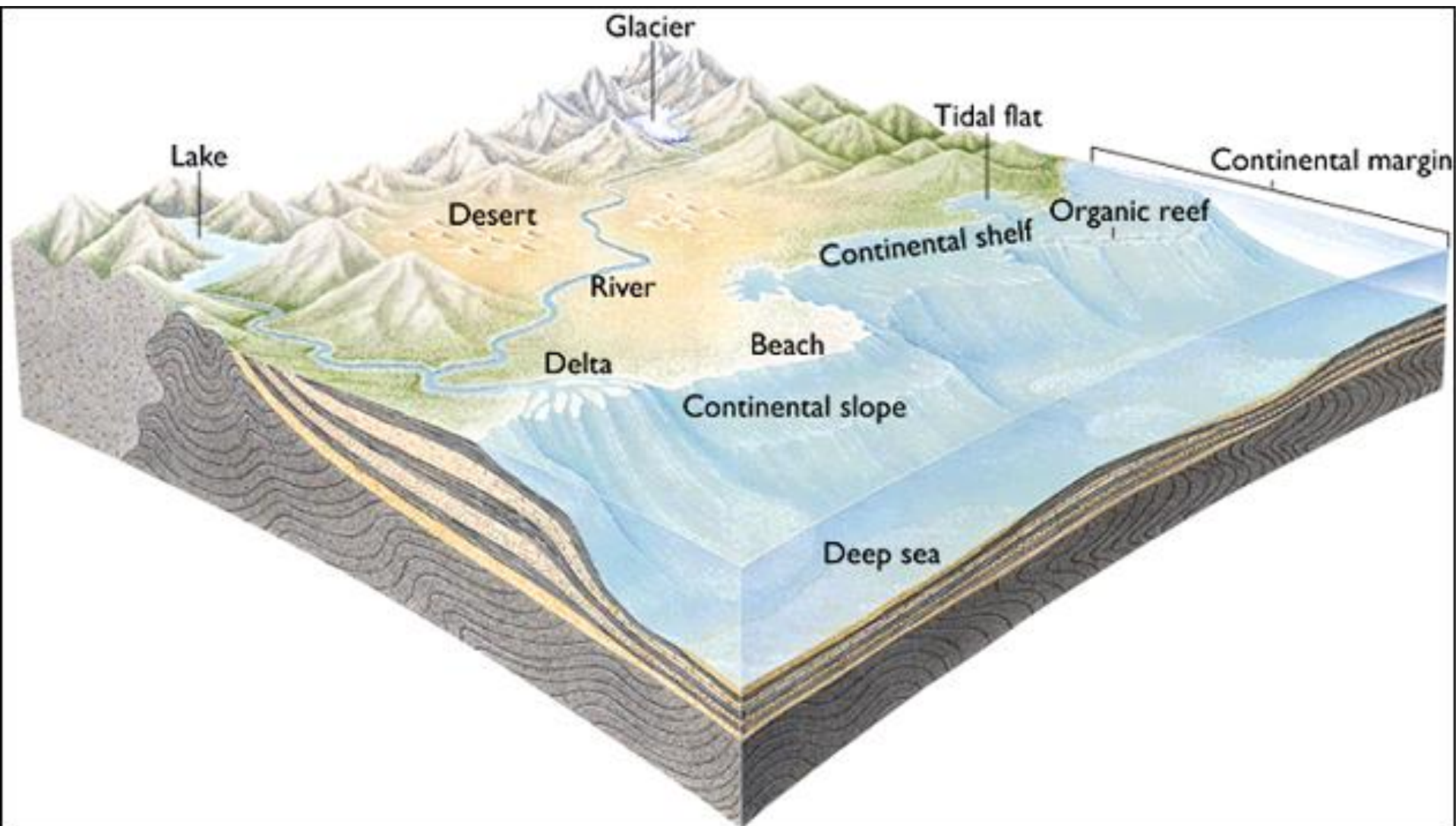


2- GMPF - Sedimenti

Stefano Lugli



Proprietà base

1. Composizione: mineralogica, chimica
2. Tessitura: caratteristiche dei componenti (granuli)
3. Struttura: stratificazione

Sabbia:

1. quarzosa, carbonatica
2. granuli di varie dimensioni a spigoli vivi o arrotondati
3. stratificazione prodotta da onde nella spiaggia o da vento nel deserto

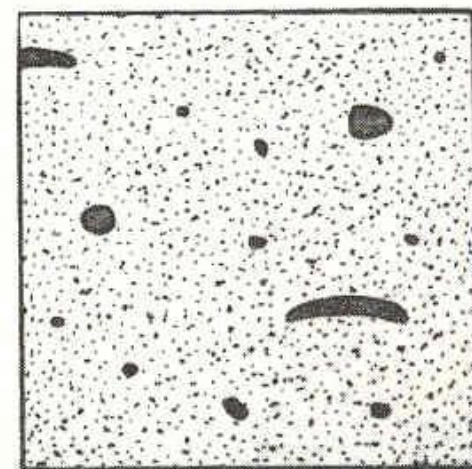
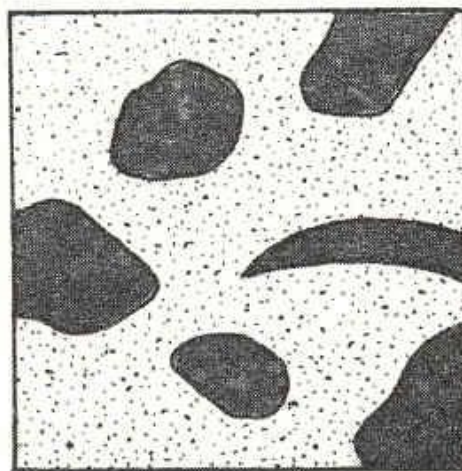
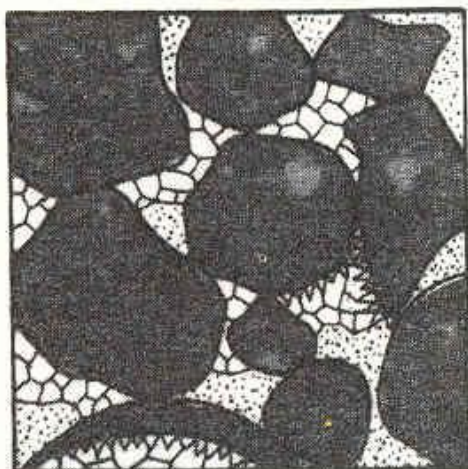
Classificazione dei sedimenti

- **Componenti terrigeni:** derivano dalla disgregazione e frammentazione di rocce preesistenti e vengono trasportate nel bacino di sedimentazione come particelle singole (granuli di quarzo, feldspato, frammenti di calcare, ecc.)
- **Componenti allochimici:** particelle originate per precipitazione chimica o secrezione organica direttamente nel bacino di sedimentazione dove possono essere poi spostate e accumulate (gusci interi, scheletri)
- **Componenti ortochimici** precipitati chimici prodotti nel sedimento stesso e non hanno subito trasporto (concrezioni)

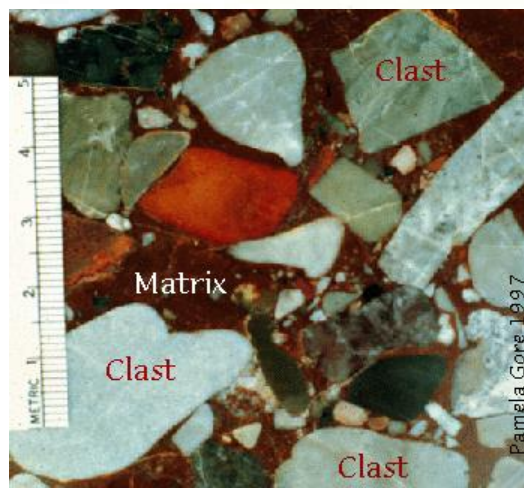
Componenti tessiturali dei sedimenti

- Granuli: ossatura che sostiene il peso del sedimento
- Vuoti: occupati da fluidi o fango che fa da matrice dell'impalcatura granulare (successivamente possono essere eliminati dal costipamento o riempiti da precipitati chimici)
- Impalcatura granulare (granuli), fango detritico (matrice) e precipitati chimici (cemento)

Tessitura e matrice: significato idrodinamico



Alta energia



Bassa energia

Composizione

Granuli terrigeni

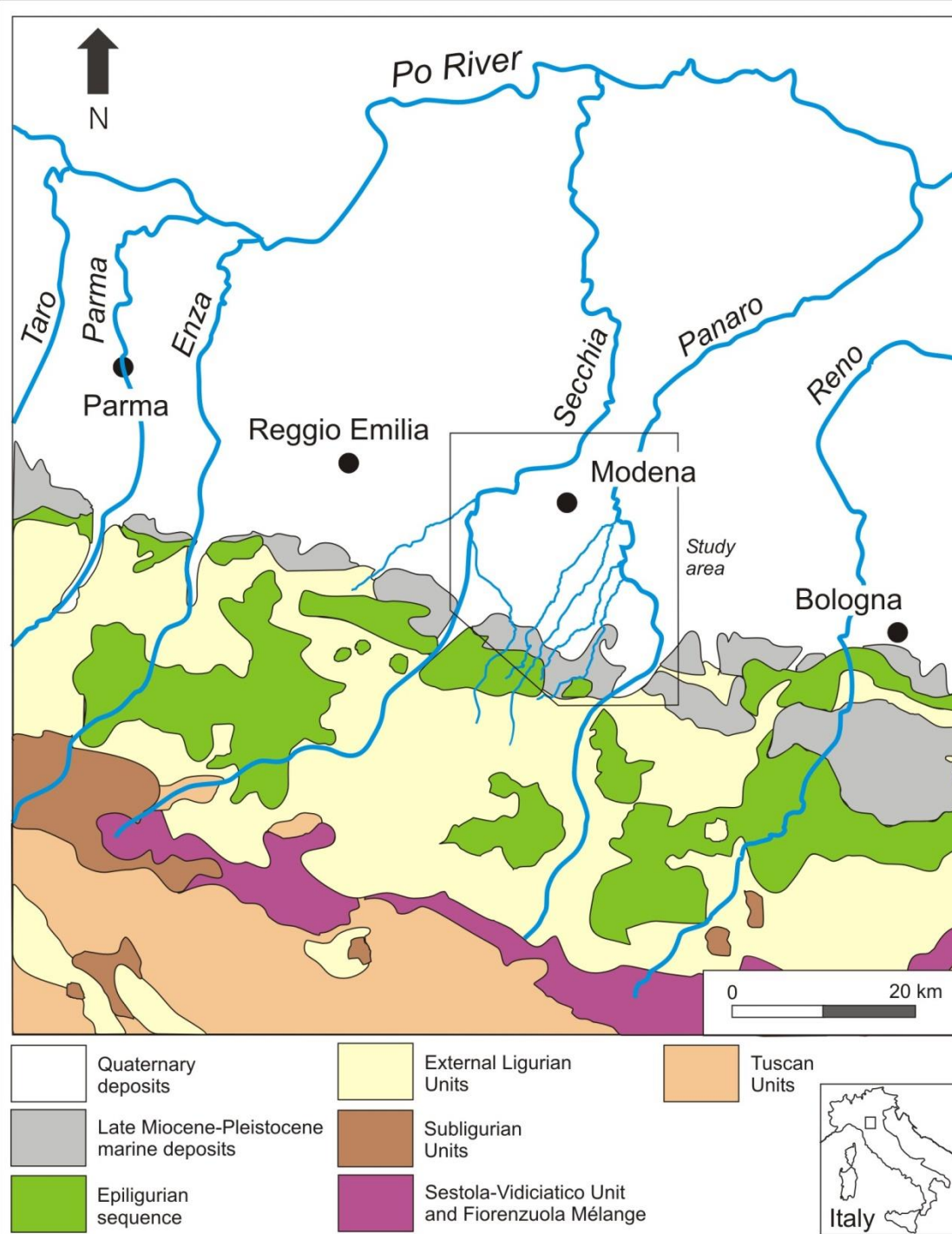
Area provenienza

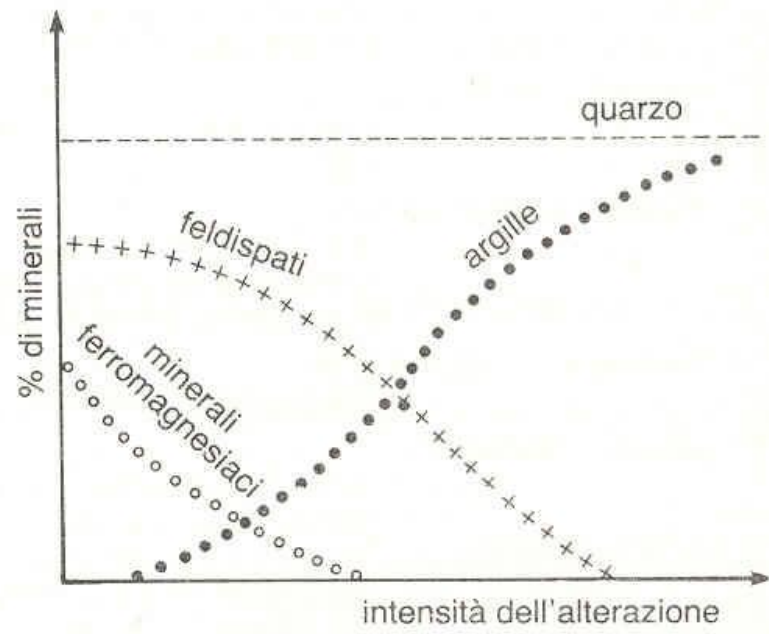
Clima e rilievo (stabilità chimica)

Durata e intensità del trasporto (resistenza meccanica)

Minerali ortochimici

Condizioni chimiche ambiente di deposizione (pH, Eh, temperatura, età)





Proximal
to weathered rocks



Distal

Intensity of Weathering

Low

Medium

High

Quartz
Feldspar
Mica
Pyroxene
Amphibole

Quartz
Feldspar
Mica
Clay minerals

Quartz
Clay minerals

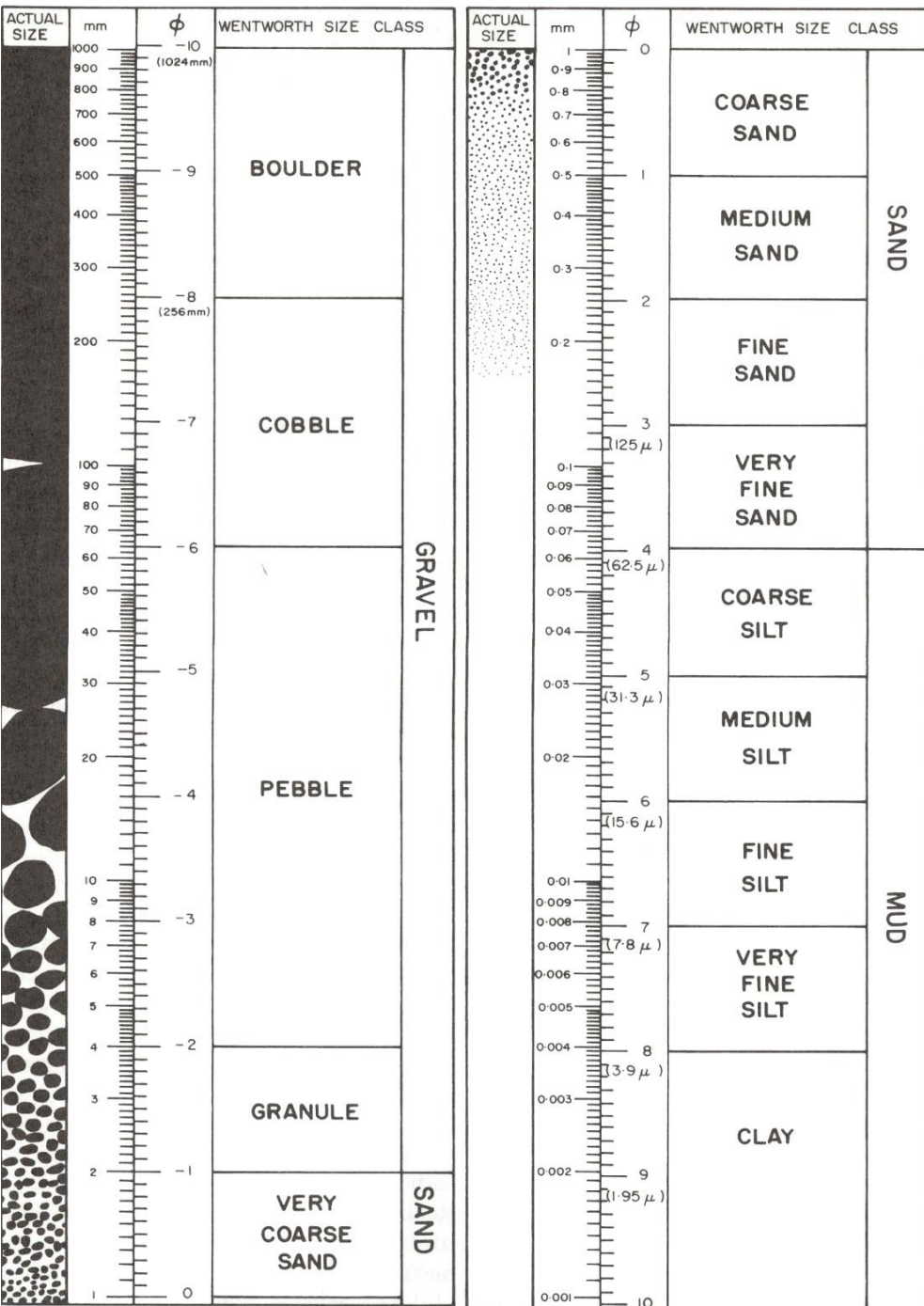
SCALA GRANULOMETRICA

MILLIMETRI	MICRON	SCALA Φ	CLASSI GRANULOMETRICHE (Wentworth)	
4096		-12	Blocchi	GHIAIA
256		-8	Ciottoli	
64		-6	Ciottoletti	
4.00		-2	Granuli	
3.36		-1.75		
2.83		-1.50		
2.38		-1.25		
2.00	2000	-1	Sabbia molto grossa	SABBIA
1.68		-0.75		
1.41		-0.50		
2.19		-0.25		
1.00	1000	0	Sabbia grossa	
0.84		0.25		
0.71		0.50		
0.59		0.75	Sabbia media	
0.50	500	1		
0.42	420	1.25		
0.35	350	1.50		
0.30	300	1.75		
0.25	250	2	Sabbia fine	
0.210	210	2.25		
0.177	177	2.50		
0.149	149	2.75		
0.125	125	3	Sabbia molto fine	
0.105	105	3.25		
0.088	88	3.50		
0.074	74	3.75		
0.0625	62.5	4	Silt grosso	SILT (limo)
0.053	53	4.25		
0.044	44	4.50		
0.037	37	4.75		
0.031	31	5	Silt medio	FANGO
0.0156	15.6	6	Silt fine	
0.0078	7.8	7	Silt molto fine	
0.0039	3.9	8	ARGILLA	
0.0020	2	9		
0.00098	0.98	10		
0.00049	0.49	11		
0.00024	0.24	12		

$$\Phi = -\log_2 \text{diam}$$

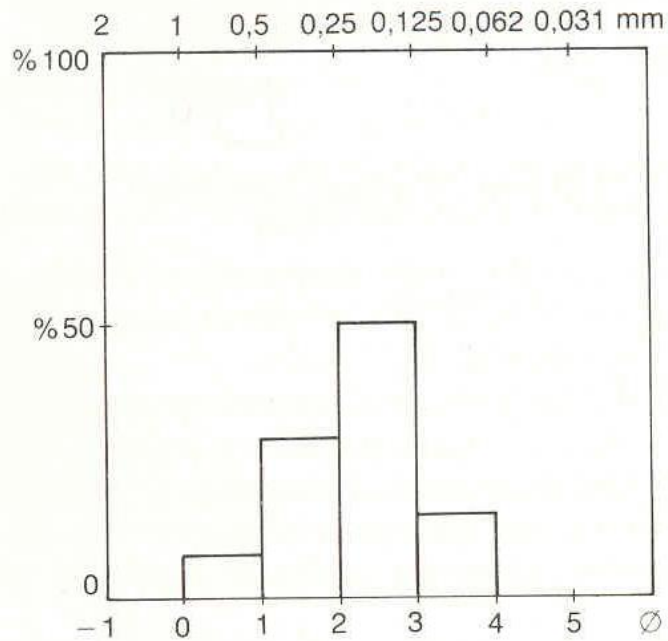


The Udden-Wentworth grade scale for grain sizes, with ϕ /mm conversion chart

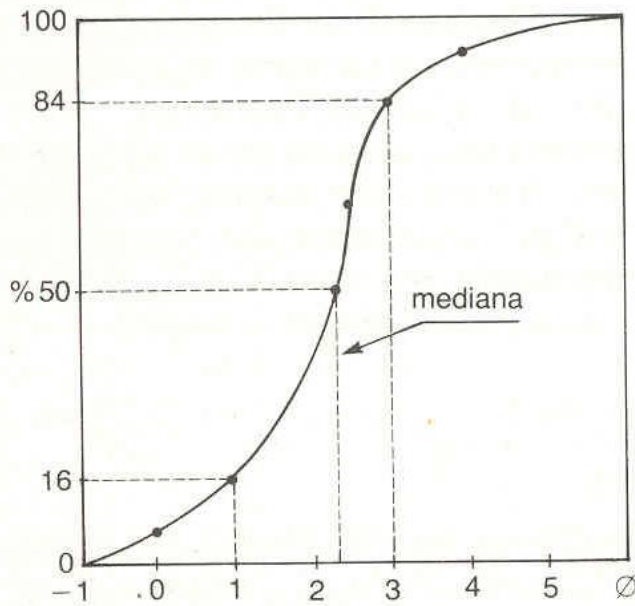


Phi Units*	Size	Wentworth Size Class	Sediment/Rock Name
-8	256 mm	Boulders	Sediment: GRAVEL
-6	64 mm	Cobbles	
-2	4 mm	Pebbles	
-1	2 mm	Granules	Rocks: SANDSTONES (arenites, wackes)
0	1 mm	Very Coarse Sand	
1	1/2 mm	Coarse Sand	
2	1/4 mm	Medium Sand	
3	1/8 mm	Fine Sand	
4	1/16 mm	Very Fine Sand	
8	1/256 mm	Silt	Sediment: MUD
		Clay	Rocks: LUTITES (mudrocks)

Udden-Wentworth Scale



a) istogramma

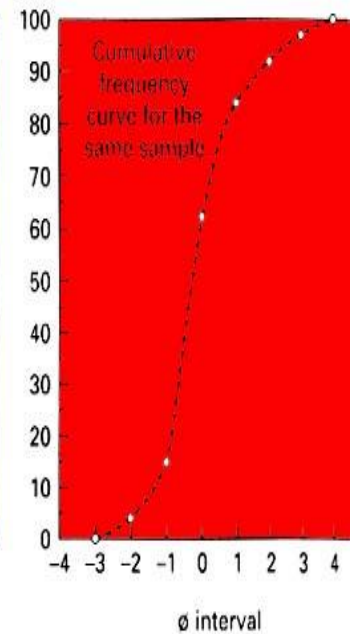
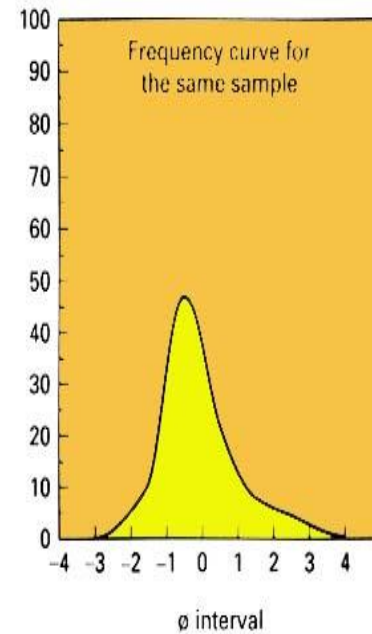
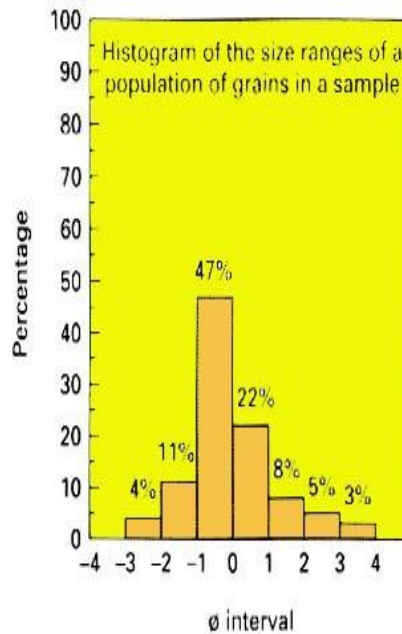


c) curva cumulativa (ordinata in scala aritmetica)

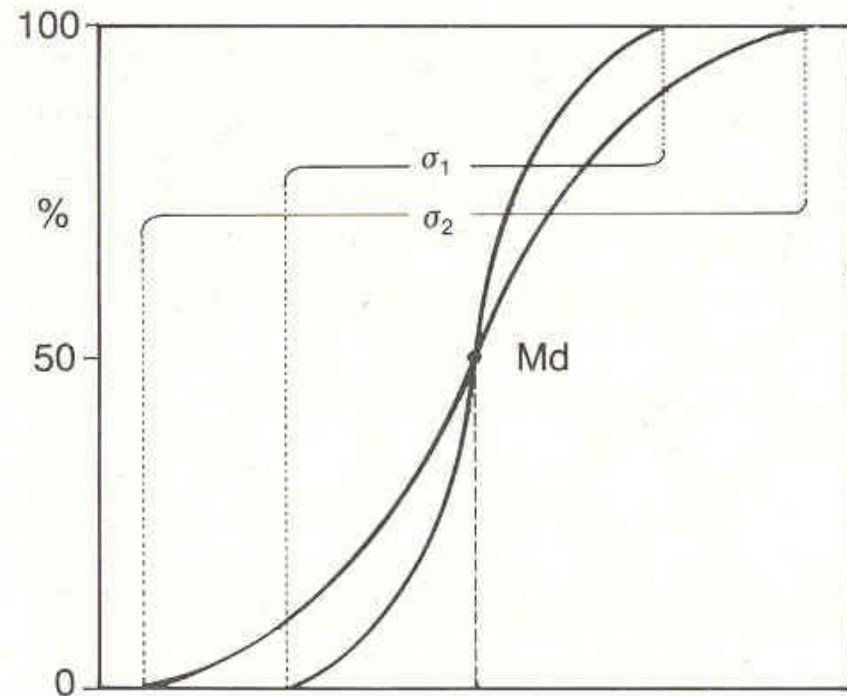
Granulometrie

Curve

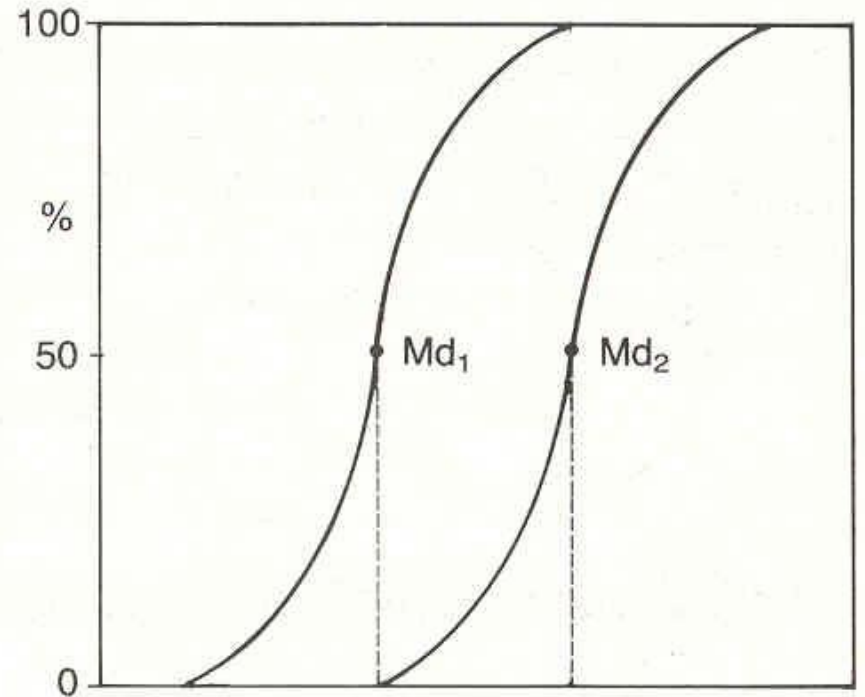
Granulometriche



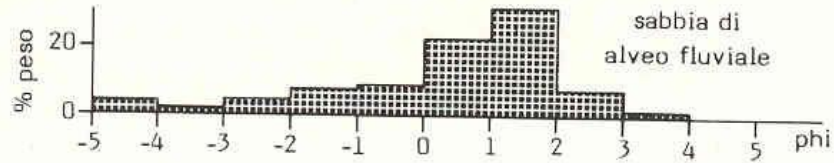
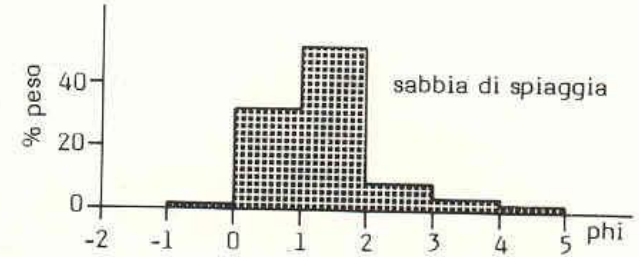
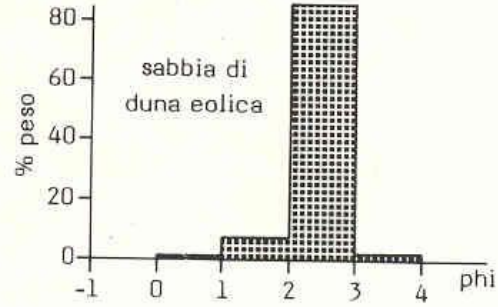
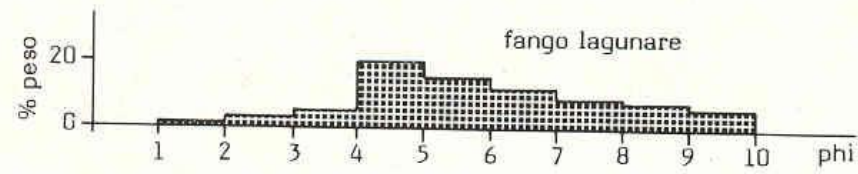
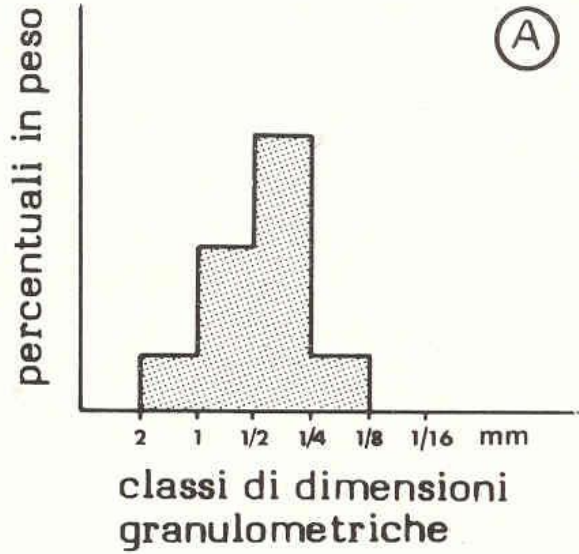
Grado di selezionamento (*sorting*)



