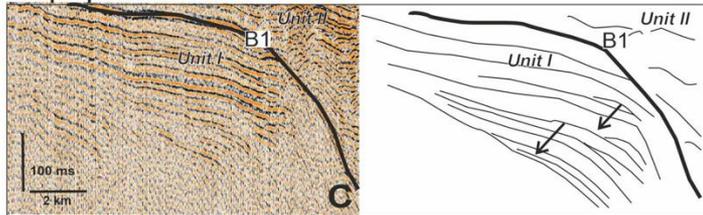
(Hemi)pelagites/Low-density turbidites



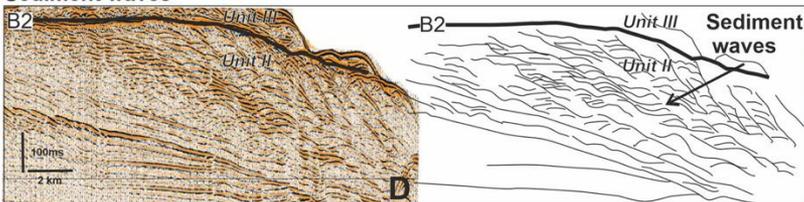
Simple separated drift



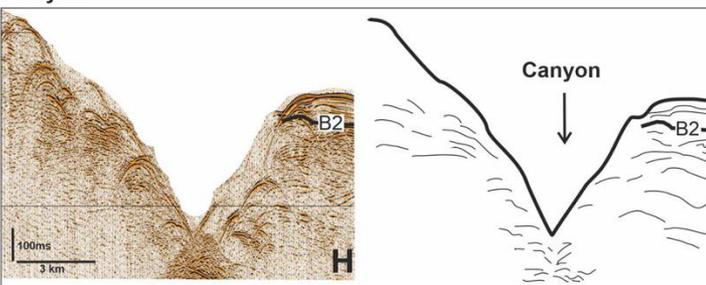
Simple plastered drift



