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

Anno accademico 2023 – 2024
Geologia Marina

Parte II

Modulo 2.3 Metodi diretti: Sondaggi superficiali ed analisi dei sedimenti

Relatore
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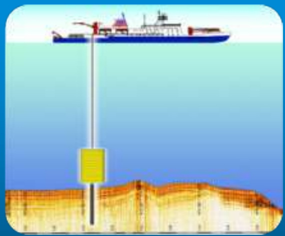
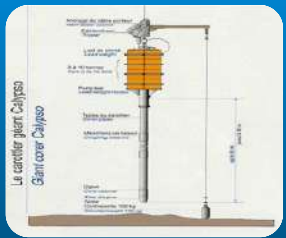
OGS

METODI DI STUDIO DIRETTI



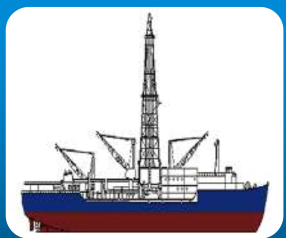
GRAVITY CORER

- Classic Gravity Corer (Emery and Dietz, 1941; Hvorslev and Stetson, 1946)
- Box-Corer
- Kastenlot Corer
- Multi-Corer



PISTON CORER

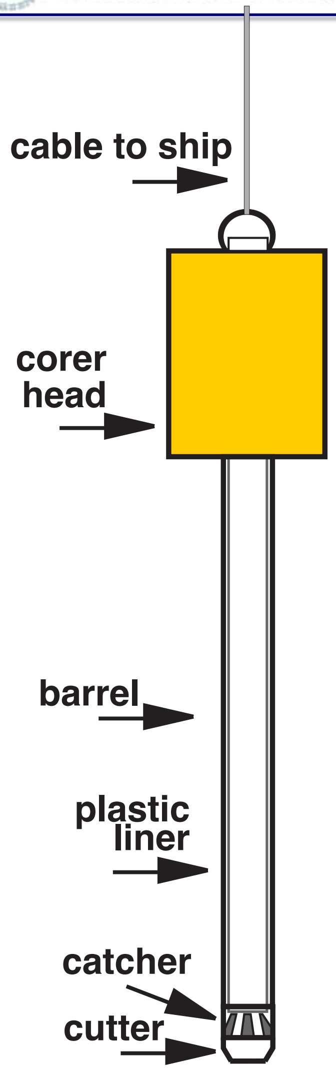
- Classic Piston Corer (Kullenberg, 1947; 1955)
- Long Piston Corer
  - Calypso Piston Corer (e.g. R/V Marion Dufresne, G.O. Sars)
  - Jumbo Piston Corer (e.g. R/V Araon)



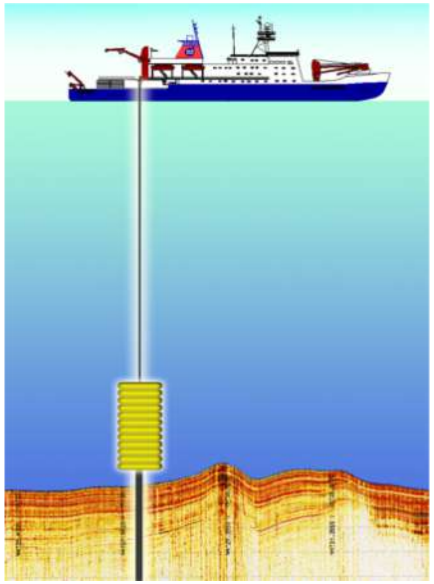
DRILLING SYSTEMS

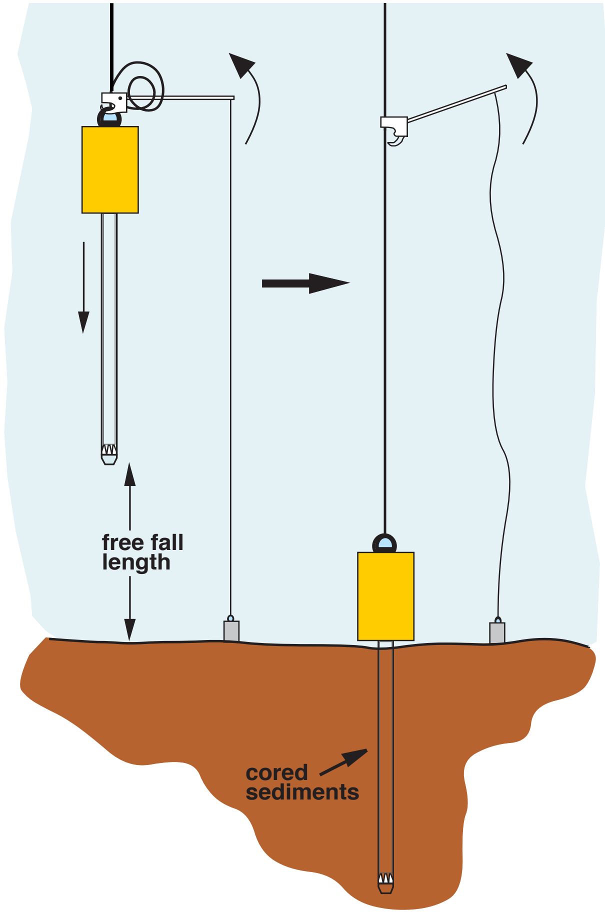
- Ocean Floor Drilling Systems (e.g. IODP-drilling vessels & semi-automated MeBo system)
- Ice Drilling Systems (e.g. EPICA-European Progect for Ice Coring in Antarctica & NorthGRIP- North Greenland Ice Core Project)

Classic Gravity Core System (Emery and Dietz, 1941)

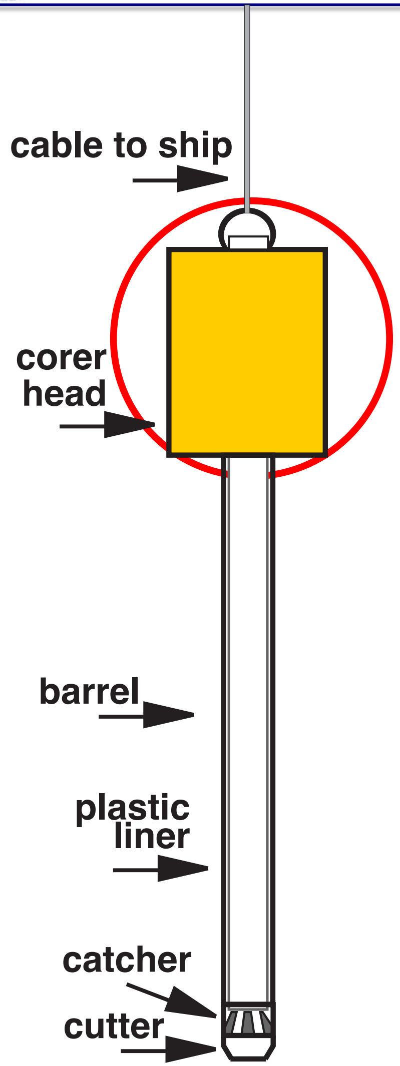


It is the simplest coring device in which the weight of the coring equipment is used to force the barrel into the sea bottom. This system can work with or without a triggering system



