Università di Trieste
LAUREA MAGISTRALE IN GEOSCIENZE
Curriculum Geofisico
Curriculum Geologico Ambientale

Anno accademico 2021 – 2022

Geologia Marina

Parte II

Modulo 2.3 **Metodi diretti: Sondaggi superficiali ed analisi dei sedimenti**

Relatore
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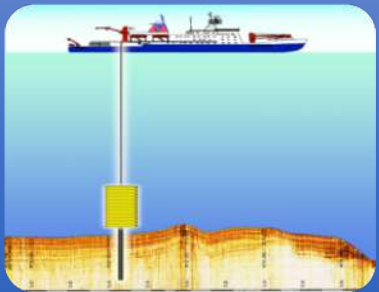
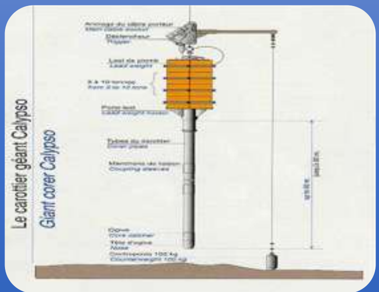
BOTTOM SAMPLING SYSTEMS



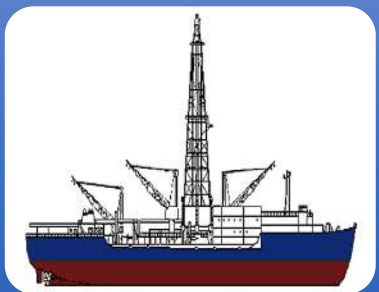
Gravity corer

- classic gravity corer (Emery and Dietz, 1941; Hvorslev and Stetson, 1946)
- box corer
- kastenlot corer
- multi-corer



Piston corer

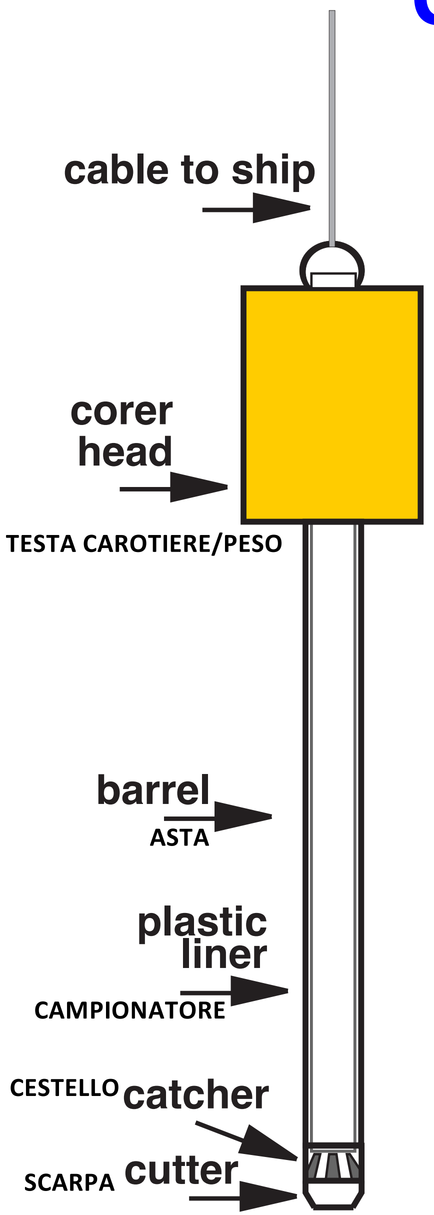
- classic piston corer (Kullenberg, 1947; 1955)
- long piston corer
  - Calypso piston corer (e.g. R/V Marion Dufresne, G.O. Sars)
  - Jumbo piston corer (e.g. R/V Araon)



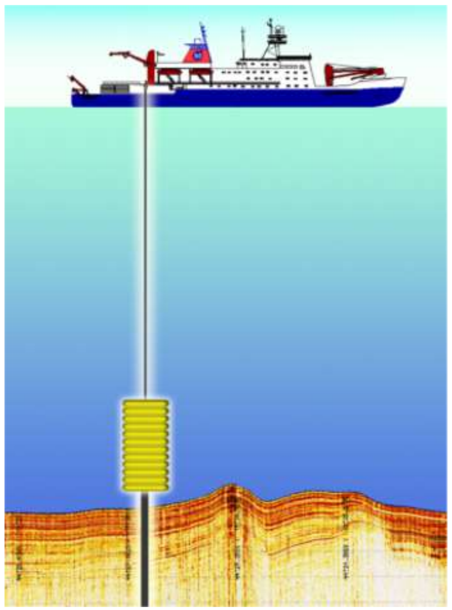
Drilling systems

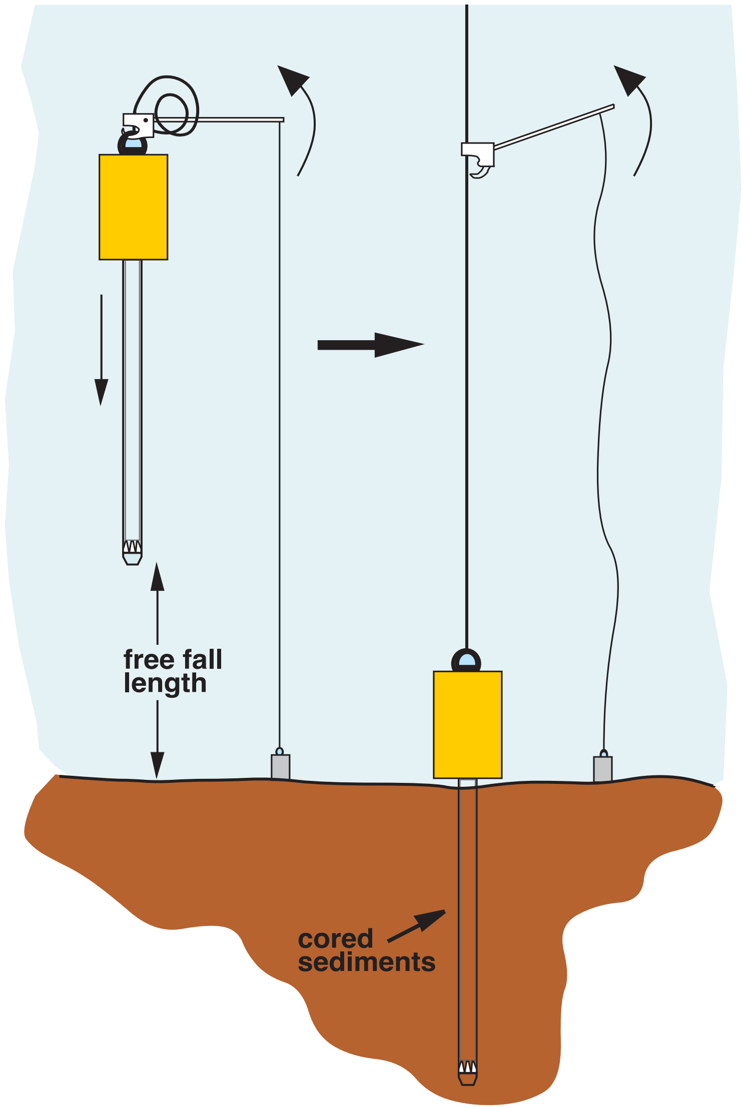
- ocean floor drilling systems (e.g. IODP-drilling vessels & semi-automated MeBo system)
- ice drilling systems (e.g. EPICA-European Progect for Ice Coring in Antarctica & NorthGRIP- North Greenland Ice Core Project)

Classic gravity core system (Emery and Dietz, 1941)

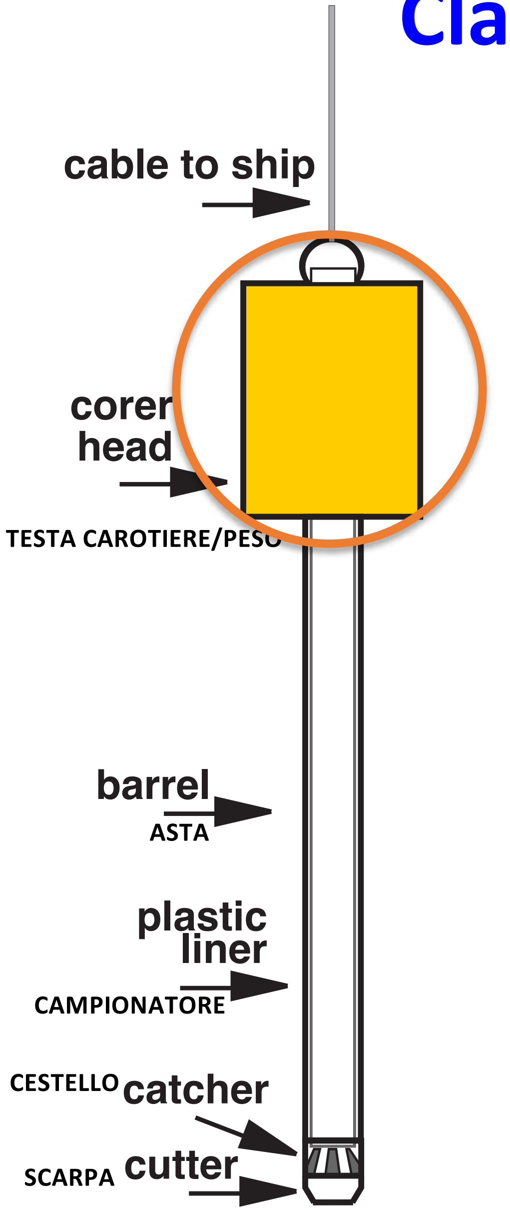


It is the simplest coring device in which the weight of the coring equipment is used to force the barrel into the sea bottom. This system can work with or without a triggering system (sistema di sgancio)



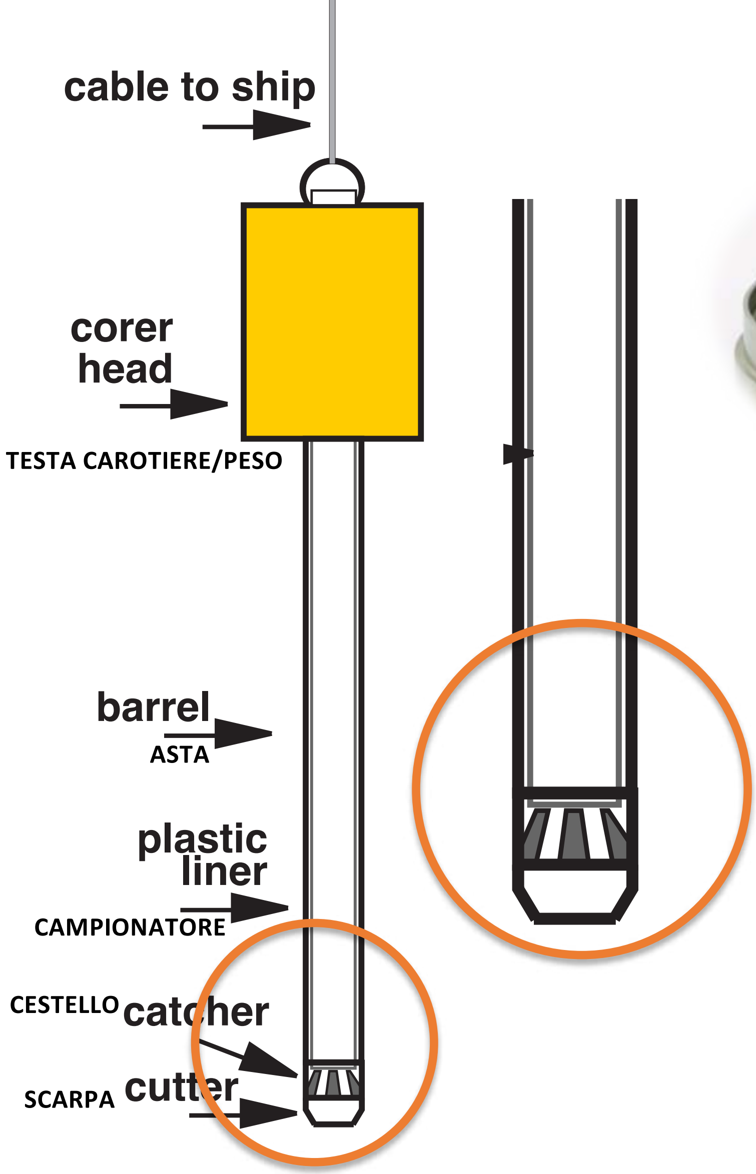


Classic gravity core system: corer head



weigth 600-800 kg
6000 kg

Classic gravity core system: core catcher and cutter



core catcher
(cestello)

core cutter
(scarpa)