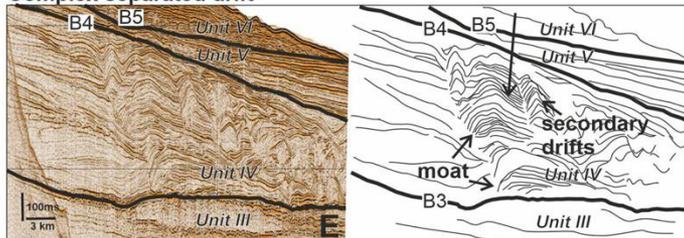
Sediment waves



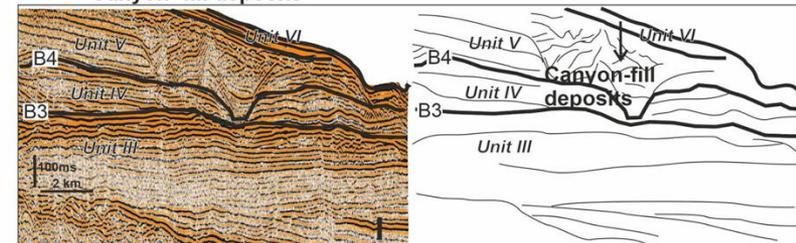
Canyon

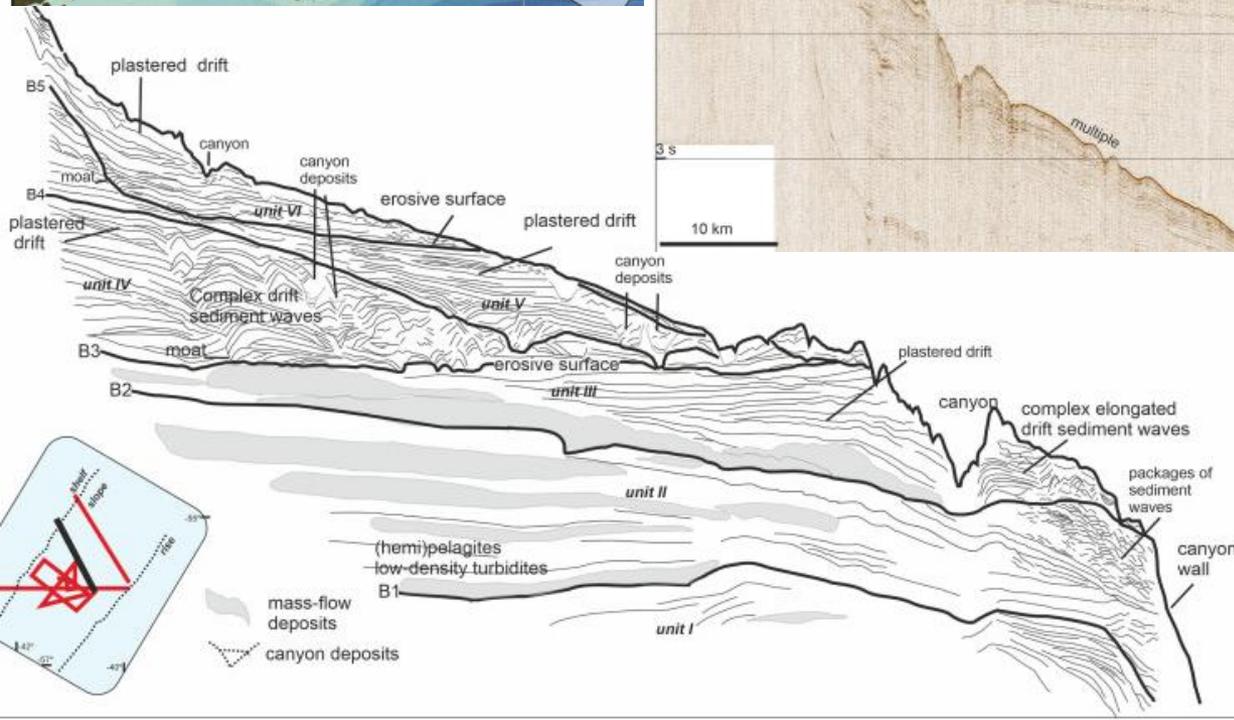
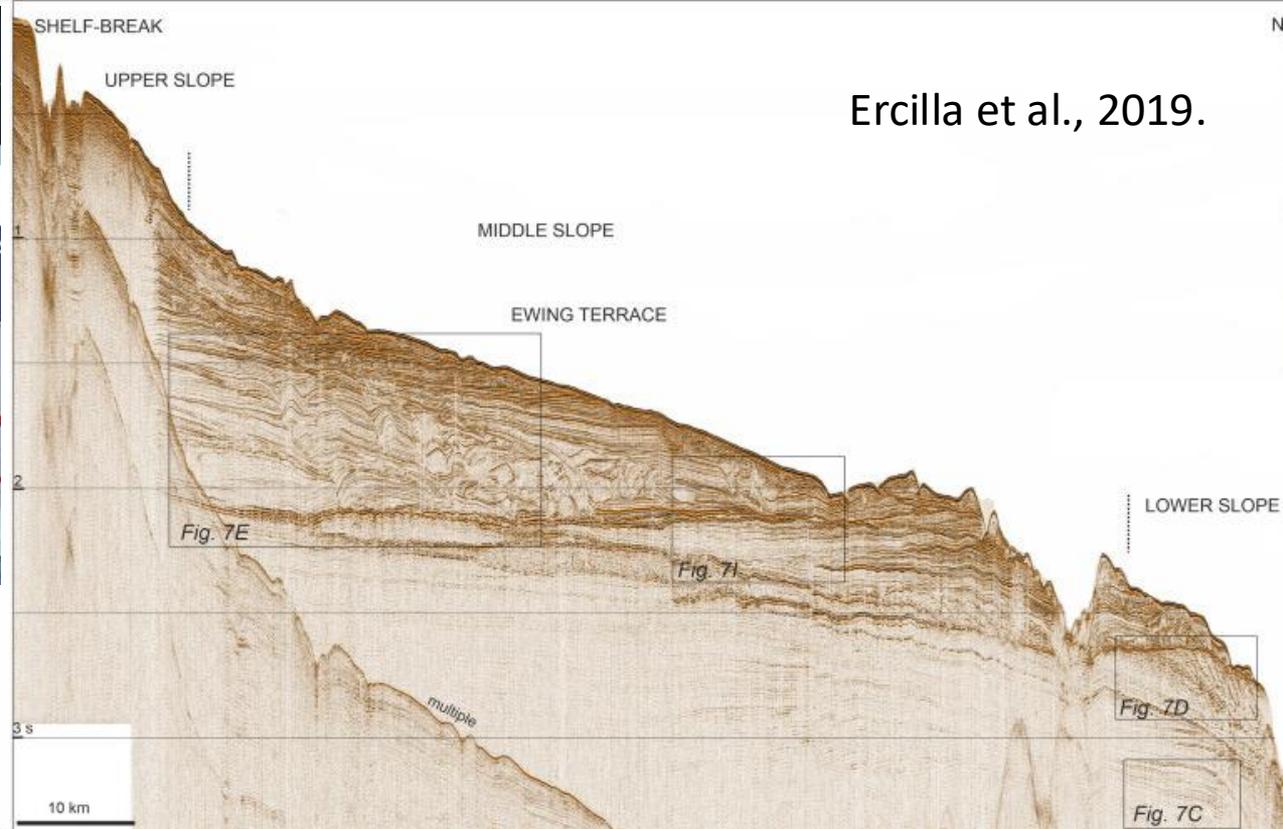
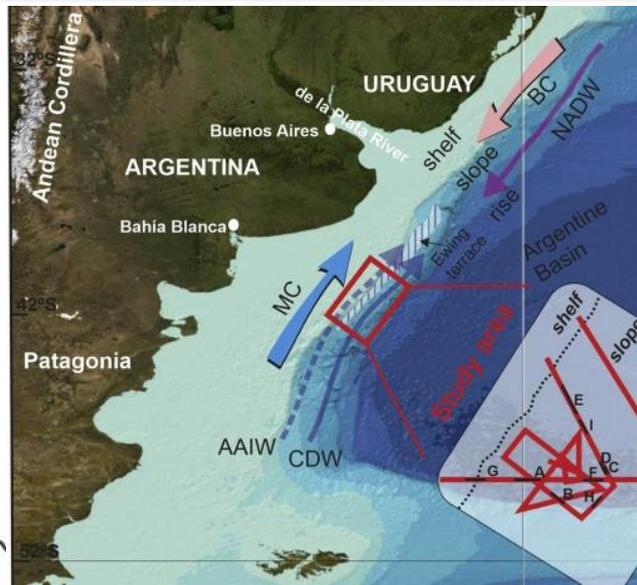