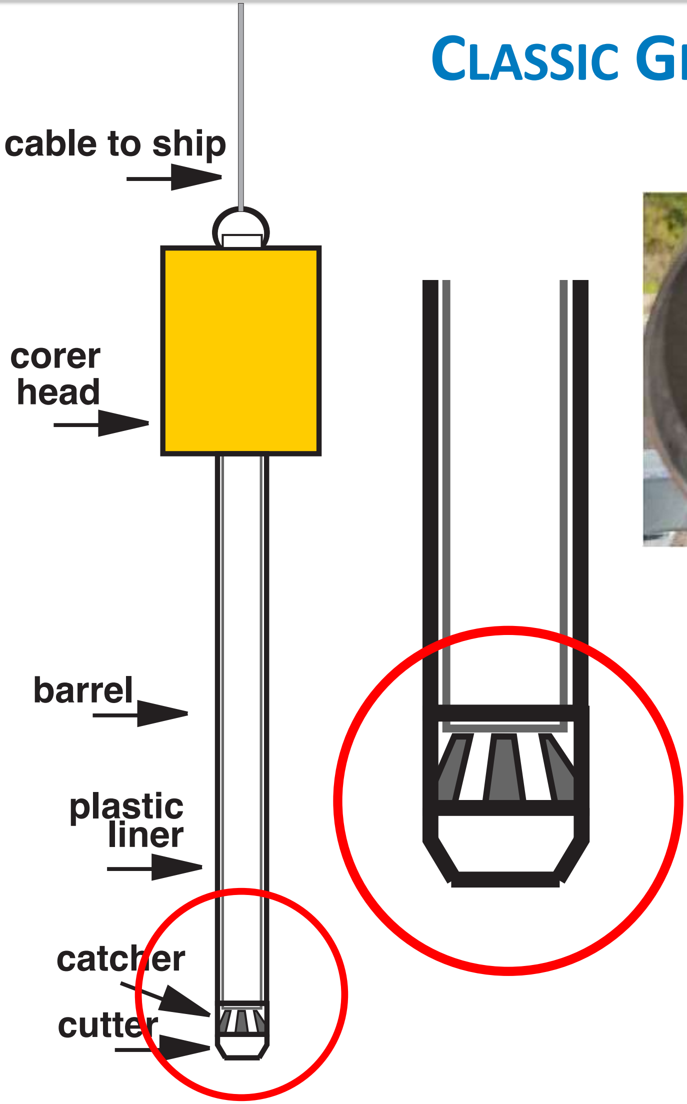


CLASSIC GRAVITY CORE SYSTEM: CORER'S HEAD



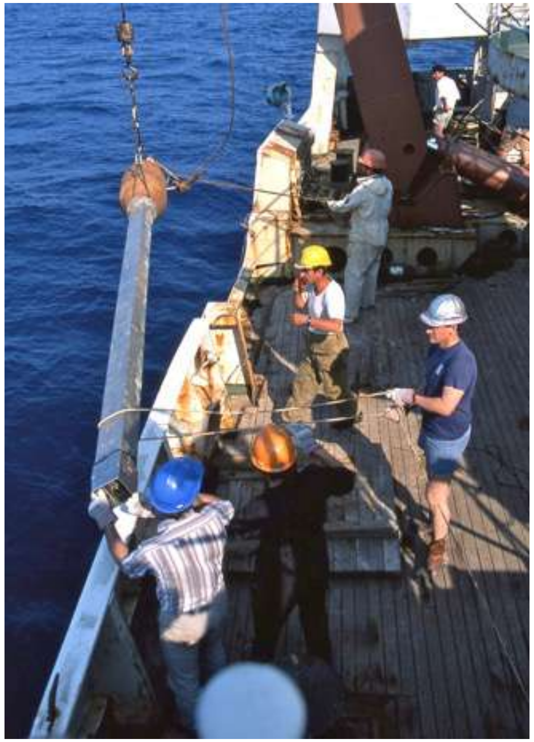
Weigth 600-800 kg
6000 kg

Classic Gravity Core System: Core Catcher and Cutter



ADDITIONAL GRAVITY CORE SYSTEMS: KASTENLOT CORER

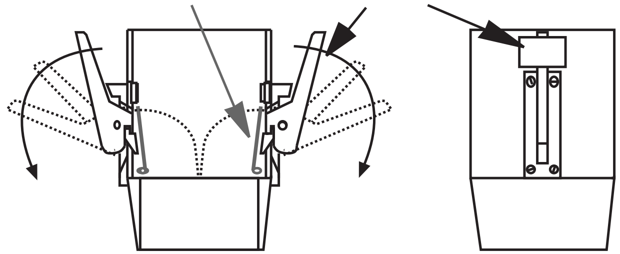
The kastenlot (kastens) corer was originally designed by Kögler (1963) it was improved and modified by Zangger and McCave (1990). The barrel, of variable lengths, is square in section (15x15 cm) and it contains a ***base plate*** that can be raised to reveal a new cleaned core surface



Square section of barrel with inner base plate

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 THE "KASTENS" CORE

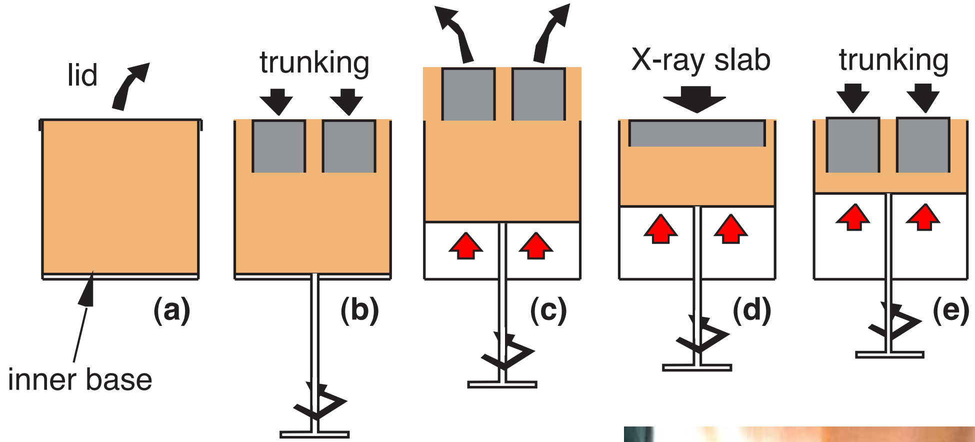
(a) removal of the barrel lid to reveal the core surface;

(b) two PVC trunkings are pushed into the sediments;

(c) the inner base is moved upward to expose the trunkings that are cut with a cheese wire at the base, and removed from the main core;

(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

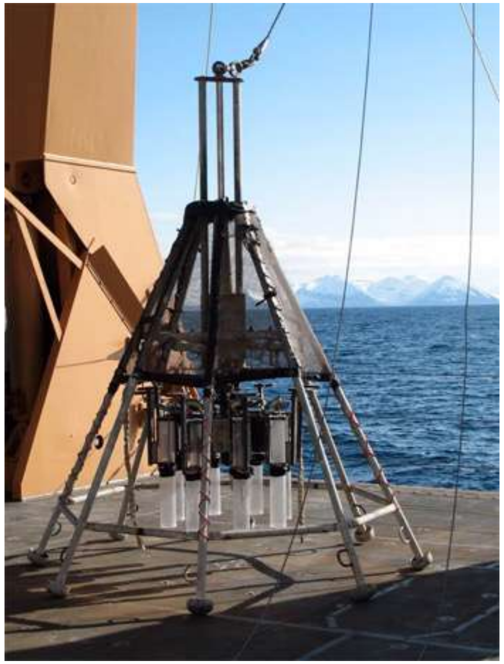
Designed for minimum disturbance of the sediment surface, ideal for coarse/stiff sea floor sediments, it allows the recovery of bottom waters.

side surface

coral sampling

glacigenic sediments

Box core sampling



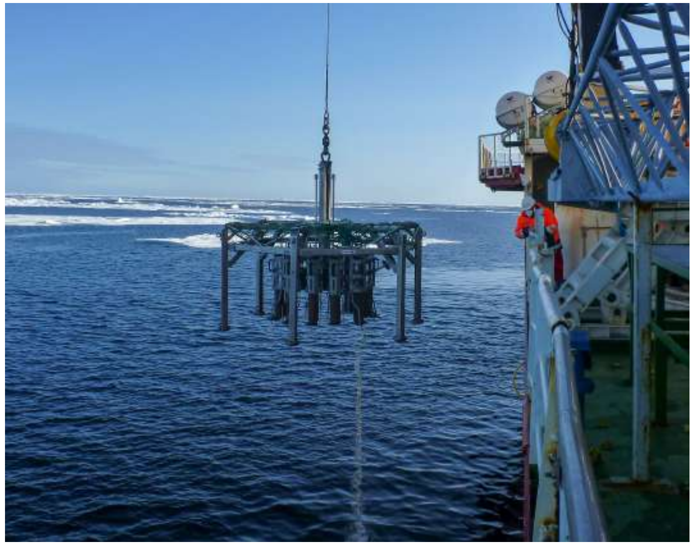
ADDITIONAL GRAVITY CORE SYSTEMS: MULTI CORER

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.