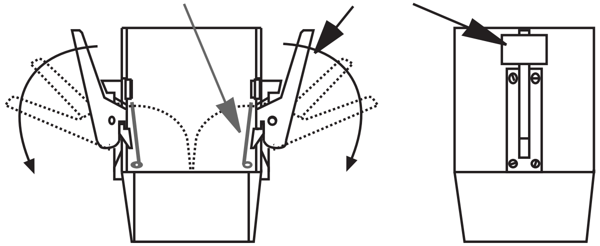
core cutter
and catcher

Additional gravity core systems: Kastenlot corer

The kastenlot (kastens) corer was originally designed by Kögler (1963) it was improved and modified by Zangger and McCave (1990). The barrel, of variable lengths, is square in section (15x15 cm) and it contains a ***base plate*** that can be raised to reveal a new cleaned core surface

Square section of barrel

Core cutter and catcher

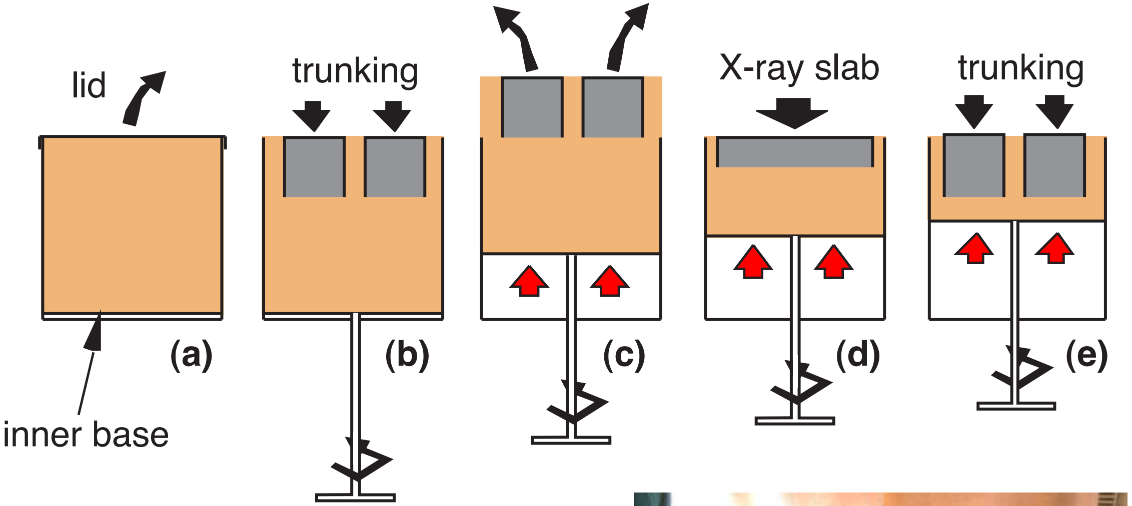


Head of kastens corer

The core catcher has a ***shutter-like closure*** consisting of two square doors held under tension and blocked in a retracted position by two levers located on the outside. During the corer pullout, the pressure of the surrounding sediments pushes down the two levers closing the doors.

Sampling of Kastens cores

(a) removal of the barrel lid to reveal the core surface;
(b) two PVC trunkings are pushed into the sediments
(c) the inner base is moved upward to expose the trunkings that are cut at the base and removed from the main core using a cheese wire;
(d) sampling with x-ray slabs, and a further set of trunkings (e). Each time the sediments are lifted upward and withdrawn with a cheese wire



Additional gravity core systems: BOX-corer

Designed for minimum disturbance of the sediment surface, ideal for coarse/stiff sea floor sediments, it allows the recovery of bottom waters.

lateral surface

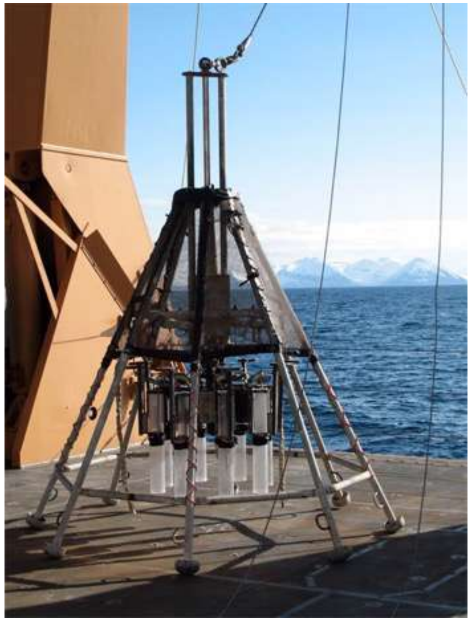
coral sampling

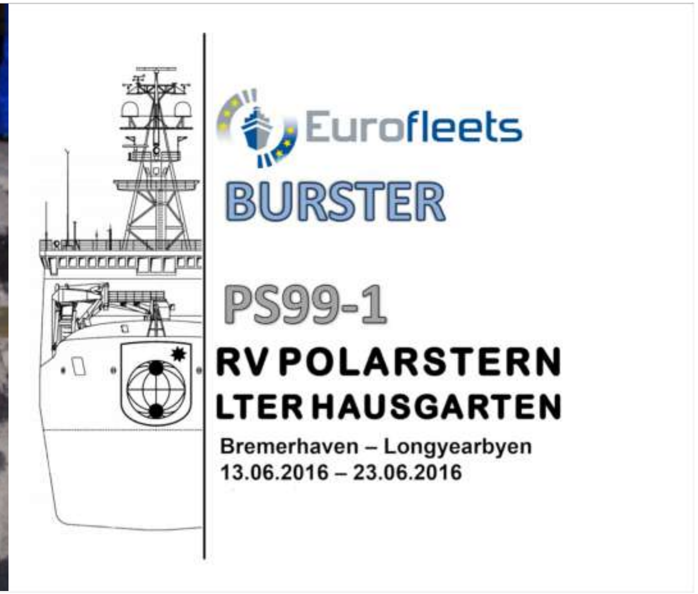
sampling of glacigenic sediments

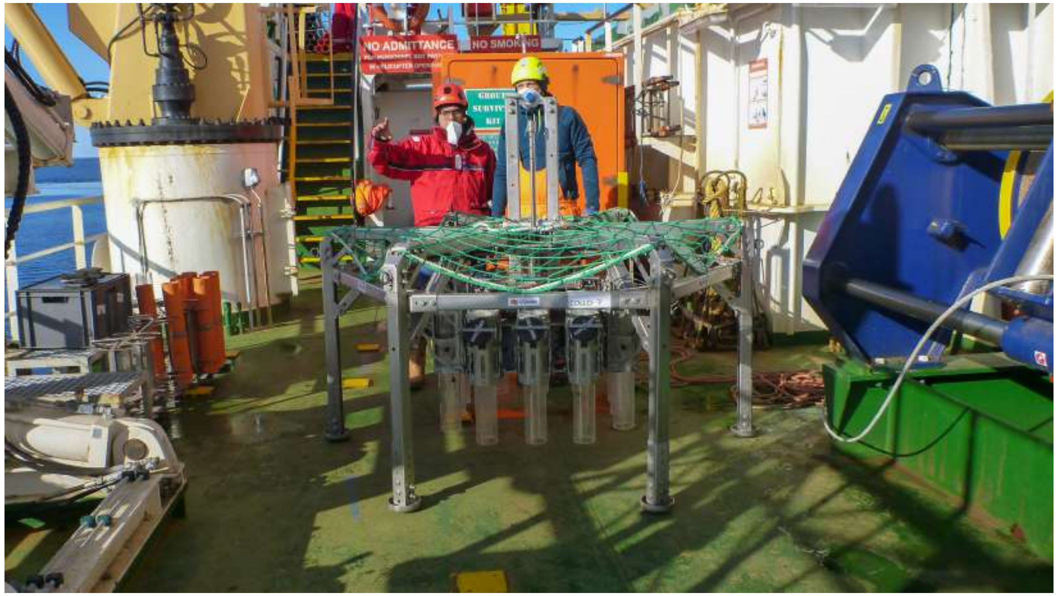
Box core sampling

Additional gravity core systems: Multi-corer

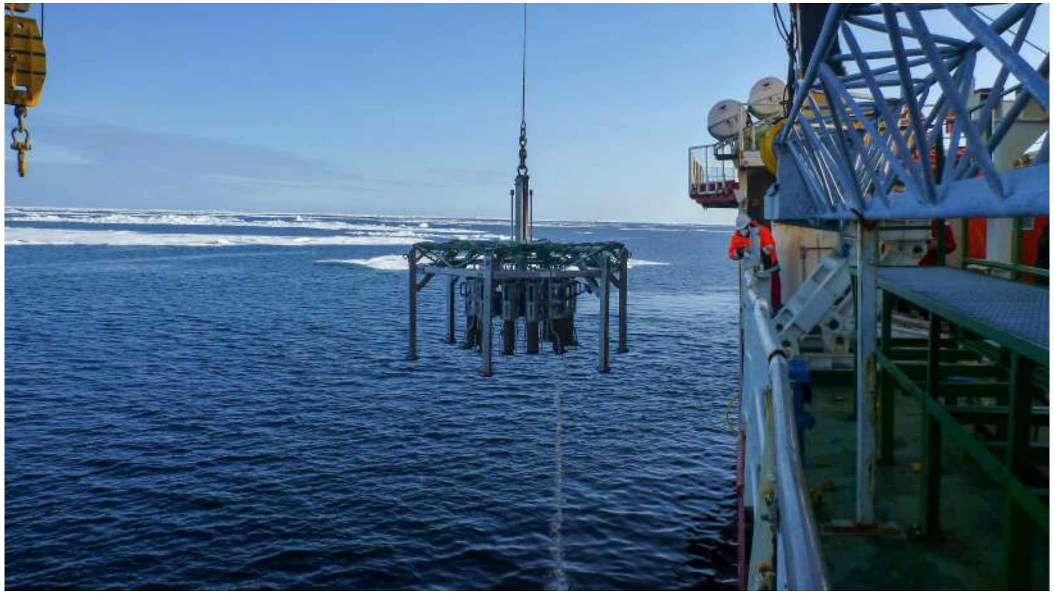
Especially designed for the sampling of sea bottom sediments-water interface, it permits to recover low disturbance sediment. Ideal for geochemical and biological sediment and water analysis.