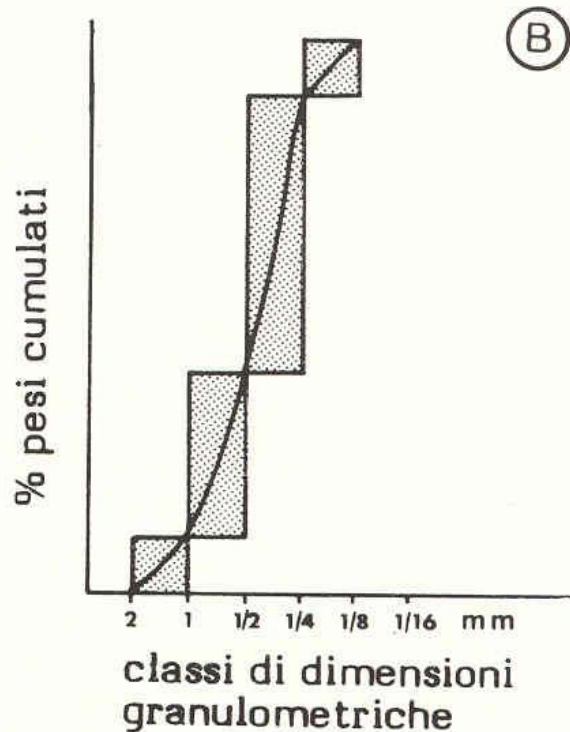
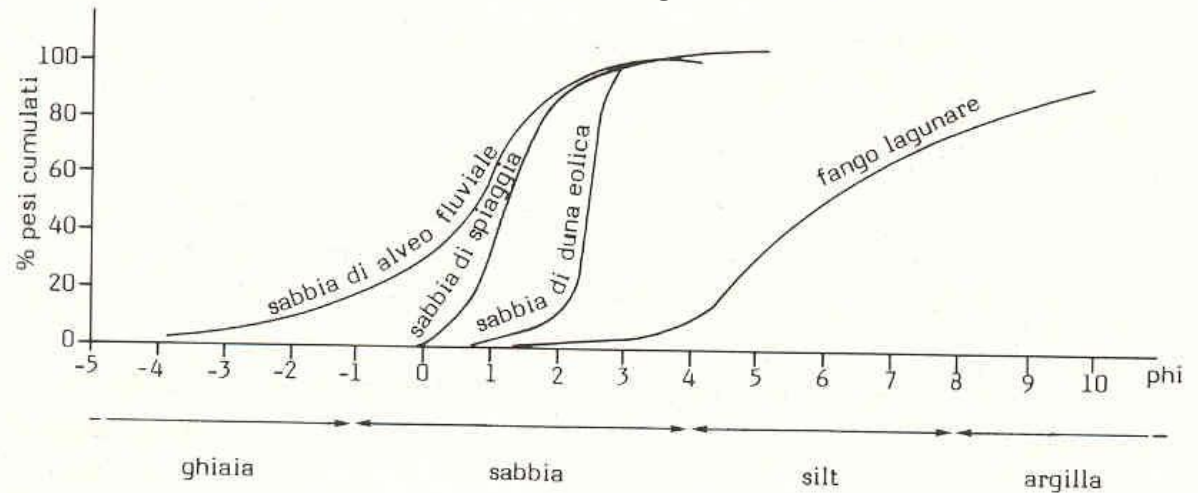
medesima mediana
selezionamento molto differente

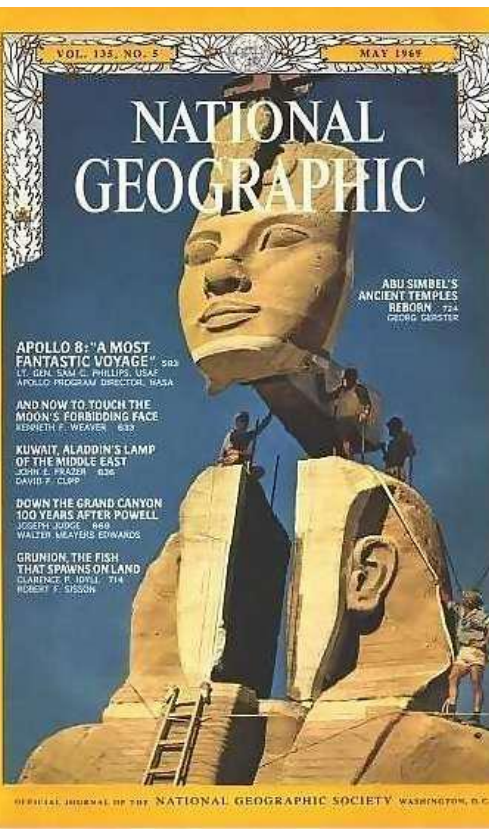


mediana diversa
medesimo selezionamento

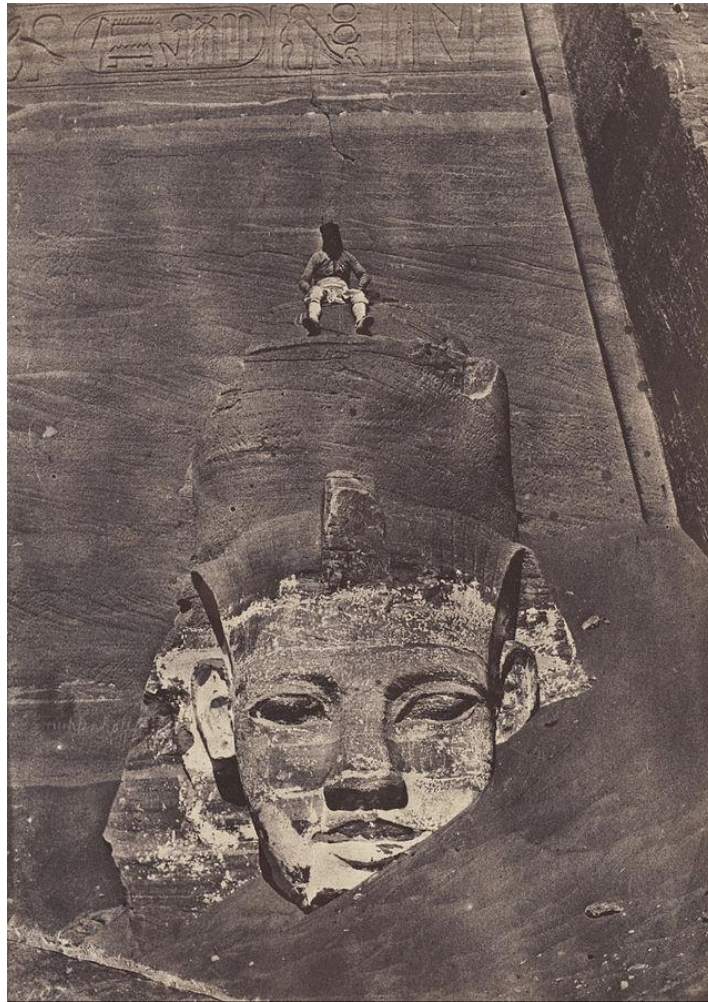


Modalità trasporto e Energia dinamica del mezzo





Both of the Abu Simbel temples were moved to higher ground in 1963-1968, before the completion of the Aswan high dam which would have flooded them. The \$40 million project is the greatest feat of rescue archaeology ever attempted. The Rameses temple was cut from the cliff, segmented into 1036 numbered blocks weighing a total of about 15,000 tons and reassembled in a concrete shell above the new waterline. The broken torso of the second Rameses was replaced at the feet of the statues. The entire complex now looks out over Lake Nasser and the large number of tourists who visit every year



Pharaoh Rameses II (Ramesses II ruled 1279-1213 BCE) ordered the building of two temples at Abu Simbel (Abû Sunbul, Aboo Simbul or Abo Simble). Nearly the entirety of the larger temple, including the entrance and most of the now famous statues of Rameses, was covered with sand for many centuries and forgotten. John Burckhardt, is credited with the discovery of the larger Ramesses temple (1813), although, the nearby Queen's temple was well known at the time. The entrance to the larger temple of Ramesses at Abu Simbel was cleared by Giovanni Belzoni in 1817.

1264 - 1244 BCE or
1244-1224 BCE



David Roberts, 1838

THE TEMPLES OF ABOO-SIMBEL, FROM THE NILE.

THE smallest of these Temples, and the nearest to the Nile, was dedicated to Isis, and is excavated about ninety feet into the rock. It was, during many ages, the only one known there; for the accumulations of sand had so concealed the Great Temple of Osiris that it remained undiscovered till Burckhardt visited Nubia, in 1813. In his "Travels" he says:—"When we reached the top of the mountain, I left my guide with the camels, and descended an almost perpendicular cleft, choked with sand, to view the Temple of Ebsambol, of which I had heard many magnificent descriptions. There is no road to this Temple, which stands just over the river, and is entirely cut out of the rocky side of the mountain; it is in complete preservation. In front of the entrance are six colossal figures, that measure from the ground to the knee six feet and a half." After describing the interior, he adds,—“Having, as I supposed, seen all the antiquities of Ebsambol, I was about to ascend the sandy side of the mountain by the same way as I had descended, when, having luckily turned more to the southward, I fell in with what is still visible of four immense colossal statues, cut out of the rock, at a distance of about two hundred yards from the Temple: they are now almost entirely buried beneath the sands. The entire head and part of the breast and arms of one of the statues are yet above the surface; the head of the next is broken off, and the bonnets of the other two only appear. It is difficult to determine whether these statues are in a sitting or a standing posture.” After describing the beauty of the head, he states,—“On the wall of the rock, in the centre of the four statues, is a figure of the hawk-headed Osiris surmounted by a globe; beneath which, I suspect, could the sand be cleared away, a vast Temple would be discovered.” On his return to Cairo he informed Belzoni of what he had seen at Aboo-Simbel; and this indefatigable traveller removed enough of the sand to effect an entrance, and disclosed one of the most perfect and extraordinary works of the ancient Egyptians.

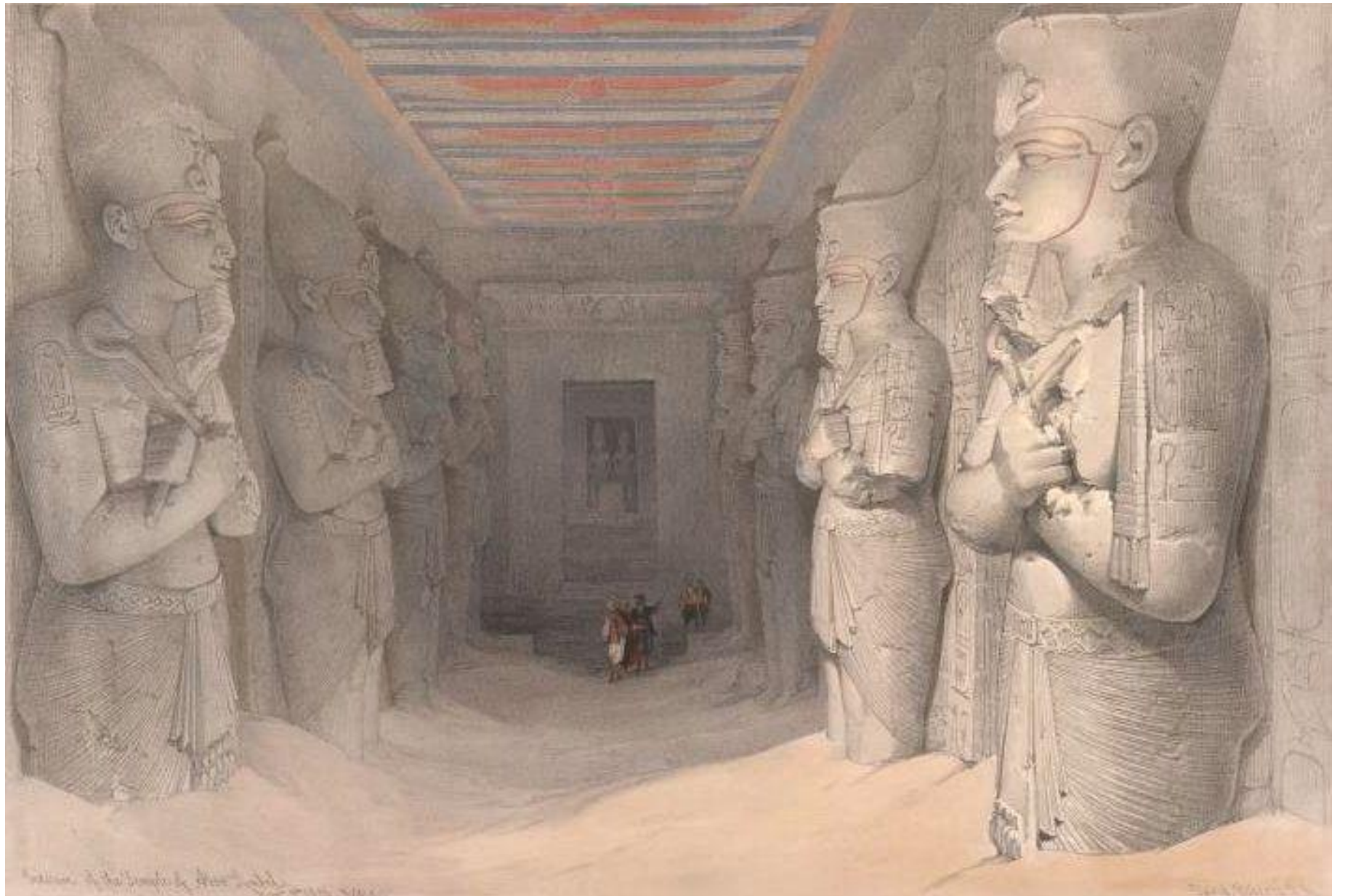
Excerpt from: Travels in Nubia by John Lewis Burckhardt

A Journey along the Banks of the Nile

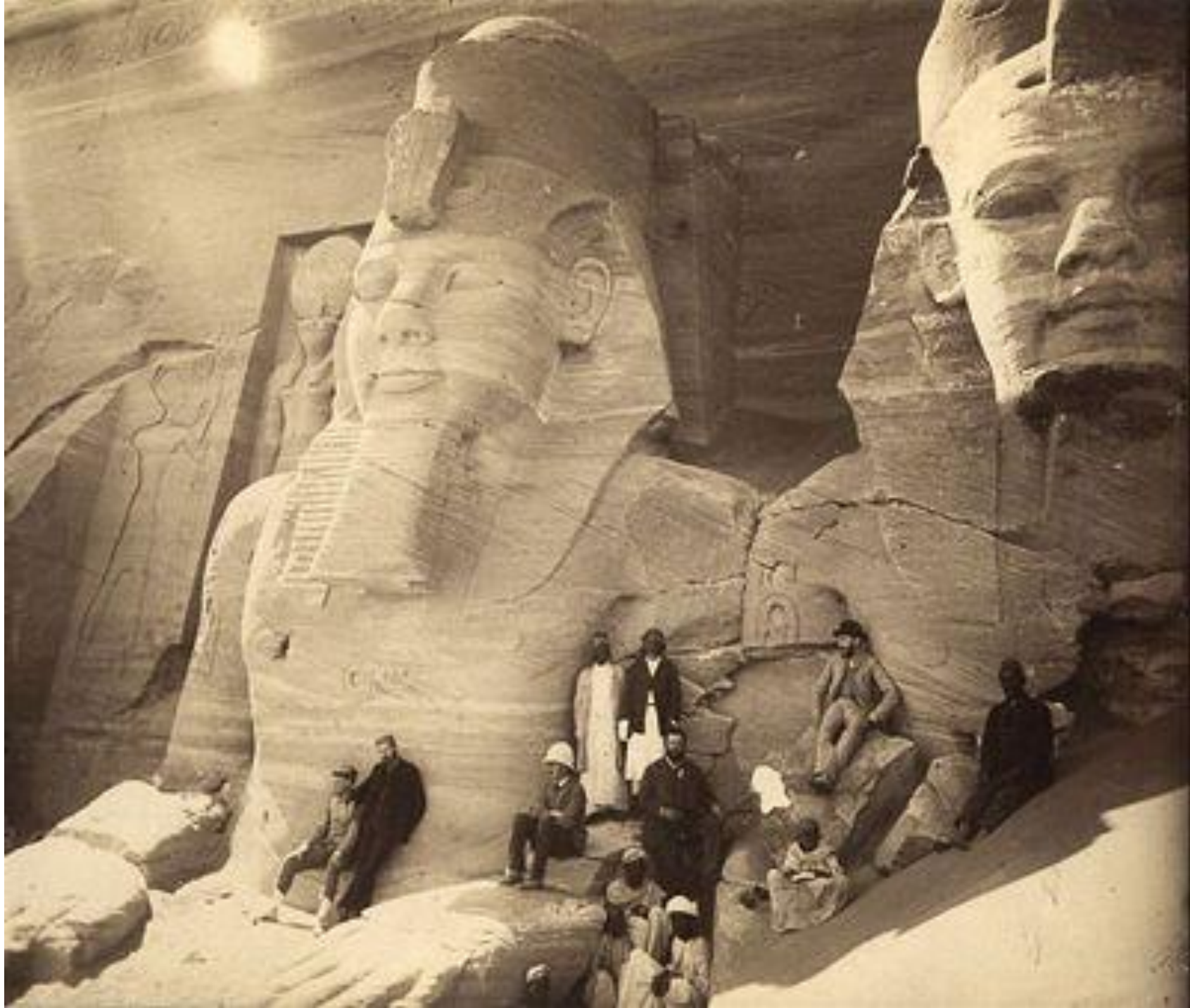
Published in 1819. Adapted for AscendingPassage.com, 2006.

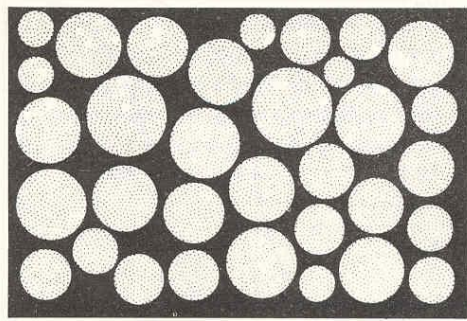
The Pharaoh's Temple, March 22nd, 1813.

Having, as I supposed, seen all the antiquities of Abu Simbel, I was about to ascend the sandy side of the mountain by the same way I had descended; when having luckily turned more to the southward, I fell in with what is yet visible of four immense colossal statues cut out of the rock, at a distance of about two hundred yards from the temple; they stand in a deep recess, excavated in the mountain; but it is greatly to be regretted, that they are now almost entirely buried beneath the sands, which are blown down here in torrents. The entire head, and part of the chest and arms of one of the statues are above the surface; of the one next to it scarcely any part is visible, the head being broken off, and the body covered with sand to above the shoulders; of the other two, the bonnets only appear. It is difficult to determine whether these statues are in a sitting or standing posture; their backs adhere to a portion of rock, which projects from the main body, and which may represent a part of a chair, or may be merely a column for support. They do not front the river, like the Queen's temple, but are turned with their faces due north, towards the more fertile climes of Egypt, so that the line on which they stand forms an angle with the course of the river.

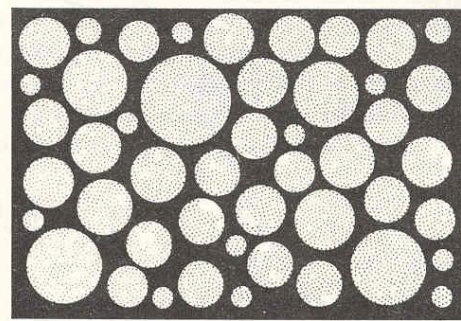




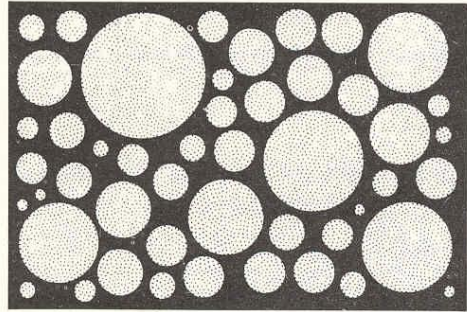




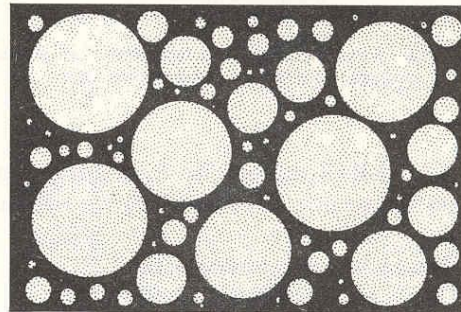
molto ben selezionato $\sigma = 0,35 \varnothing$



ben selezionato $\sigma = 0,50 \varnothing$

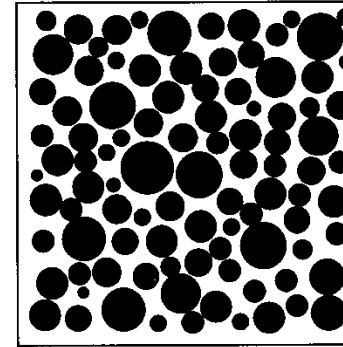


moderatamente selezionato $\sigma = 1,00 \varnothing$

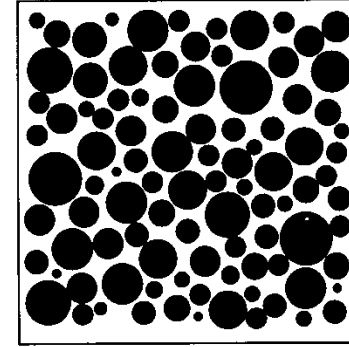


poco selezionato $\sigma = 2,00 \varnothing$

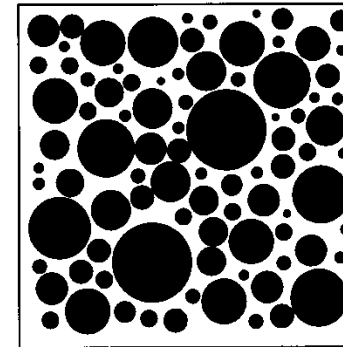
Very well sorted 'Standard deviation' < 0.35
 Well sorted = 0.35–0.5
 Moderately well sorted = 0.5–0.71
 Moderately sorted = 0.71–1.0
 Poorly sorted = 1.0–2.0
 Very poorly sorted > 2.0



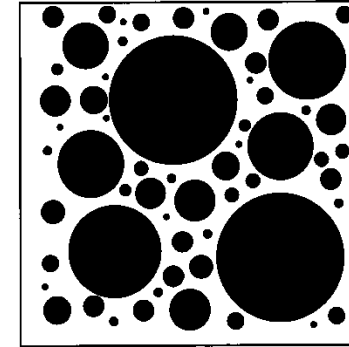
'Standard deviation' = 0.35



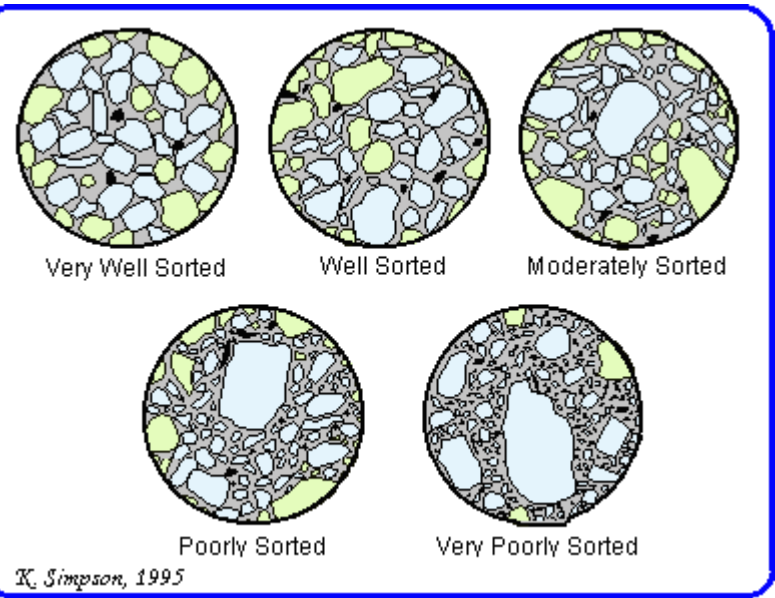
'Standard deviation' = 0.5



'Standard deviation' = 1.0



'Standard deviation' = 2.0



Very Well Sorted

Well Sorted

Moderately Sorted

Poorly Sorted

Very Poorly Sorted

K. Simpson, 1995

Miglior selezionamento in natura =
 Sabbie dune eoliche e spiagge
 Selezionamento molto scarso = Morene



Well-sorted sand



Poorly sorted sand

Significato geologico dei parametri granulometrici

Processi deposizionali responsabili del deposito

$$\frac{\text{Quantità di materiale fornito all'ambiente}}{\text{Efficienza selezionatrice del mezzo}}$$

Scorrimento superficiale (rotolamento)