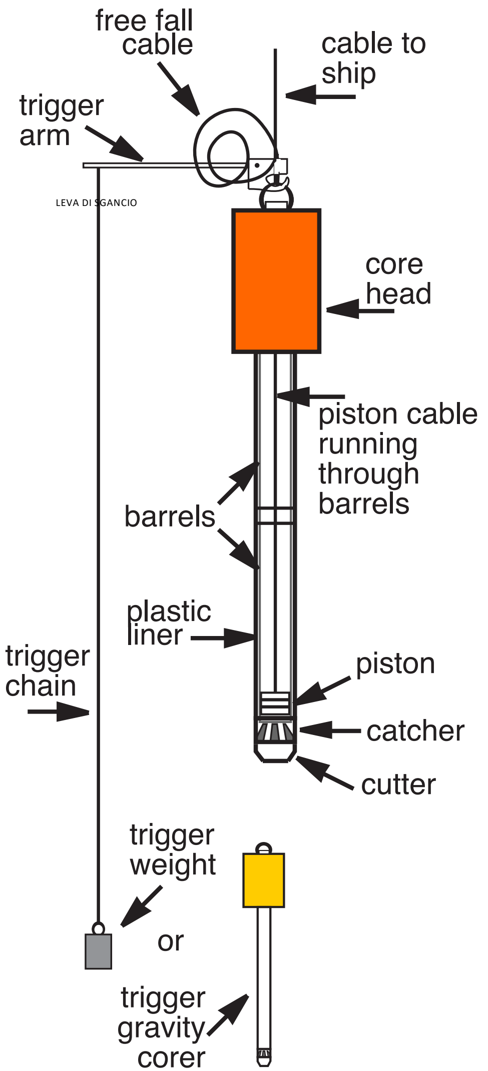
Research Polar Vessel Laura Bassi

N/R Laura Bassi

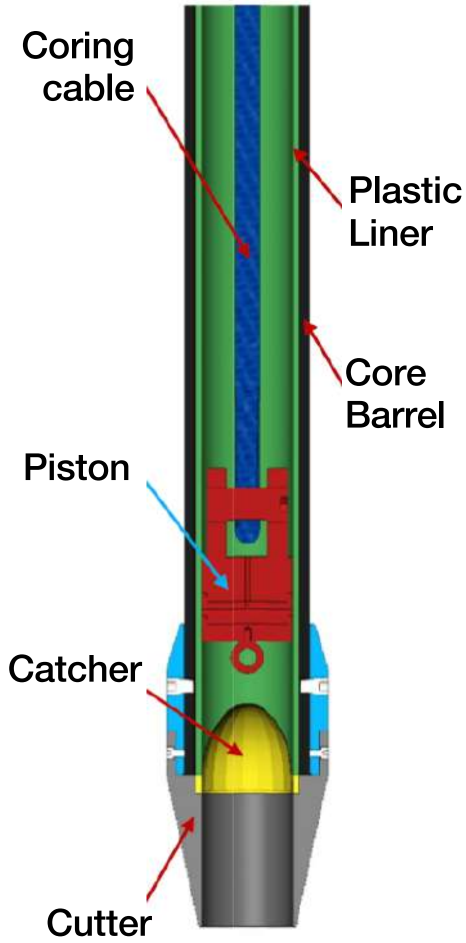
OKTOPUS Multi-corer with up to 12 core tubes

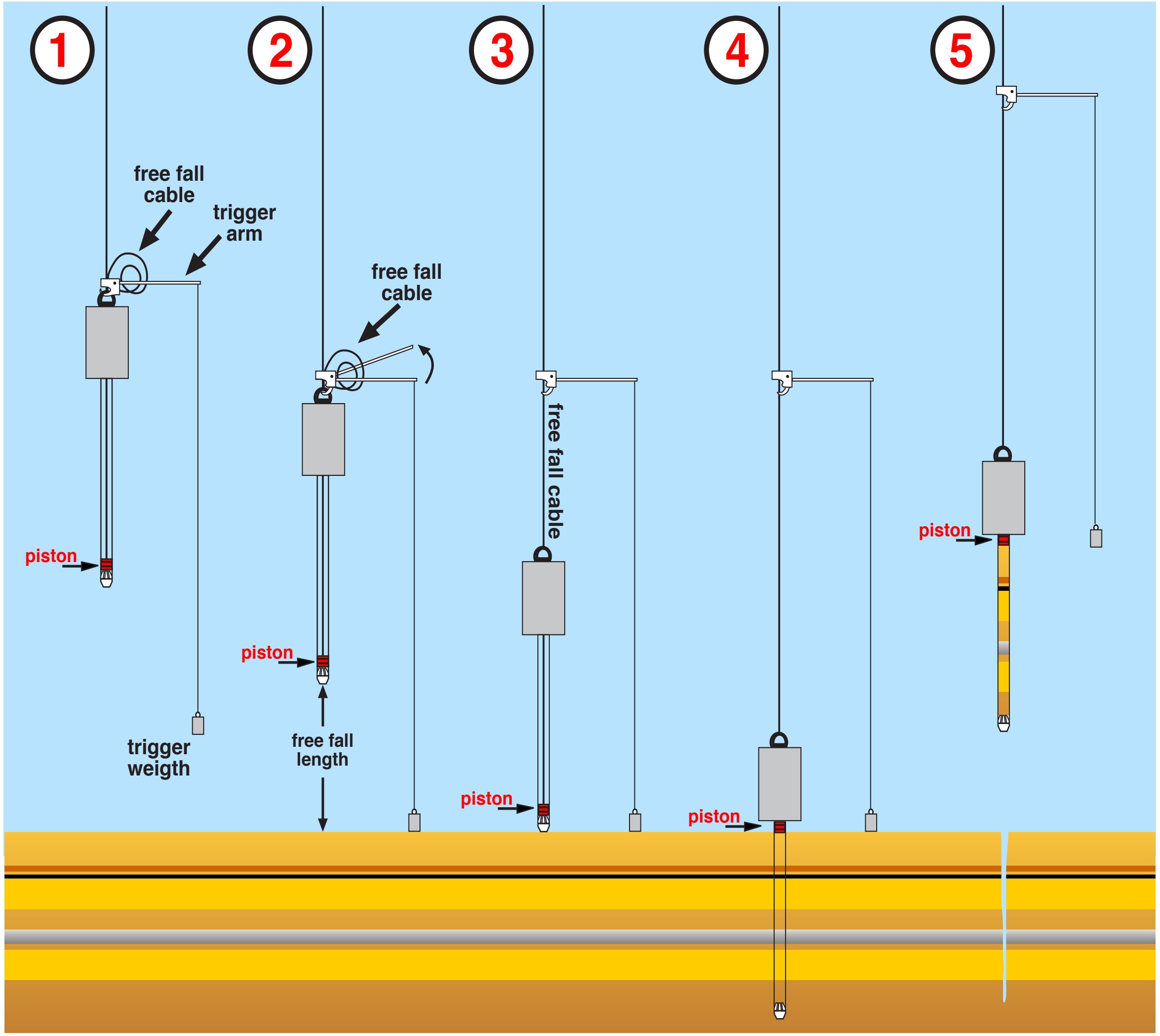


KULLEMBERG PISTON CORE SYSTEM



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.





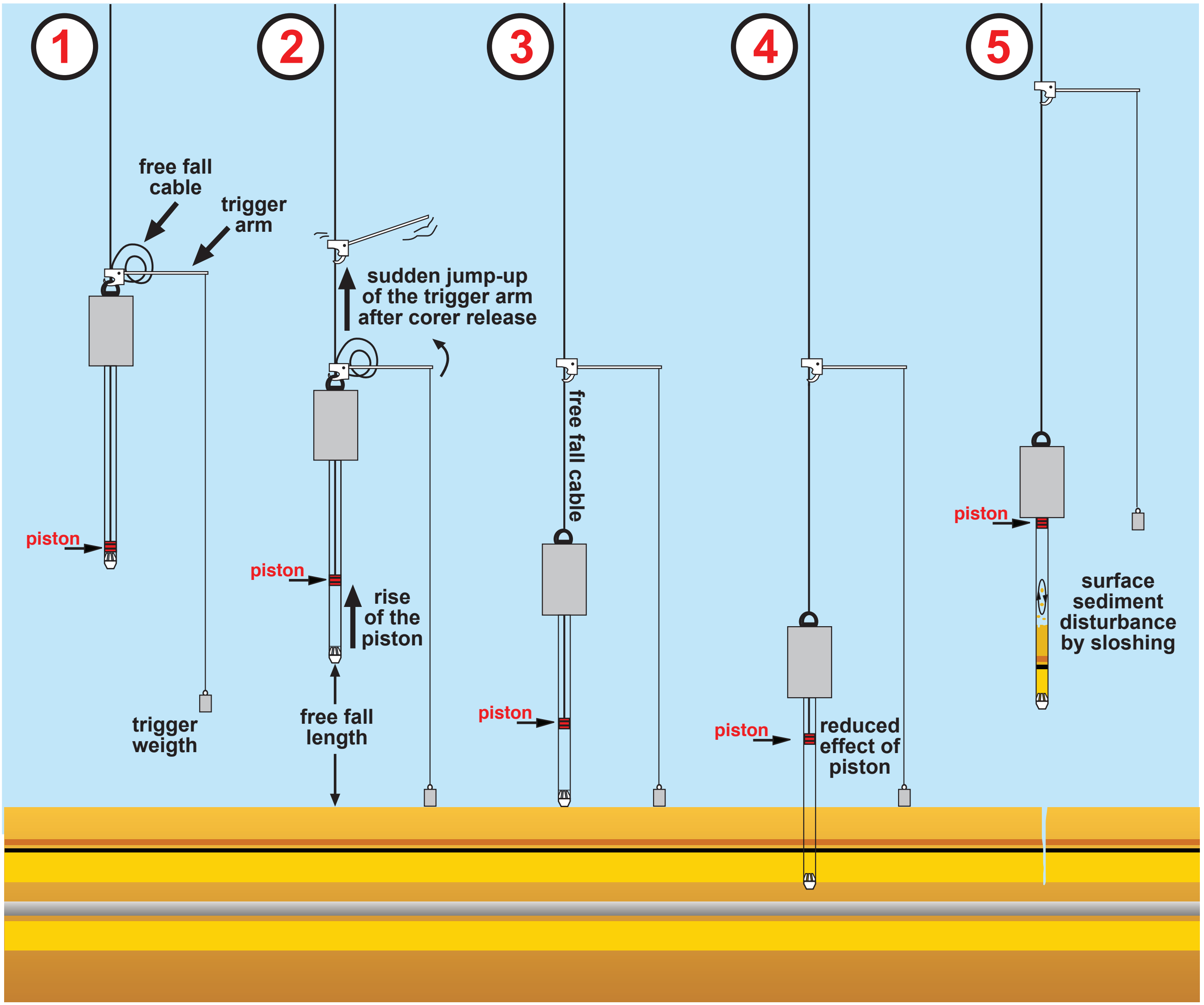
KULLEMBERG PISTON CORE SYSTEM

1) During the deployment the piston is located behind the core catcher and cutter. All the system is held by the trigger arm.