Complex separated drift



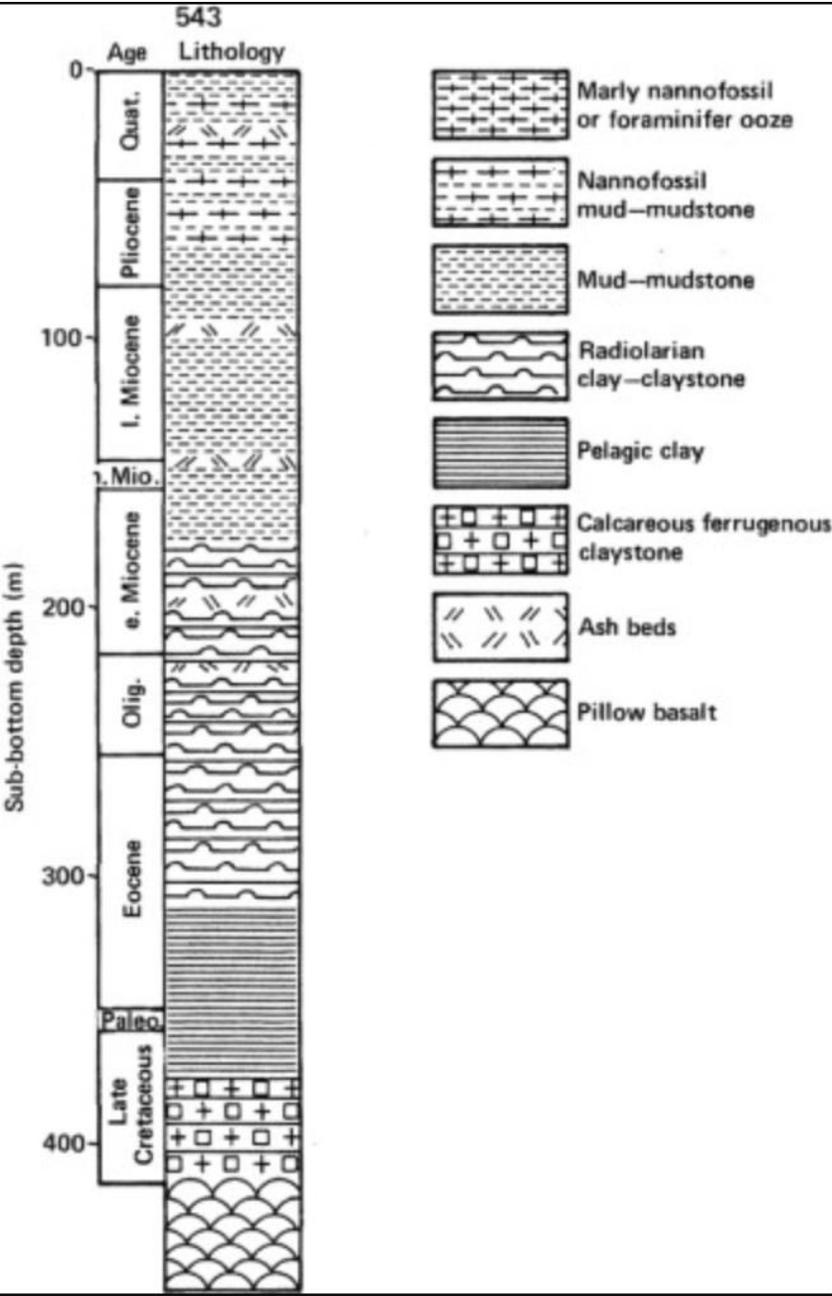
Canyon -fill deposits



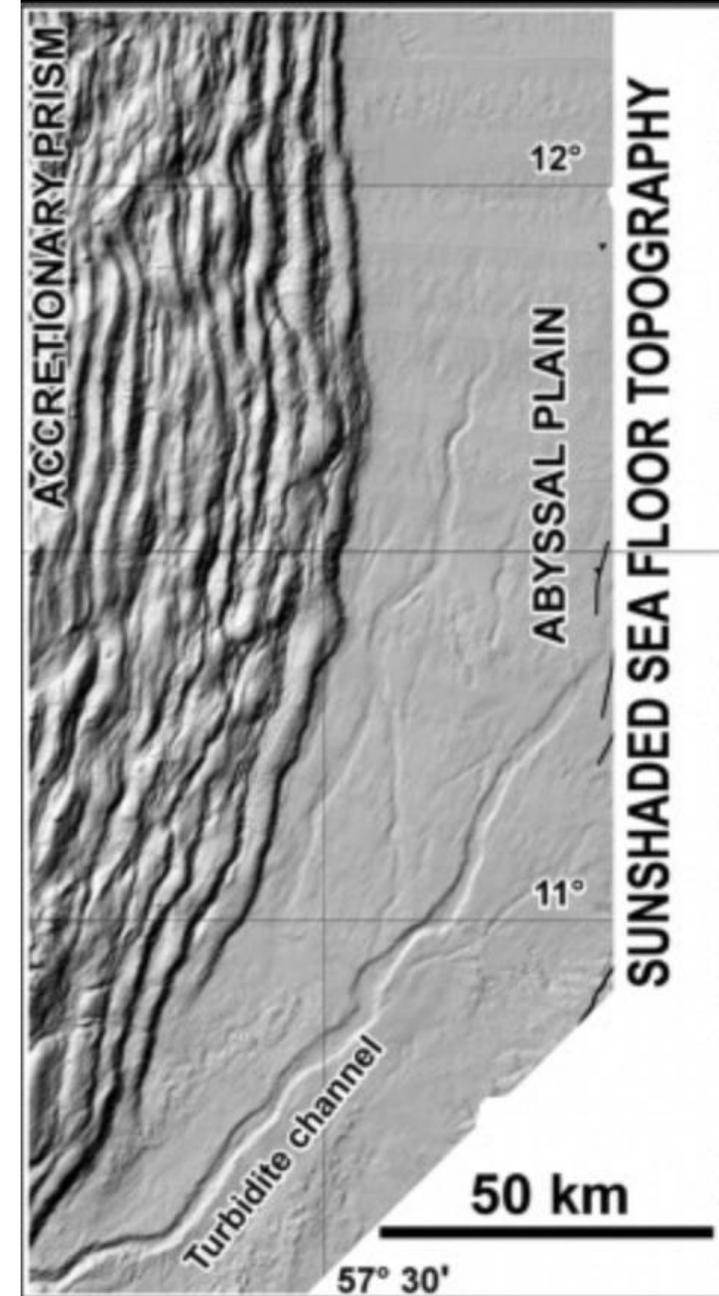


Seismic profile and line drawing across the physiographic domains of the Bahia Blanca slope. The most relevant sedimentary features (i.e., mass-flow deposits, (hemi)pelagites/low-density turbidites, contourites, and canyon deposits) are indicated.

Ercilla et al., 2019.



Deville & Mascle, 2012, The Atlantic abyssal plain: The Barbados ridge. in Regional Geology and Tectonics: Principles of Geologic Analysis