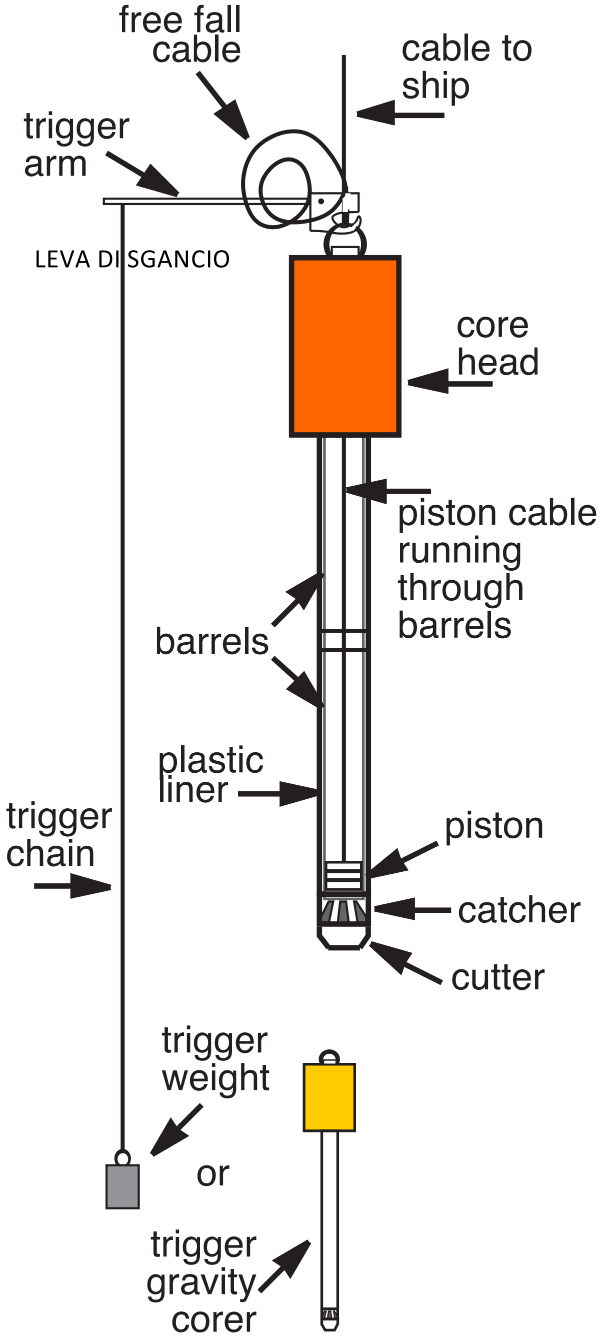



NO ADMITTANCE
NO SMOKING


Oktopus

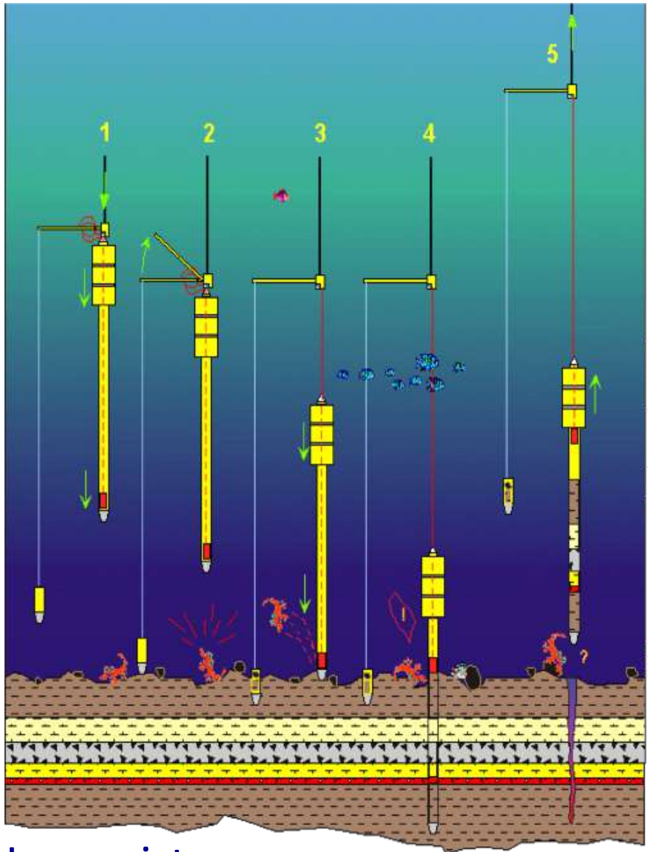


Kullenberg piston corer system



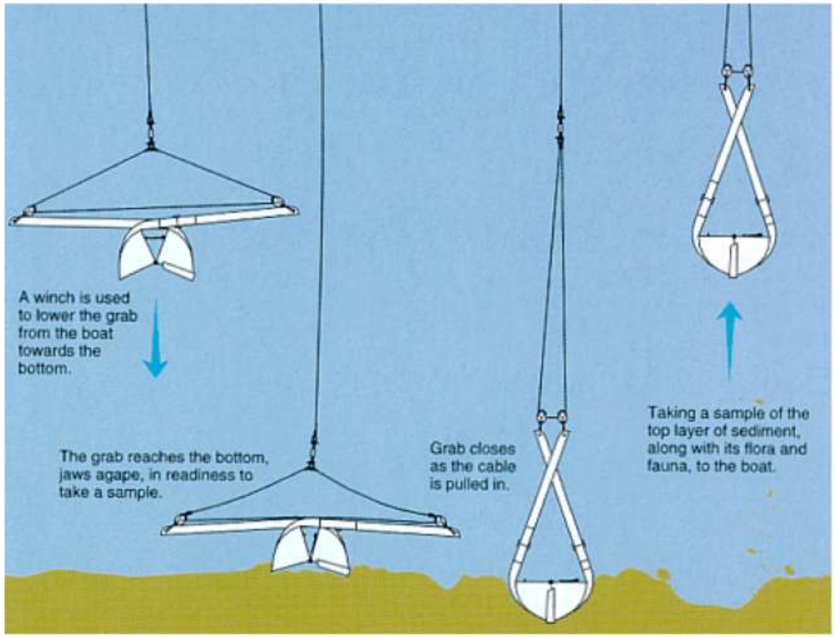
Standard assemblage for piston coring. The core barrel penetration is maximised by the action of a piston located in the lower barrel (or into the lower plastic liner if present) that helps to overcome the friction between sediments and the coring tube by generating Vacuum behind the cutter. The sediment cores obtained are less compacted and distorted than gravity cores. This system is always used coupled with a trigger mechanism.

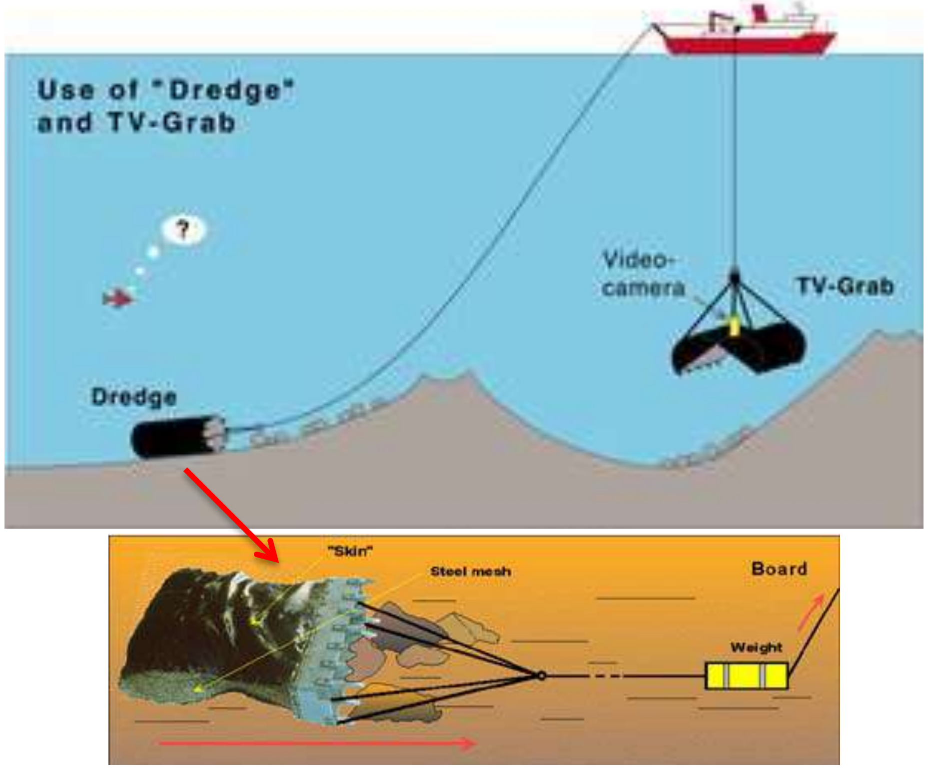
Specifications	Kullenberg piston corer	Long piston corer
headweight	600 kg	6000 kg
barrel length	6 m	13 m
barrel inner diameter	65 mm	140 mm
barrel thickness	5 mm	5 mm
plastic liner outer diameter	63 mm	113 mm
plastic liner thickness	3 mm	5 mm
maximum cable length	5000 m	10000 m
cable diameter	12 mm	30 mm
freefall	4-5 m	1.5 m



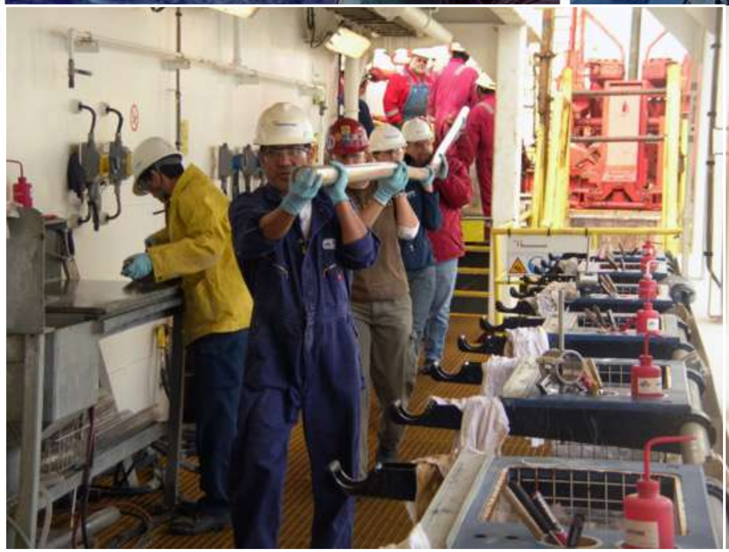
Long piston corers: Claypso, Jumbo etc.

Grab (benna) — Dredge (draga)





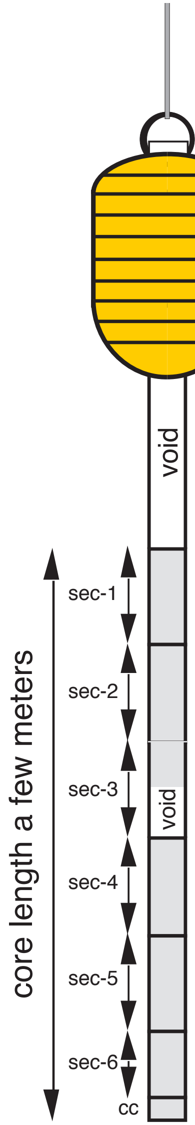
CORE ON DECK!



CUT INTO SECTIONS

The plastic liner is estracted from the brrel and cut into sections 1-1.5 m-long

SECTIONS' LABELING

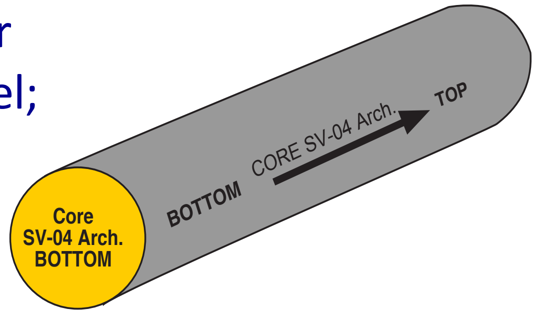


The sections are numbered consecutively from bottom to top of the core or *vice versa* depending on the total length of the core.