2) The trigger weight (or trigger gravity corer) touch the seafloor releasing the trigger arm, that release the piston corer to free fall mode.

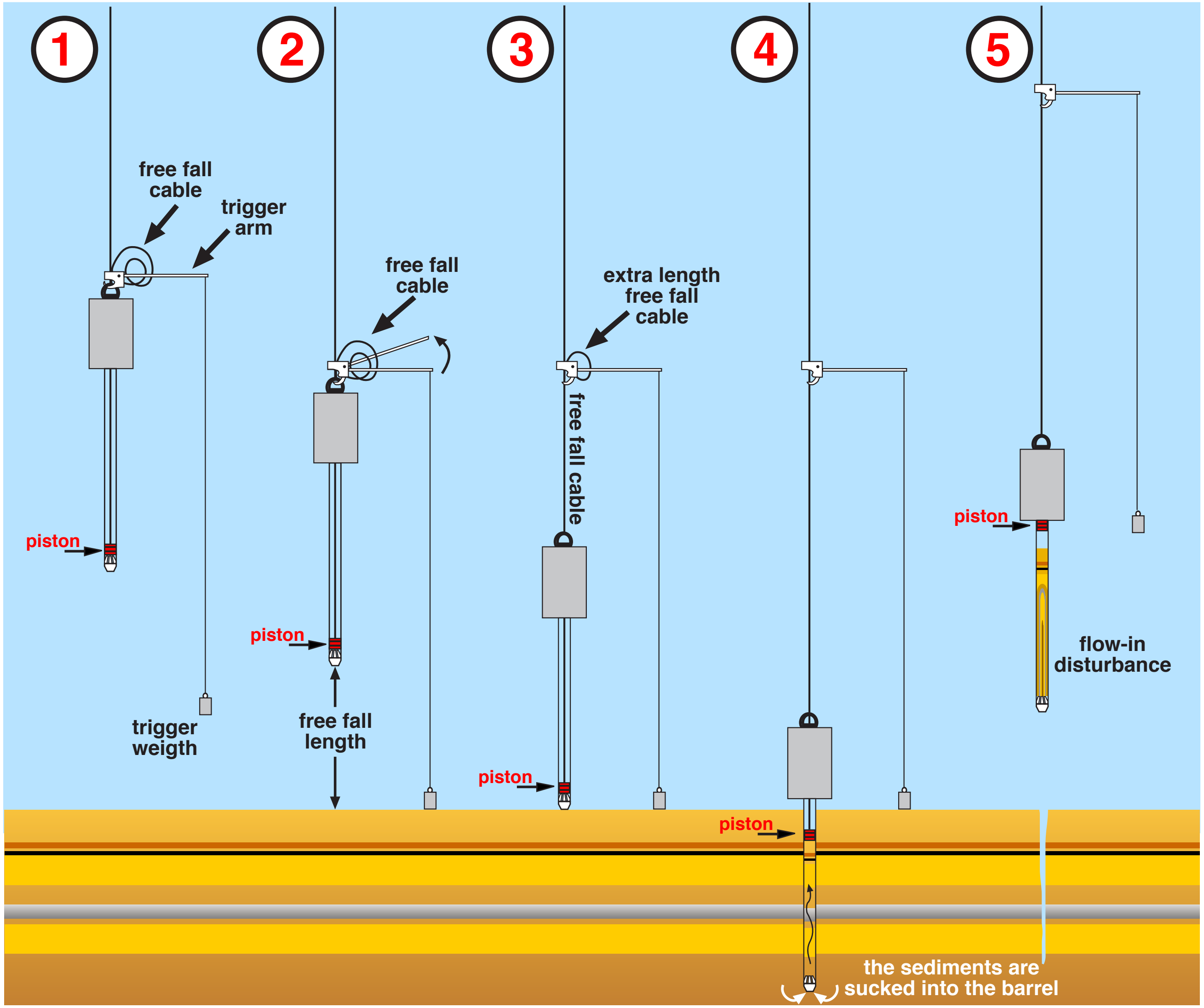
3-4) When the corer penetrates the sediments the piston (red segment) remains at the seafloor surface generating vacuum behind the cutter.

5) During the coring system recovery the piston is positioned below the corer head holding the weight of the whole system



CORING DISTURBANCE

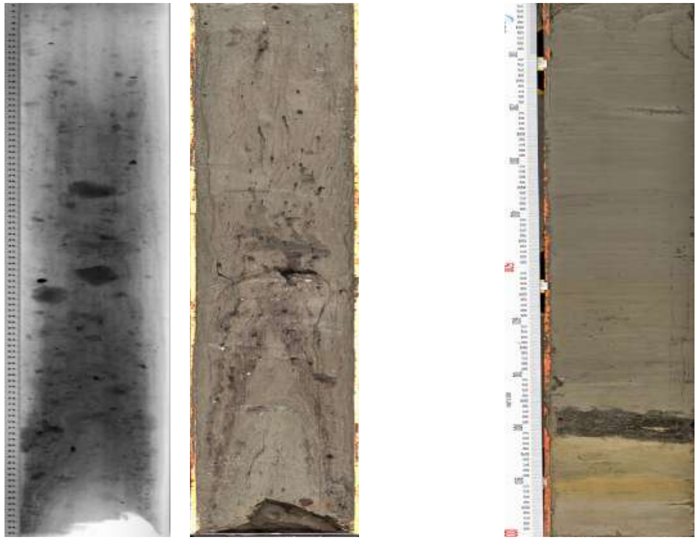
Case 1: rise of the piston during the deployment



CORING DISTURBANCE

Case 1: rise of the piston during the deployment

Case 2: wrong (longer) length of the free fall cable (flow-in disturbance)