Saltazione

Sospensione

Sedimenti grossolani

sedimenti fini

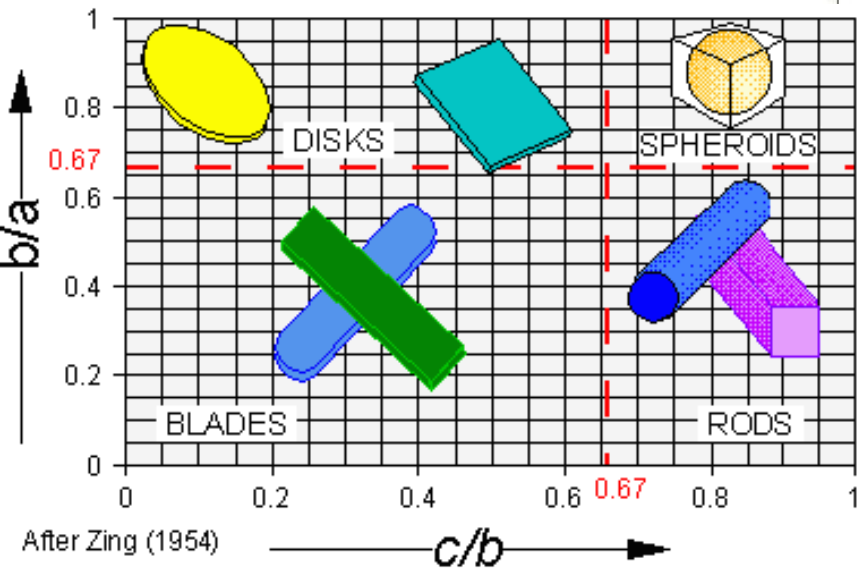
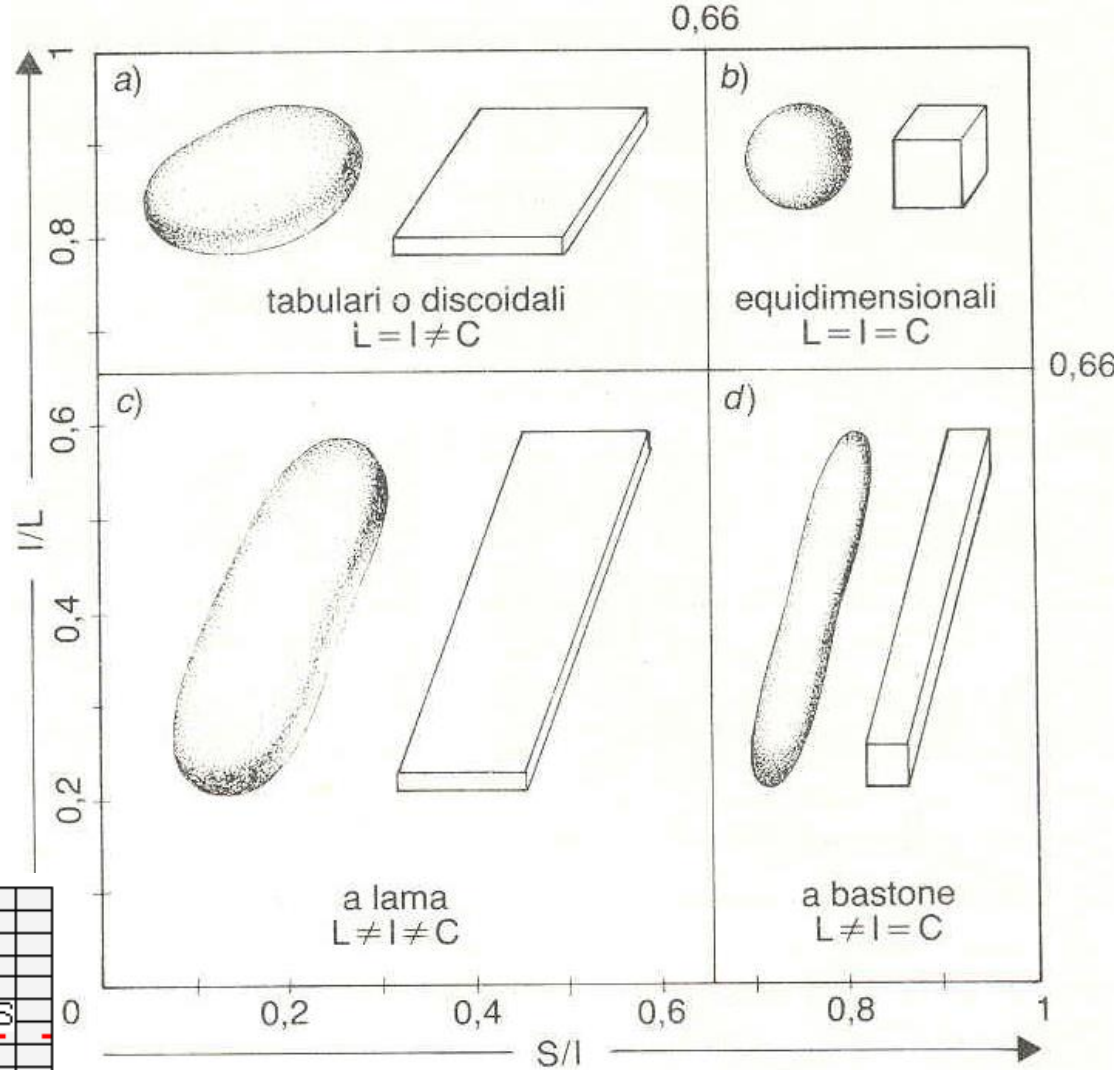
Selezionamento

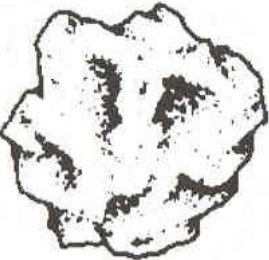
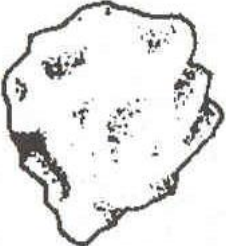
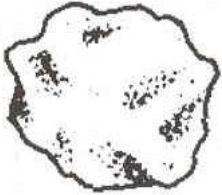
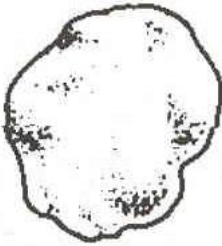
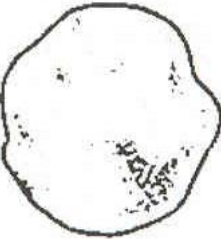
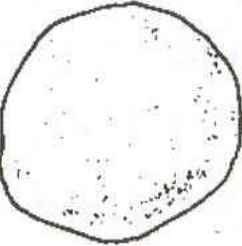





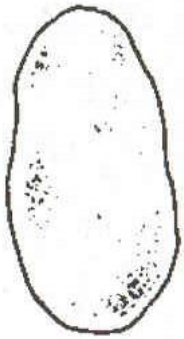
- Selezionamento ottimale: corrente opera continuamente su strato sottile di granelli (spiaggia)
- Selezionamento pessimo: deposizione forzata da impilamento quasi istantaneo (frane)

Morfometria

può essere utilizzata per qualunque materiale: naturale o artificiale

- Assi
- L = lungo
- I = intermedio
- S = corto



alta sfericità						
bassa sfericità						
0	1	2	3	4	5	6
molto angoloso	angoloso	subangoloso	subarrotondato	arrotondato	ben arrotondato	



Arrotondamento

Legato all'entità del trasporto



Scavo di Piazza Ghiaia
Parma

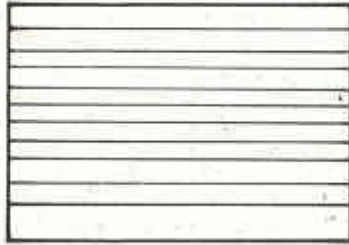


Stratificazione e laminazione

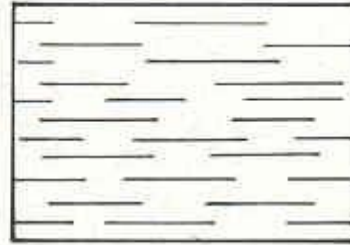
Parallele

Non parallele

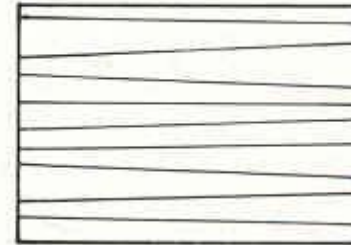
PIANE



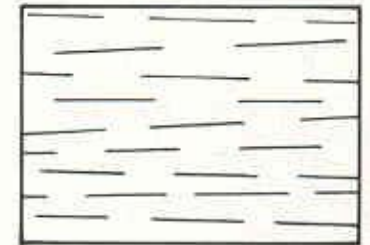
piane e
parallele



piane discontinue
e parallele

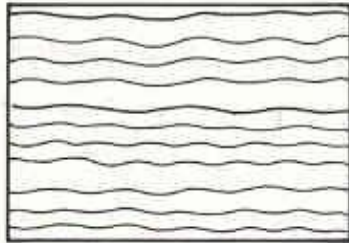


piane e non
parallele

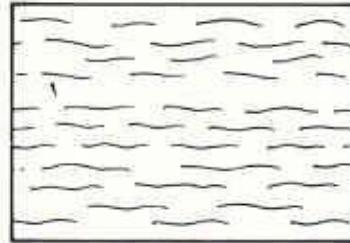


piane discontinue
e non parallele

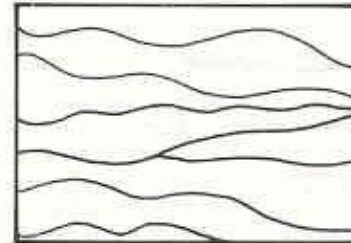
ONDULATE



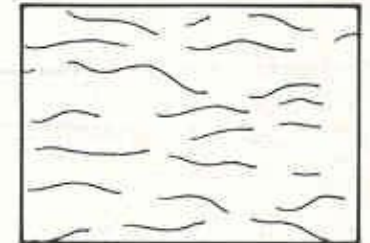
ondulate e
parallele



ondulate, discontinue
e parallele

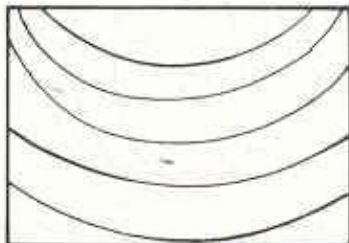


ondulate e
non parallele

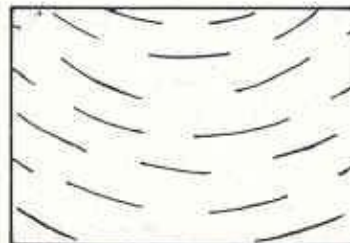


ondulate, discontinue
e non parallele

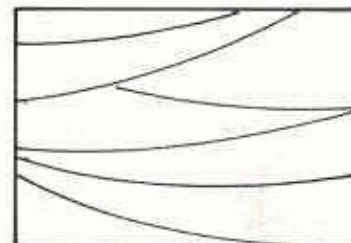
CURVE



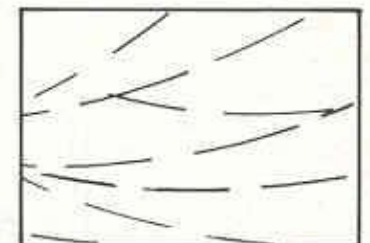
curve e
parallele



curve, discontinue
e parallele



curve e non
parallele



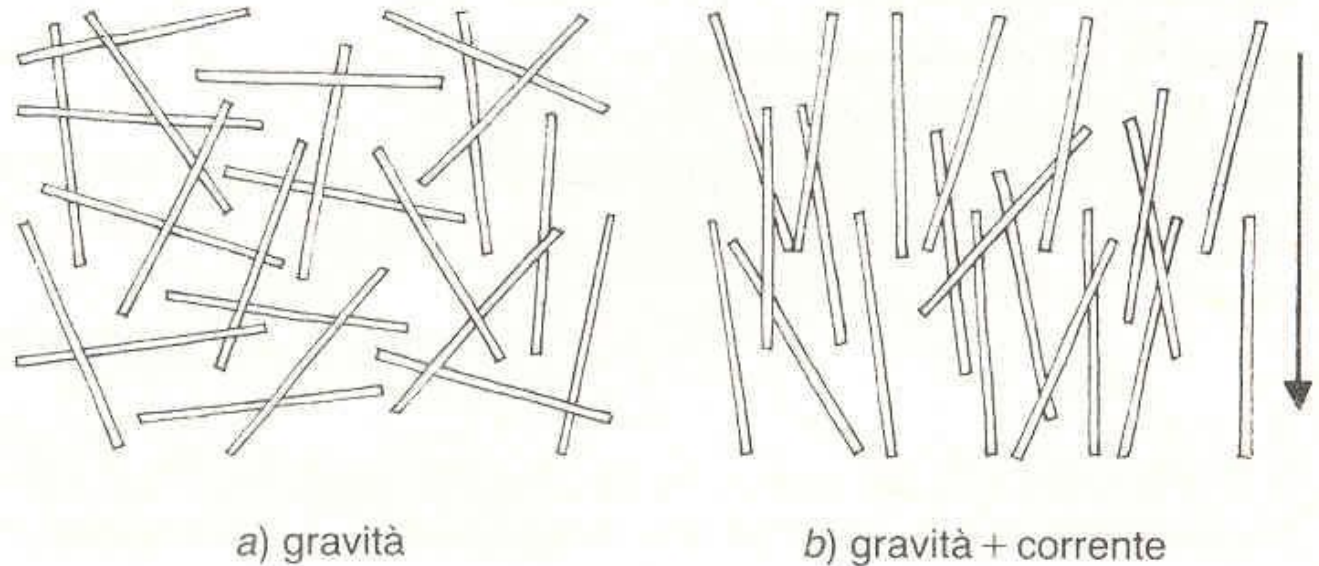
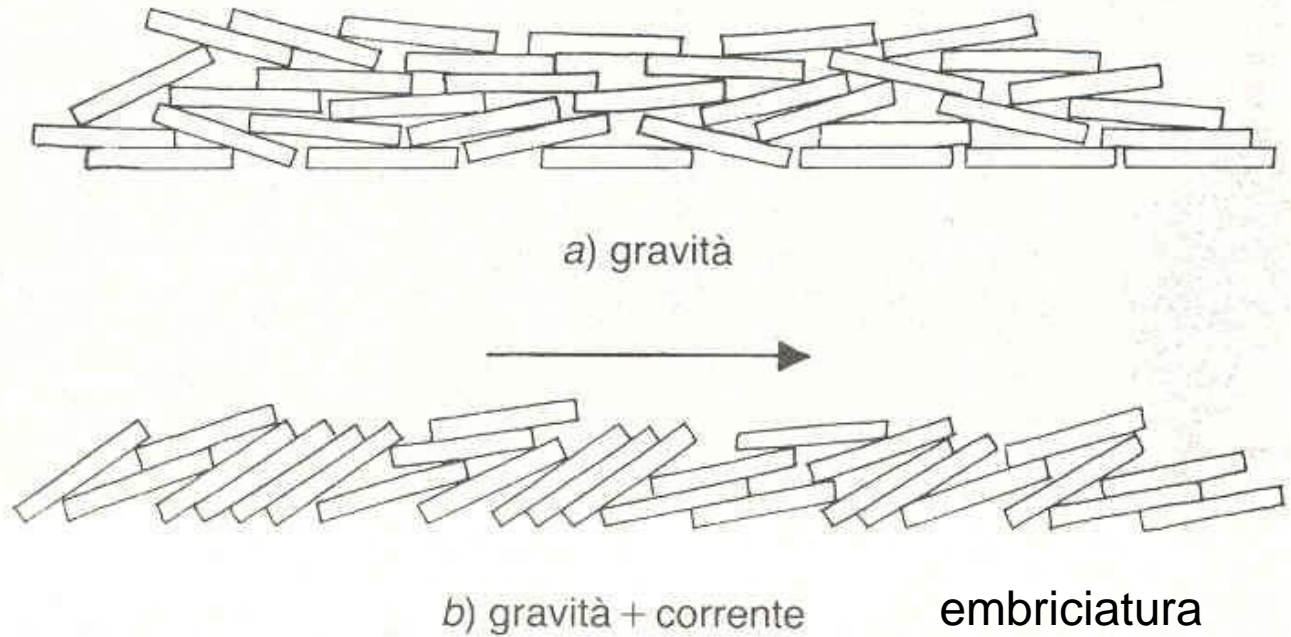
curve, discontinue
e non parallele

Strati e lamine

	strati molto spessi
1 metro	
	strati spessi
0,3 m	
	strati medi
0,1 m	
	strati sottili
0,03 m	
	strati molto sottili
10 mm	
	lamine spesse
3 mm	
	lamine sottili

Fabric (tessuto – struttura)

- Orientazione e disposizione spaziale degli elementi che compongono un sedimento



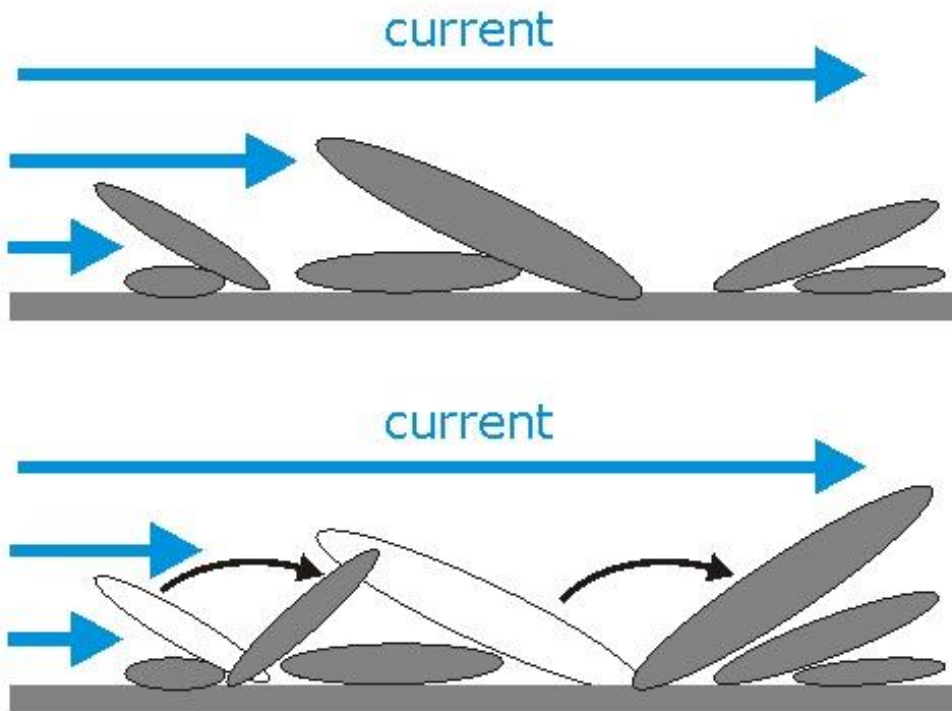
Fiume Tànarò, Alba: embriciatura



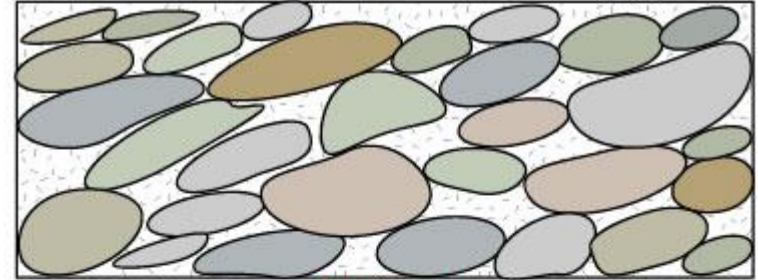


Minjiang river: embriciatura

Embriciatura Imbrication edge-wise conglomerate

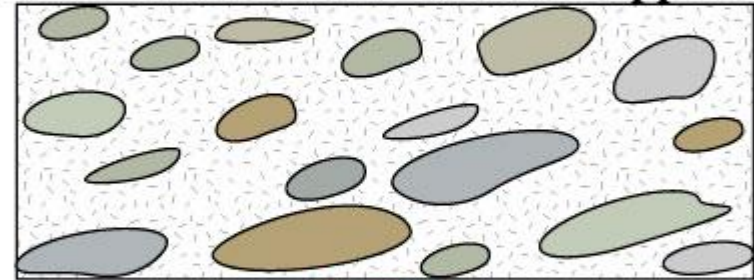


Imbricated Pebbles - Clast Supported



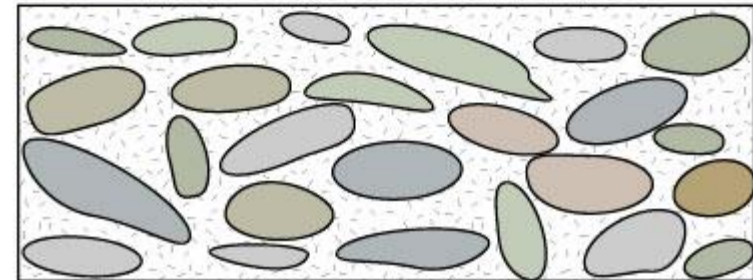
Current →

Imbricated Pebbles - Matrix Supported



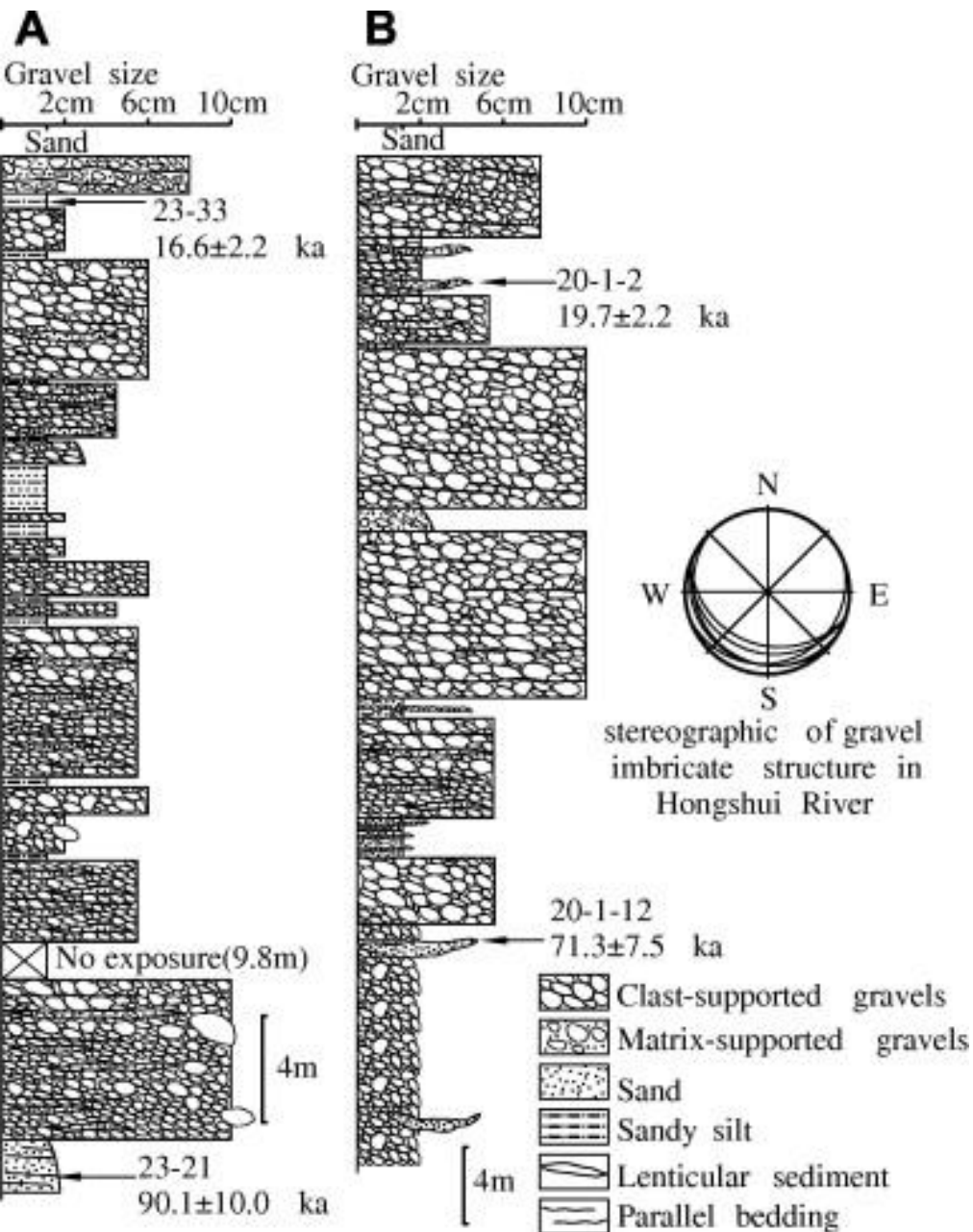
Current →

Non - Imbricated Pebbles



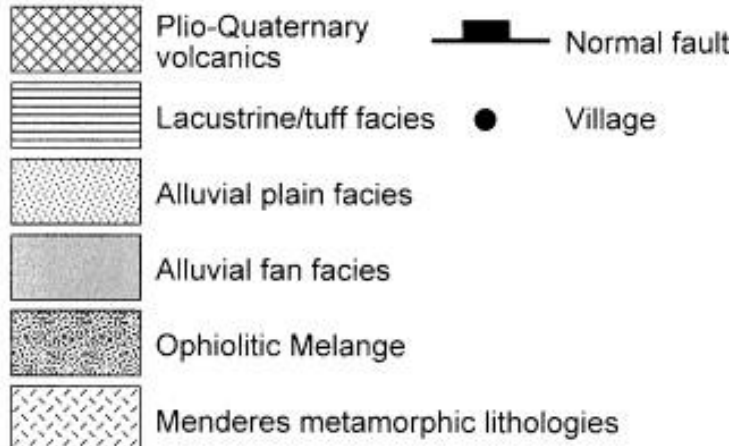
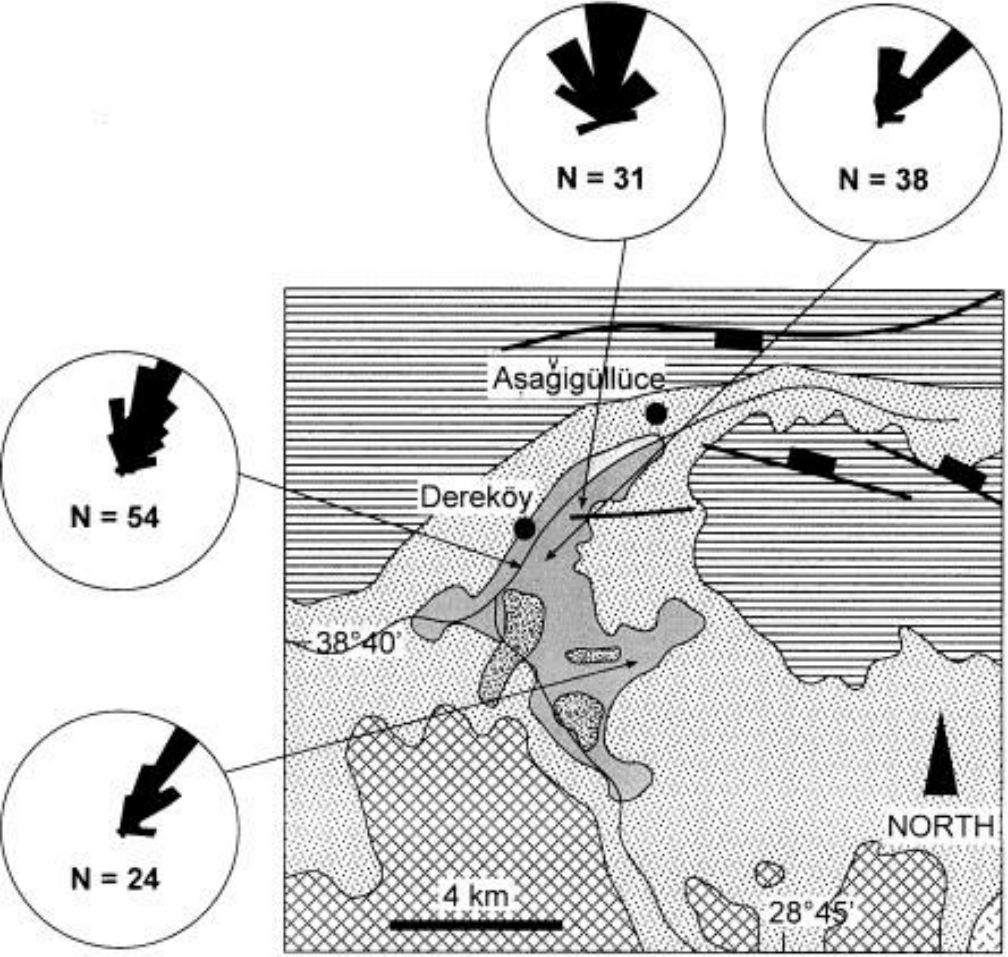
University of Montana Geology Department [2011]

<http://all-geo.org/highlyallochthonous/2008/02/imbrication-and-potholes-in-the-zebra-river/>

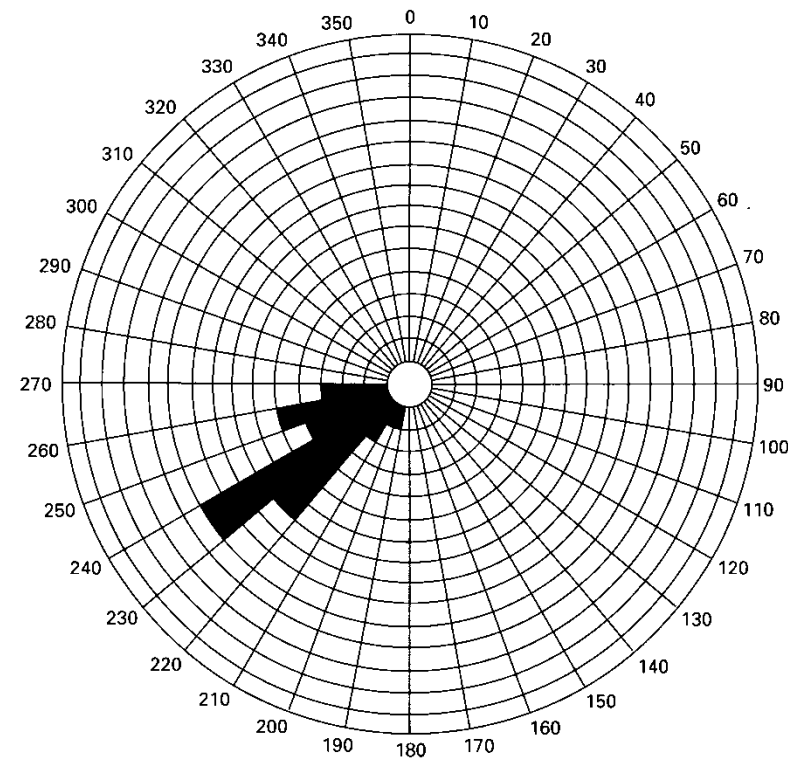


Stratigraphic columns of valley fill sequences. (A) Kunlun River valley at Sanchakou (35°53.42'N, 94°23.52'E, 3690 m asl). (B) Hongshui River valley (35°52.58'N, 92°12.43'E, 4204 m asl); gravel imbricate structure in this sequence is plotted in stereographic projection.