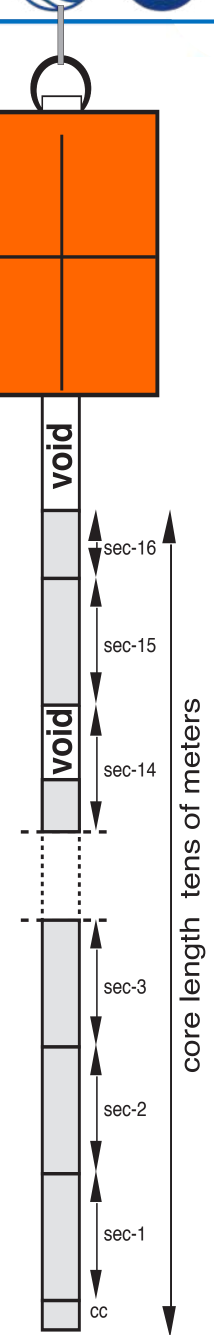
Short cores are numbered consecutively from top to bottom.

Long cores are numbered consecutively on removal from the barrel from bottom to top of core.

Each section is labeled with a code indicating
» name of the project and/or
» name of the research vessel;
» core number;
» section number
» stratigraphic orientation (top-bottom, arrow)



!!!! The arrow ALWAYS indicates the TOP !!!!!



CORE OPENING AND SEDIMENTS ANALYSIS

The plastic liner of each section is cut longitudinally. The plastic liner is cut by means of an elettric saw/microvibro saw, while the sediments are cut using a "cheese wire".

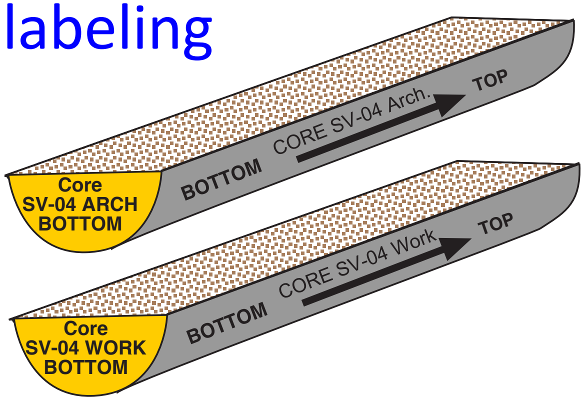
The two splitted half-sections are labeled as **working section** and **archive section** and will undergone a different analitycal process:

ARCHIVE SECTIONS: not distructive analyses

X-radiographs
multi-sensor core logger
XRF core-scan
photographs

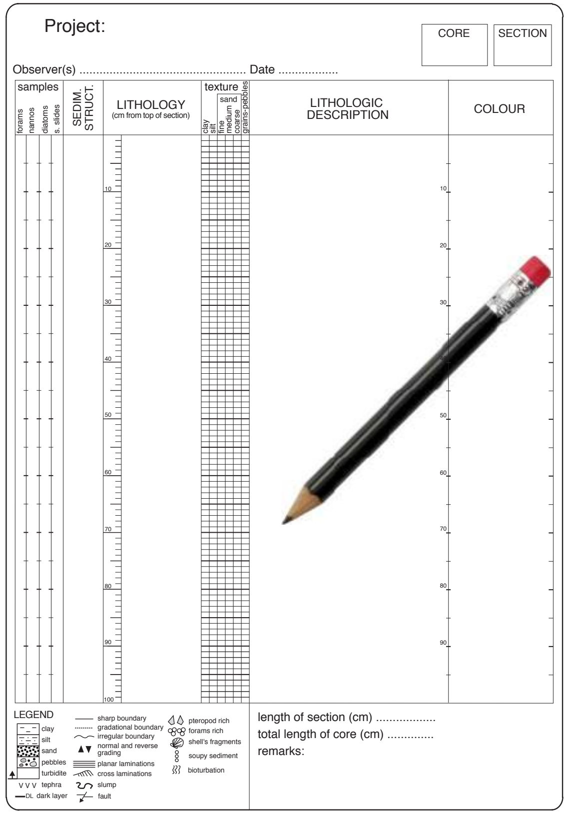
WORKING SECTIONS: visual logging and sub-sampling

Half-sections' labeling

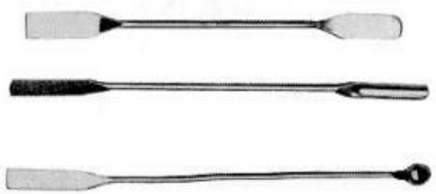


CORE DESCRIPTION

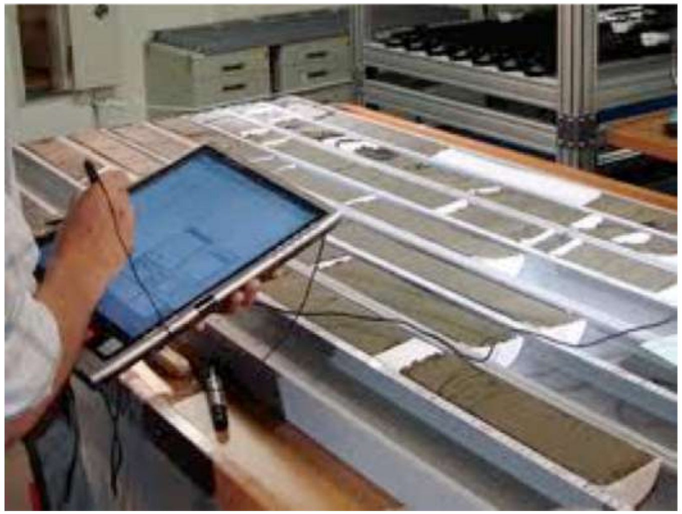
Visual core description 1st step

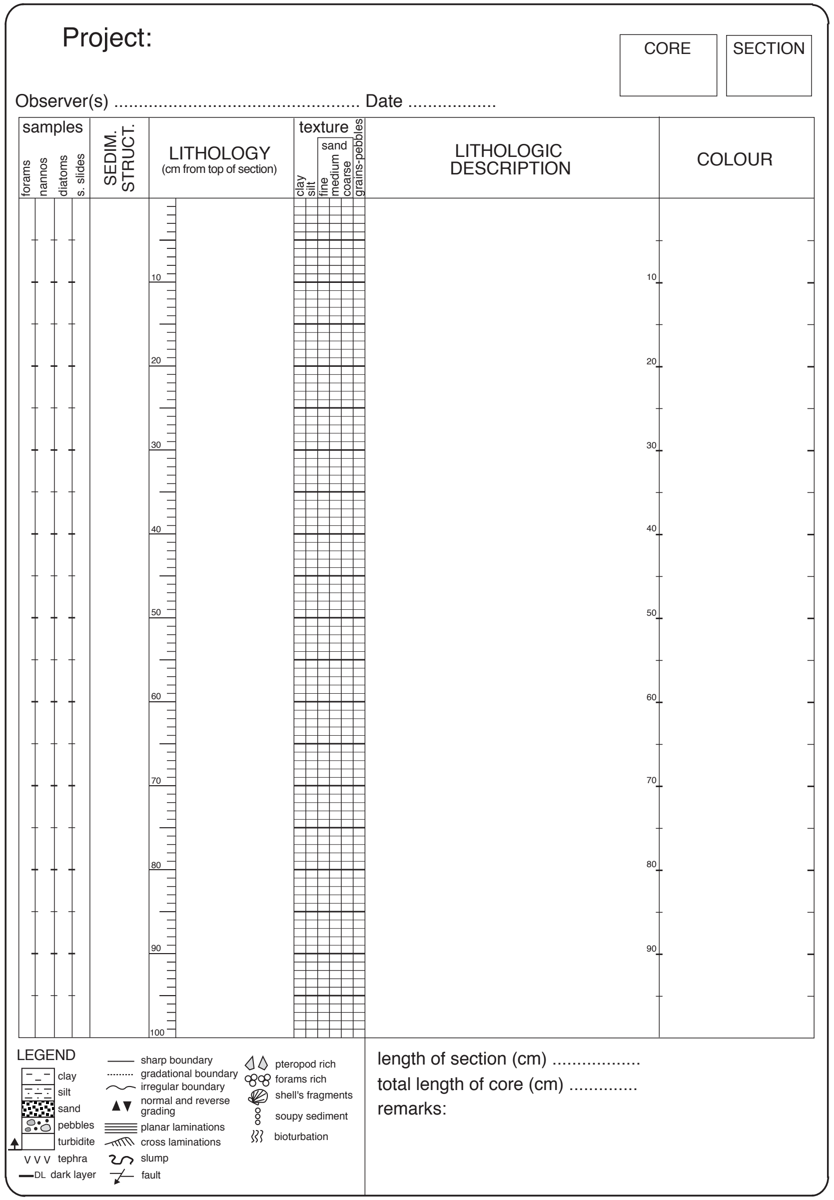


- ***Definition of lithological units*** based on:
  - Lithology including composition and texture
  - Color
  - Sedimentary structures (laminations, bioturbations, faults)
  - Boundaries (transitional, sharp not erosive, sharp erosive, irregular)
- ***Definition of sediment disturbance***
  - Soupy sediments
  - Bended boundaries at the lateral ends
  - Flow-in (piston cores)
  - Core re-bouncing (repetition of stratigraphic sections) in gravity cores



Visual core description FORM



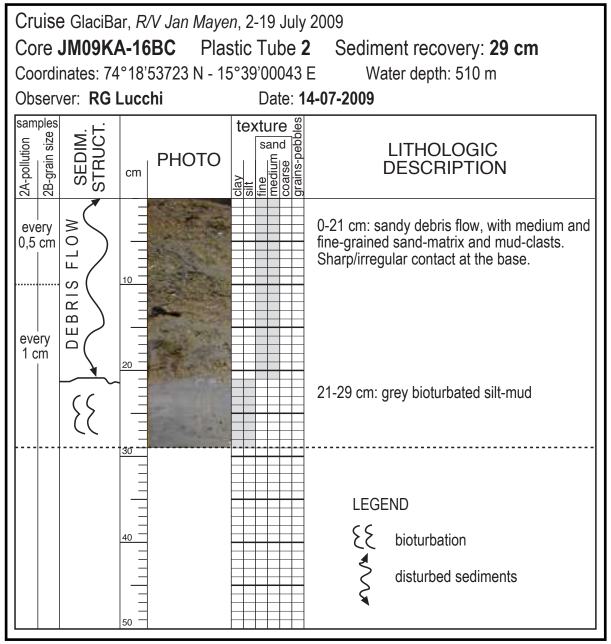

Project:
CORE
SECTION
Observer(s) .... Date ....

samples: forams, nannos, diatoms, s. slides
SEDIM. STRUCT.
LITHOLOGY (cm from top of section)
texture: clay, silt, sand (fine, medium, coarse), grains-pebbles
LITHOLOGIC DESCRIPTION
COLOUR

10
20
30
40
50
60
70
80
90
100

LEGEND
clay
silt
sand
pebbles
turbidite
tephra
DL dark layer
sharp boundary
gradational boundary
irregular boundary
normal and reverse grading
planar laminations
cross laminations
slump
fault
pteropod rich
forams rich
shell's fragments
soupy sediment
bioturbation