RESEARCH POLAR VESSEL LAURA BASSI

N/R Laura Bassi

OSIL Standard Piston Corer

Maximum core length 15 m using 3-5 m long barrels

Barrel ID 102 mm, OD 114 mm

Plastic liner OD 100 mm

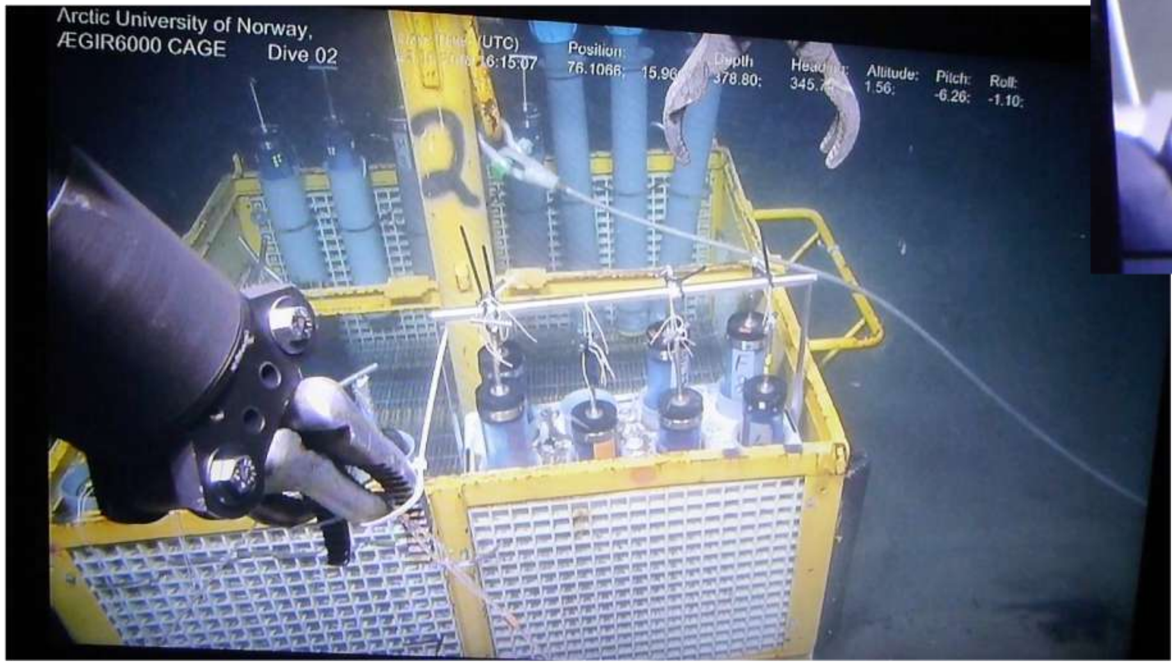
Corer head 300 kg variable

Trigger weight 100 kg

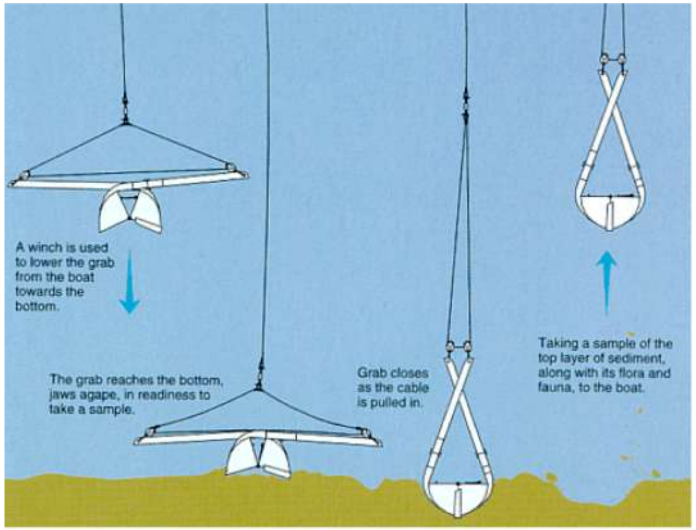
Trigger pilot (gravity corer) 1 m long

ROV: PUSH CORES AND BLADE BOX CORES

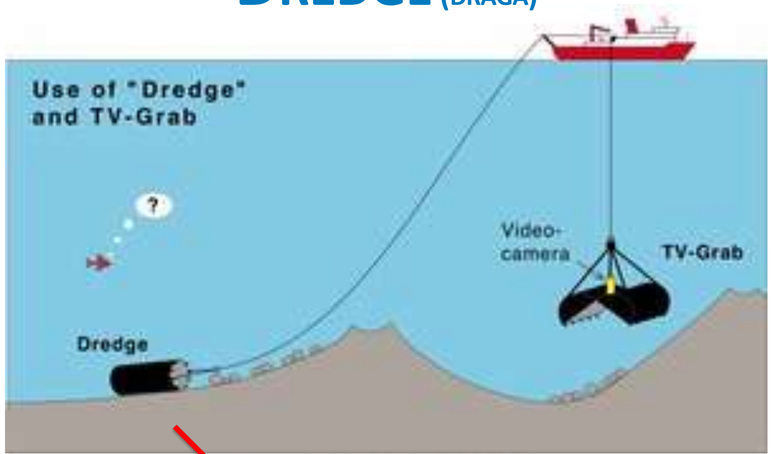
ROV: PUSH CORES AND BLADE BOX CORES

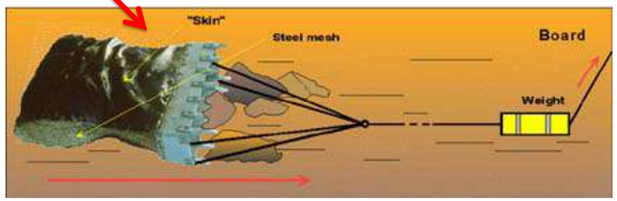


GRAB (BENNA)

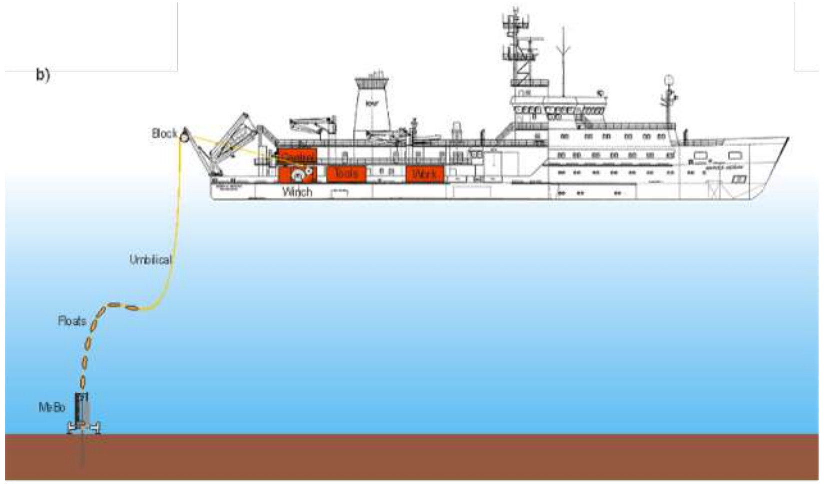


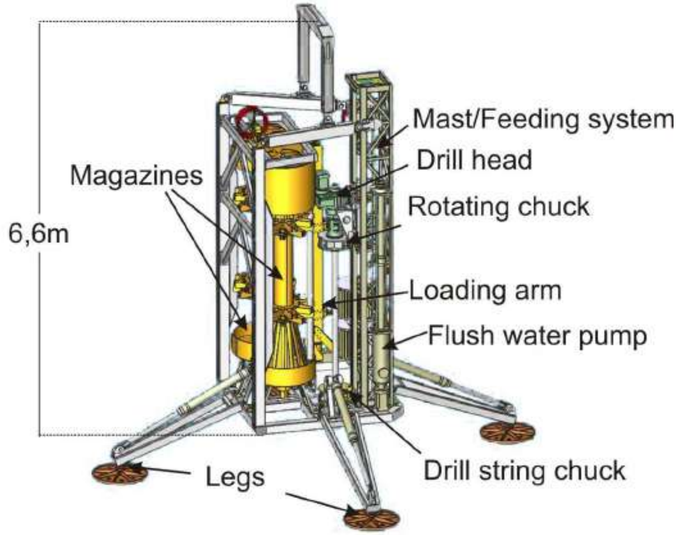
DREDGE (DRAGA)





SEA FLOOR DRILL RIG MEBO





MeBo specifications

Drilling depth 200 m
Coring of soft sediments and hard rocks
Core diameter 55 – 84 mm
Deployment depth 0 – 2000 m
MeBo weight about 10 tonnes
Total system weight about 75 tonnes
Transport within six 20‘ containers

System concept

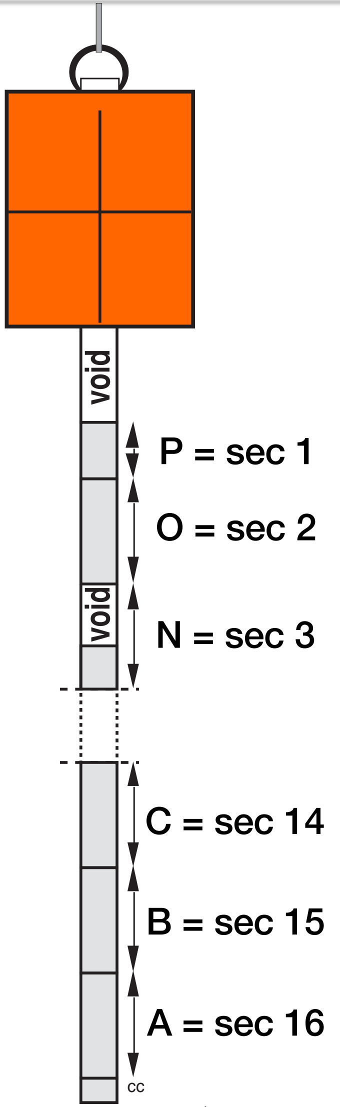
- Mast, drill head and flush water pump form the central drilling unit
- Drill rig has access to drilling tools stored within two magazines
- The drill string is built up and down using a loading arm and two chucks
- Stability on the sea floor is increased by movable legs

CORE ON DECK!!!!