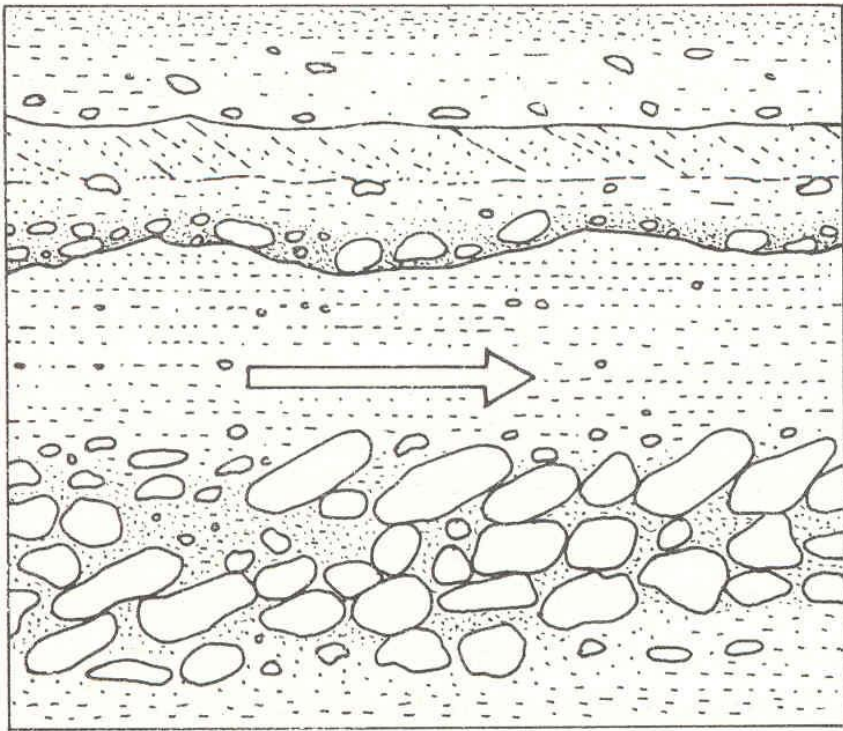
Wang et al., 2009



- Geological map of the Selendi Basin (Turkey) showing palaeocurrent trends determined from clast imbrication (100 measurements per location)



Embriciatura



Ciottoli discoidali: piano di massima proiezione inclinato contro corrente (verso monte)

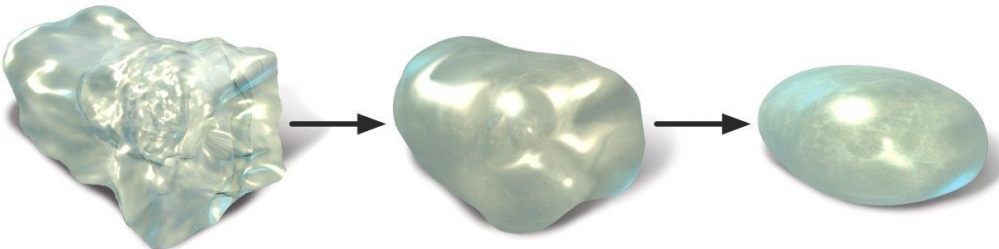
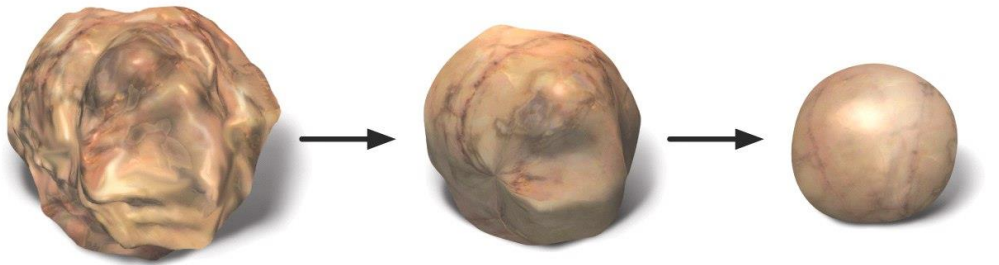
- Fiumi: 10-30°
- Spiagge: 15° verso mare
- Morene 20-25°

Distance of transport

Short

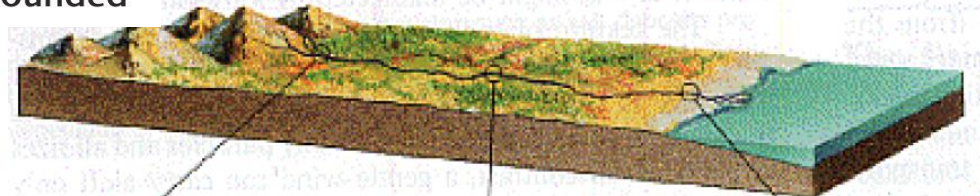
Moderate

Long



Larger,
more angular

Smaller,
more rounded



Particles are large and irregular, and consist of a variety of lithologies, including the least resistant.

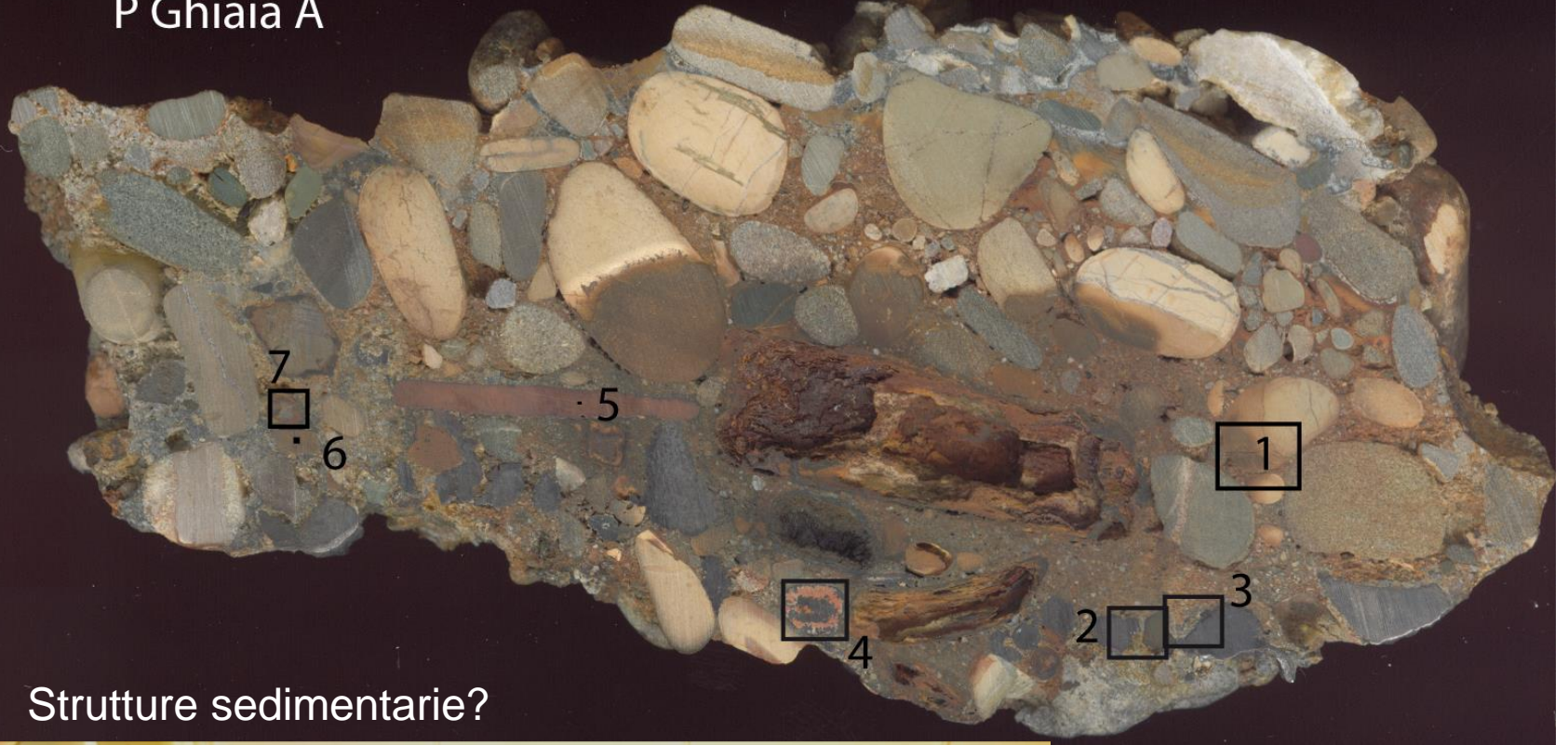


Particles are mid-sized and of intermediate sphericity, and include resistant and nonresistant lithologies.



Particles are small and nearly spherical, and consist mainly of the most resistant lithologies, such as quartz.

P Ghiaia A



Strutture sedimentarie?



Scavo di Piazza Ghiaia (PR)

Trasporto selettivo e trasporto in massa

- Comportamento idraulico: è funzione di dimensioni, forma e peso specifico, ma soprattutto della **granulometria**
- Processo di smistamento (selezione idraulica) per forma (frustoli vegetali, lamelle di mica) e peso specifico (minerali pesanti)

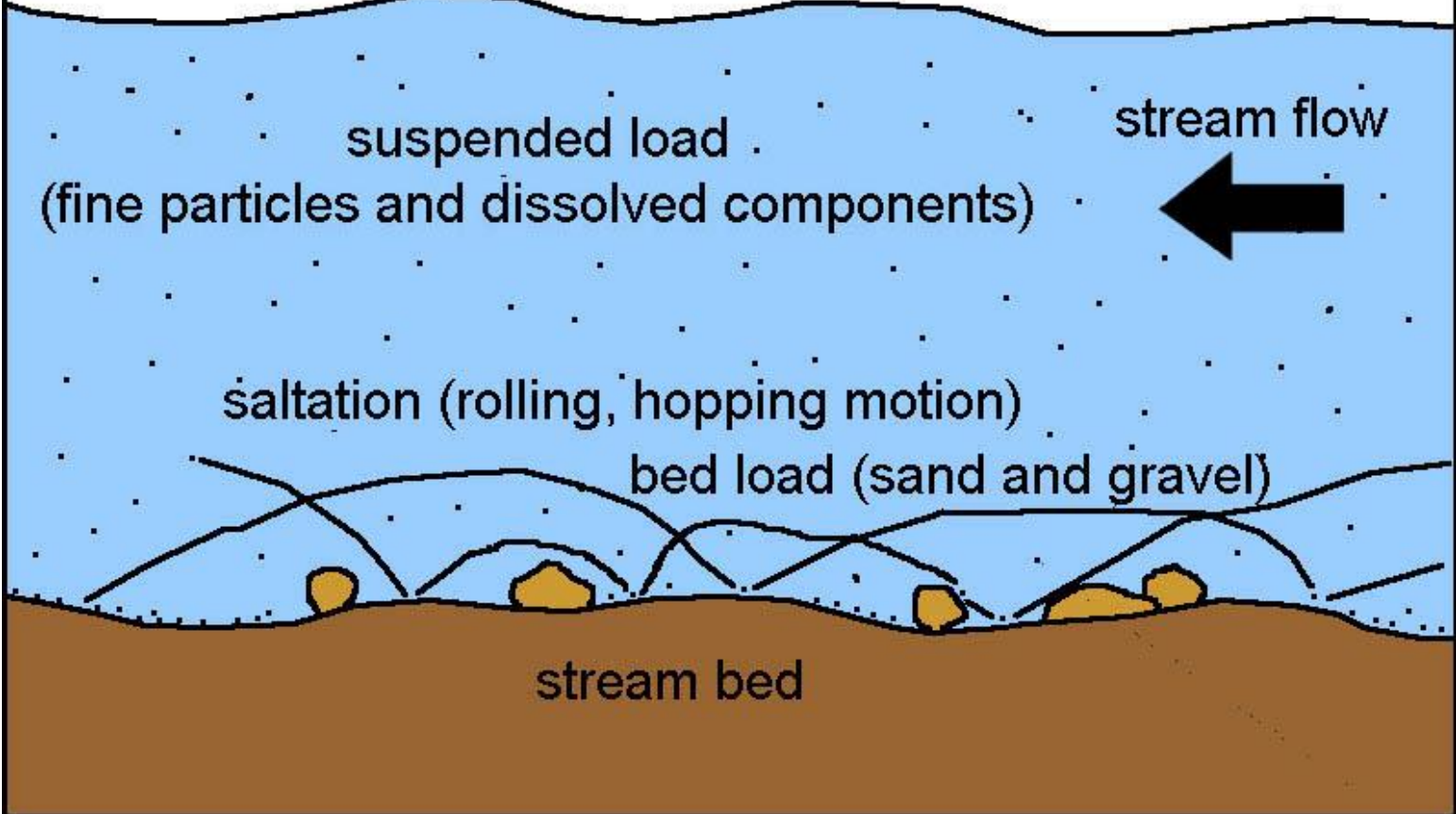
Trasporto selettivo e trasporto in massa

- L'azione selettiva si riflette nella tessitura e nell'organizzazione geometrica resa visibile dalle strutture sedimentarie
- Trasporto **selettivo**: deposito strutturato e organizzato (strati suddivisi in lamine, clasti orientati)
- Trasporto in **massa**: depositi disorganizzati (omogenei, massivi caotici, privi di strutture)

Selezione idraulica

- Separazione tra carico di fondo (ghiaia, sabbia) e carico sospeso (silt, argilla)
- **TRAZIONE**: trascinamento delle particelle sul fondo (rotolamento, scorrimento, saltellamento)
- **DECANTAZIONE**: deposizione di materiale in sospensione
- Processi selettivi: trattivi e decantativi

how sediments move in a stream

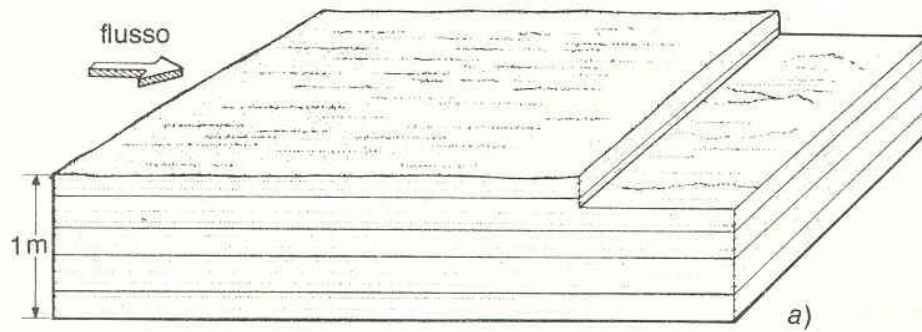


Suspended load:
Mud
(silt+clay)

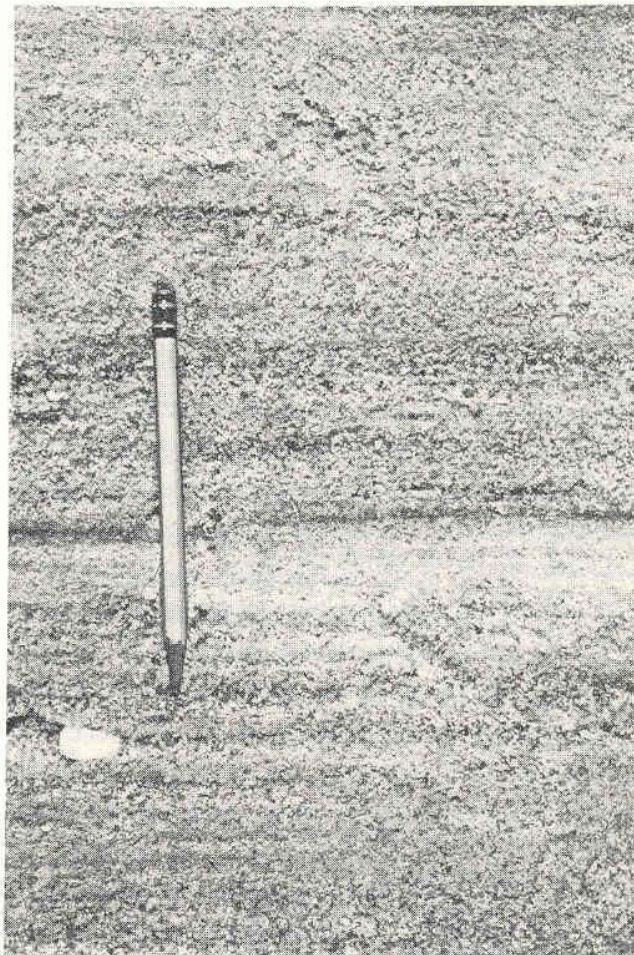
Bed load:
Boulder
gravel
sand

Processi trattivi

- Velocità carico di fondo \ll velocità corrente
- Azione trattiva può essere associata a decantazione: sabbie sporche (matrice) e forme di fondo particolari
- Azione trattiva può alternarsi a decantazione. Particolare tipo di stratificazione (alternanze sabbia e fango)



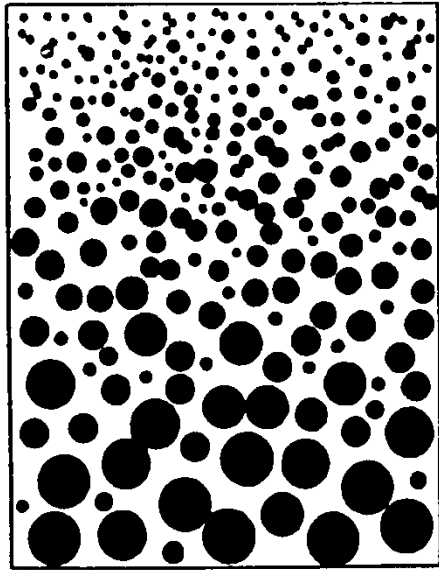
b) c)



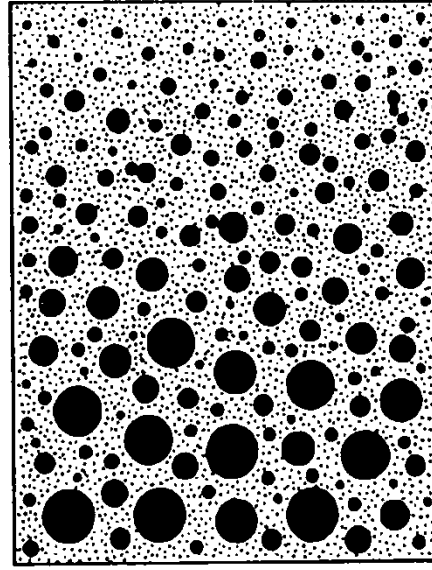
Lineazioni e lamine
da corrente trattiva

Lamine gradate
Inversamente
(pressione collisionale
e effetto "setaccio")

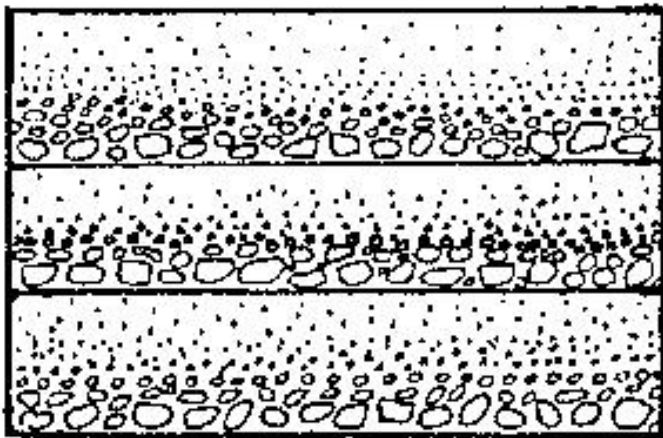
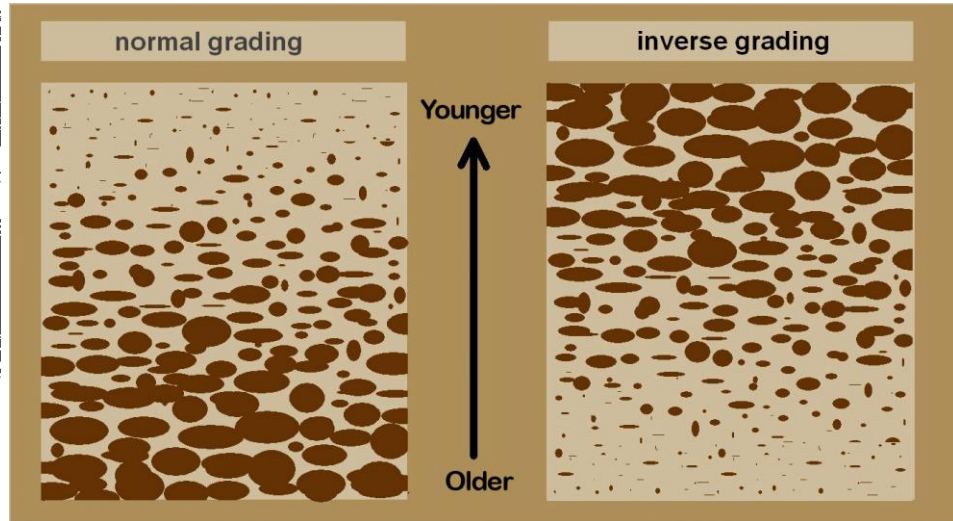
Gradazione Graded bedding



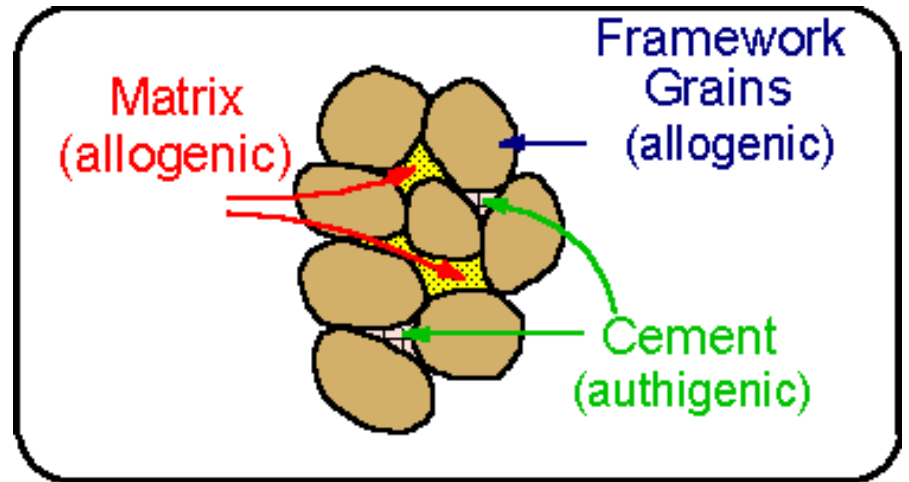
(a)



(b)



Normal Grading



Ripples (incredspature)

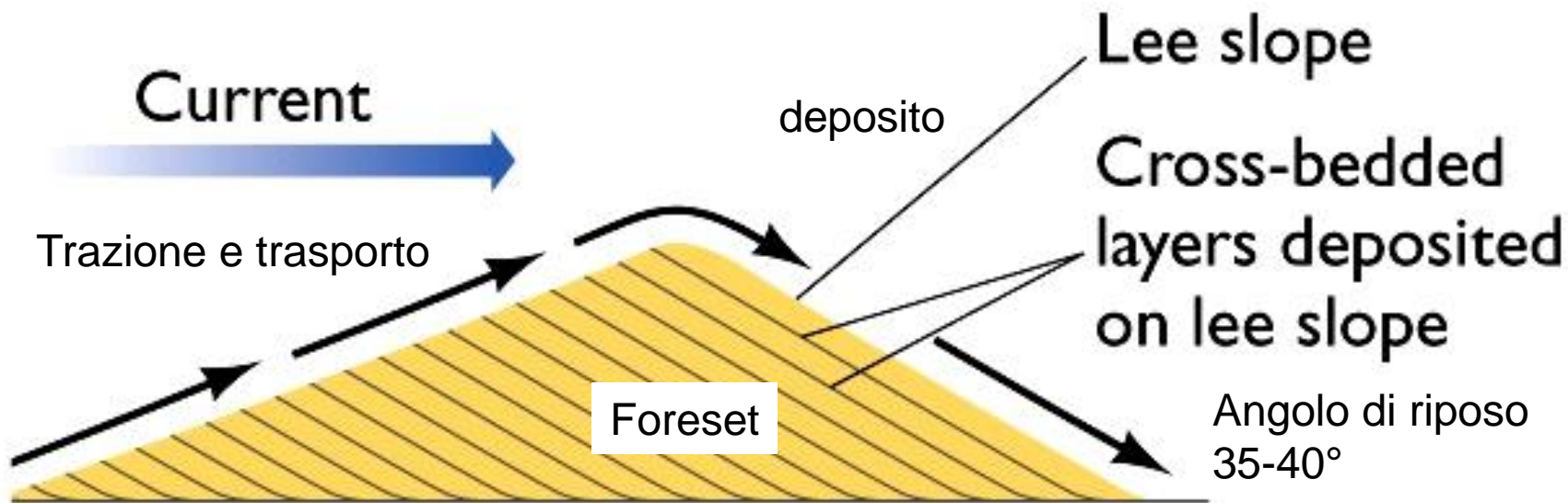
Correnti deboli:
10-30 cm/s

Formazione in
pochi minuti

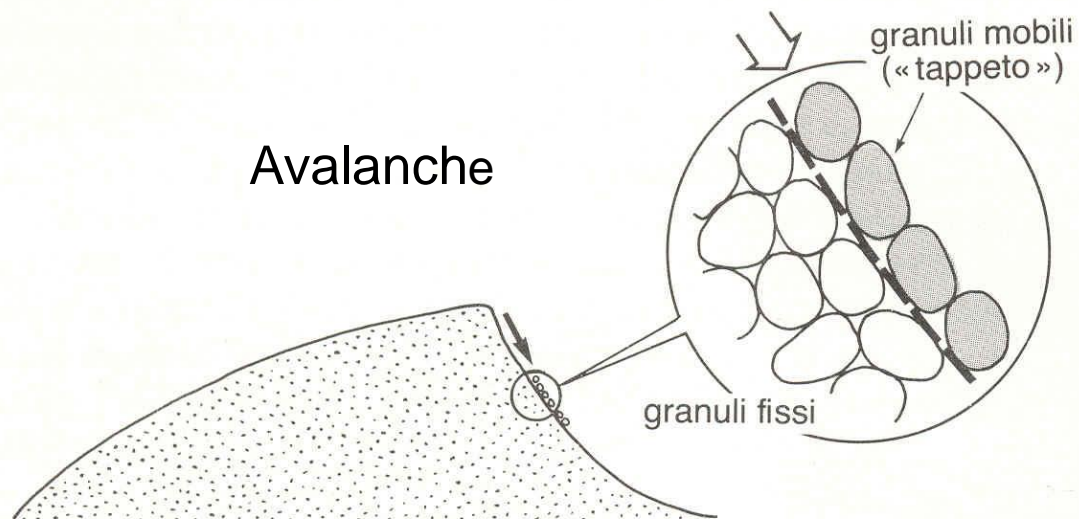


Ripples (in crescendo)