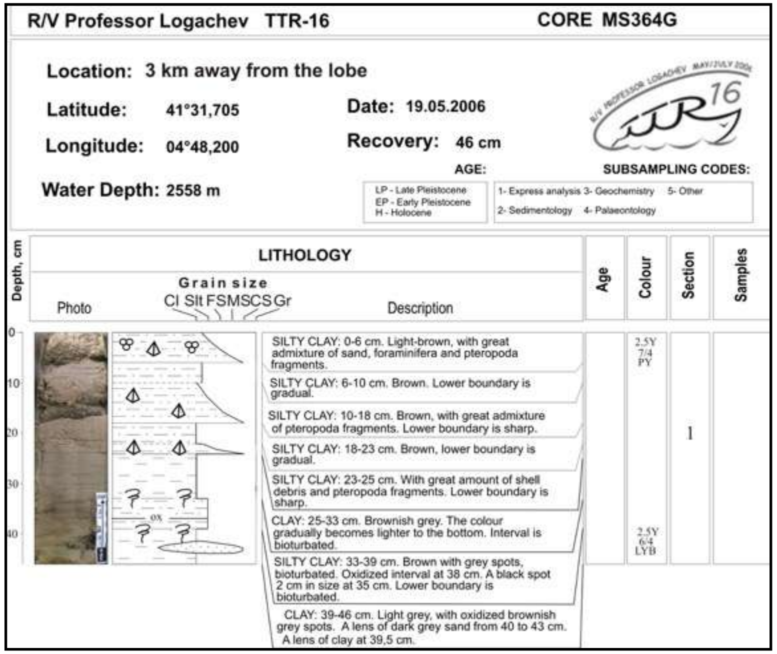
length of section (cm) ....
total length of core (cm) ....
remarks:



Cruise GlaciBar, *R/V Jan Mayen*, 2-19 July 2009
Core **JM09KA-16BC** Plastic Tube **2** Sediment recovery: **29 cm**
Coordinates: 74°18'53723 N - 15°39'00043 E Water depth: 510 m
Observer: **RG Lucchi** Date: **14-07-2009**

samples (2A-pollution, 2B-grain size)	SEDIM. STRUCT.	cm	PHOTO	texture (clay, silt, sand: fine, medium, coarse, grains-pebbles)	LITHOLOGIC DESCRIPTION
every 0,5 cm / every 1 cm	DEBRIS FLOW	0–50			0-21 cm: sandy debris flow, with medium and fine-grained sand-matrix and mud-clasts. Sharp/irregular contact at the base. 21-29 cm: grey bioturbated silt-mud

LEGEND
bioturbation
disturbed sediments



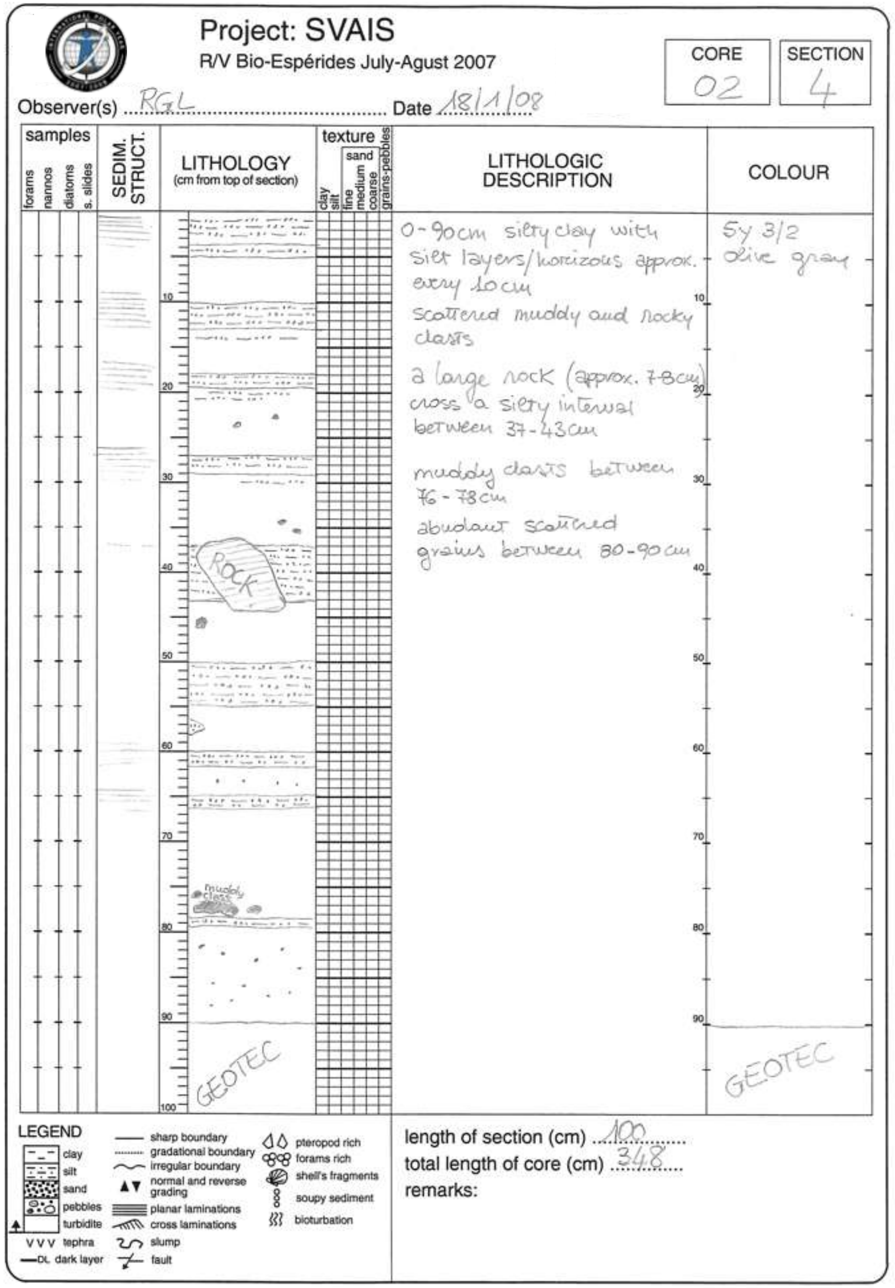
R/V Professor Logachev TTR-16 **CORE MS364G**

Location: 3 km away from the lobe
Latitude: 41°31,705
Longitude: 04°48,200
Water Depth: 2558 m
Date: 19.05.2006
Recovery: 46 cm

R/V PROFESSOR LOGACHEV MAY/JULY 2006 TTR 16

AGE: LP - Late Pleistocene, EP - Early Pleistocene, H - Holocene
SUBSAMPLING CODES: 1- Express analysis 3- Geochemistry 5- Other 2- Sedimentology 4- Palaeontology

Depth, cm	LITHOLOGY: Photo	Grain size (Cl Slt FS MS CS Gr)	Description	Age	Colour	Section	Samples
0			SILTY CLAY: 0-6 cm. Light-brown, with great admixture of sand, foraminifera and pteropoda fragments.		2.5Y 7/4 PY	1	
10			SILTY CLAY: 6-10 cm. Brown. Lower boundary is gradual.				
			SILTY CLAY: 10-18 cm. Brown, with great admixture of pteropoda fragments. Lower boundary is sharp.				
20			SILTY CLAY: 18-23 cm. Brown, lower boundary is gradual.				
30			SILTY CLAY: 23-25 cm. With great amount of shell debris and pteropoda fragments. Lower boundary is sharp.				
		ox	CLAY: 25-33 cm. Brownish grey. The colour gradually becomes lighter to the bottom. Interval is bioturbated.				
40			SILTY CLAY: 33-39 cm. Brown with grey spots, bioturbated. Oxidized interval at 38 cm. A black spot 2 cm in size at 35 cm. Lower boundary is bioturbated.		2.5Y 6/4 LYB		
			CLAY: 39-46 cm. Light grey, with oxidized brownish grey spots. A lens of dark grey sand from 40 to 43 cm. A lens of clay at 39,5 cm.				



Project: SVAIS
R/V Bio-Espérides July-Agust 2007
CORE 02 SECTION 4
Observer(s) RGL Date 18/1/08

samples (forams, nannos, diatoms, s. slides)	SEDIM. STRUCT.	LITHOLOGY (cm from top of section)	texture (clay, silt, sand: fine, medium, coarse, grains-pebbles)	LITHOLOGIC DESCRIPTION	COLOUR
		0–100; Rock; muddy clasts; GEOTEC		0-90cm silty clay with silt layers/horizons approx. every 10cm scattered muddy and rocky clasts a large rock (approx. 7-8cm) cross a silty interval between 37-43cm muddy clasts between 76-78cm abundant scattered grains between 80-90 cm	5y 3/2 olive gray GEOTEC

LEGEND
clay, silt, sand, pebbles, turbidite
V V V tephra
DL dark layer
sharp boundary
gradational boundary
irregular boundary
normal and reverse grading
planar laminations
cross laminations
slump
fault
pteropod rich
forams rich
shell's fragments
soupy sediment
bioturbation

length of section (cm) 100
total length of core (cm) 348
remarks:

Visual core description 2nd step

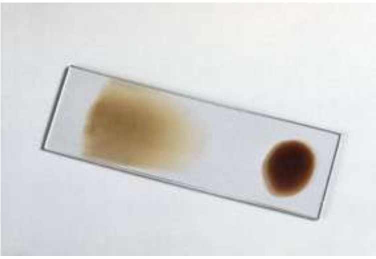
sediment composition

Mud composition - Smear slides

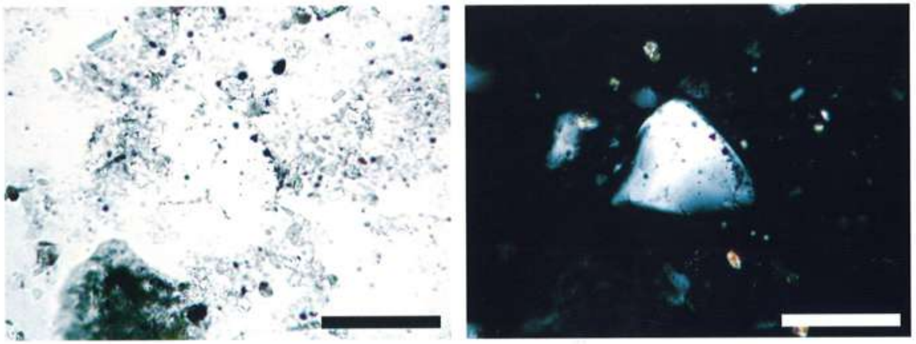
(view https://www.youtube.com/watch?v=2sDejrpwxD4&feature=youtu.be)

- A smear slide is a thin layer of unconsolidated sediment embedded on a glass slide for petrographic microscopic examination;
- Smear slides are a useful tool to quickly assess the ***compositional content*** of clay-silty sediment samples;
- Smear slides are a powerful method for rapidly evaluating tiny quantities of sediment (mineralogy, components, form, size) as the basis for ***sediment classification***, and for ascertaining the presence of microfossils.