PLASTIC LINER EXTRACTION AND CUT INTO SECTIONS

The plastic liners can be entirely extracted and the cut into sections or it can be cut at the extraction

SECTIONS' LABELLING AND CUT INTO SECTIONS



Short cores the plastic liner is fully extracted, labelled, and cut into sections

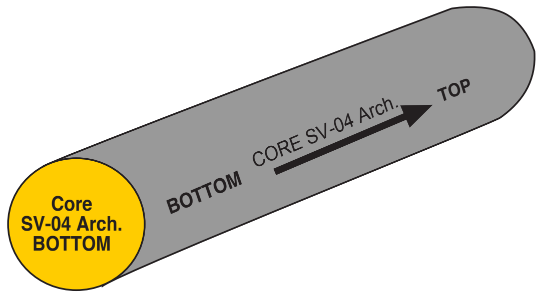
Long cores the liner is cut into sections during the liner extraction. The sections are initially labelled alphabetically (A= deepest section), then converted into sequential number from top (section 1) to bottom.

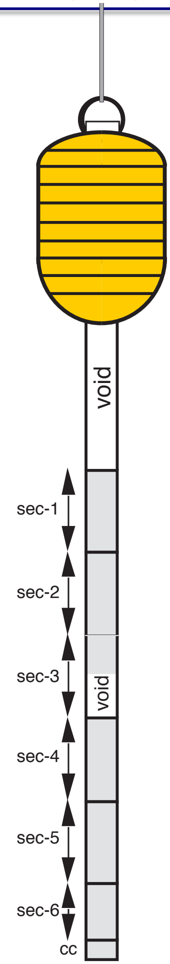
Each section is labelled with a code indicating:

- Name of Project and/or Research Vessel
- Number or name of the core site
- Number of the section
- Stratigraphic orientation: top and bottom

A **arrow** can be used to **indicate the TOP**

TOP





CORE OPENING AND SEDIMENT ANALYSIS

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

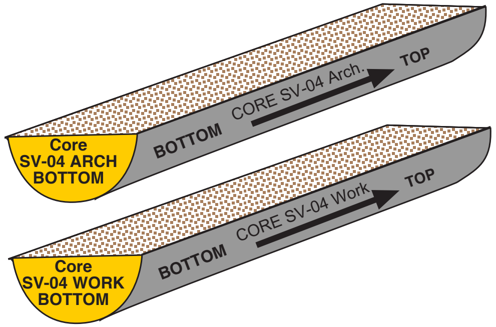
The two splitted half-sections are labeled as working section and archive section and will undergone a different analitycal process:

ARCHIVE SECTIONS: not distructive analyses

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

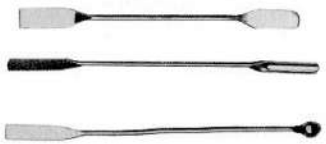
WORKING SECTIONS: Sub-sampling for analysis

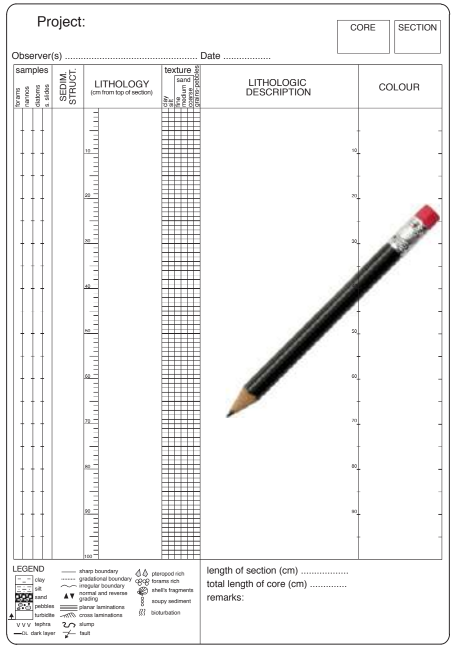
Half-sections' labeling



CORE DESCRIPTION

VISUAL CORE DESCRIPTION STEP-1

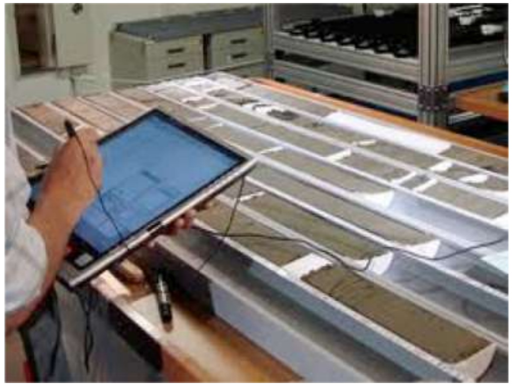


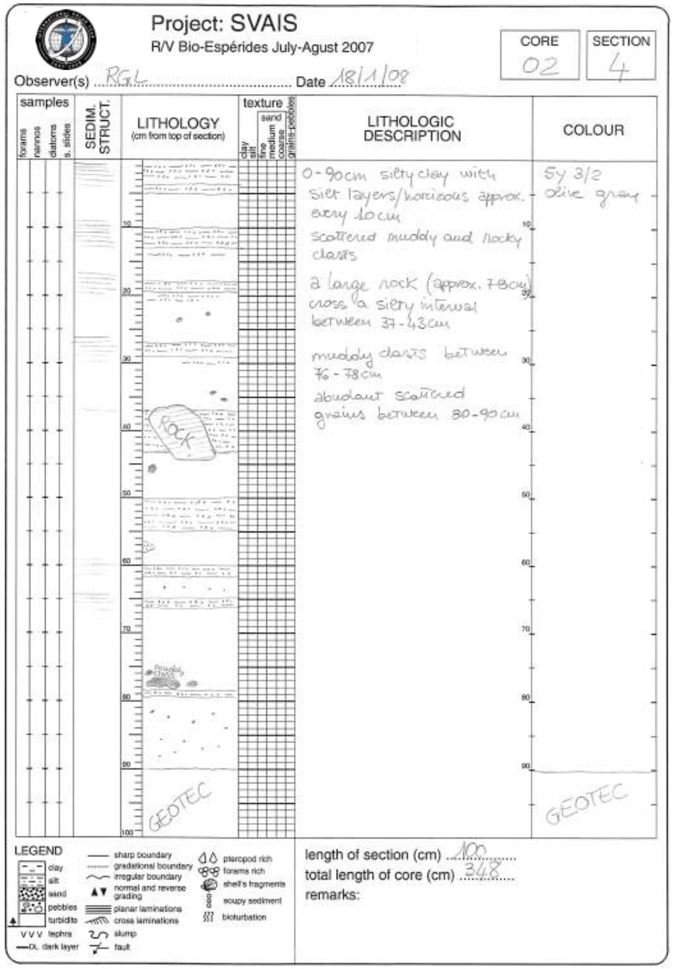


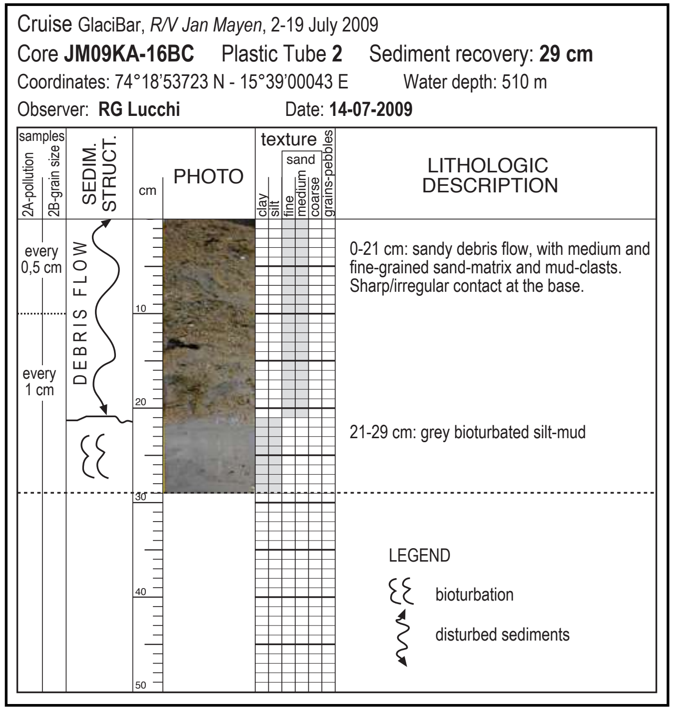
- ***Definition of lithological units*** based on:
  - Lithology including composition and texture
  - Color
  - Sedimentary structures (laminations, bioturbations, faults)
  - Boundaries (transitional, sharp not erosive, sharp erosive, irregular)

- ***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







VISUAL CORE DESCRIPTION STEP-2 SEDIMENT COMPOSITION

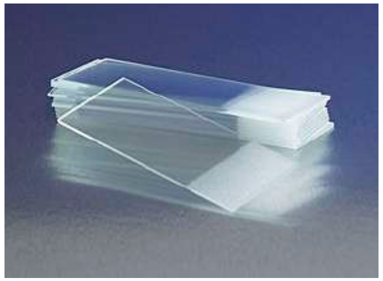
Foto: IODP Exp. 307

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

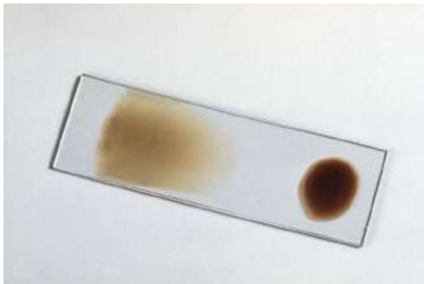
A smear slide is a thin layer of unconsolidated sediment embedded on a glass slide for petrographic microscopic examination;