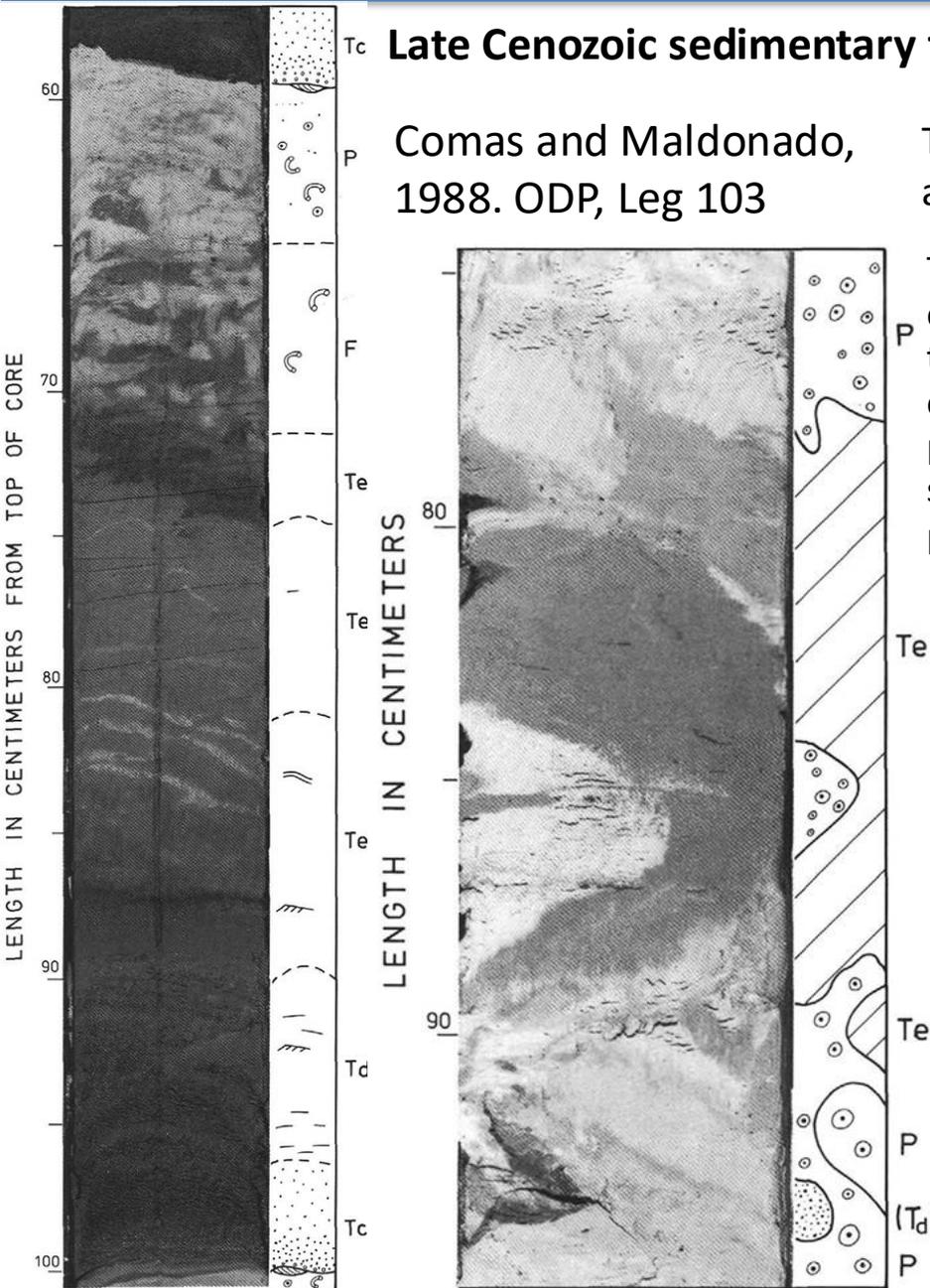


Late Cenozoic sedimentary facies and processes in the Iberian Abyssal Plain.

Comas and Maldonado, 1988. ODP, Leg 103

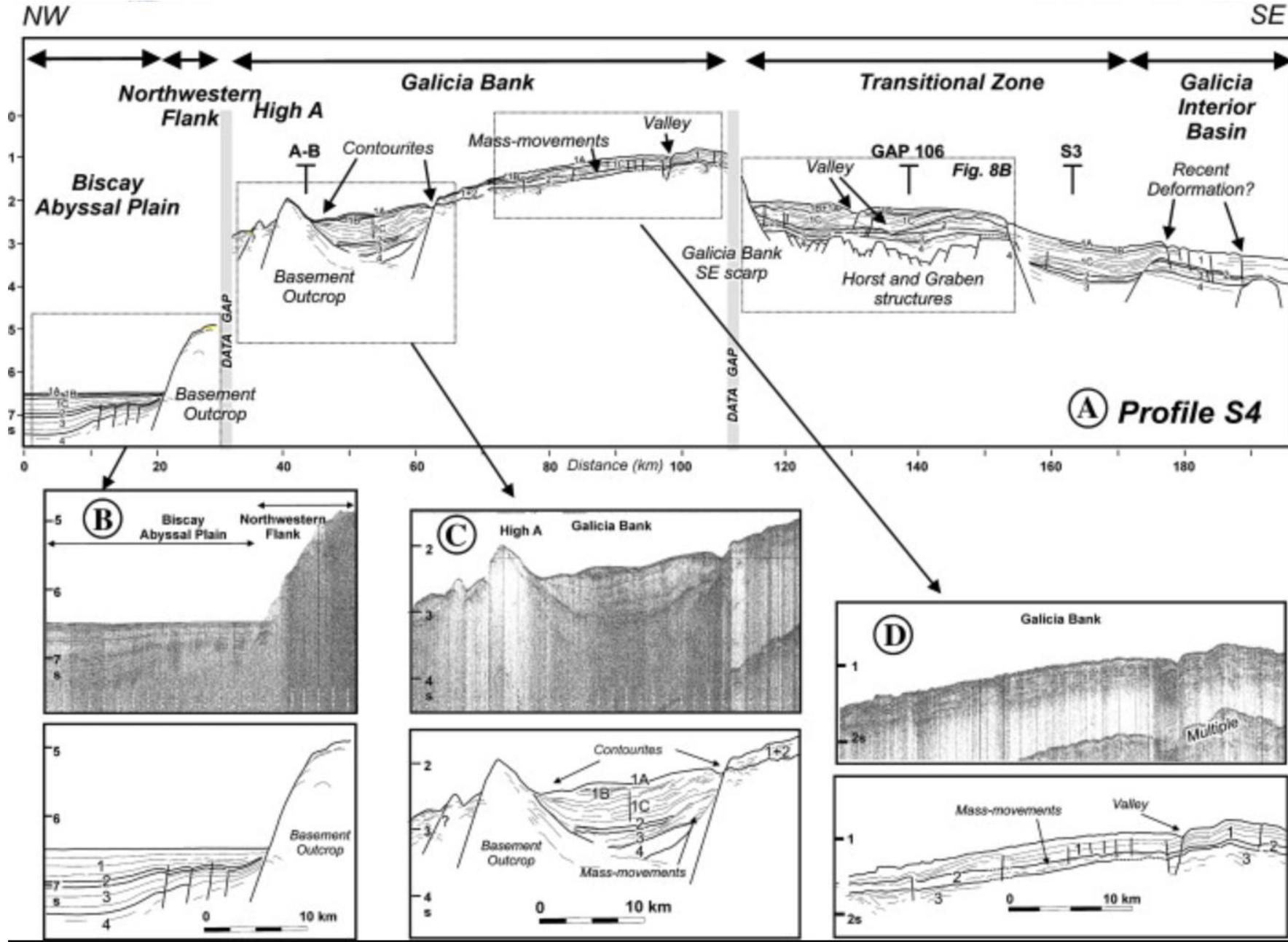
The pelagic and hemipelagic facies type encompasses a wide spectrum of calcareous oozes and marls.

The more pelagic end-member of this facies consists of white calcareous, foraminifer-rich, nannofossil ooze. The mixed terrigenous-biogenic hemipelagic end-member includes light-colored, clayey, calcareous nannofossil ooze and marl. The primary source for these deposits is pelagic biogenic material; sedimentation represents a complex balance between primary productivity, terrigenous input, and dissolution.