Foto: IODP Exp. 307

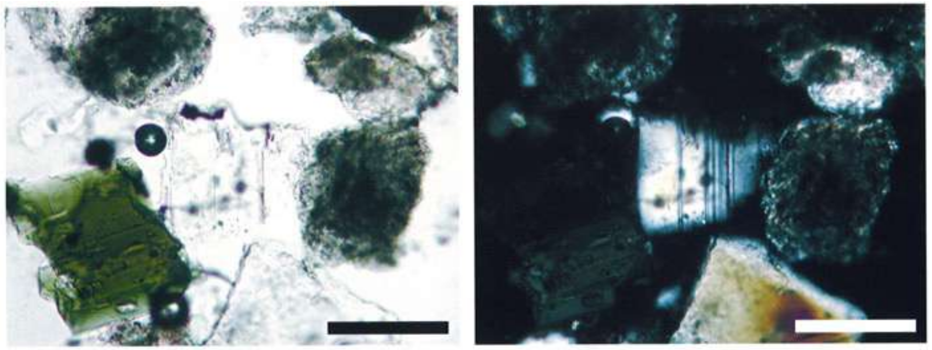


Quarz

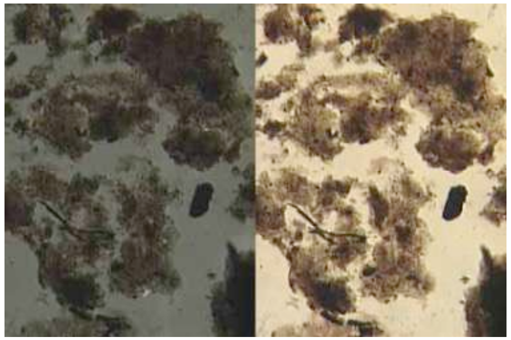


IODP Exp .320

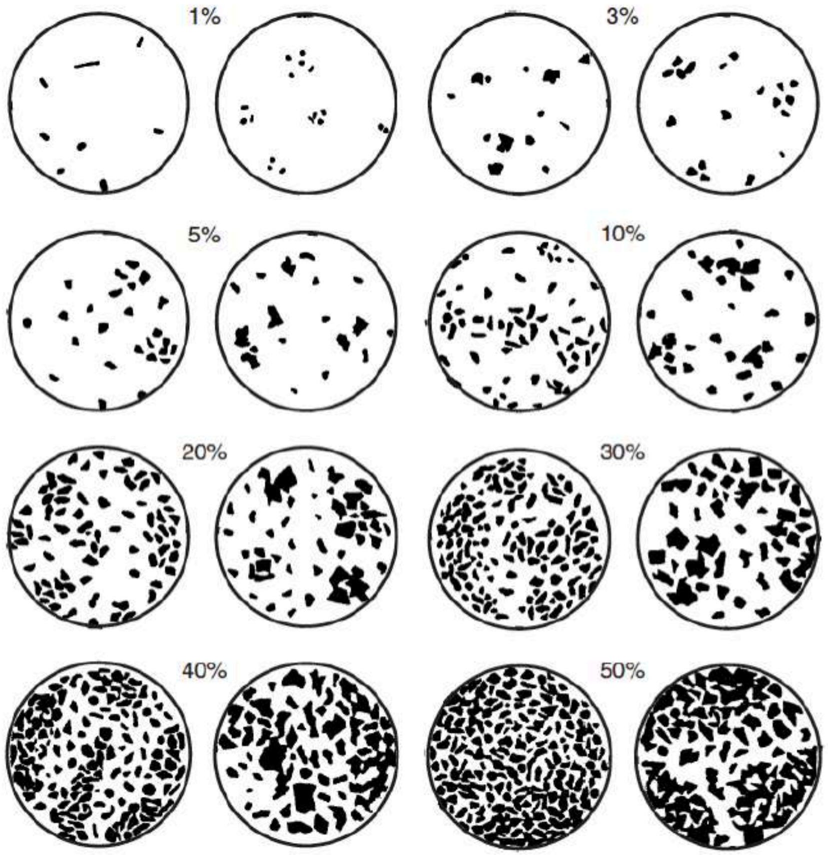
Plagioclase



Clay fraction

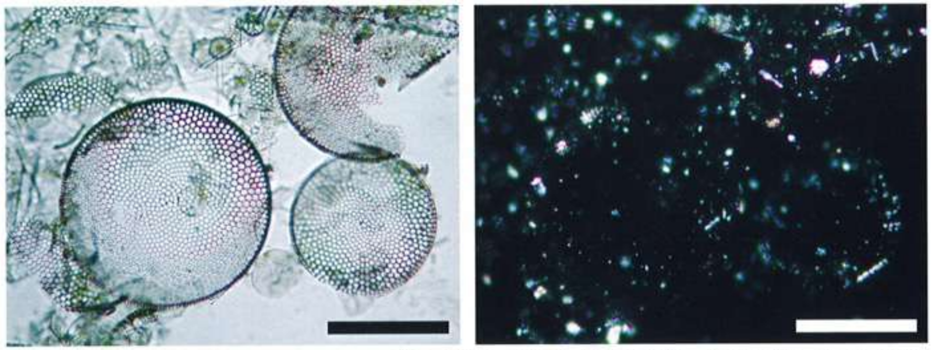


Composition/Quantification



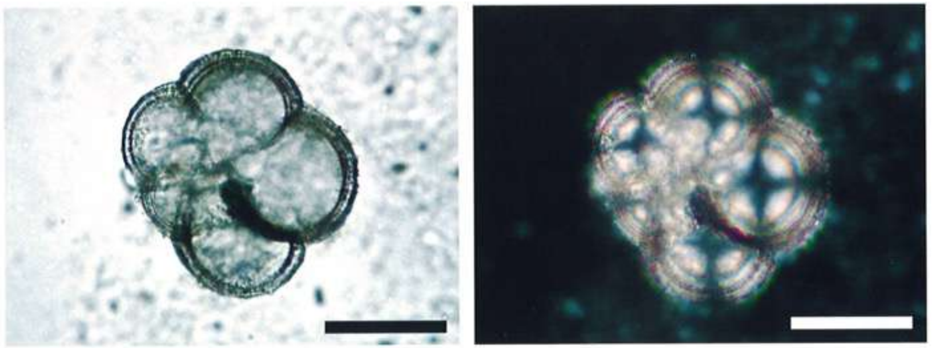
Rothwell R.G., 1988. Minerals and mineraloids in marine sediments. An Optical Identification Guide. Elsevier Science Publishers, 279 pp

Diatoms



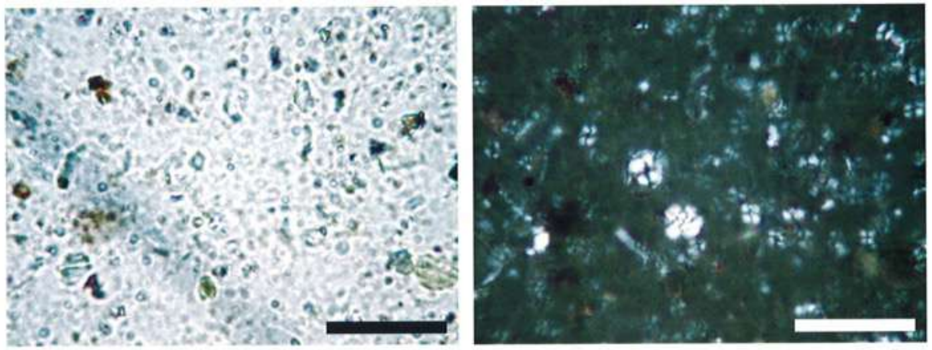
オホーツク海・中心部, 水深 1107m, XP98, PC1, Sec.1, 20cm
200 倍, スケールは横 100 μm

Foraminifers



太平洋・熊野トラフ, 水深 2190m, KT02-1, KK2PC
400 倍, スケールは横 50 μm

Calcareous nannoplancton



東地中海・キプロス沖, ODP Leg160, 967D, 1H, Sec.1, 0-5cm
1000 倍, スケールは横 20 μm

IODP Exp .320

Sand composition

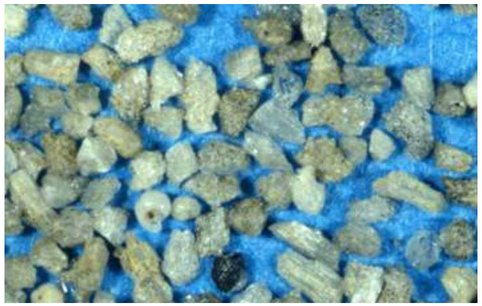
• wet sievings at 63 microns are used to investigate the composition of sediment coarse fraction, the grains form and roundness, in order to define the sediment provenance. The sand fraction is also used for biostratigraphic purposes.



Ice Rafted Debris (Antarctica)

Beach sands (Menorca-Spain)

Glacigenic sediments (Arctic)



Tephra (volcanic glass) (Tyrrhenian)

SEDIMENT SAMPLE DESCRIPTION

Project:

lat. N .... long. E .... water depth (m) ....

core .... section .... cm .... cm from core top ....

sediment type .... lithology ....

colour .... remarks ....

DESCRIPTION OF RESIDUE

textural characteristics

sorting: very good ...... good ...... moderately ...... poor .... very poor ......
sphericity: high ...... low ....
angularity: very angular .... angular ...... sub-angular/rounded .... rounded ...... well rounded ......

remarks ....

residue composition
(AA=very abundant; A=abundant; O=occurring; R=rare; RR=very rare)

terrigenous components: ☐ predominant ☐ not predominant

quartz .... calcite .... K-feldspar .... gypsum .... glauconite ....
mica .... pyrite .... dark minerals .... volcanic glass .... micronodules ....
rock fragments .... others ....

bioclastic components: ☐ predominant ☐ not predominant

benthic forams .... planktonic forams .... pteropods .... bryozoa ....
echinoid spines .... sponge spicules .... ostracods .... corals ....
bivalves .... gastropods .... corals .... algae ....
radiolarians .... diatoms .... spores .... fish teeth ....
plant debris .... coccoliths .... discoasters .... organic matter ....
micrascidites of tunicates .... others ....

Foraminifera: list of the most characteristic taxa

G. bulloides	*G. tenellus*	*H. siphonifera*	*G. coriaconensis*
G. trilobus	*N. eggeri duttertrei*	*G. quinqueloba*	*G. inflata*
N. pachyderma	*G. ruber*	*G. scitula*	*O. universa*
G. gomitulus	*G. sacculifer*	*G. glutinata*	*G. truncatulin. exc.*
G. conglobatus	*G. quadrilobatus*	*H. pelagica*	*G. digit./preadigit.*
S. ionica	others		

....

AGE ....

ZONE ....

FACIES ....

REMARKS ....

SMEAR SLIDES DESCRIPTION

Project:

lat. N .... long. E .... water depth (m) ....

core .... section .... cm .... cm from core top ....

sediment type .... lithology ....

colour .... remarks ....

DESCRIPTION OF SMEAR SLIDES

Calcareous nannofossil: list of the most characteristic taxa and their abundance
(AA=very abundant; A=abundant; O=occurring; R=rare; RR=very rare)

E. huxleyi	*G. oceanica*	*G. caribbeanica*	*small Gephyrocapsa*
H. carteri	*C. leptoporus*	*S. pulchra*	*S. histrica*
C. pelagicus	*S. recurvata*	*P. scutellum*	*O. antillarum*
R. clavigera	*R. stylifer*	*S. fossilis*	*B. bigelowi*
U. tenuis	*C. jonesii*	*T. saxea*	*C. rugosus*
C. cristatus	*P. multipora*	*P. lacunosa*	*C. macintyrei*
D. broweri	*H. sellii*	*Discoater sp.*	

others..

Sediment composition
(AA=very abundant; A=abundant; O=occurring; R=rare; RR=very rare)

terrigenous component: ☐ predominant ☐ not predominant

quartz .... calcite .... K-feldspar .... gypsum .... glauconite ....
mica .... dark minerals .... pyrite .... volcanic glass .... micronodules ....
dolomite .... aragonite .... Fe oxides .... zeolite .... plagioclase ....
rock fragments .... clay minerals...
others..

bioclastic component: ☐ predominant ☐ not predominant

benthic forams .... planktonic forams .... pteropods .... bryozoa ....
echinoid spines .... sponge spicules .... ostracods .... corals ....
bivalves .... gastropods .... corals .... algae ....
radiolarians .... diatoms .... spores .... fish teeth ....
plant debris .... coccoliths .... discoasters .... fish remain ....
shell fragments .... silicoflagellates ....organic matter ....
others..