Smear slides are a useful tool to quickly assess the *compositional content* of clay-silty sediment samples

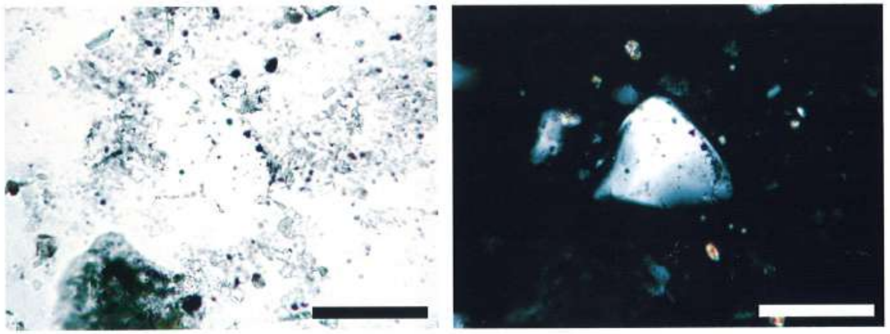
Smear slides are a powerful method for rapidly evaluating tiny quantities of sediment (mineralogy, components, form, size) as the basis for *sediment classification*, and for ascertaining the presence of microfossils.



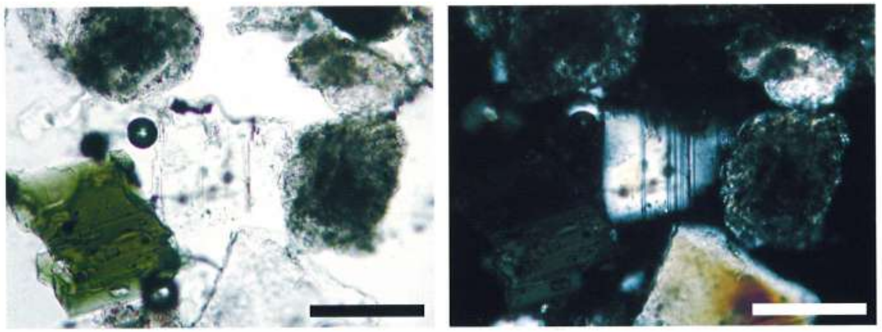
glass and cover-glass



LITHOLOGICAL FRACTION

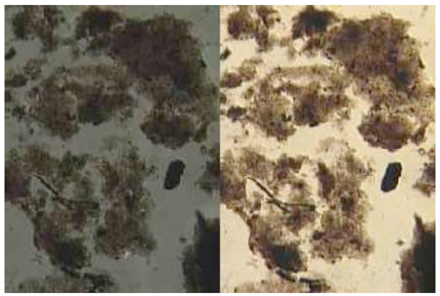


Quarz

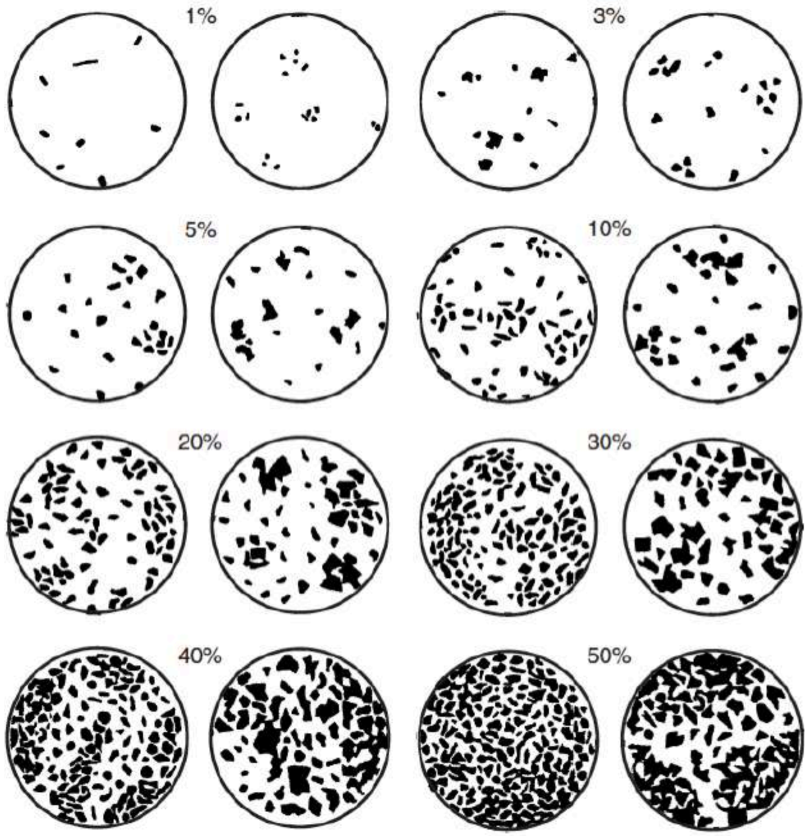


Plagioclase

Clay fraction

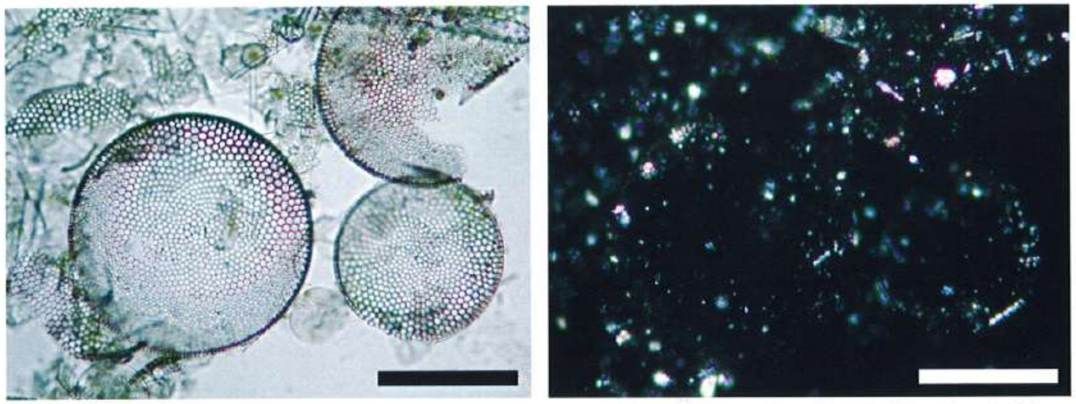


Composition quantification



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

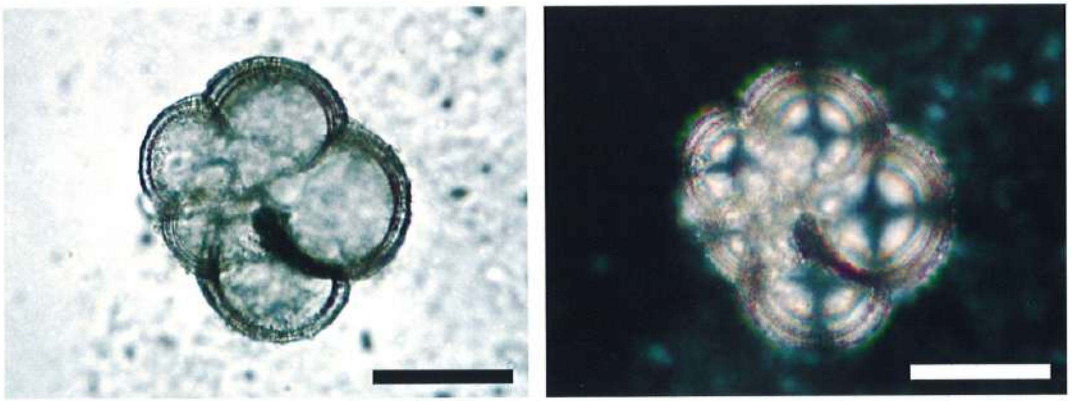
BIOGENIC FRACTION



Diatoms

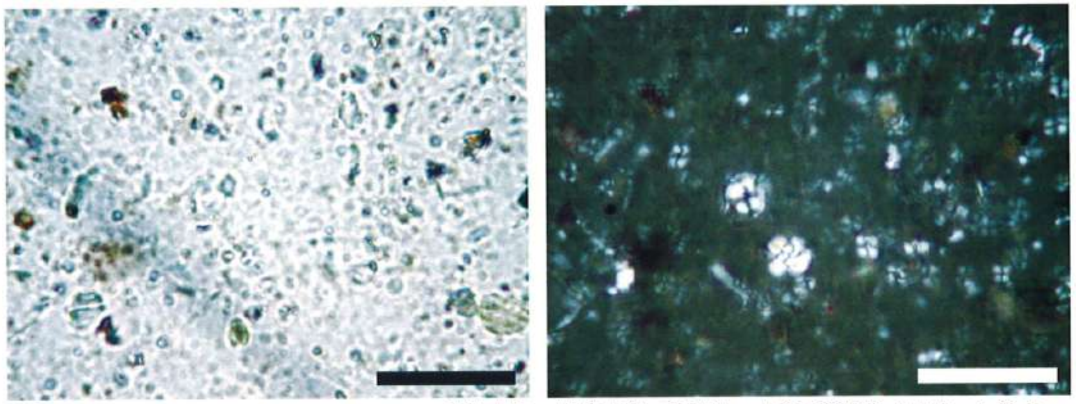
オホーツク海・中心部，水深 1107m，XP98, PC1, Sec.1, 20cm
200 倍．スケールは横 100 μm