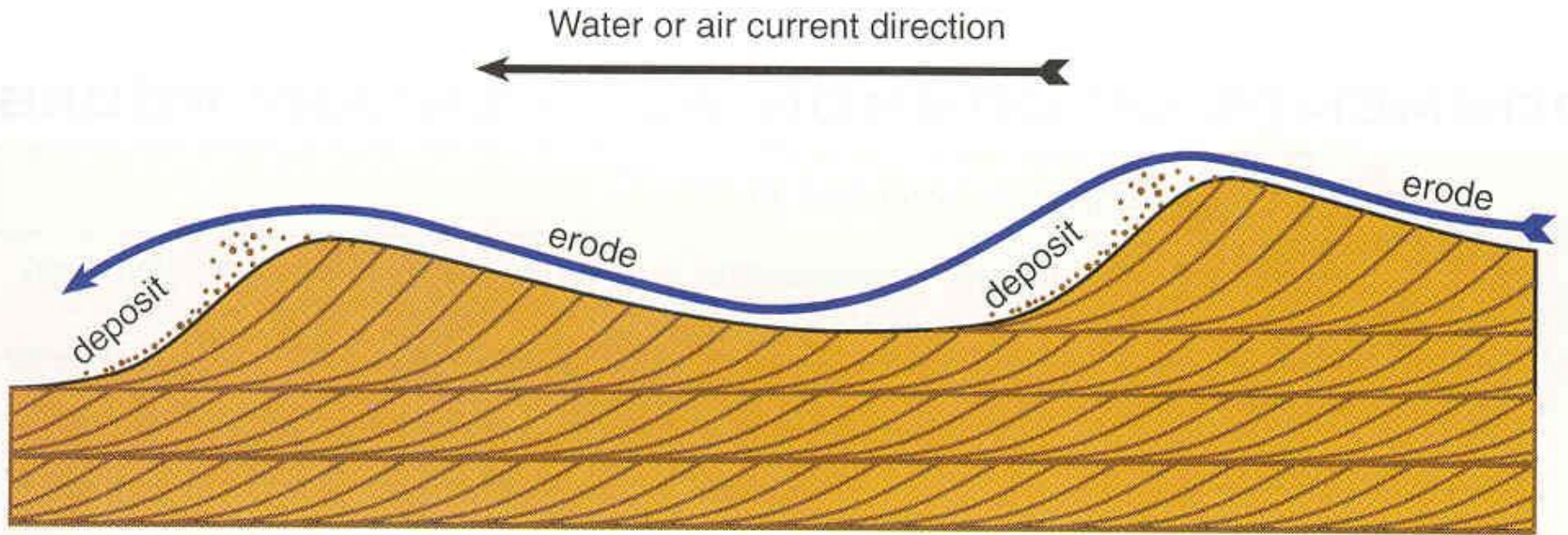




Stratificazione incrociata
 o
 Laminazione obliqua

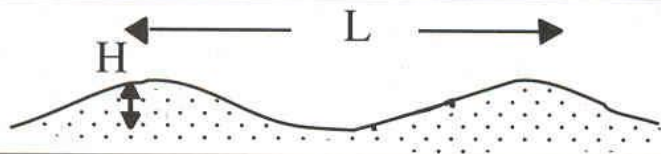


sand



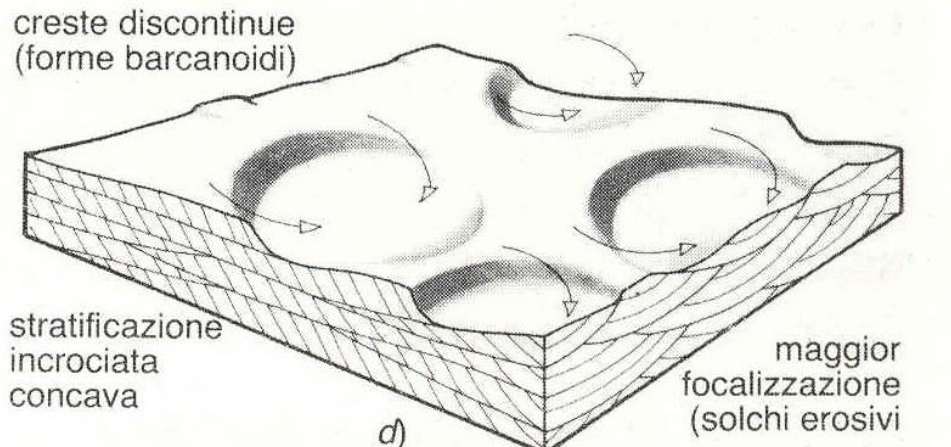
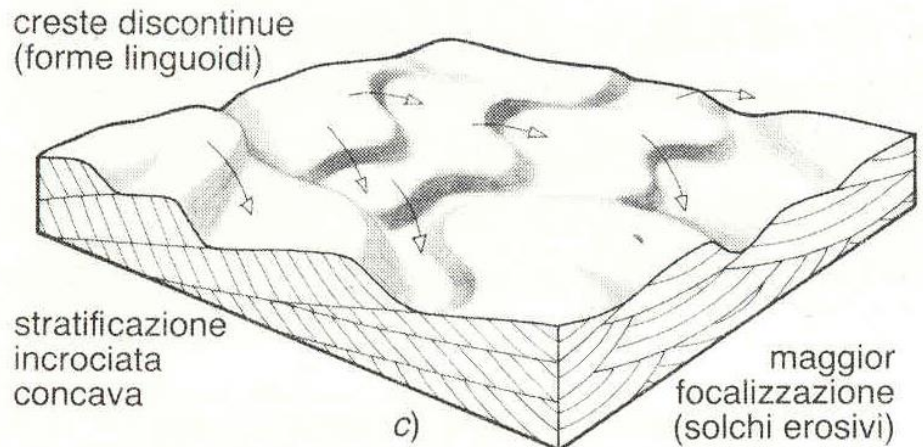
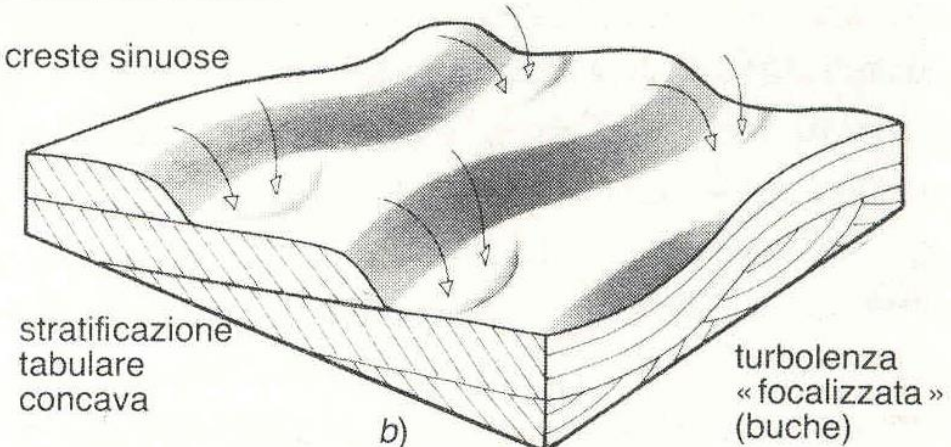
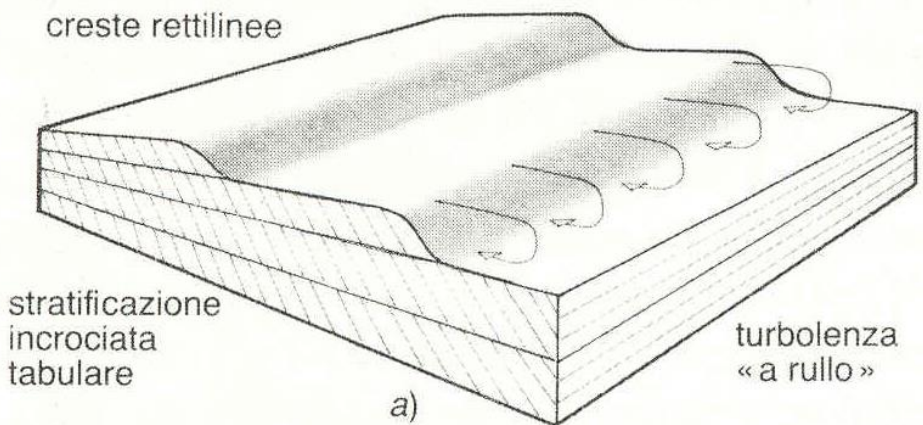
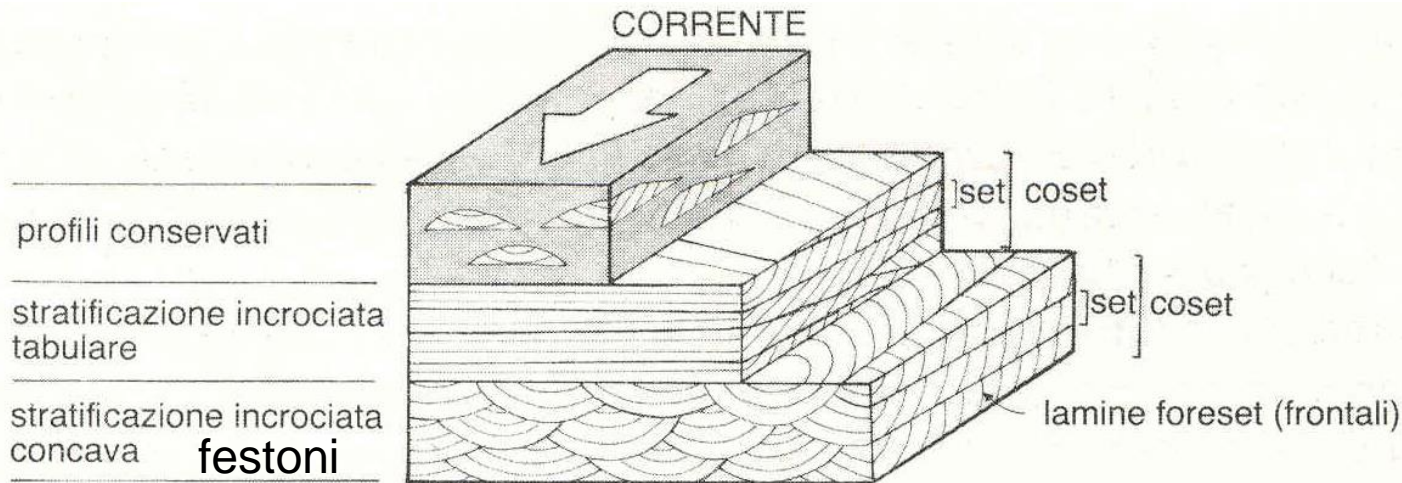
A.

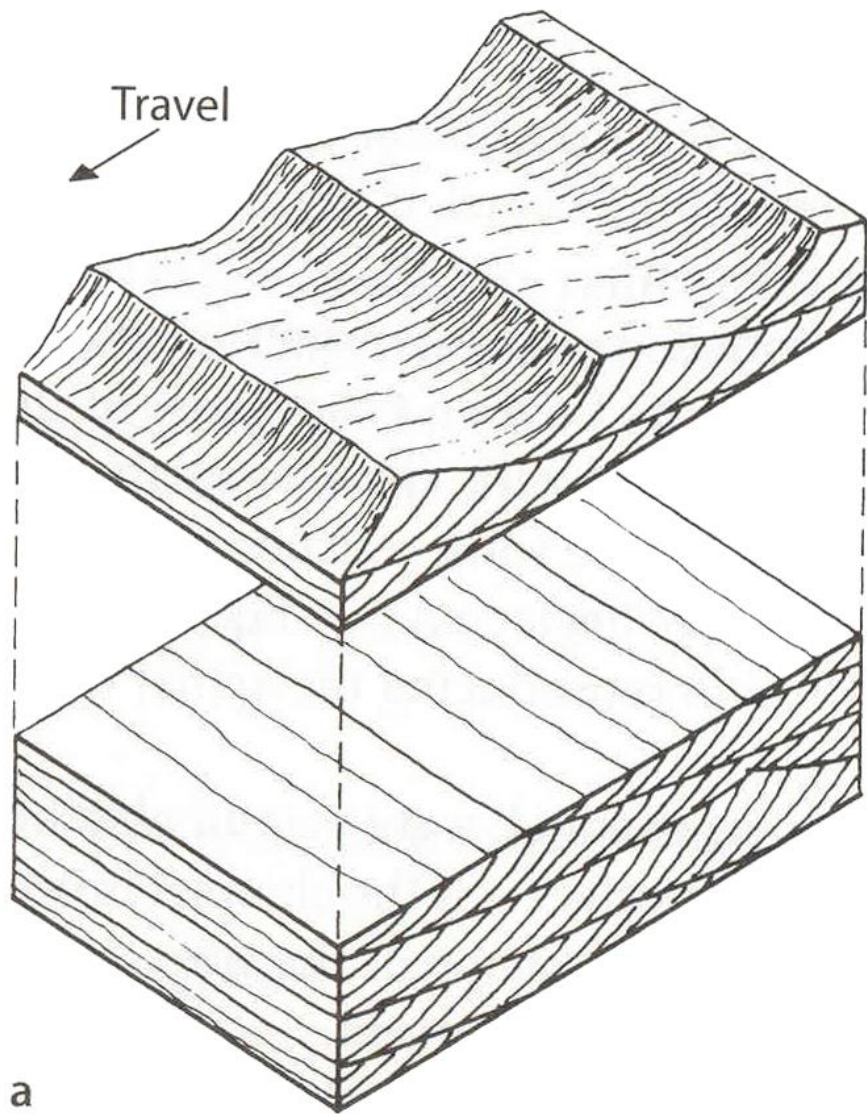
<i>ripple</i> da onda + (biforcazioni)	rettilinei	sinuosi	catenari	<i>ripple</i> linguoidi	dune barcanoidi
	<i>ripple</i> e dune da corrente				



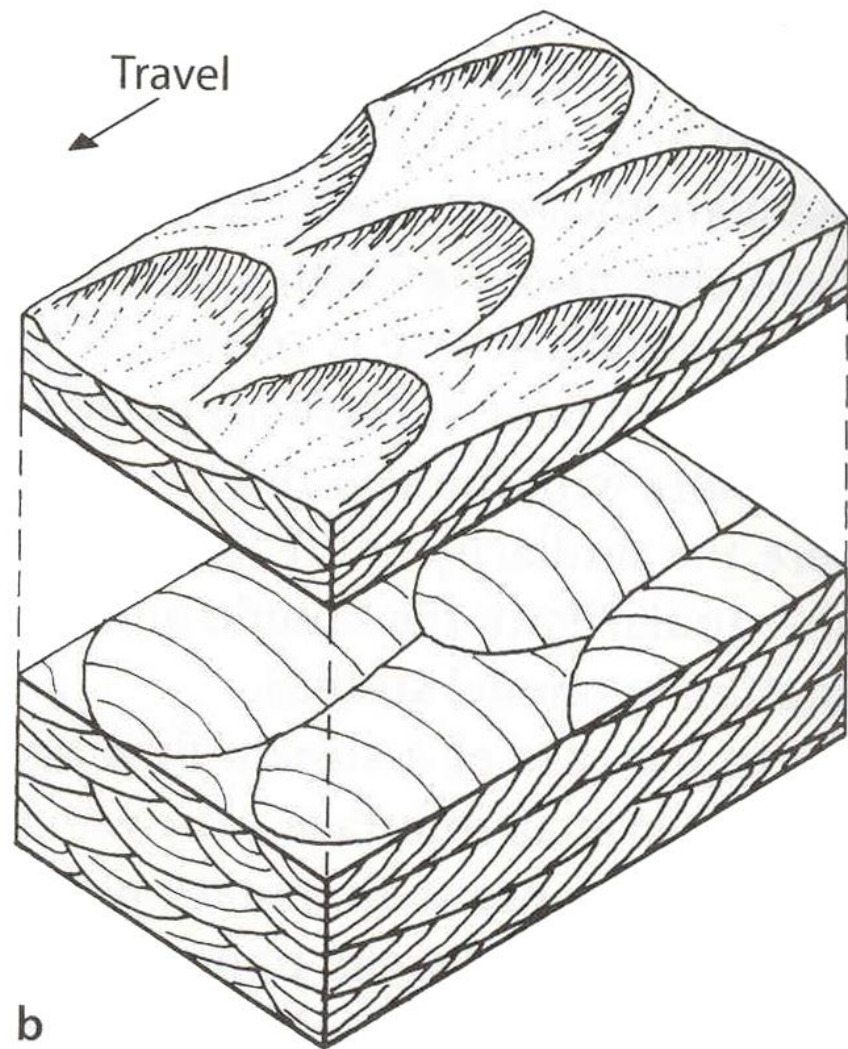
indice di *ripple* = L/H

<i>ripple</i> eolici	L 2,5 - 25 cm	H 0,5 - 1,0 cm	in genere 10 - 70
	Più piatti		
<i>ripple</i> da onda	L 0,9 - 200 cm	H 0,3 - 25 cm	4 - 13 in genere 6 - 7
<i>ripple</i> da corrente	L < 60 cm	H < 6 cm	> 5 in genere 8 - 15



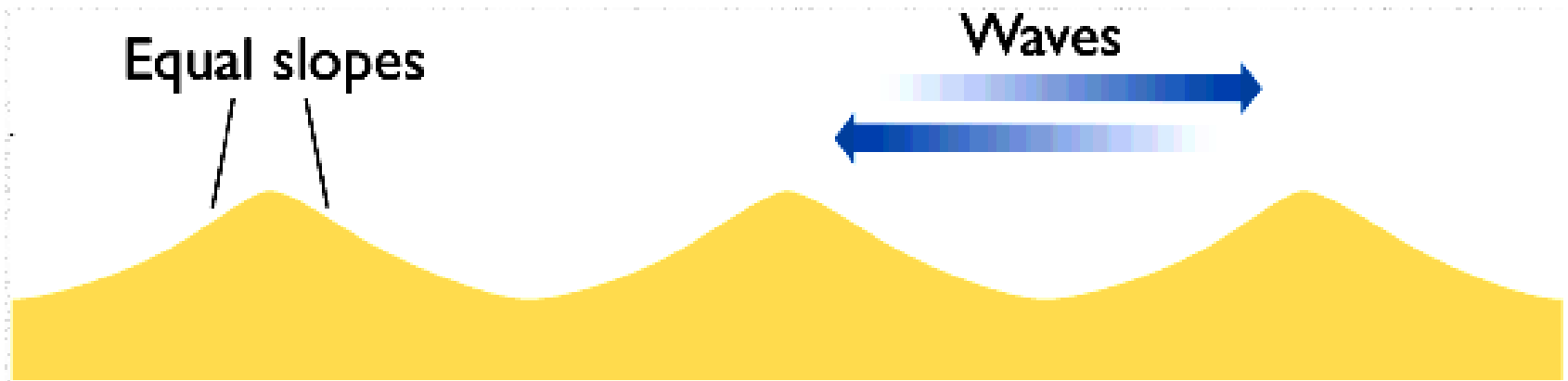


a

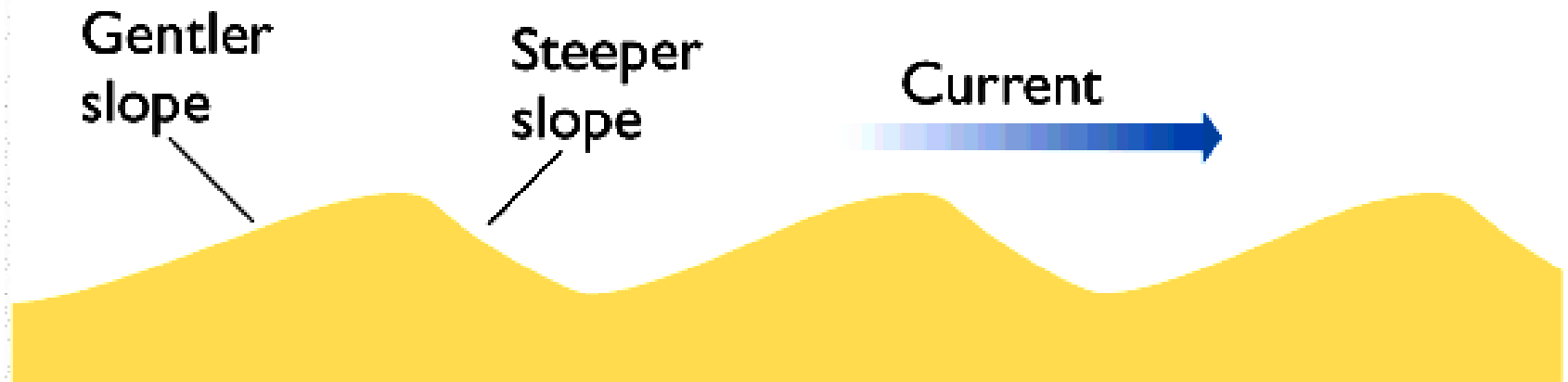


b

Strutture trattive da correnti oscillatorie



Symmetrical ripples (beach)

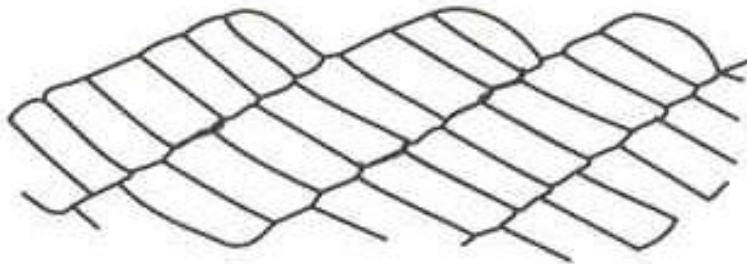


Asymmetrical ripples (dune)

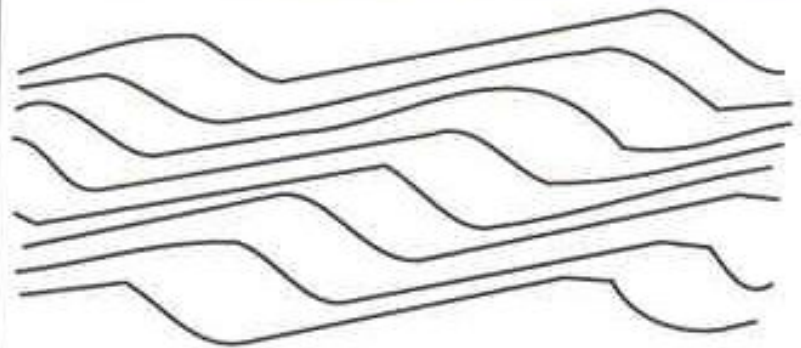
Trazione e decantazione

- Corrente in fase calante (decelerazione, diminuzione di profondità): deposizione
- Se ci sono particelle in sospensione la trazione è accompagnata dalla decantazione (matrice o lamine scure), trazione è ostacolata, migrazione rallenta: deposizione anche sul lato posteriore: *climbing ripples*

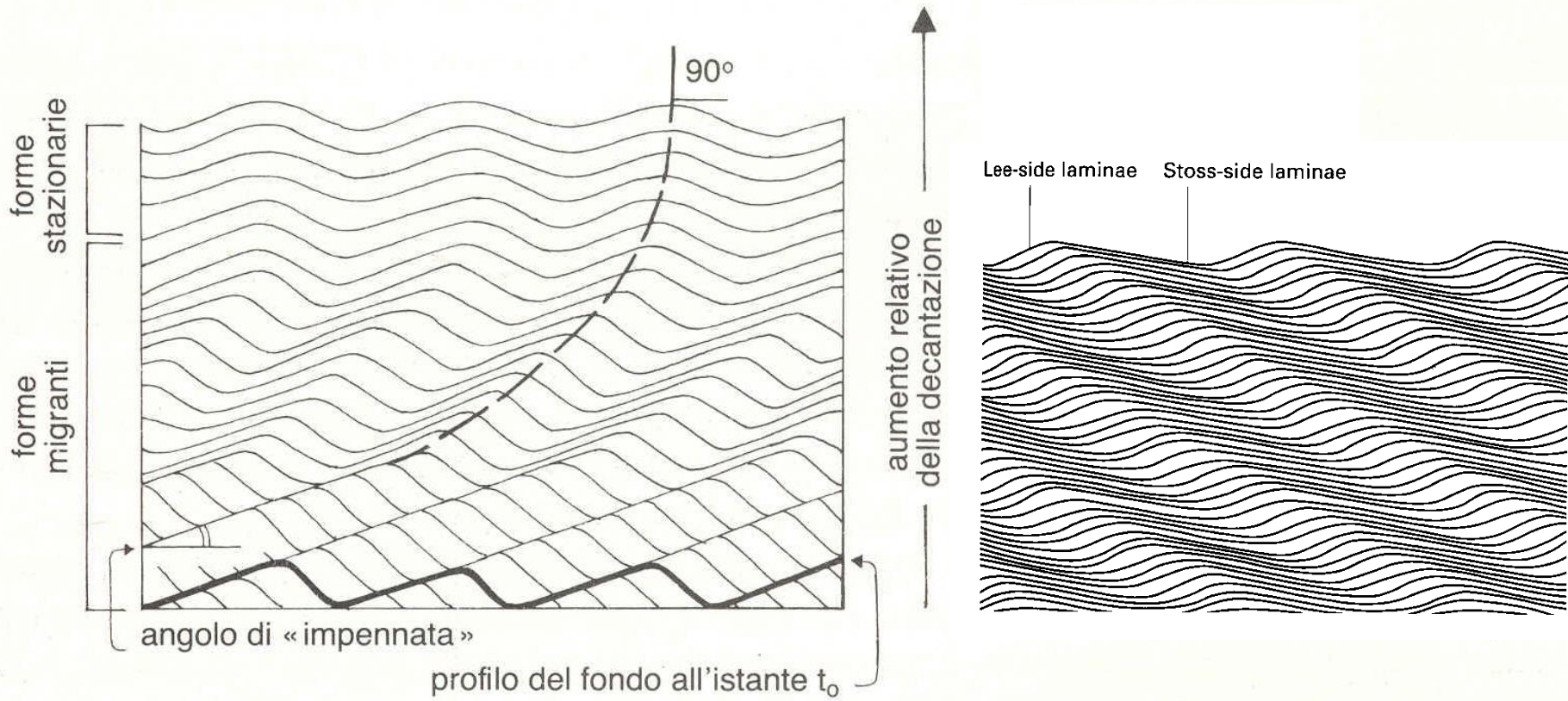
laminazione incrociata in *ripple* rampicanti



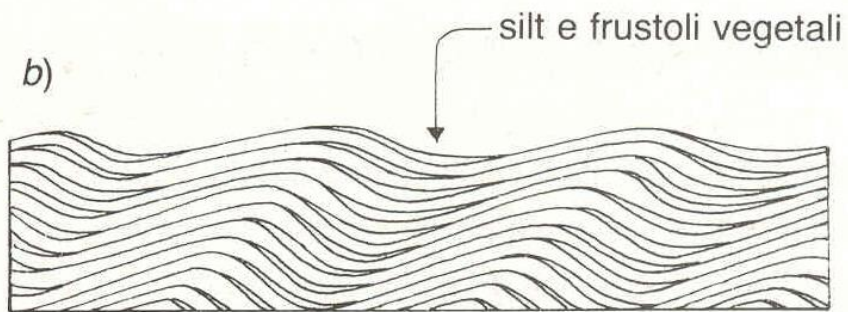
(a) superficie di erosione sul fianco posteriore



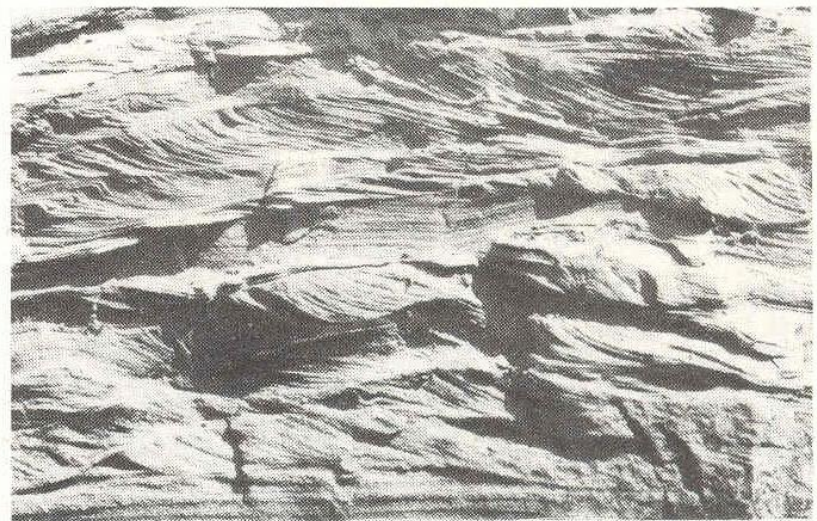
(b) lamine *stoss* preservate sul fianco posteriore