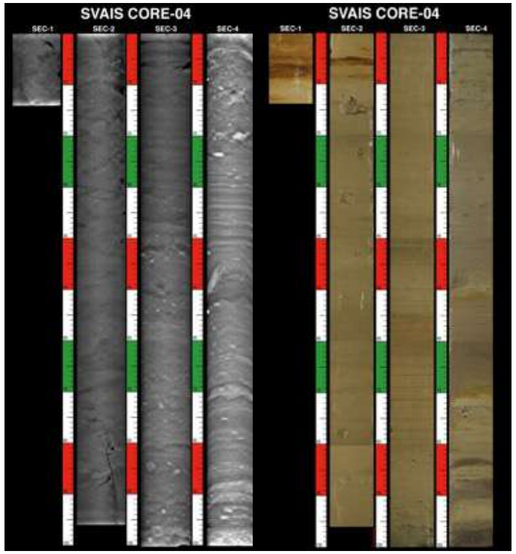
....

AGE ....

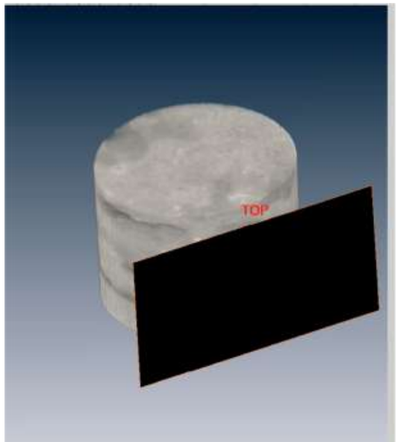
ZONE ....

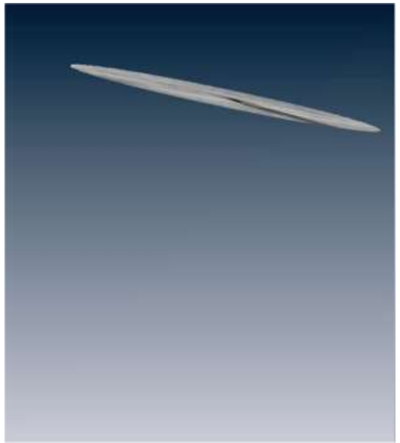
FACIES ....

REMARKS ....