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 nannofossils



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 SIEVED SEDIMENTS

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)

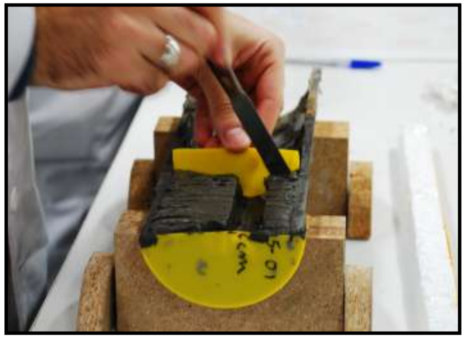
Beach sands (Menorca-Spain)

Glacigenic sediments (Arctic)

Tephra (volcanic glass) (Tyrrhenian)

SEDIMENT CORE ANALYSIS

ANALYSIS ON INDIVIDUAL SAMPLES



Type of analysis	Purposes
X-ray Computed Tomography	radiograph's facies analyses
Core sediment description	structure, texture colour, facies
Digital photo of sediments	photographic record
Minolta colour-scan	colour changes compositional-stratigraphic insits
Multi-sensor core logger	Magetic susceptibility Density, P-wave velocity
Undrain Shear Strength cone and vane strength	Profile of shear strength properties, slope stability
Water content	density and porosity
Grain size Coulter-laser LS230	texture, sedimentary processes
Geochemistry elemental analyzer	Corg., Ntot., $CaCO_3$ organic matter
XRF core-scanner Avaatech	sediment composition provenance
SEM-EDAX and XRD analyses	sediment composition provenance
Foraminifera, nannos, Diatoms	palaeo-stratigraphy palaeoceanography
Magnetic palaeointensity	palaeo-stratigraphy palaeoceanography
C14 dating on foraminifera tests	cronology/stratigraphy

CORE SCAN TECHNIQUES

Geotek Multi-sensor core logger
sediment physical properties

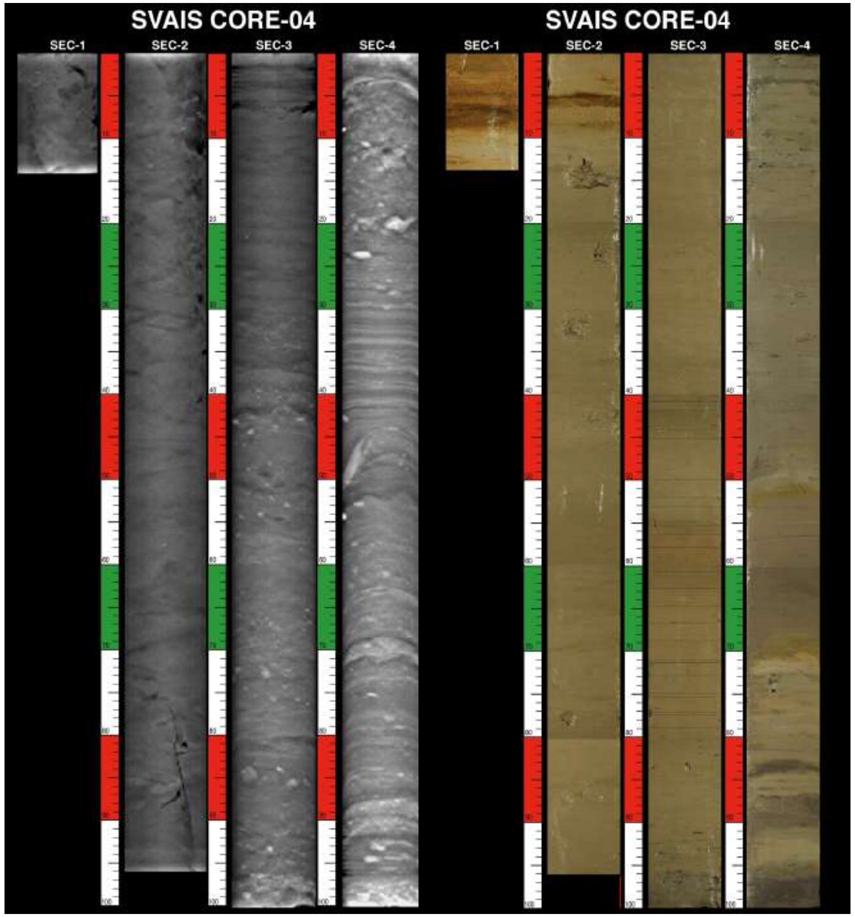
Aavatech XRF core scan element
composition of sediments

THE CORE LOGGING LAB

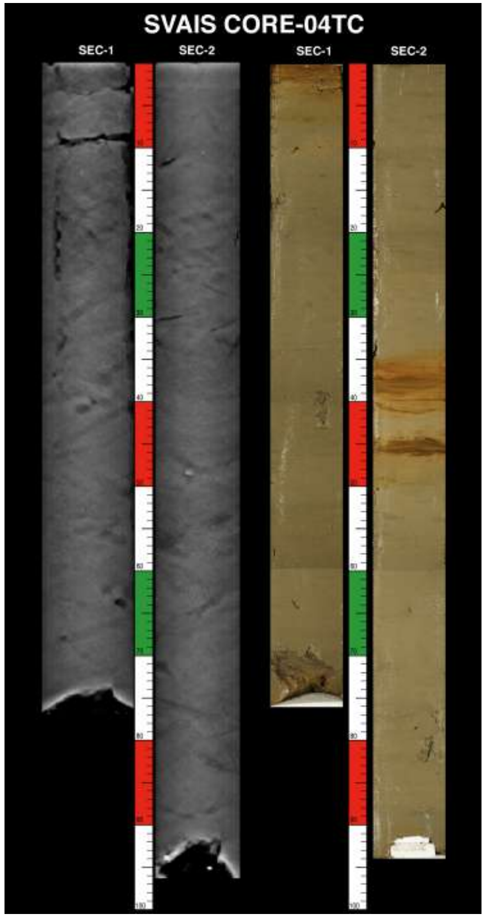
Core Logging LAB

X-RADIOGRAPH

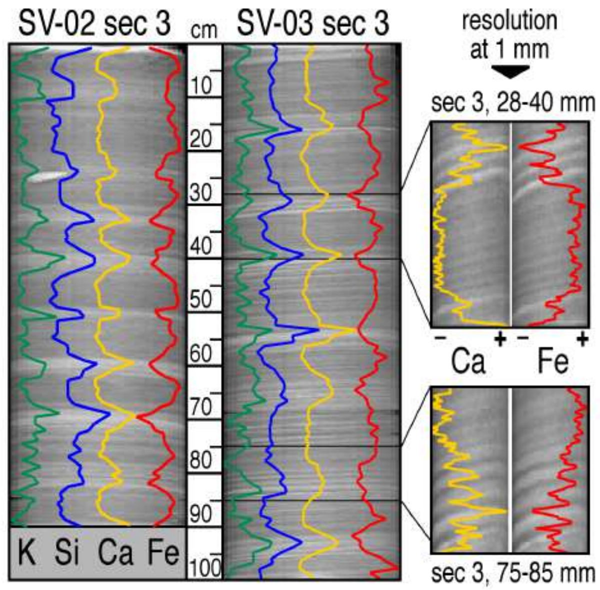
PHOTO OF SEDIMENT SURFACE



CORING DISTURBANCE



XRF-SCAN ANALYSES ON LAMINATED SEDIMENTS



SEDIMENT CORE STORAGE

At the end of the analytical process the sediment cores are located in D-tubes and stored in a ***Core Repository*** at a constant temperature of 4°C.

Some cores are stored in cooler rooms (-20°C or less) depending on the kind of analytical destination