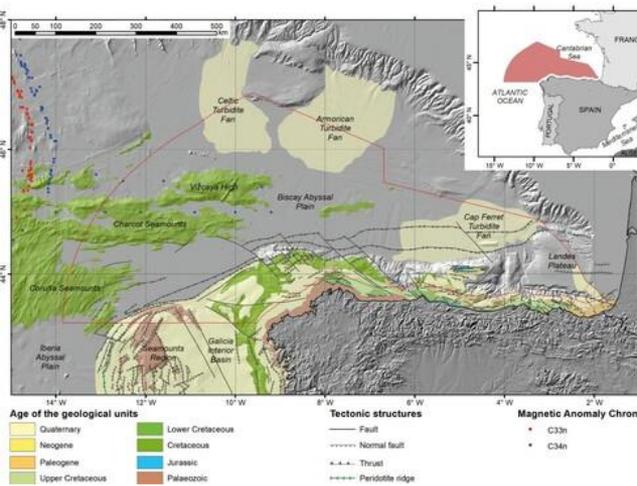


Process	Facies type symbol	Lithologic description
Pelagic-hemipelagic settling	Transition P	Pelagic calcareous biogenic to transitional sediments: white (5Y 8/2) nannofossil-foraminifer oozes to light gray (5Y 7/1, 5Y 7/2) clayey nannofossil oozes and light gray (5Y 6/1), grayish green (5Y 5/2), and light olive gray (5Y 6/1) nannofossil marls
	F	Transitional calcareous biogenic to terrigenous sediments: light olive gray to gray (5Y 6/2, 5Y 5/1), grayish green (5Y 5/2), and pale olive (5Y 6/3) nannofossil marls and grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/4) calcareous clays
Turbidity currents	Transition T _{e3}	Terrigenous sediments: gray (5Y 5/2), brown (10YR 5/3), and olive gray (5GY 5/2) clays to silty clays (some calcareous)
	T _{e2}	Terrigenous sediments: olive to gray (5Y 5/1, 5Y 5/2, 5GY 5/2) and grayish brown (2.5Y 5/2) silty clays (some calcareous)
	T _{e1}	Terrigenous sediments: dark gray to gray (5Y 4/1, 5Y 5/1) and olive gray (5Y 5/2) silty clays to clayey silts (some calcareous)
	T _d	Terrigenous sediments: dark gray to gray (5Y 4/1, 5Y 5/1) and olive gray (5Y 5/2) clayey silt to sandy-clayey silts (some calcareous)
	T _c	Terrigenous sediments: dark gray to gray (5Y 4/1, 5Y 5/1) and dark olive gray (5Y 3/2) calcareous silty sand to sandy-clayey silts
Contour currents	FC	Calcareous biogenic sediments: white (5Y 8/1, 5Y 7/1) foraminiferal sands to foraminifer-nannofossil oozes
	SC	Terrigenous sediments: variegated yellowish brown (10YR 5/4, 10YR 6/4), dark grayish brown to grayish brown (2.5Y 4/2, 2.5Y 5/2) and pale brown (10YR 6/3) sand-rich clayey silts to sand-rich silty clays (some nannofossil rich)
	MC	Terrigenous sediments: variegated dark grayish brown (10YR 4/2) and brown (10YR 6/3, 2.5Y 5/4) silty clays to clays (some nannofossil rich)
	CC	Terrigenous sediments: light yellowish brown (10YR 6/4, 2.5Y 6/4) and pale brown (10YR 6/3, 10YR 5/4) clays