Decantazione e trazione

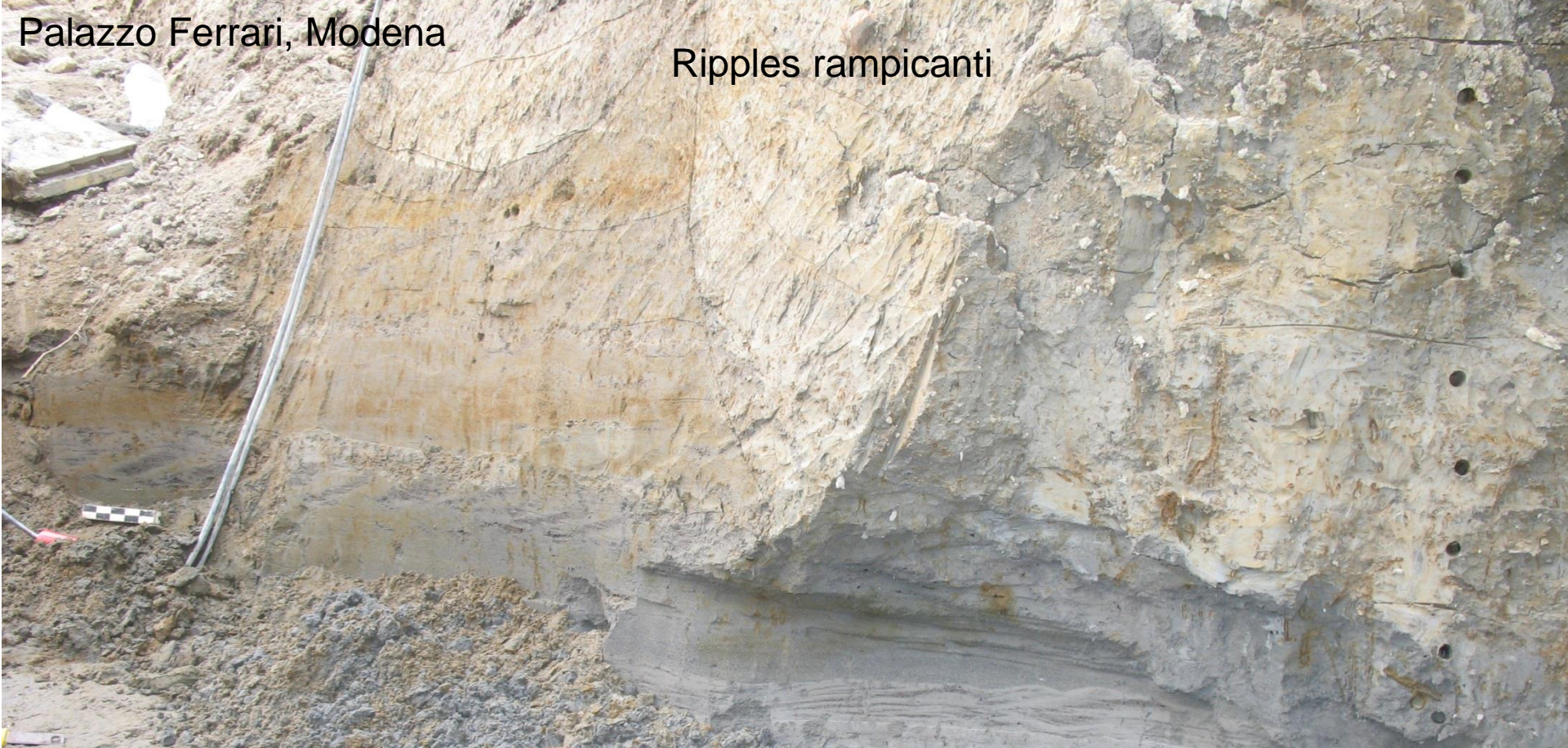


c)



Palazzo Ferrari, Modena

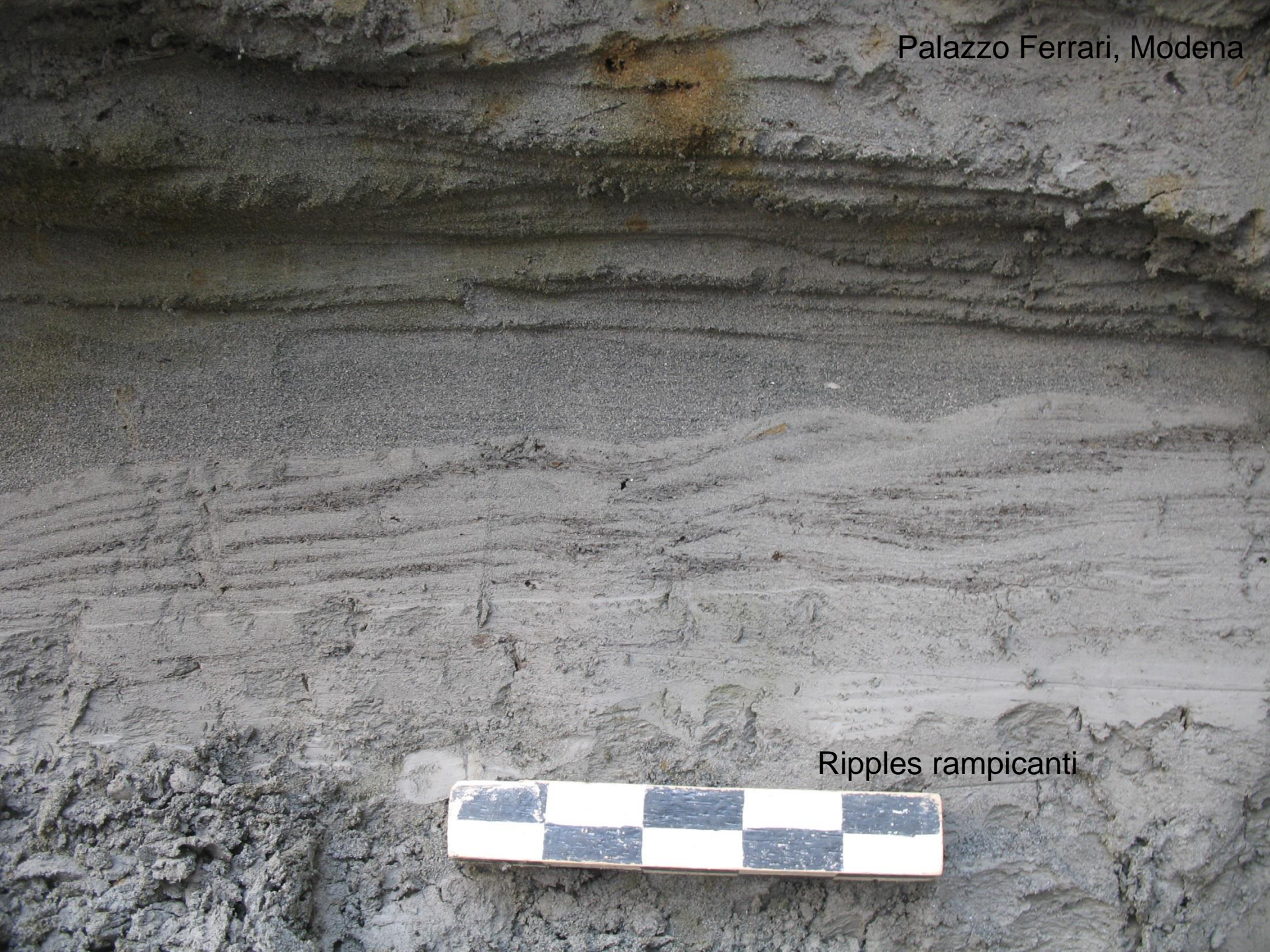
Ripples rampicanti



Livello archeologico romano



Palazzo Ferrari, Modena

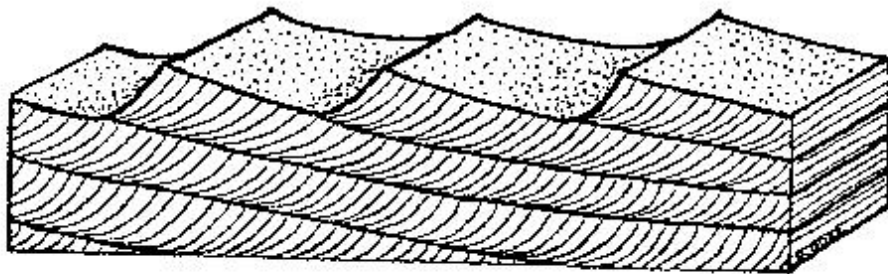


Ripples rampicanti



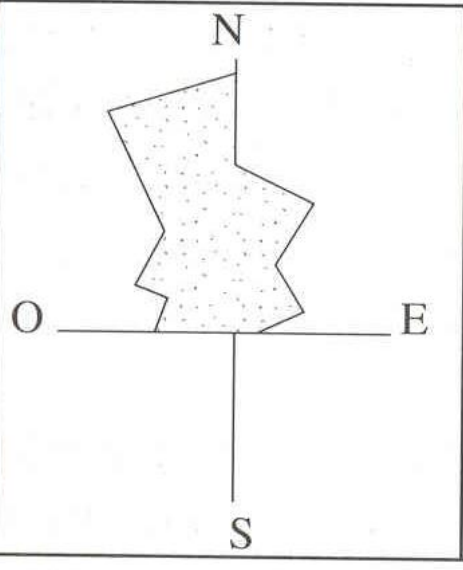
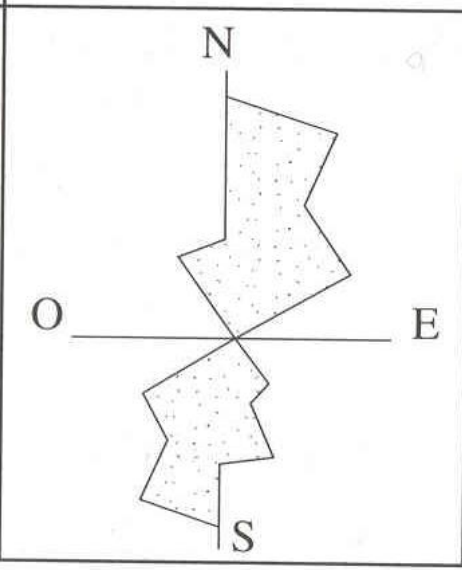
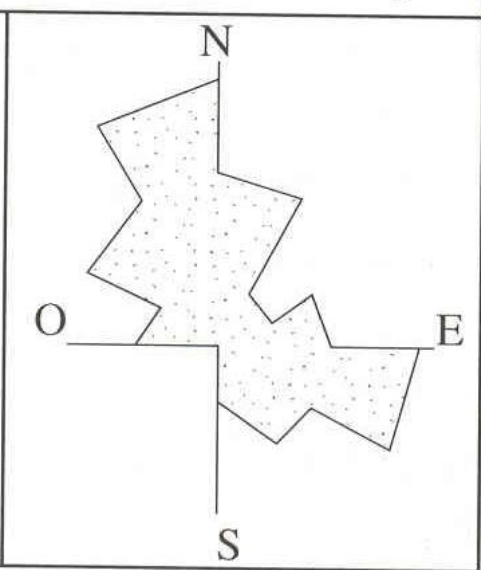
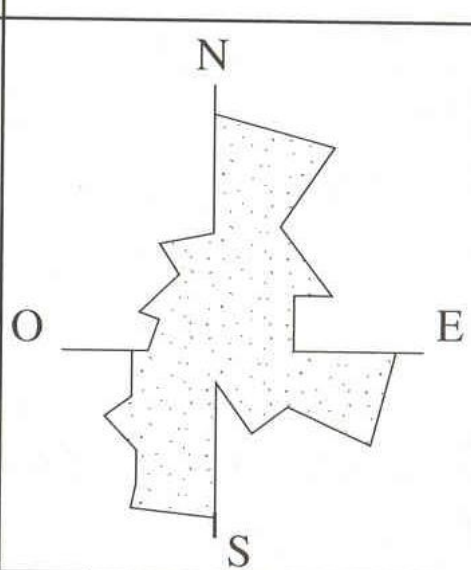
Ripples rampicanti

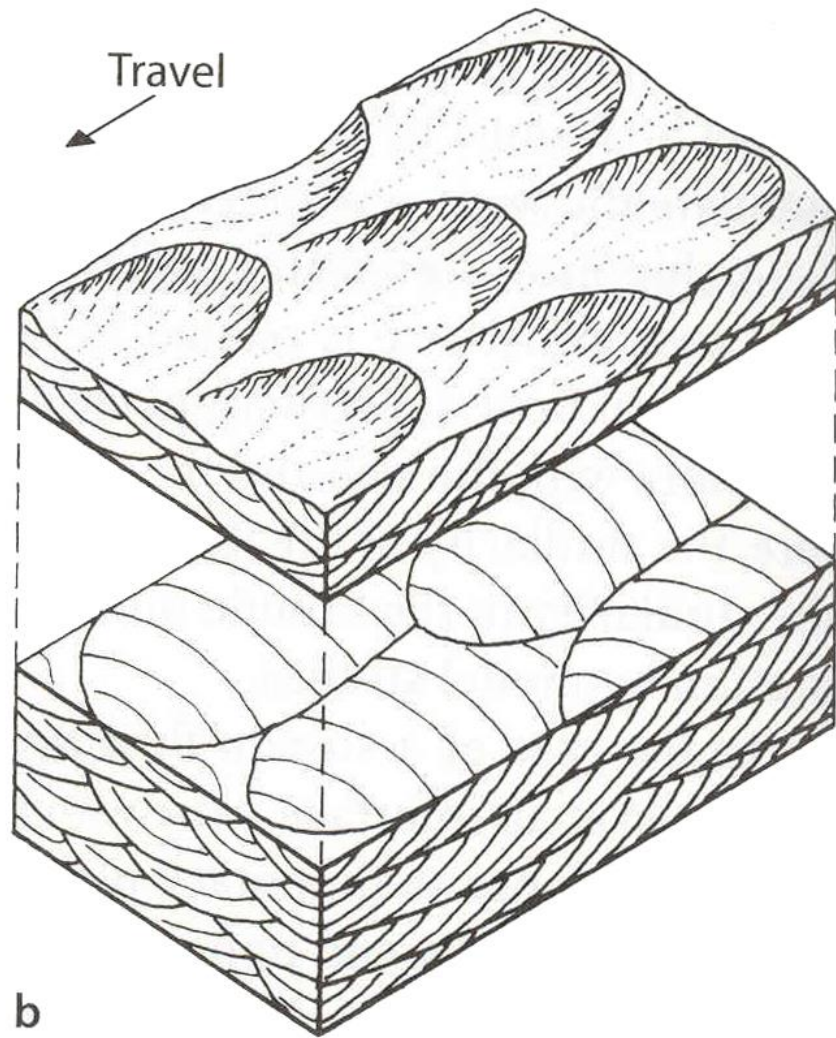
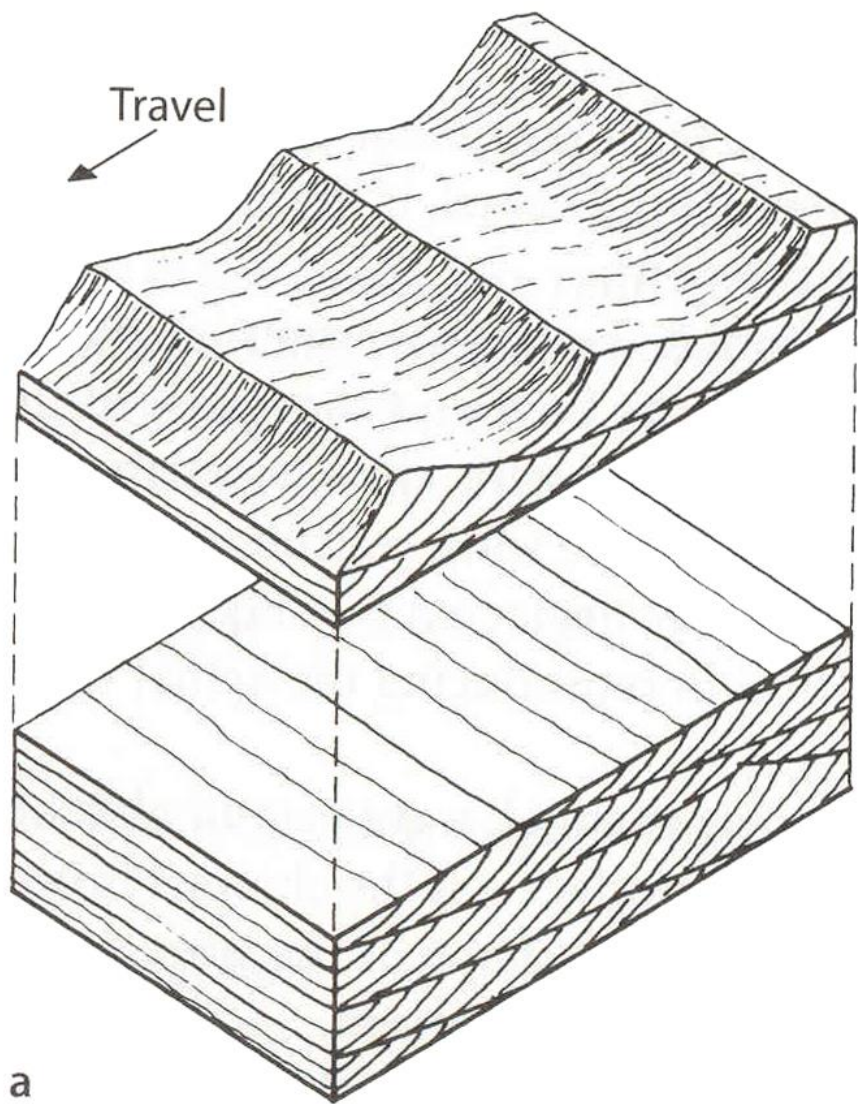
← Flow direction



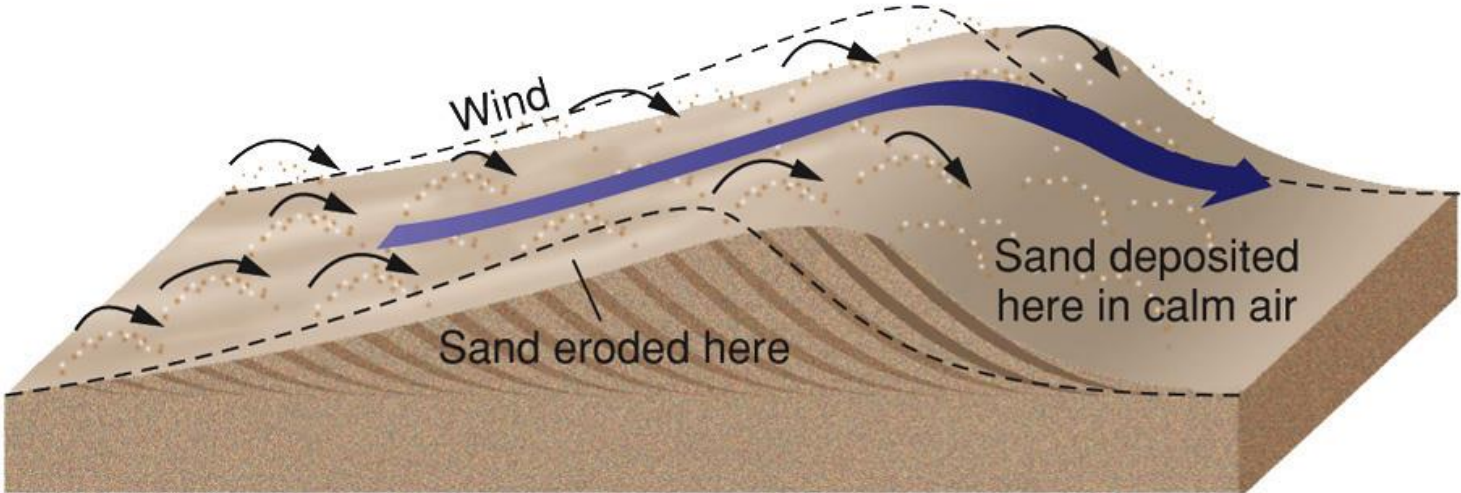
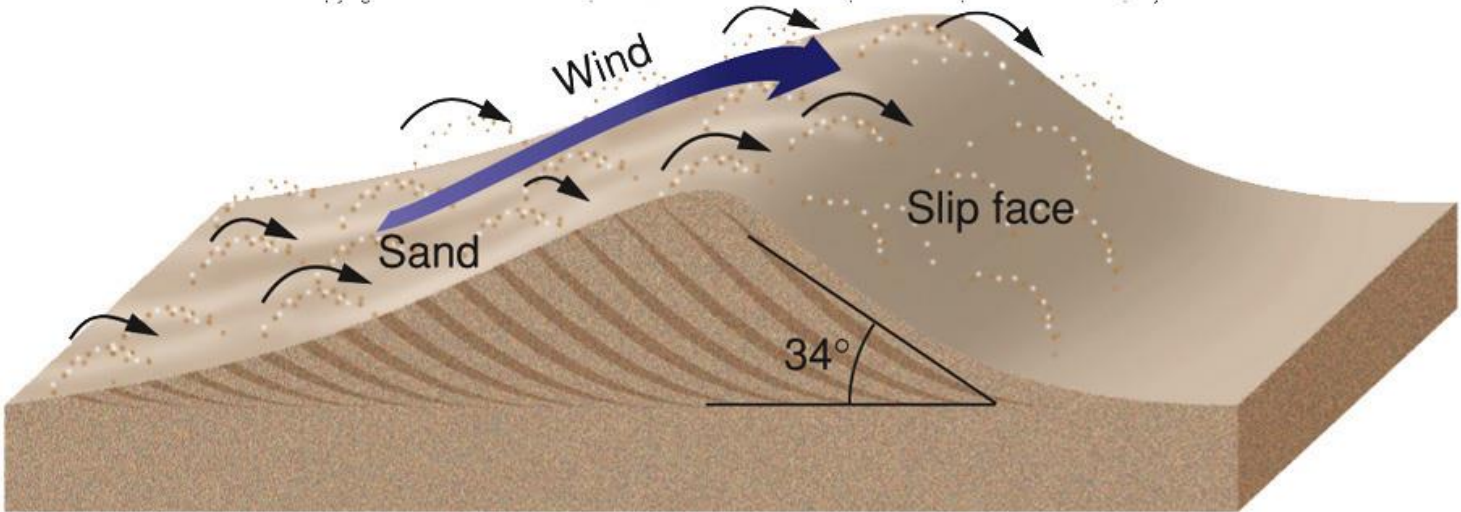
Current Ripple