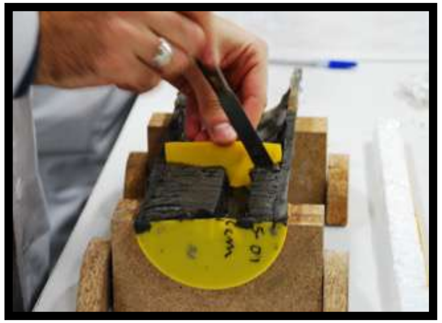
SEDIMENT CORE SCAN ANALYSES

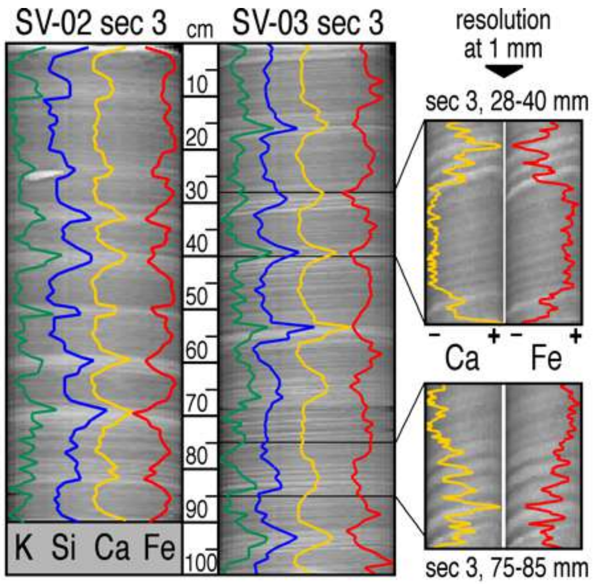




X-Ray tomography
ENI-E&P Division

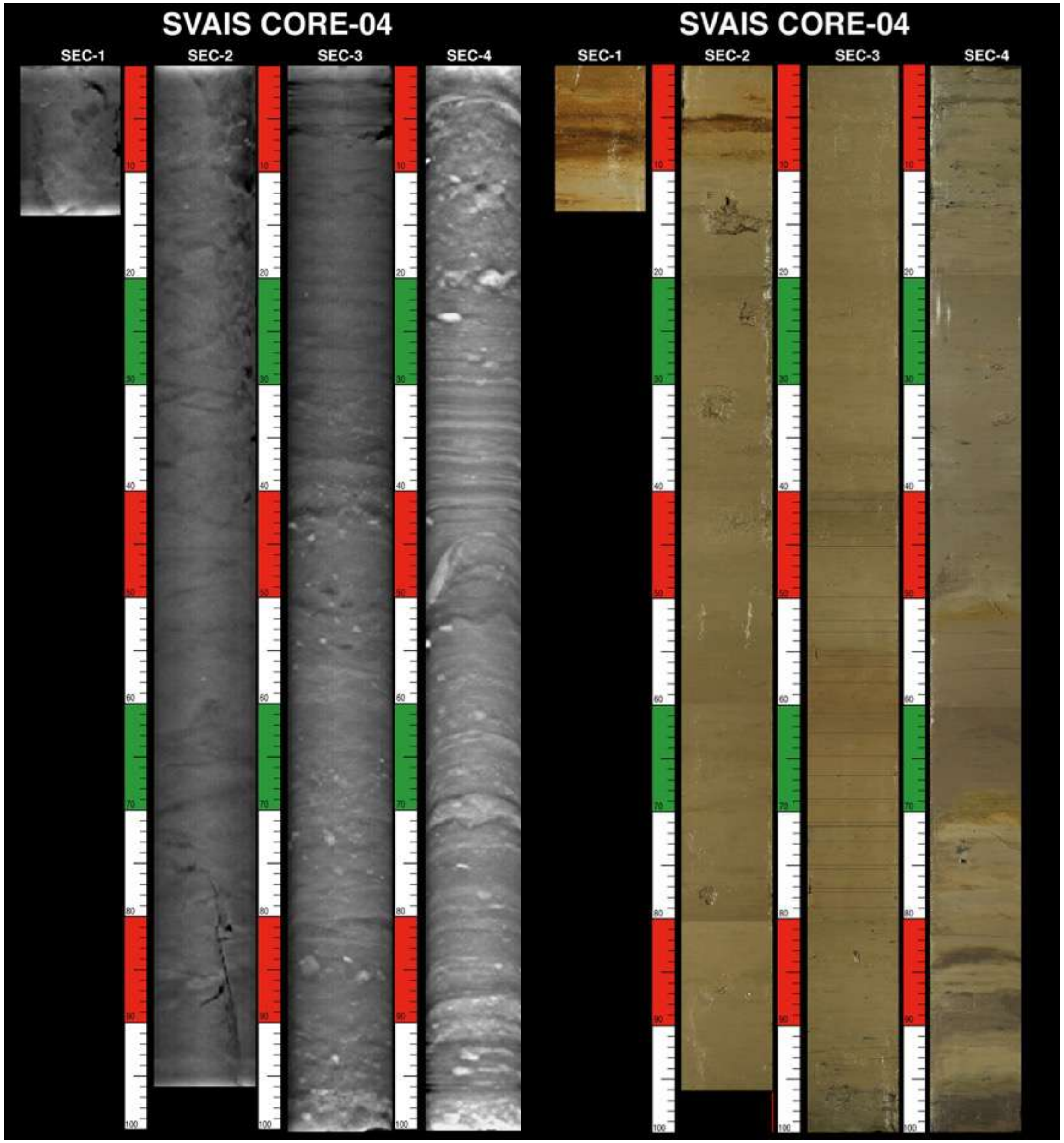
Multi-sensor core logger
ICM Barcelona



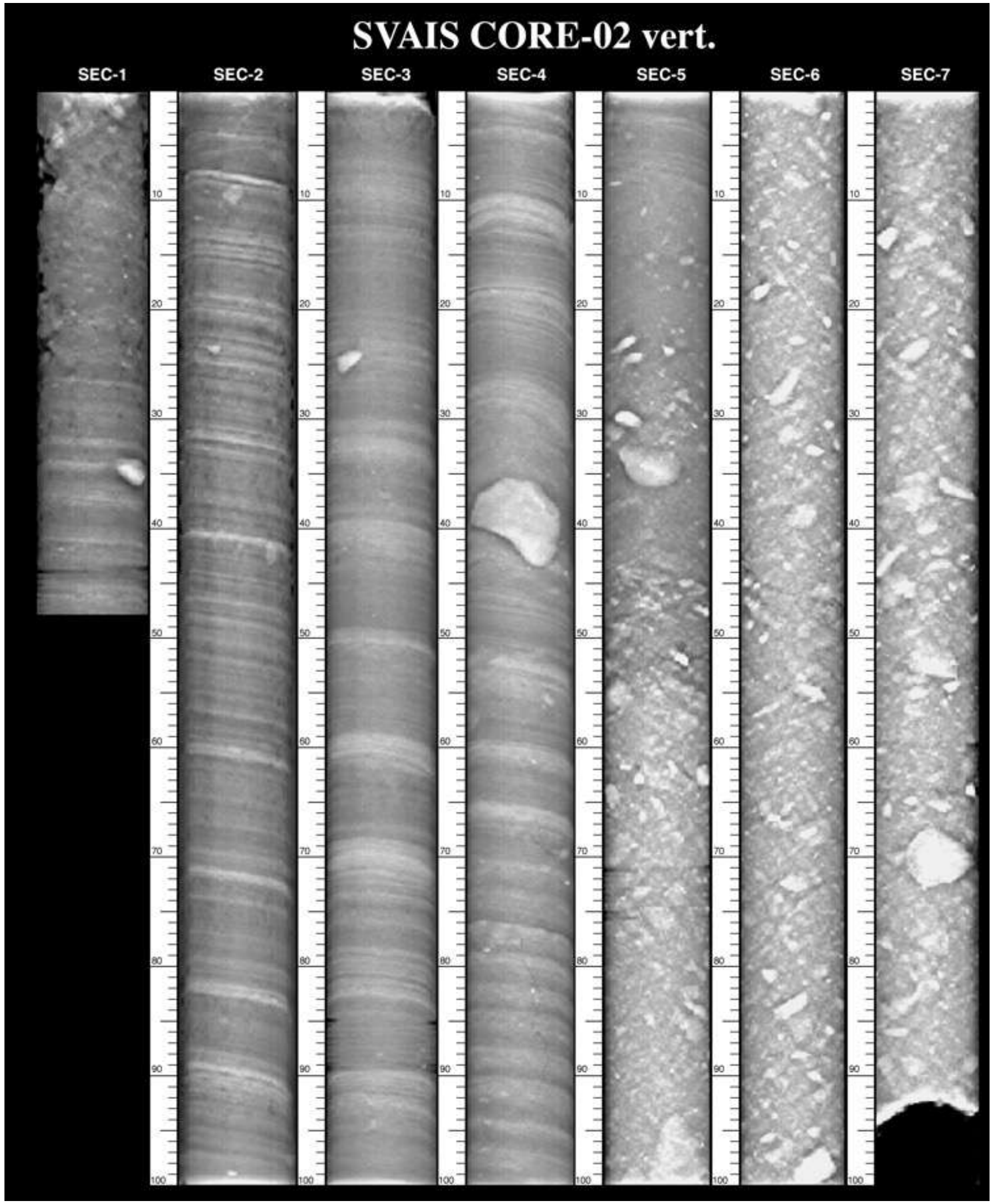


XRF core scan
MARUM
Bremen

X-RAY

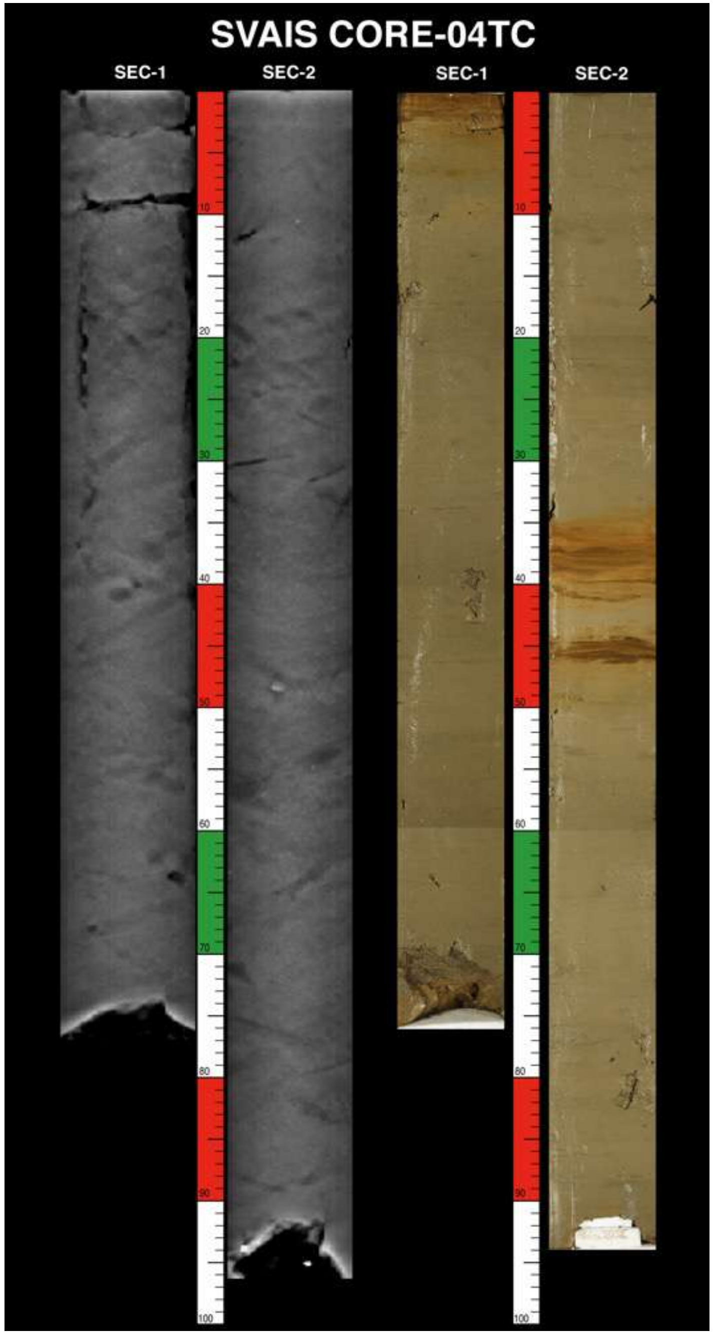


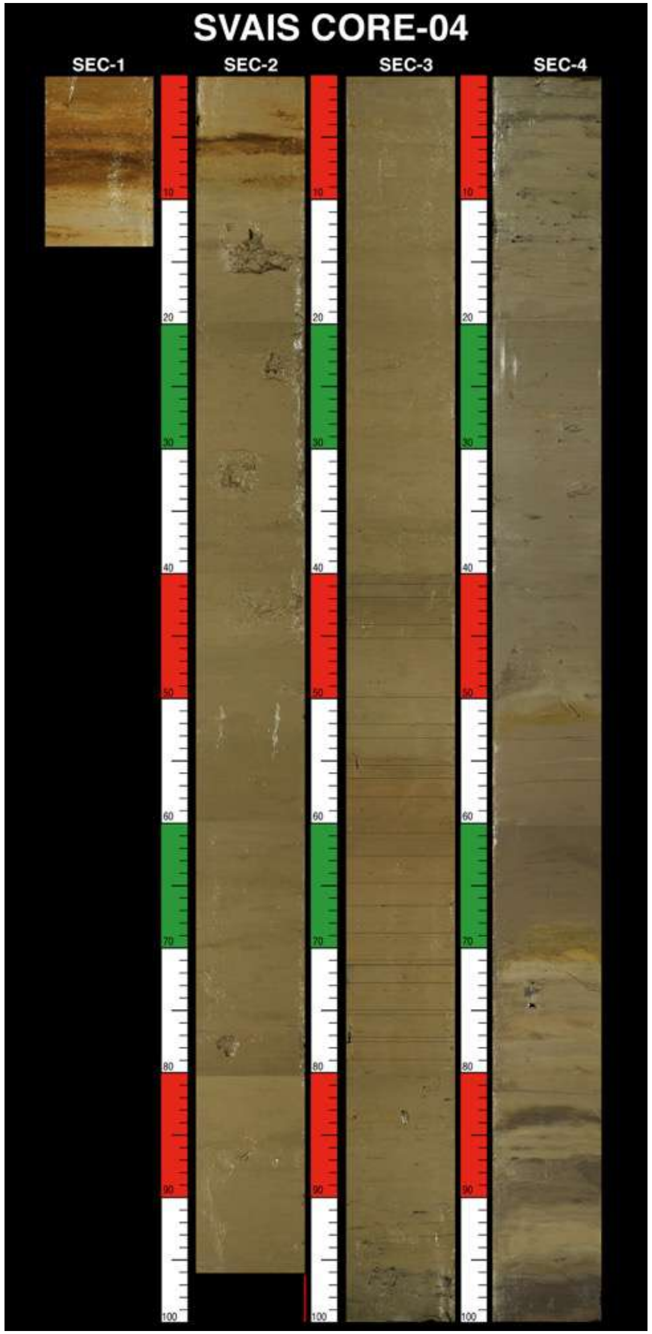
SEDIMENT SURFACE

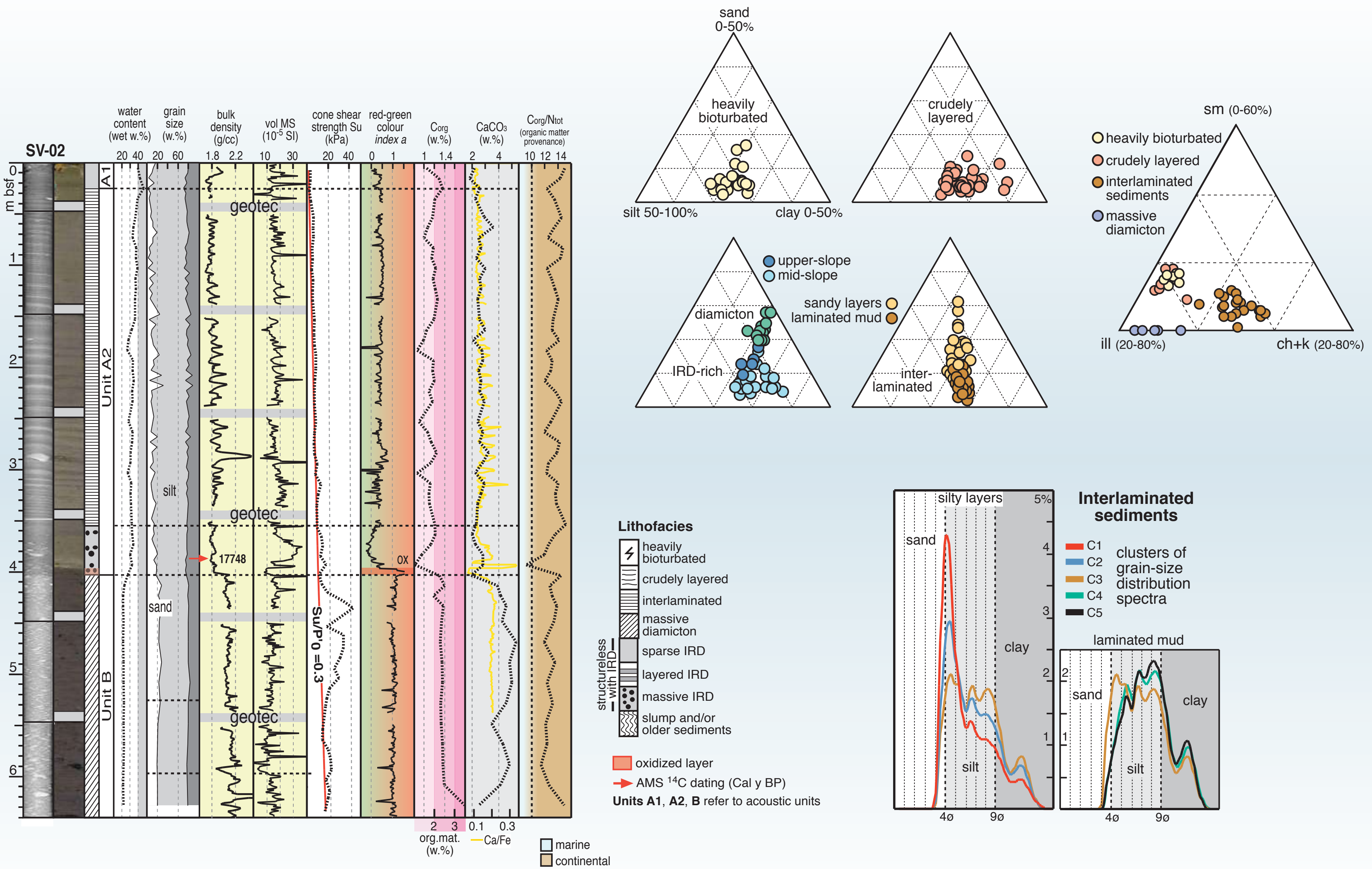

SVAIS CORE-02 vert.
SEC-1
SEC-2
SEC-3
SEC-4
SEC-5
SEC-6
SEC-7


SVAIS CORE-02
SEC-1
SEC-2
SEC-3
SEC-4
SEC-5
SEC-6
SEC-7
GEOTEC

CORING DISTURBANCE






SV-02
m bsf
water content (wet w.%)
grain size (w.%)
bulk density (g/cc)
vol MS (10^{-5} SI)
cone shear strength Su (kPa)
red-green colour index a
Corg (w.%)
CaCO3 (w.%)
Corg/Ntot (organic matter provenance)
Unit A1
Unit A2
Unit B
geotec
silt
sand
17748
ox
Su/P'o =0.3
org.mat. (w.%)
Ca/Fe
marine
continental
Lithofacies
heavily bioturbated
crudely layered
interlaminated
massive diamicton
structureless with IRD
sparse IRD
layered IRD
massive IRD
slump and/or older sediments
oxidized layer
AMS 14C dating (Cal y BP)
Units A1, A2, B refer to acoustic units
sand 0-50%
silt 50-100%
clay 0-50%
heavily bioturbated
crudely layered
diamicton
IRD-rich
upper-slope
mid-slope
sandy layers
laminated mud
inter-laminated
sm (0-60%)
ill (20-80%)
ch+k (20-80%)
massive diamicton
interlaminated sediments
silty layers
clay
Interlaminated sediments
C1
C2
C3
C4
C5
clusters of grain-size distribution spectra
laminated mud

CORE REPOSITORY 4°C