Ericlla et al., 2008. Galicia Margin



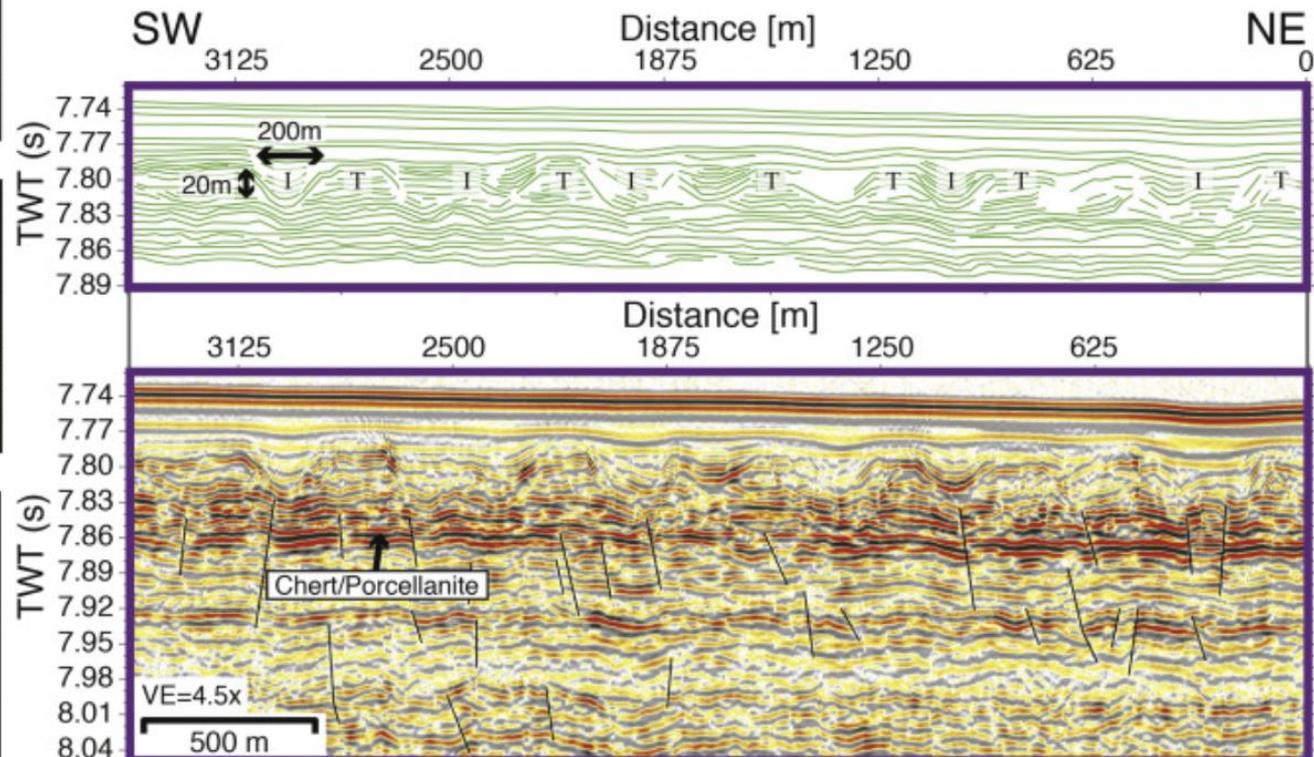
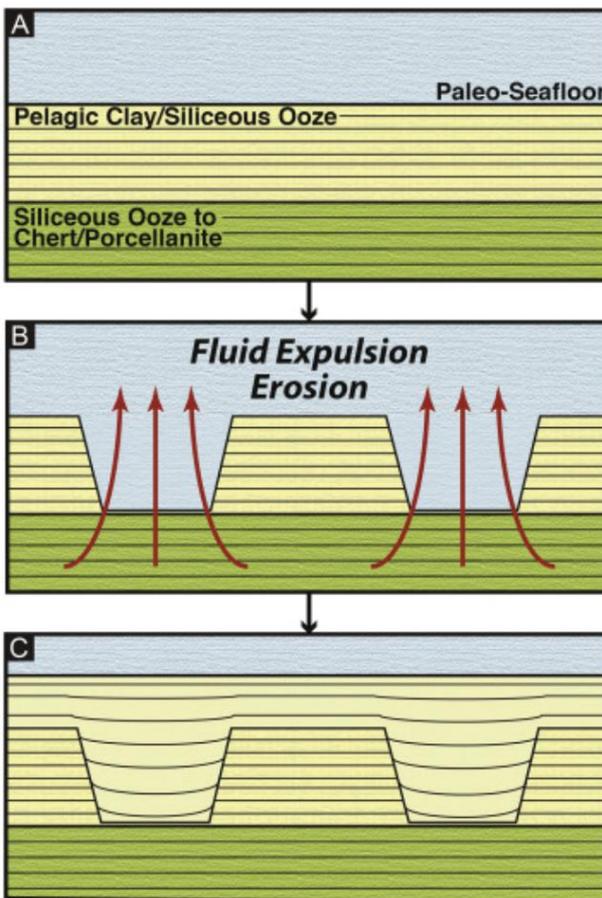
Maestro et al., 2021. Echo-character distribution in the Cantabrian Margin and the Biscay Abyssal Plain