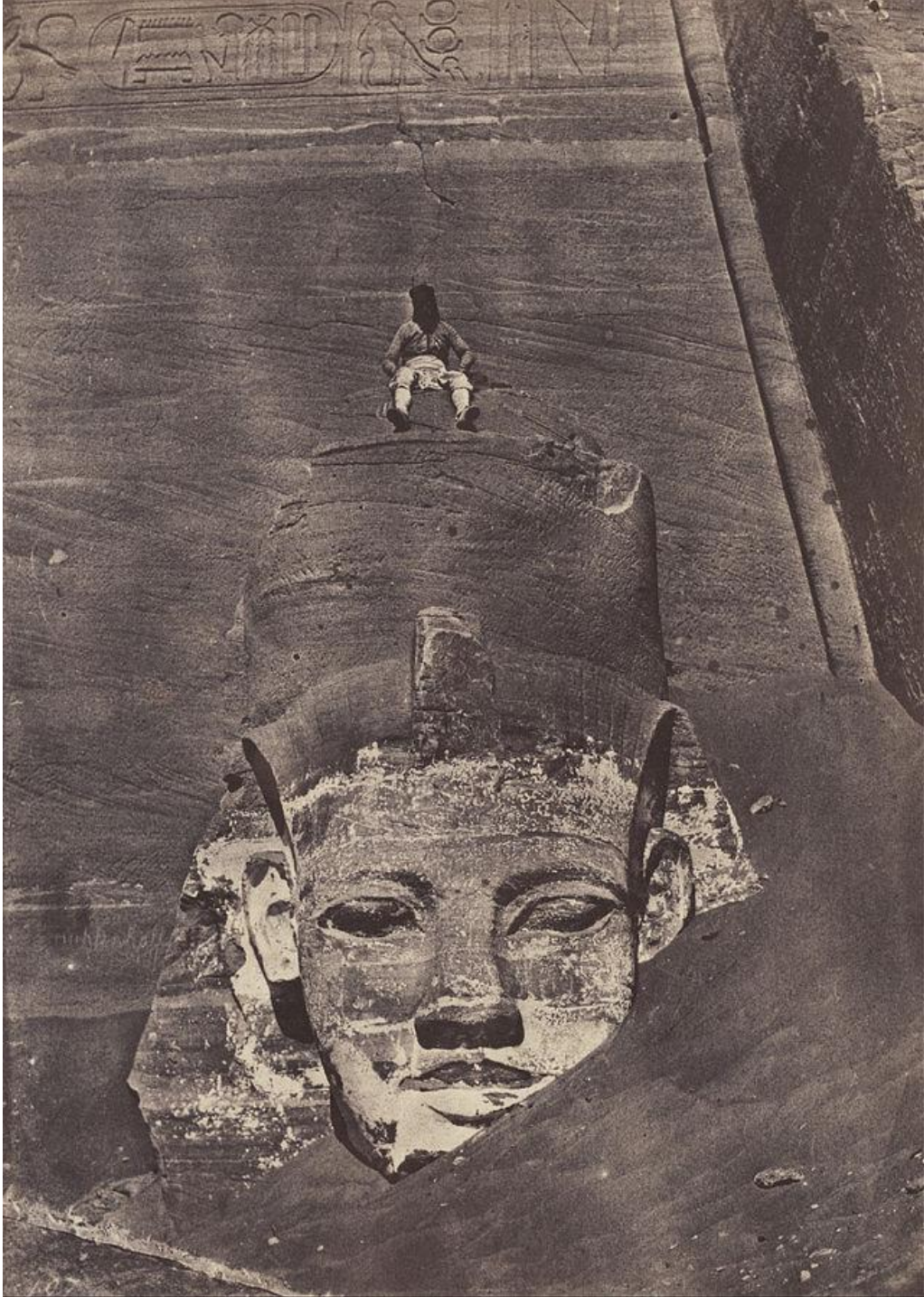
Direzione corrente

unimodale	bimodale		polimodale
	bipolare	obliqua	
			



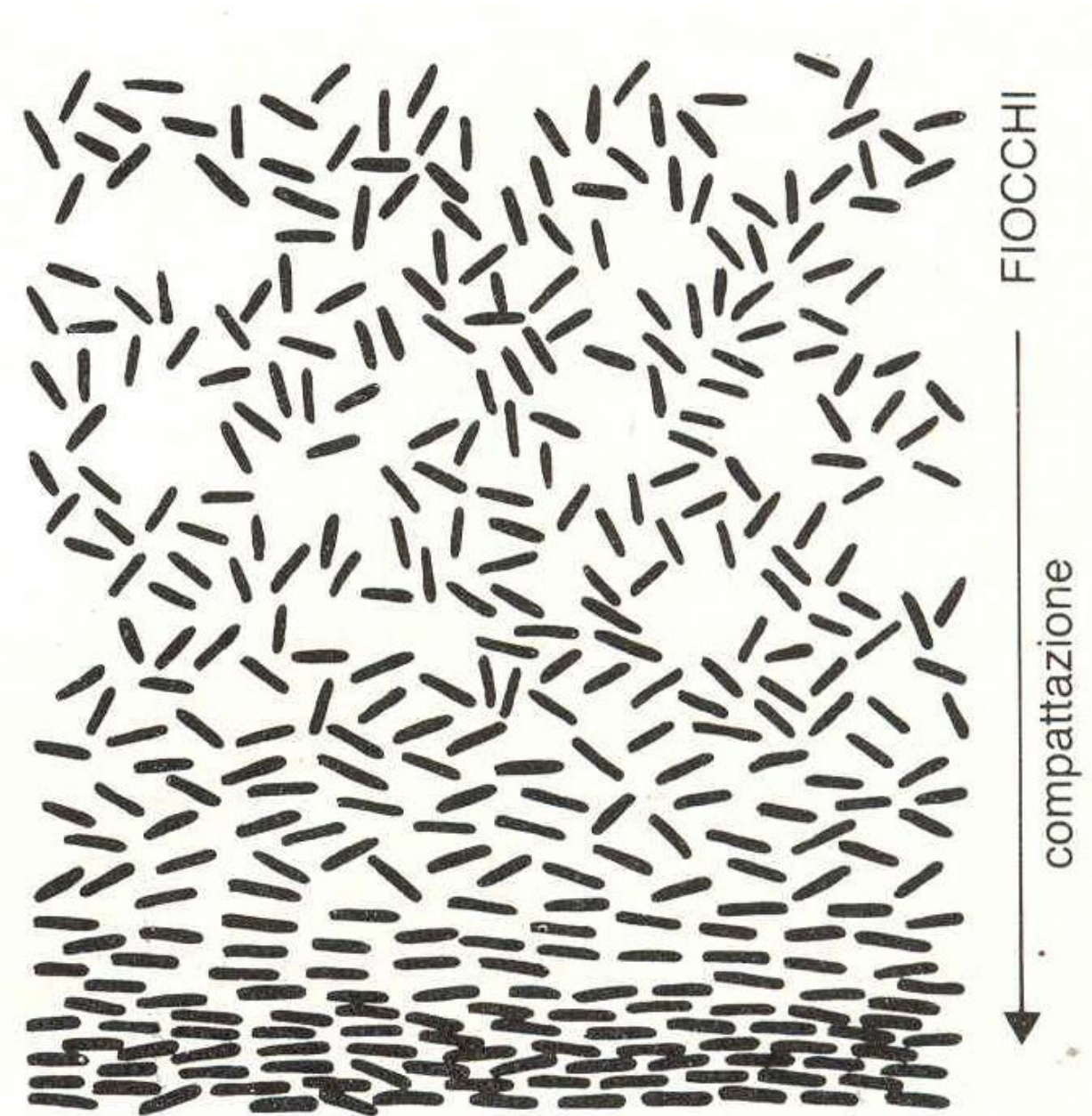
Dune eolice





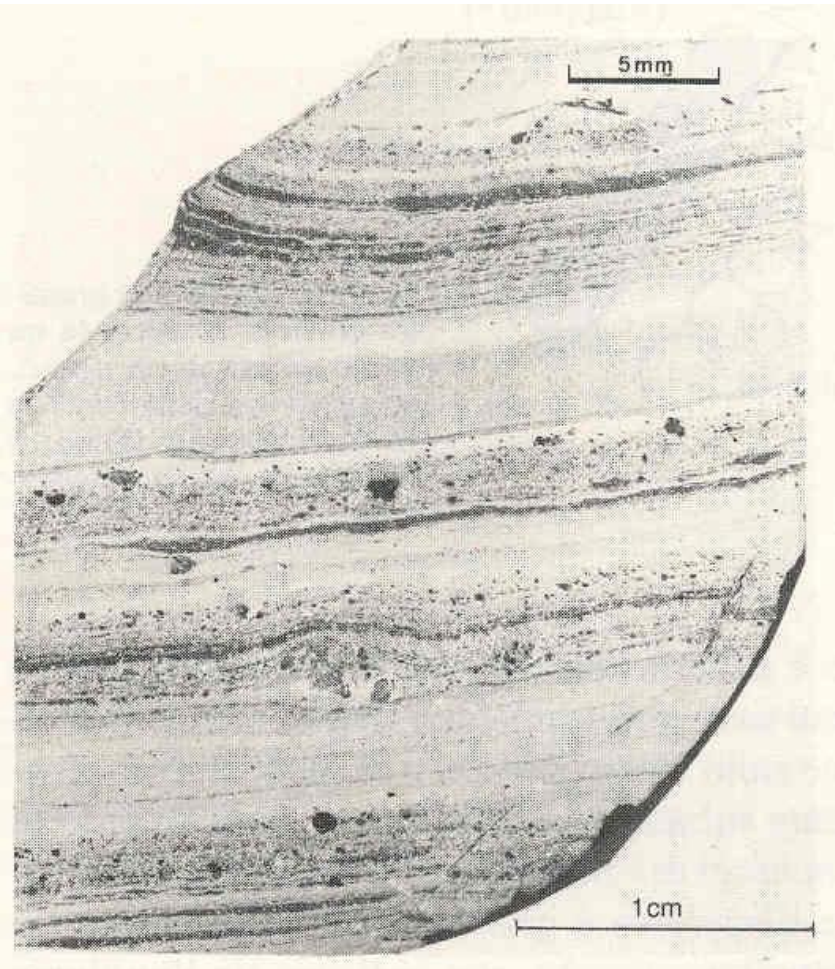
Strutture
sedimentarie?

Decantazione



- Da sospensioni diluite (concentrazione $<0.1\%$) quando V della corrente scende e turbolenza non sostiene particelle
- Fango (silt+argilla+grani “leggeri”) gradato
- Sottili lamine piano parallele

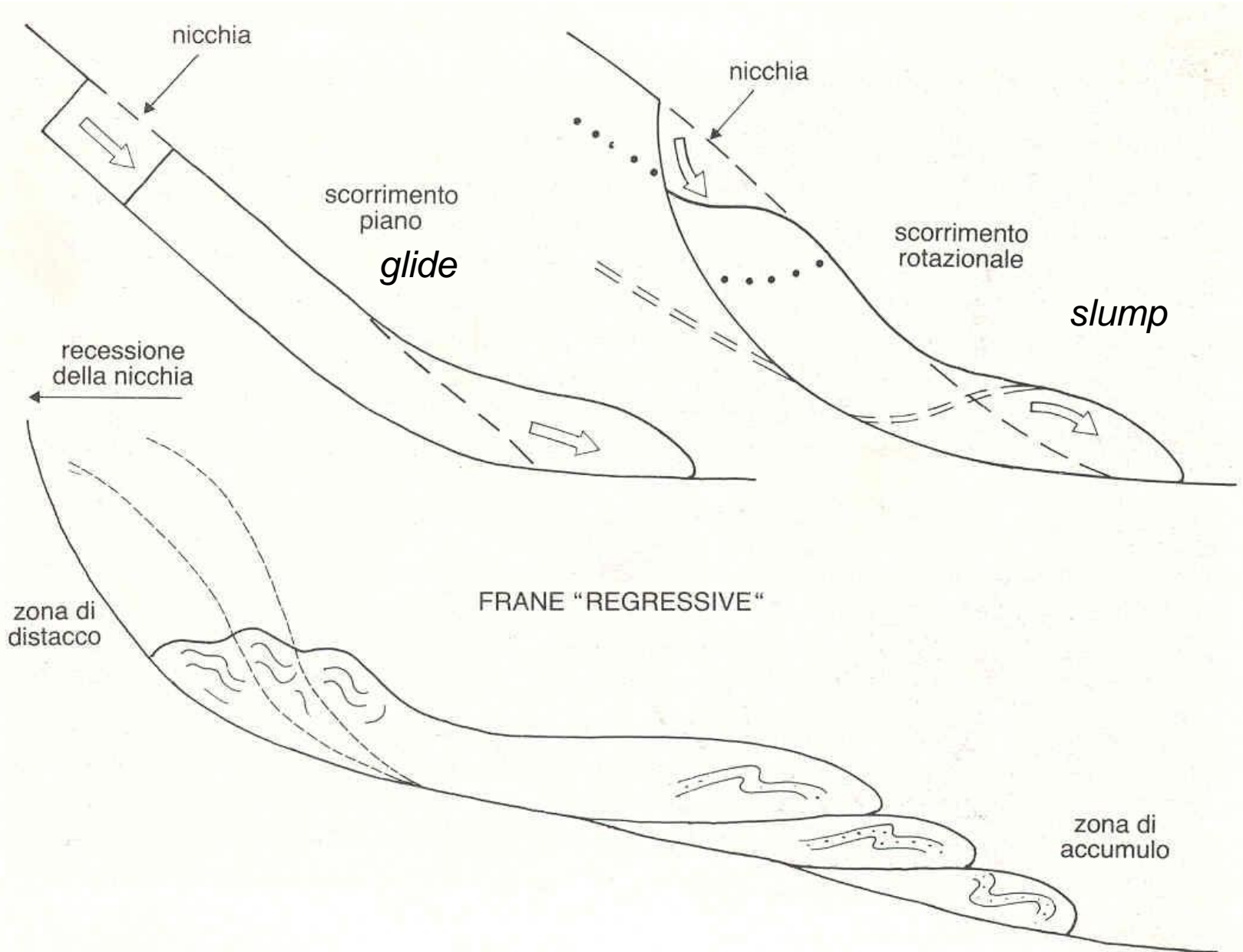
Varve



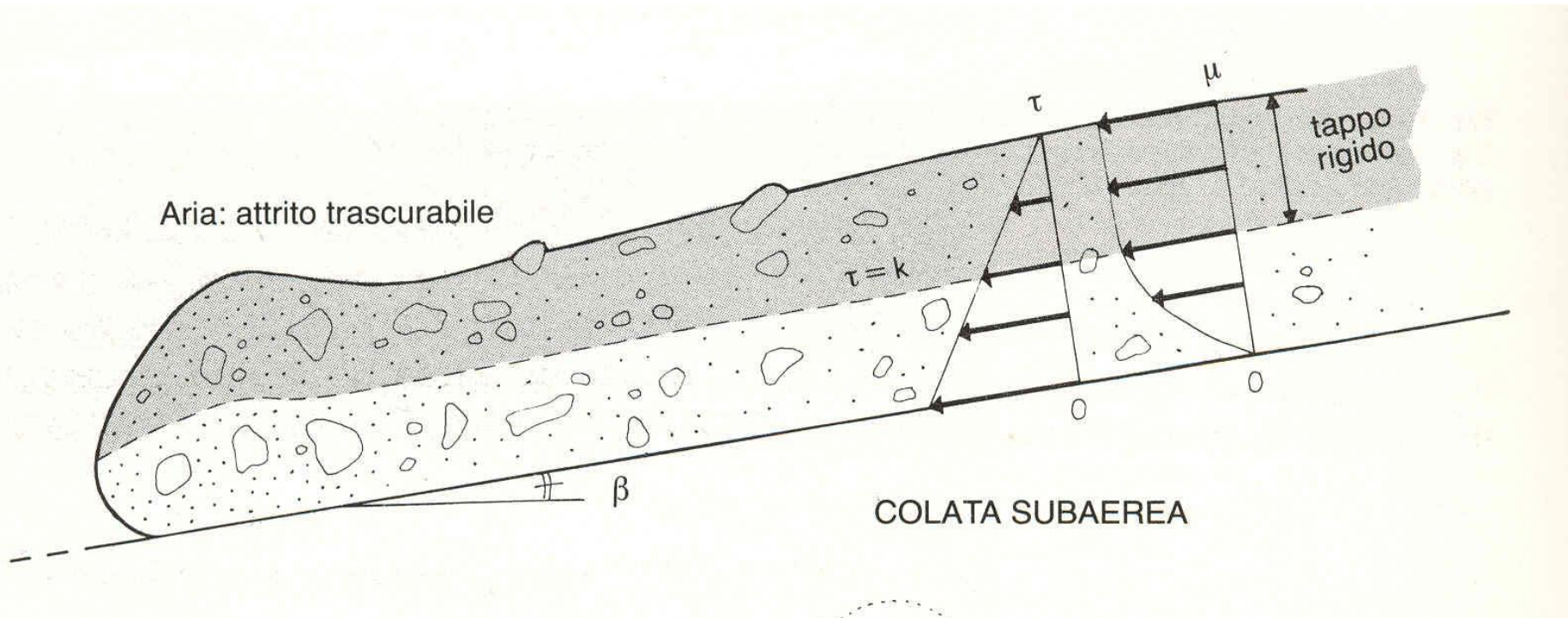
Sottili strati di
decantazione
organizzati in coppie
annuai che hanno
colmato i laghi
periglaciali quaternari

Estate: grossolano
Inverno: fine e sottile

Processi gravitativi: frane



Processi gravitativi: colate fangose



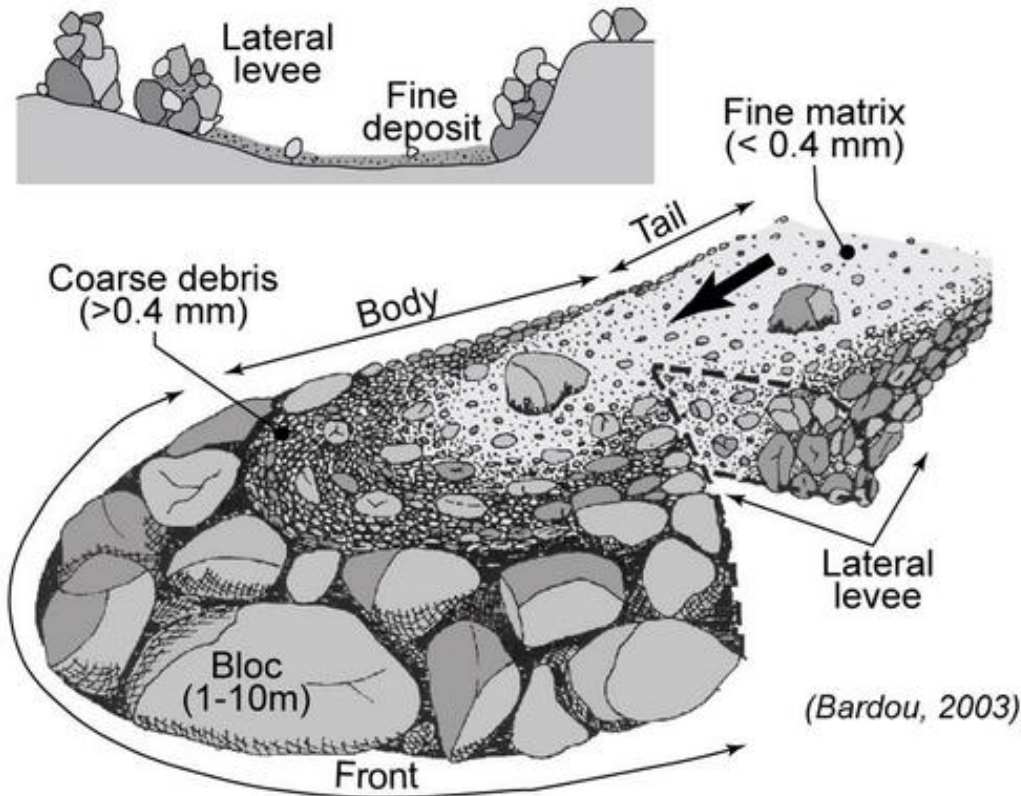
- Mud flow
- Sand flow
- Debris flow

Fango supporta le particelle grossolane e smorza gli attriti: competenza
Colata con $v = 50 \text{ cm/s}$ può trasportare blocchi di 1m

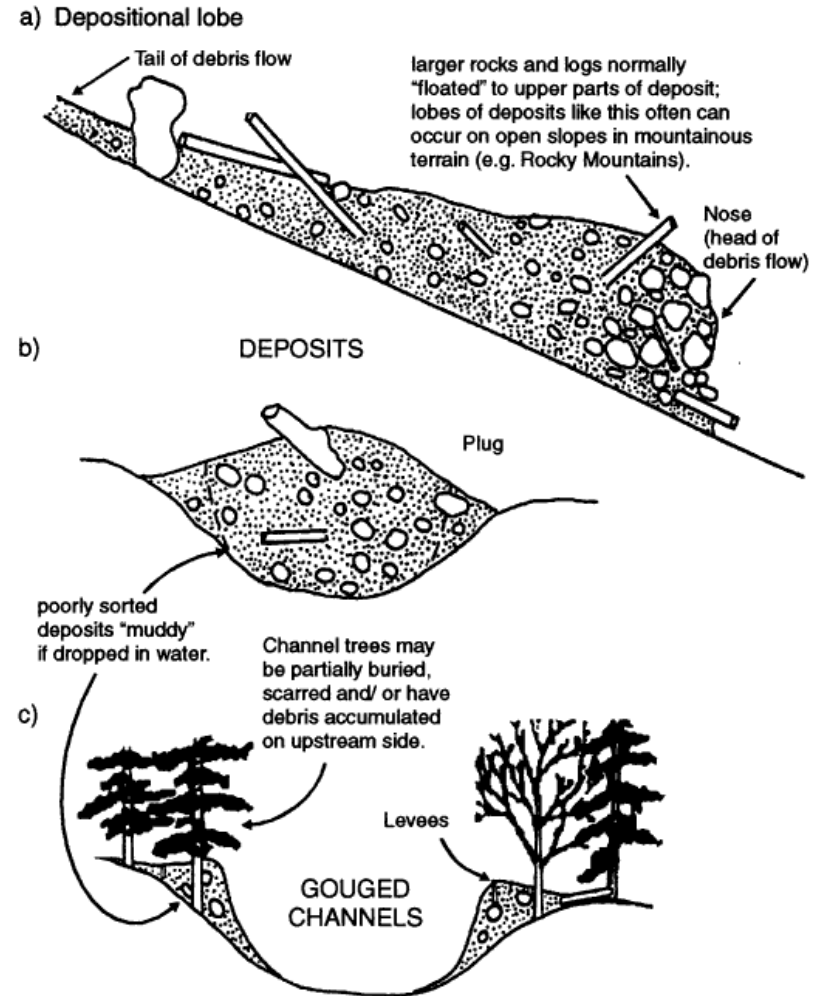


Postseismic debris flows fan driven by heavy rainfall in Hongchun Gully on August 13, 2010 (taken 14 August, 2010)

Debris flow



COMMON DEBRIS FLOW (TORRENT) FEATURES

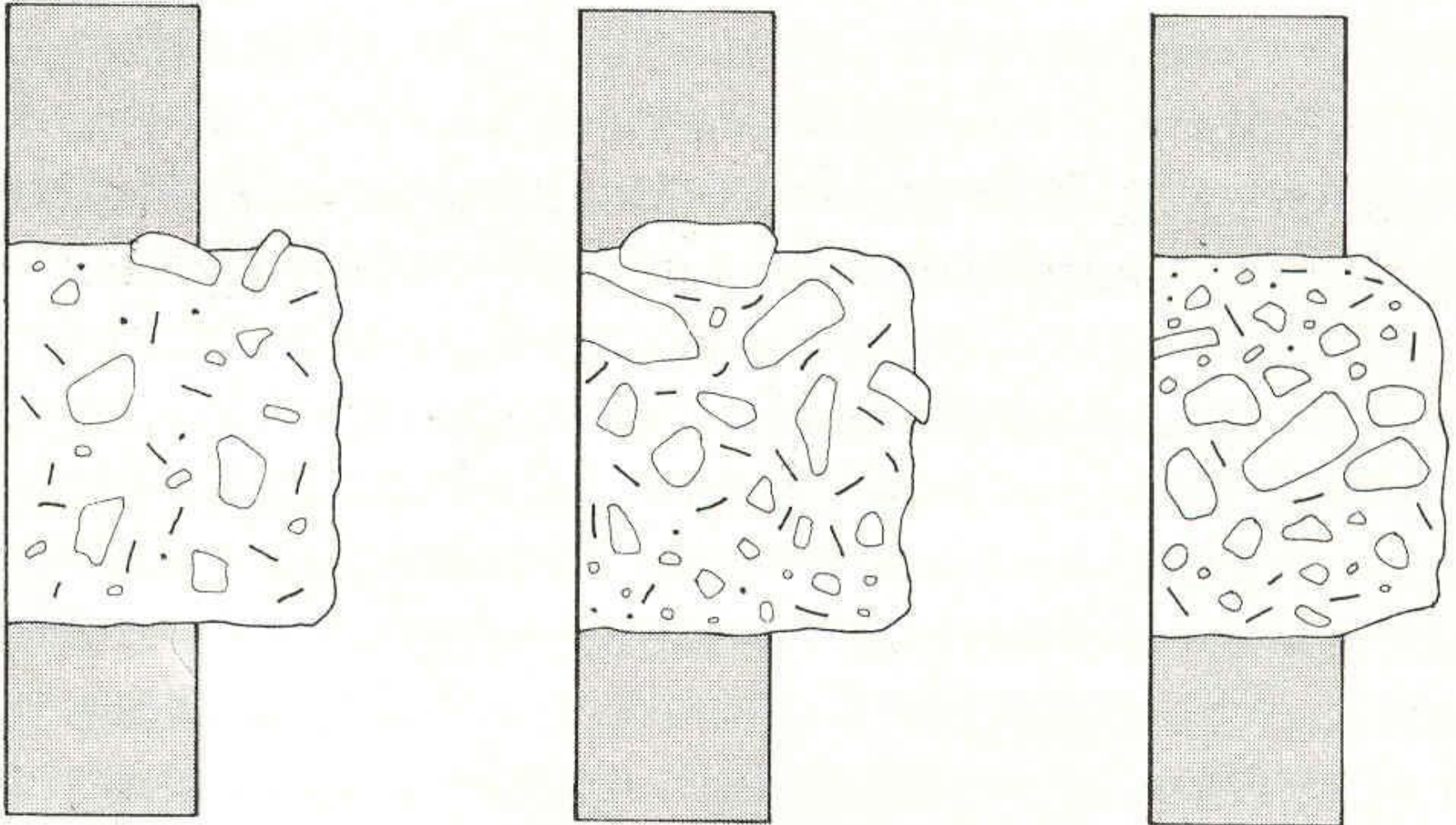


- Debris flows are made up of "loose" particles that move independently within the flow, at least 50% of particles are sand-size or larger particles
- A slide is a coherent block of material that "slides" over a failure surface.
- A mud flow is composed of mud and water.

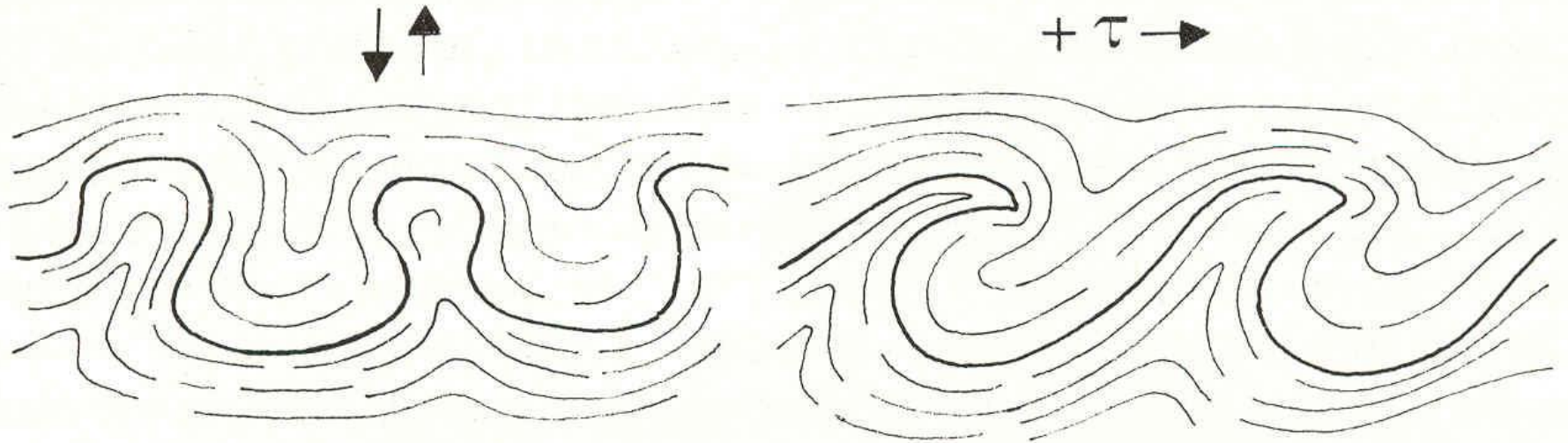
In areas of very steep slopes they can reach speeds of over 160 km/hour. However, many debris flows are very slow, 30 to 60 cm/year)

Colate di detrito (*debris flow*)

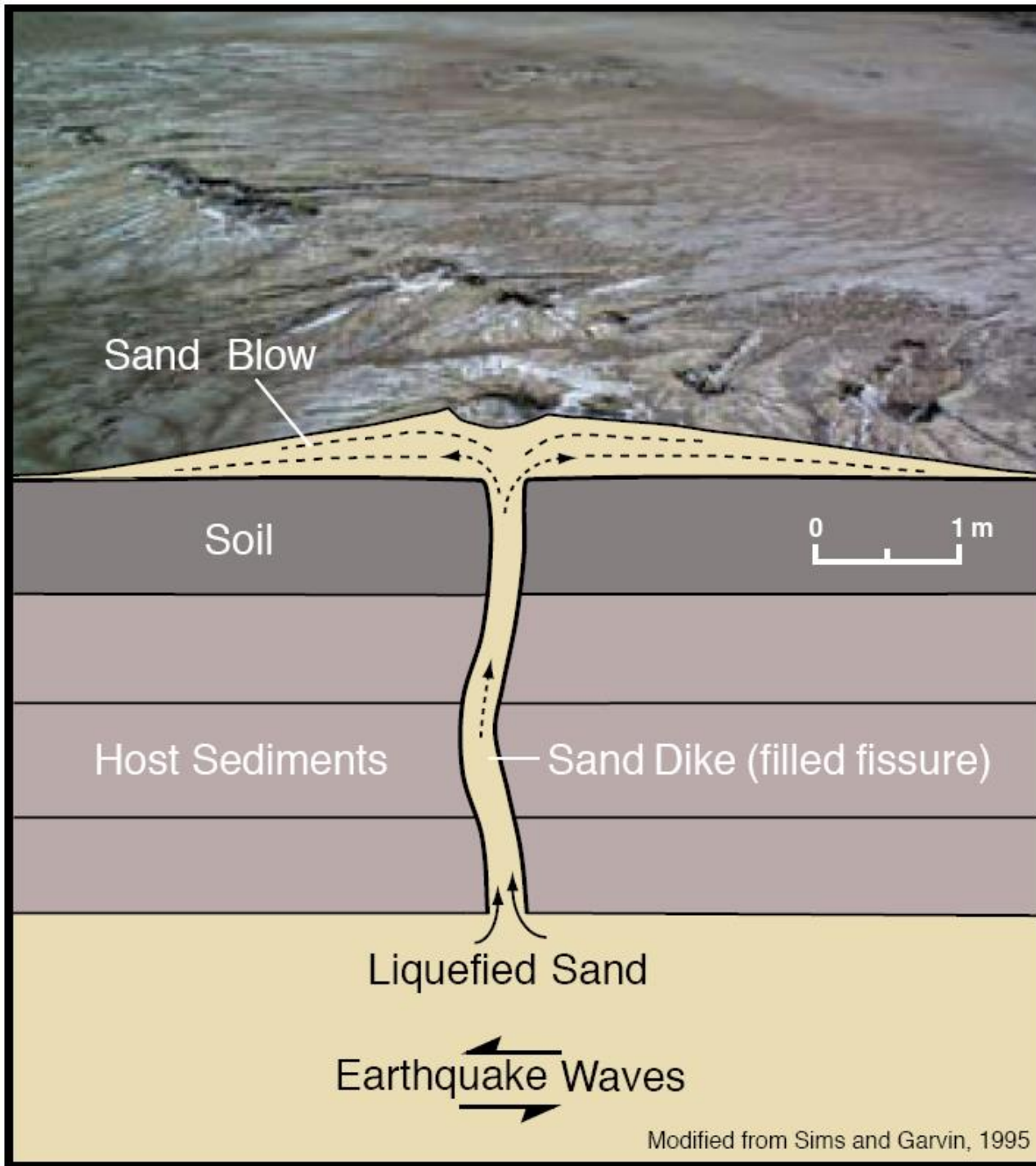
Arresto: “congelamento” - giacitura tipicamente caotica e disorganizzata



Strutture deformative



- convoluzioni



Liquefaction

Tuttle, 2011

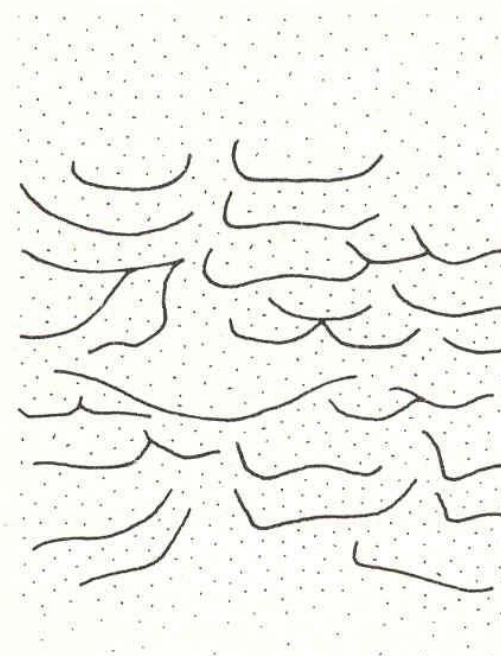
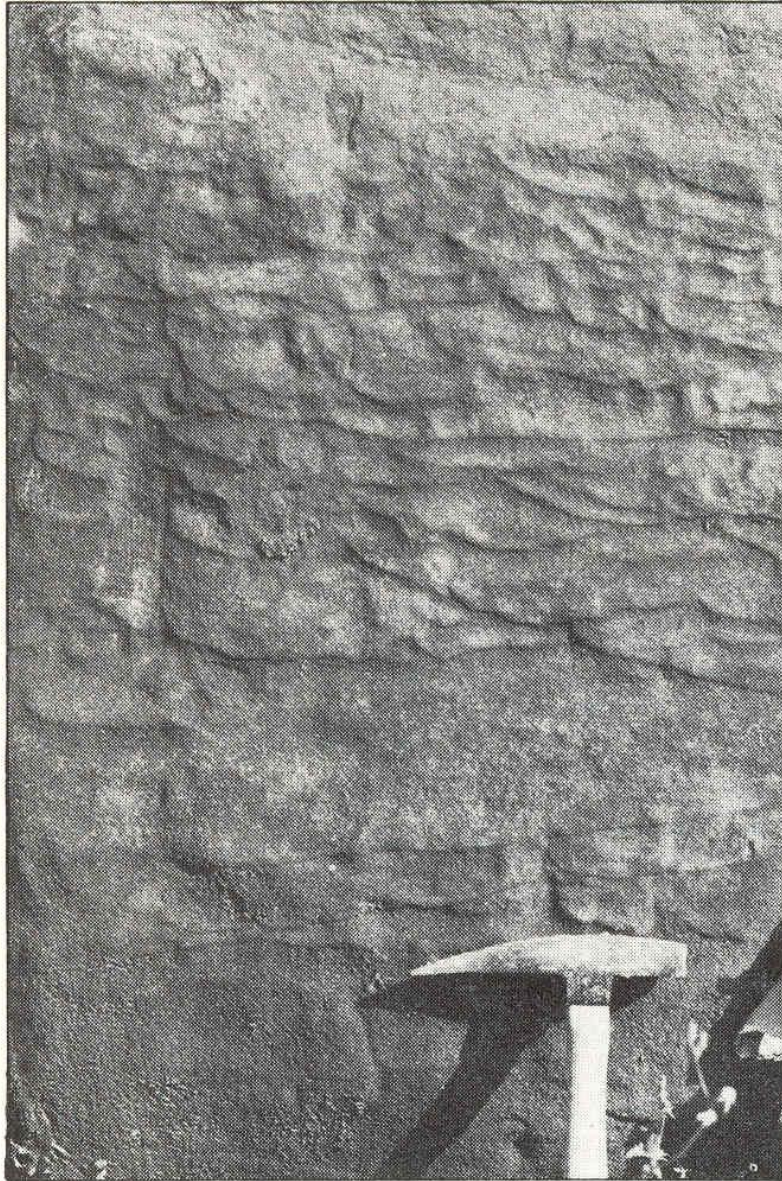
**80 % of the effects induced on May 20,
20% on May 29.**

Many liquefaction phenomena have been reactivated by the second quake.