Subtype	TOPAS example	Line draw	Legend	Characteristics	Distribution	Subtype	TOPAS example	Line draw	Legend	Characteristics	Distribution						
Choked Echoes																	
1A				Absence of sub-bottom reflectors underneath a distinct continuous bottom echo	Continental Shelf and Slope	2C				Distinct and irregular bottom echo and sub-bottom acoustic blanking with high reflective and subparallel to the bottom reflectors in the base	Continental Slope						
1B				Parallel and stratified sub-bottom reflectors underneath a distinct continuous bottom echo	Continental Slope and Abyssal Plain	2D				Distinct and irregular bottom echo and sub-bottom acoustic blanking with stratified reflectors in the base obscured by vertical transparent zones	Abyssal Plain						
1C				Turbate sub-bottom reflectors underneath a distinct continuous bottom echo	Continental Slope and Abyssal Plain	Hyperechoic Echoes											
1D				Distinct and uniform bottom echo and sub-bottom acoustic blanking with stratified reflectors in the base	Continental Slope and Abyssal Plain	3A				Bottom echo with irregular hyperboles overlapping in a single hyperbole with variable elevations of the vertex with respect to the bottom	Continental Slope and Abyssal Plain						
1E				Distinct and uniform bottom echo and sub-bottom propagating reflectors	Continental Slope and Abyssal Plain	3B				Bottom echo with regular hyperboles with variable elevations of the vertex with respect to the bottom and sub-bottom and with reflectors	Continental Slope and Abyssal Plain						
1F				Distinct and uniform bottom echo and sub-bottom stratified reflectors with a distinct reflector in the base	Abyssal Plain	3C				Bottom echo with small and regular hyperboles overlapping with tangent vertex to the bottom	Continental Slope and Abyssal Plain						
1G				Distinct and uniform bottom echo and sub-bottom stratified reflectors with acoustic blanking in the base	Continental Slope	3D				Bottom echo with irregular hyperboles with variable elevations of the vertex with respect to the bottom and sub-bottom without reflectors	Continental Slope and Abyssal Plain						
1H				Distinct and uniform bottom echo and sub-bottom alternation of high reflective parallel reflectors to bottom and acoustic blanking levels	Continental Slope and Abyssal Plain	3E				Bottom echo with irregular overlapping hyperboles and sub-bottom with associated reflectors	Continental Slope						
1I				Distinct and uniform bottom echo and sub-bottom alternation of propagating and continuous reflectors and acoustic blanking levels	Continental Slope and Abyssal Plain	3F				Bottom echo with regular overlapping hyperboles with the vertex tangent to the bottom	Abyssal Plain						
1J				Distinct and uniform bottom echo and sub-bottom acoustic blanking with alternation of high reflective reflectors and acoustic blanking levels in the base	Abyssal Plain	Uncluttered Echoes											
1K				Distinct and uniform bottom echo and sub-bottom oblique reflectors	Continental Slope	4A				Uncluttered bottom echo and sub-bottom alternation of high reflective reflectors and acoustic blanking levels parallel to the bottom	Continental Slope and Abyssal Plain						
1L				Distinct and uniform bottom echo and sub-bottom high reflective oblique, disrupted reflectors, parallel to each other but not to the bottom reflectors, with vertical transparent zones	Continental Slope	4B				Uncluttered bottom echo and sub-bottom parallel to each other but not to the bottom reflectors	Abyssal Plain						
1M				Distinct and uniform bottom echo and sub-bottom high reflective oblique, truncate and parallel reflectors	Continental Slope and Abyssal Plain	4C				Uncluttered bottom echo and sub-bottom acoustic blanking with a distinct reflector in the base	Continental Slope						
1N				Weak bottom echo and sub-bottom parallel and truncate reflectors	Continental Slope and Abyssal Plain	4D				Uncluttered bottom echo with semi-parallel-sub-bottom reflectors which thin or wedge out	Abyssal Plain						
Irregular Echoes																	
2A				Distinct and irregular bottom echo and sub-bottom acoustic blanking with high reflective and protruded reflectors in the base	Continental Slope	4E				Uncluttered bottom echo and semi-parallel truncate sub-bottom reflectors	Abyssal Plain						
2B				Distinct and irregular bottom echo and sub-bottom without reflectors	Continental Slope	4F				Uncluttered bottom echo with parallel sub-bottom reflectors disrupted by vertical transparent zones	Continental Slope						

Deep-ocean paleo-seafloor erosion in the northwestern Pacific identified by high-resolution seismic images

Greene et al., 2020 . Marine Geology 429, 106330



Exercises

seafloor	Seismic Facies Description	Seismic Facies Interpretation	Seismic Unit
	High-amplitude parallel, continuous (onlapping onto underlying units)	Hemipelagic to pelagic sediments (including ice-rafted debris)	Unit 5
Horizon H5			
	Moderate- to high-amplitude, concordant, semi-continuous (mounded geometries common)	Sediment wave-dominated muddy drift deposits (and minor moat levee features)	Unit 4
	Moderate- to low-amplitude and concordant (wavy geometries common)		
Horizon H4			
	Very low-amplitude (transparent)	Muddy drift deposits	Unit 3
Horizon H3			
	Moderate- to high-amplitude, semi-continuous to discontinuous	Interbedded pelagic sediments	Unit 2
Horizon H2			
	Moderate- to high-amplitude, semi-continuous to continuous	Interbedded pelagic sediments (rare shallow-marine carbonate)	Unit 1
Horizon H1			
	Moderate- to high-amplitude, discontinuous to chaotic (acoustic basement)	Volcanic basement (possibly rare shallow-marine carbonate)	

Examples	Seismic character	Seismic facies	Interpretation
	Concave bottom, lenticular configuration, moderate to high amplitude, moderate continuity, lens shape	Lenticular (LF)	Lobes formed by deposition from unconfined concentrated turbidity currents
	Channel-like external boundary, subparallel configuration, moderate to high amplitude, high to low continuity	Channel-fill (CF)	Deposition within channels from confined turbidity currents
	Wedge to mound shape, flat bottom, convergent configuration, moderate amplitude, moderate to high continuity	Wedge-to-mound-shaped (WSF)	Overbank deposits formed by dilute turbidity currents that spilled out of channels
	Continuous wavy configuration, moderate amplitude, high continuity, upslope migration	Wavy (WF)	Sediment waves formed by unconfined supercritical turbidity currents
	Transparent to chaotic configuration, low amplitude, low continuity, irregular shape	Transparent to chaotic (WF)	Mass transport deposits
	Parallel to subparallel configuration, moderate to high amplitude, high continuity, sheeted shape	Parallel to subparallel (PF)	Mixed pelagic and unconfined dilute turbidity current deposition

Rebesco et al., 2021. Malta Escarpment. Marine Geology 441, 106596