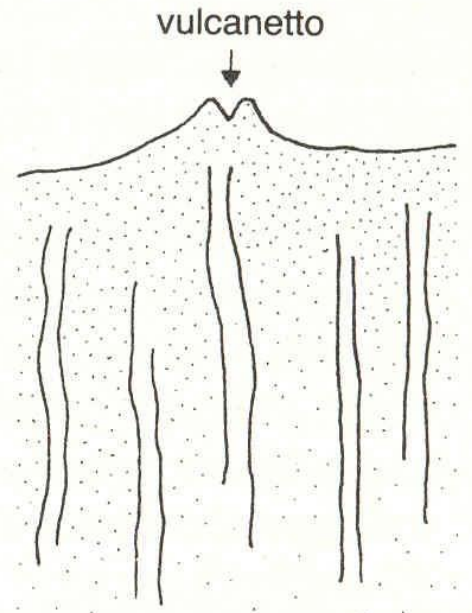




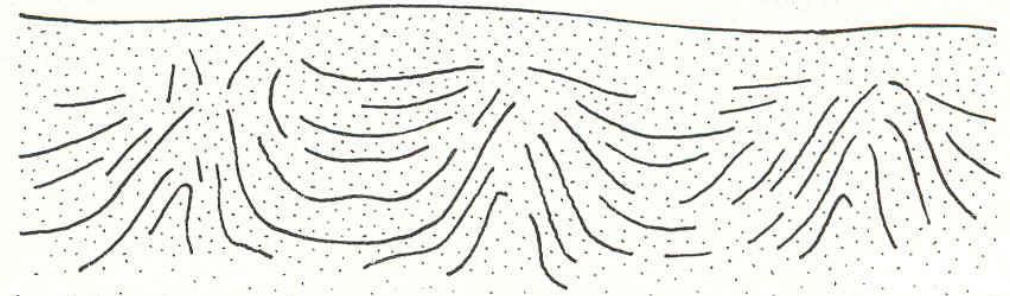
Iniezione e fluidificazione



DISH



PILASTRI



“CONVOLUZIONI A CUSPIDE”

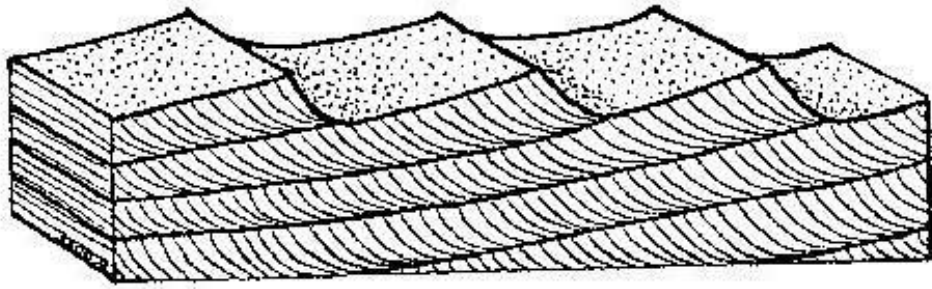


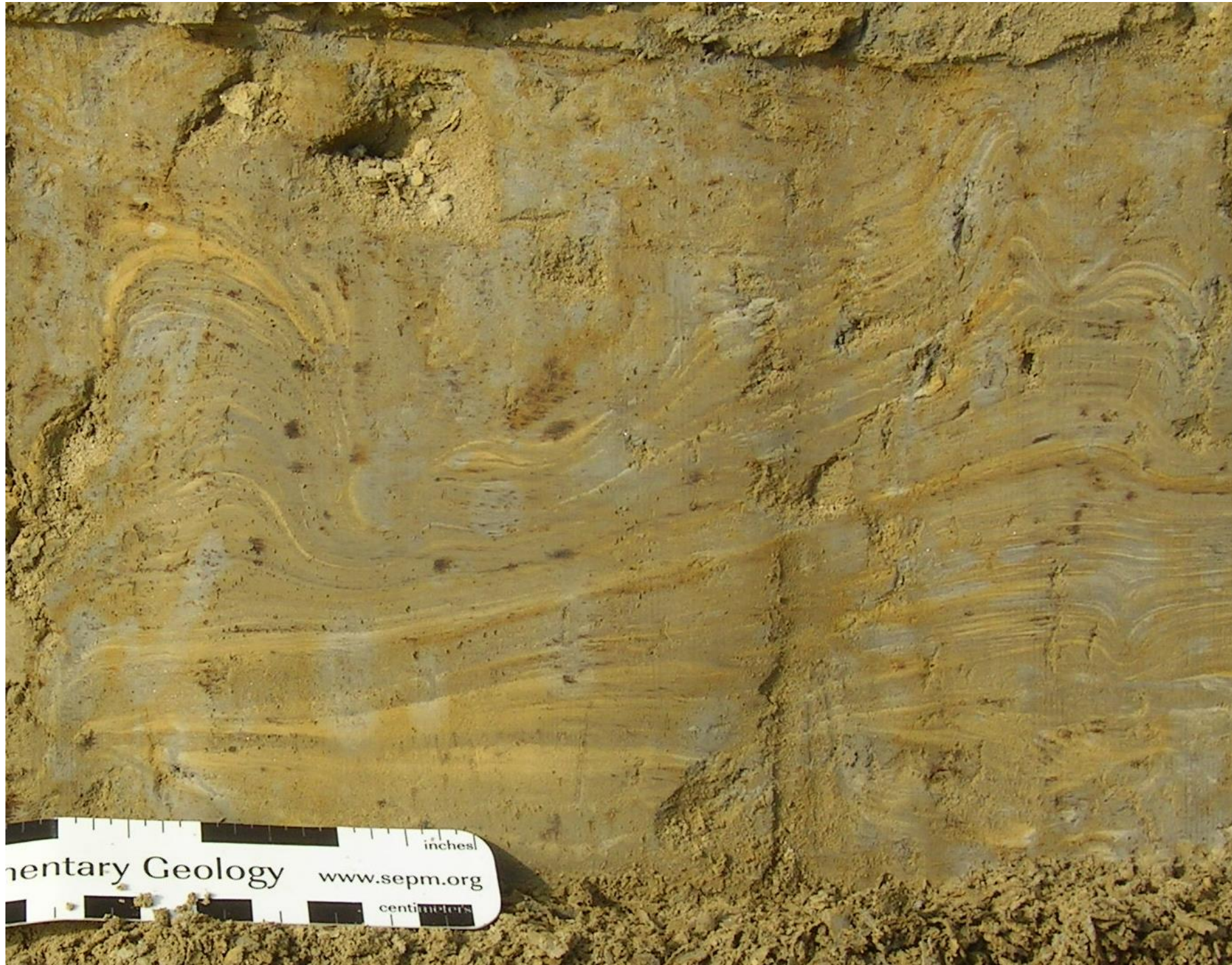
Lo scavo di Via Emilia Est





corrente →



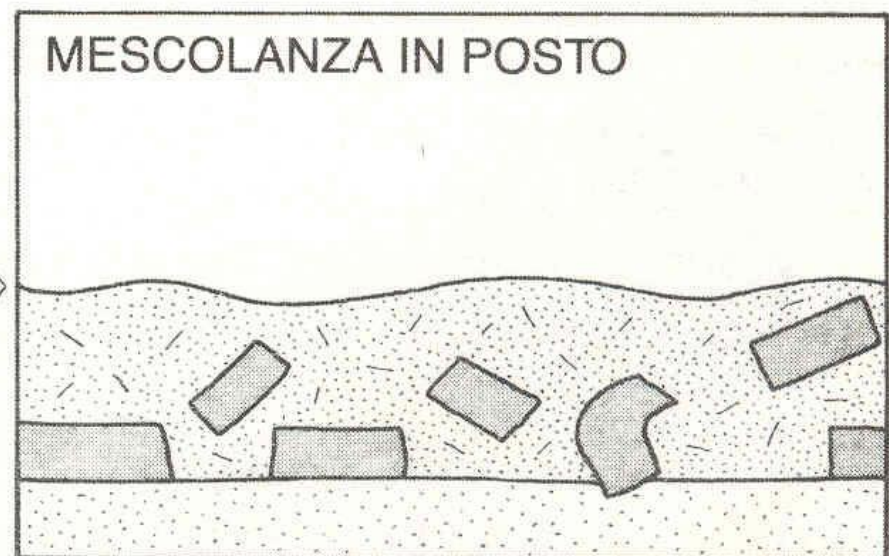
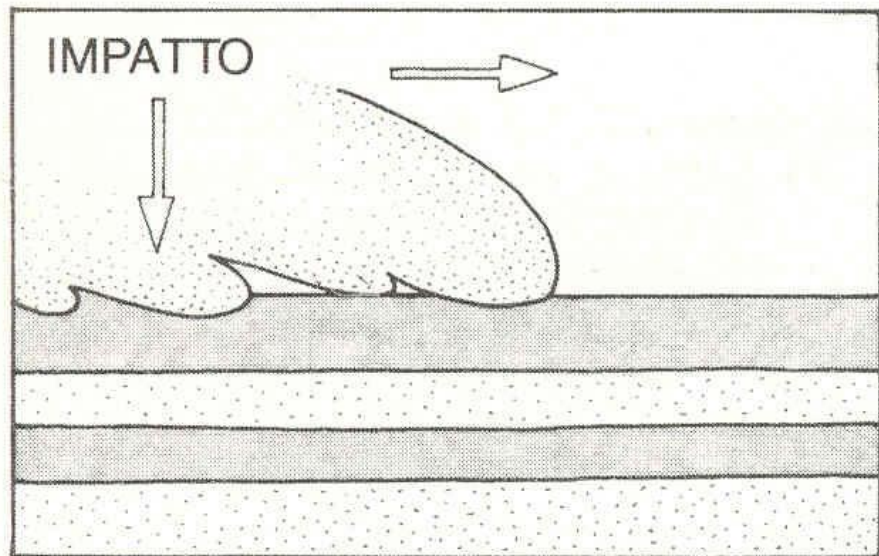
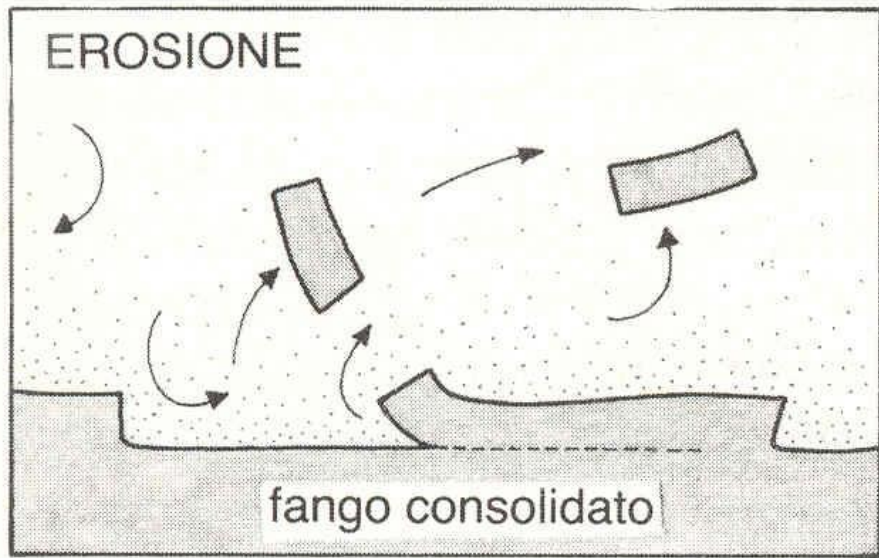


Elementary Geology

www.sepm.org

inches

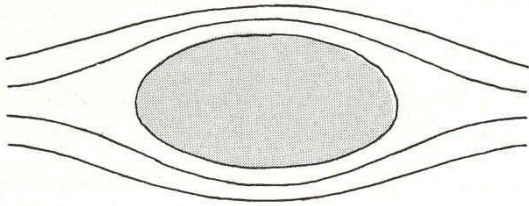
centimeters



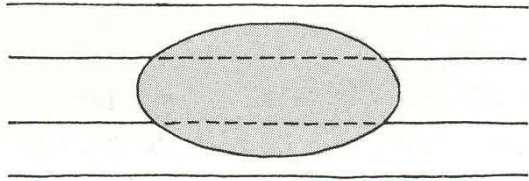
a)

b)

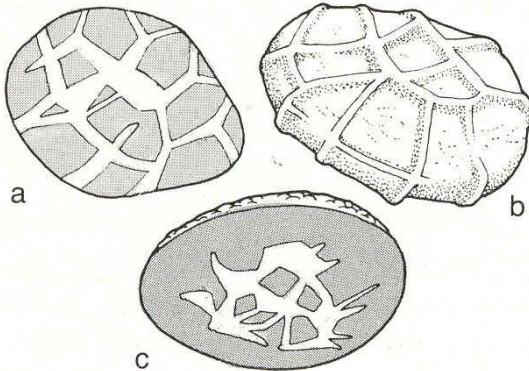
CONCREZIONE



a) Diagenesi precoce (pre-consolidamento):
deformazione passiva

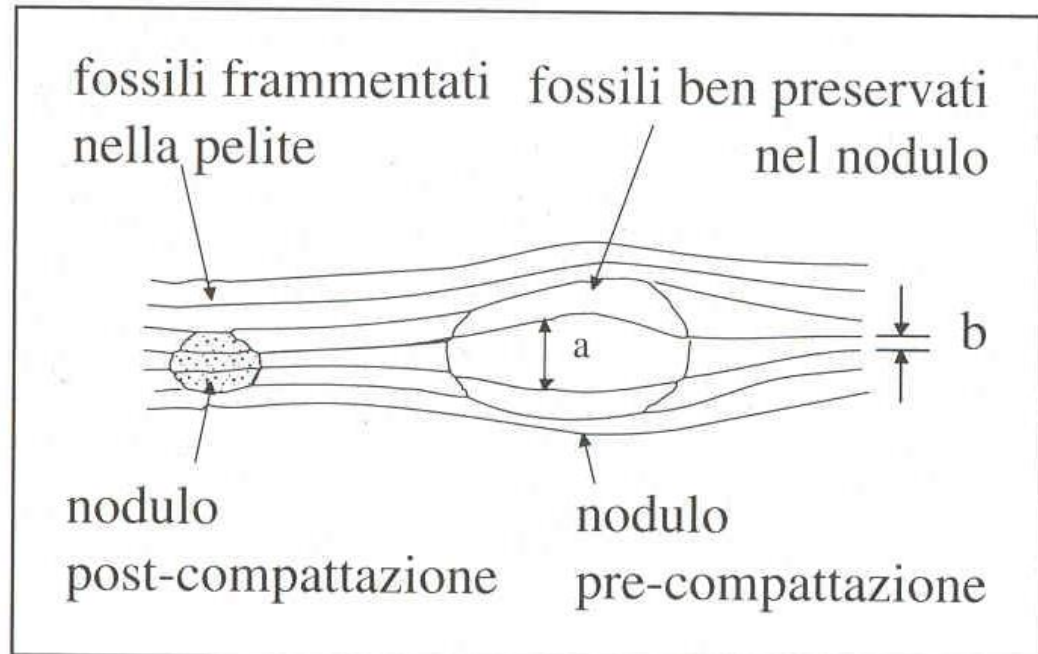


b) Diagenesi tardiva (post-litificazione):
assenza di deformazione

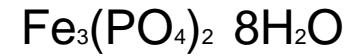


c) septarie: a) levigata da trasporto
fluviale, b) con creste sporgenti per
erosione della marna, c) in sezione
(cavità riempita da sali)

Strutture chimiche



Vivianite is a bluish mineral sometimes encountered in archaeological deposits particularly those associated with human remains and ancient industries. It is notable for its tendency to change color from white or grayish to blue on exposure to air. Vivianite requires specific conditions for its formation: sources of iron, phosphate, and water, as well as low levels of oxygen and sulfide



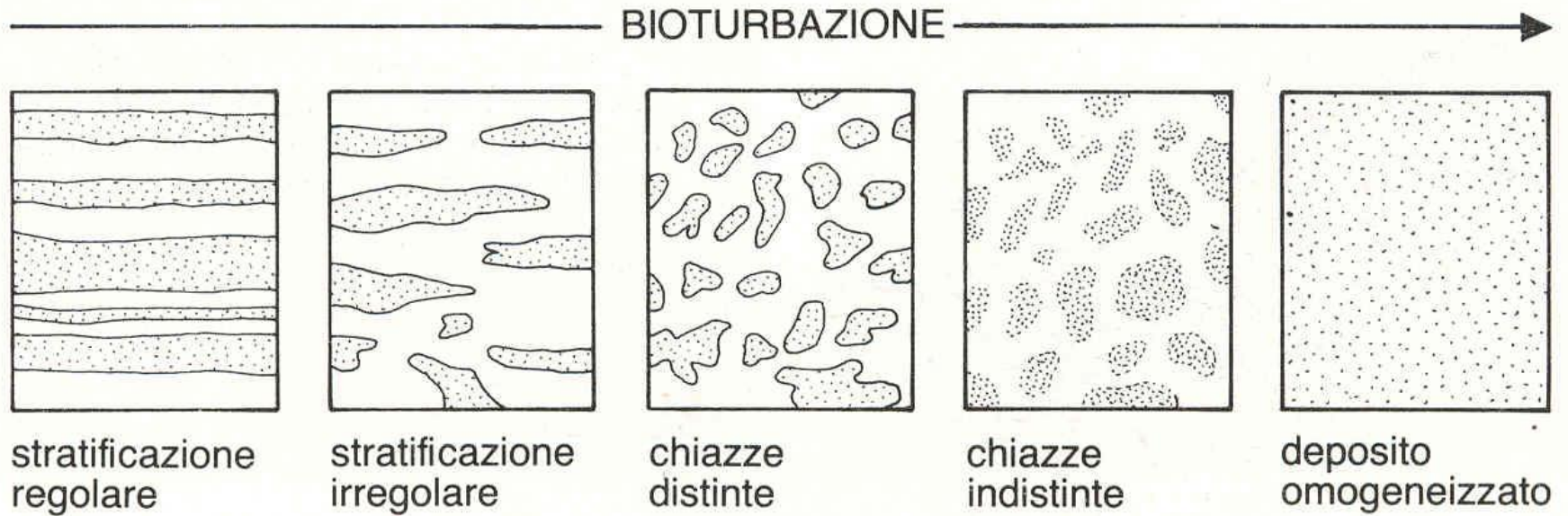
<http://alexandriaarchive.org/bonecommons/items/show/1880>

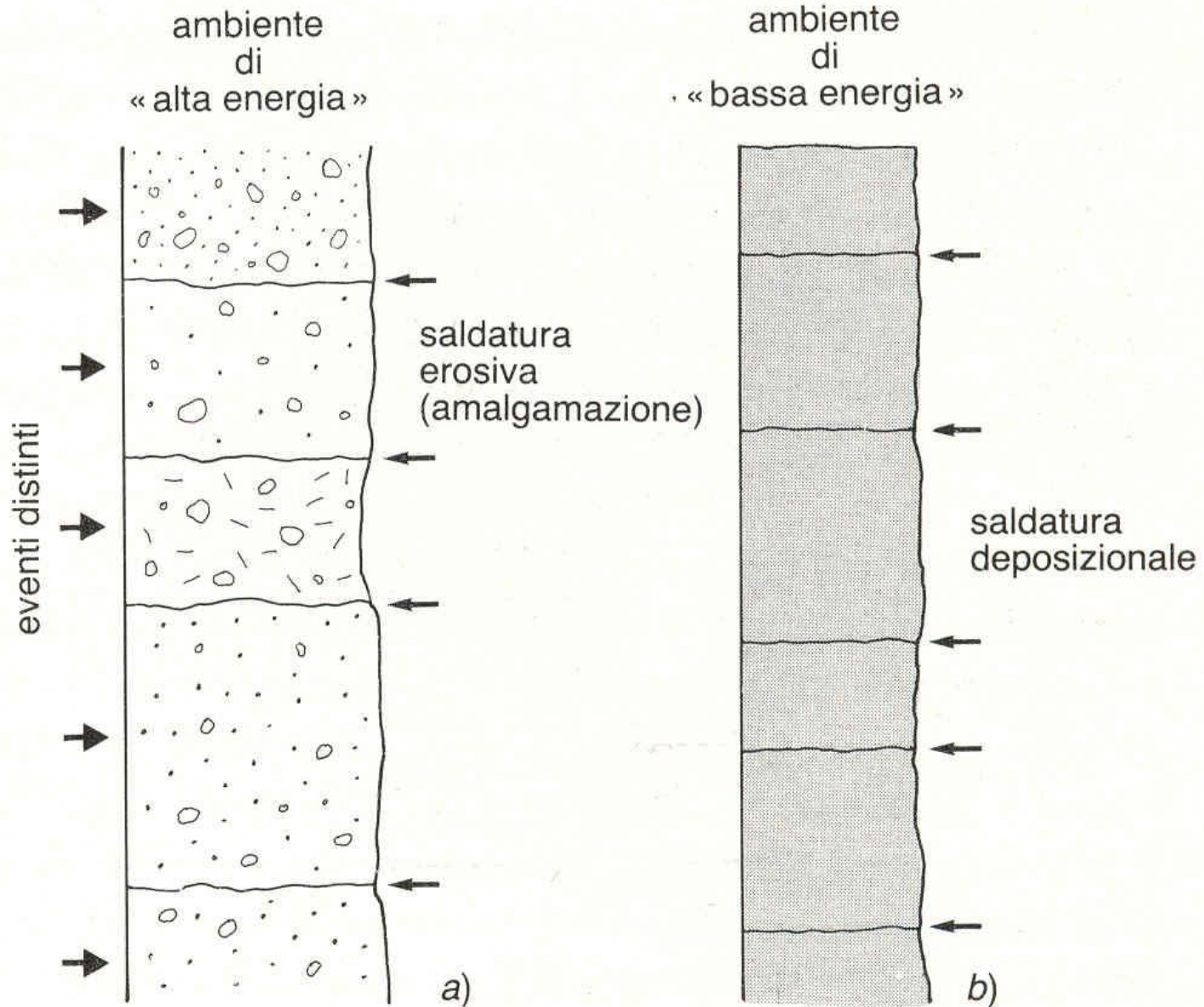


<http://alexandriaarchive.org/bonecommons/items/show/1881>

Pabst and Hofer (1998) studied deposits within the lung tissue and on the surface of the skin of the Tyrolean Iceman discovered in 1991. Ötzi the Iceman – the 5,000-year-old mummy – has oxidized Vivianite in the lung tissue. In places where the Iceman’s skin was in contact with the underlying rock, an iron-containing para/ortho-gneiss, blue “pustules” of vivianite were found on the skin surface (Pabst and Hofer, 1998). In this case, the source of the iron for the vivianite is suggested as the iron-containing gneiss underlying the body, while the phosphate is thought to have derived either from the manure of animals using the rock hollow as a shelter from the elements, or from the Iceman’s own tissue

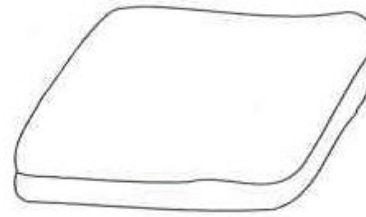
Strutture biogene



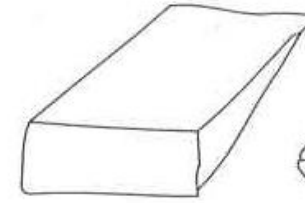


	strati molto spessi
1 metro	
	strati spessi
0,3 m	
	strati medi
0,1 m	
	strati sottili
0,03 m	
	strati molto sottili
10 mm	
	lamine spesse
3 mm	
	lamine sottili

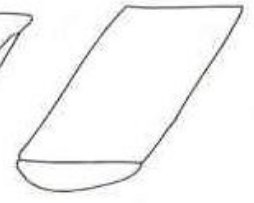
geometria degli strati/unità litologiche (a piccola scala)



tabulare

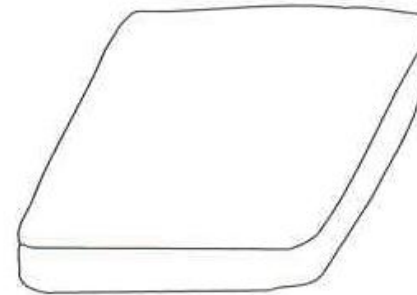


cuneiforme

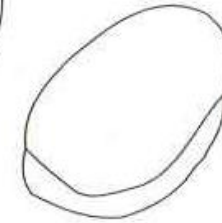


lenticolare

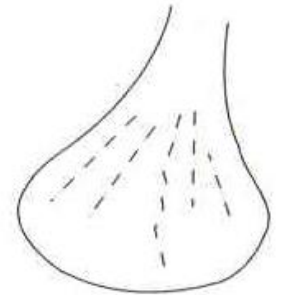
geometria dei corpi sedimentari (a grande scala)



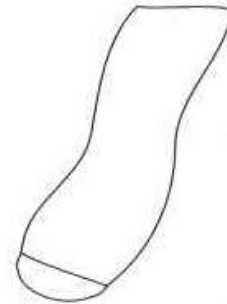
laminare



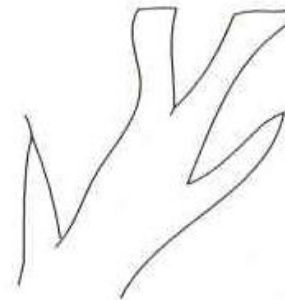
a placca



a ventaglio/cono



nastri-forme



dendroide



catenaria

- **Strato:** singolo evento deposizionale “finito” (sedimentazione come fenomeno discontinuo)
- **Lamina:** evento minore “infinitesimo” (pulsazione o fluttuazione delle condizioni entro un processo continuo)