Research

European Commission

Fifth Framework Programme

Thematic Programme: Environment and Sustainable Development

On Board "Le MARION DUFRESNE"
From ISTANBUL 09/05/2004 to ISTANBUL 24/05/2004

Energy, Environment and Sustainable Development

INTRODUCTION

ASSEMBLAGE is a European collaborative project focused on the assessment of the Black Sea sedimentary system from its North-western part, including the continental shelf and slope, down to the deep-sea zone.

The first scientific cruise dedicated to the project was undertaken on board the French Research Vessel "Le MARION DUFRESNE" from ISTANBUL, 9th of May 2004 to ISTANBUL, 24th of May 2004. The ship and scientific technology for the cruise ASSEMBLAGE 1 were provided by IPEV (Institut Paul Emile Victor) and the project was under the direction of Gilles Lericolais, co-ordinator of the European ASSEMBLAGE project. The project proposes a new, extensive and complex marine research programme in the Black Sea using modern scientific equipment and technology and high expertise. Within this project there is a clear will to unify the efforts of scientists from Western Europe and Central-Eastern Europe.

The scientific party was composed by the project partners: Partner 1, 2 and 3 from France, Partner 4 from Germany, Partner 5 and 6 from Romania, Partner 7 from Bulgaria, Partner 10 from Spain and Partner 11 from Italy. The team was completed by guest scientists from the United Kingdom, Turkey and the United States of America.

The western Black Sea is a unique feature characterised by a particularly wide shelf of 100-150 km, which is under the jurisdiction of Ukraine, Romania and Bulgaria. The north-western Black Sea receives water and sediment discharge from some major European rivers (Danube, Dniepr, Dniestr) and is characterised by high sedimentation rates which present favourable conditions for paleoclimatic studies of this region. Its geographical position and that of its drainage basin makes it sensitive to changes in the ice-cap during the last Glacial period which is also recorded in the sedimentary record.

The knowledge of past climatic and environmental changes provides important scientific support to facilitate the access and sustainable use of the Black Sea floor resources, primarily for the benefit of the riparian East European countries. The project aims to quantify the impacts of climate change and the sensitivity of the Black Sea system to external forcing, with respect to natural processes and human activity. Progress in resolving these major issues will be achieved through the examination of:

(1) the geomorphology and stratigraphy of the north-western shelf of the Black Sea to its deep-sea,

(2) a series of long cores retrieved from the Bosphorus outlet, the north-western shelf and the deep-sea fans using the Marion Dufresne technology,

(3) the determination of the consequences of a reduction of the river input,

(4) the use of a computationally efficient ecological model and

(5) the reconstruction of the depositional history of the sequences laid down during the out-building of the Danube delta.

The BlaSON 1 and BlaSON 2 cruises have already provided detailed images of the seafloor by swath mapping, side-scan sonar and very-high-resolution seismic profiling. These cruises have increased our understanding of the timing of and the processes controlling Holocene sea-level rise on the shelf and to reconstruct the outbuilding of the Danube delta and deep-sea fan. To characterise the last transgression (invasion of saltwater into a giant low salinity lake?), sediments need to sampled from the coast to the deep basin to cover the Late Pleistocene lacustrine phase to the Holocene marine phase of the Black Sea. Core samples retrieved by the Marion Dufresne will allow detailed age determinations. By studying the stable isotopes, pollen, molluscs, ostracods, foraminifers, diatoms and clay mineralogy of these cores and using proxies delivered by rivers that drain the interior of Asia and Europe, it will be possible to understand the history of climate change at a cm core-resolution. Because the abrupt Holocene re-connection of the Black Sea to the Mediterranean is perhaps one of the most dramatic climatic events of the last 18,000 years in Europe, this research can be used as a proxy for the future. This project can be linked to previous and recent researches carried out in the Marmara Sea in order to decipher the timing and processes of the re-connection.

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Core location and routes of the survey

1. CORE LOCALITIES AND ROUTES OF THE SURVEY

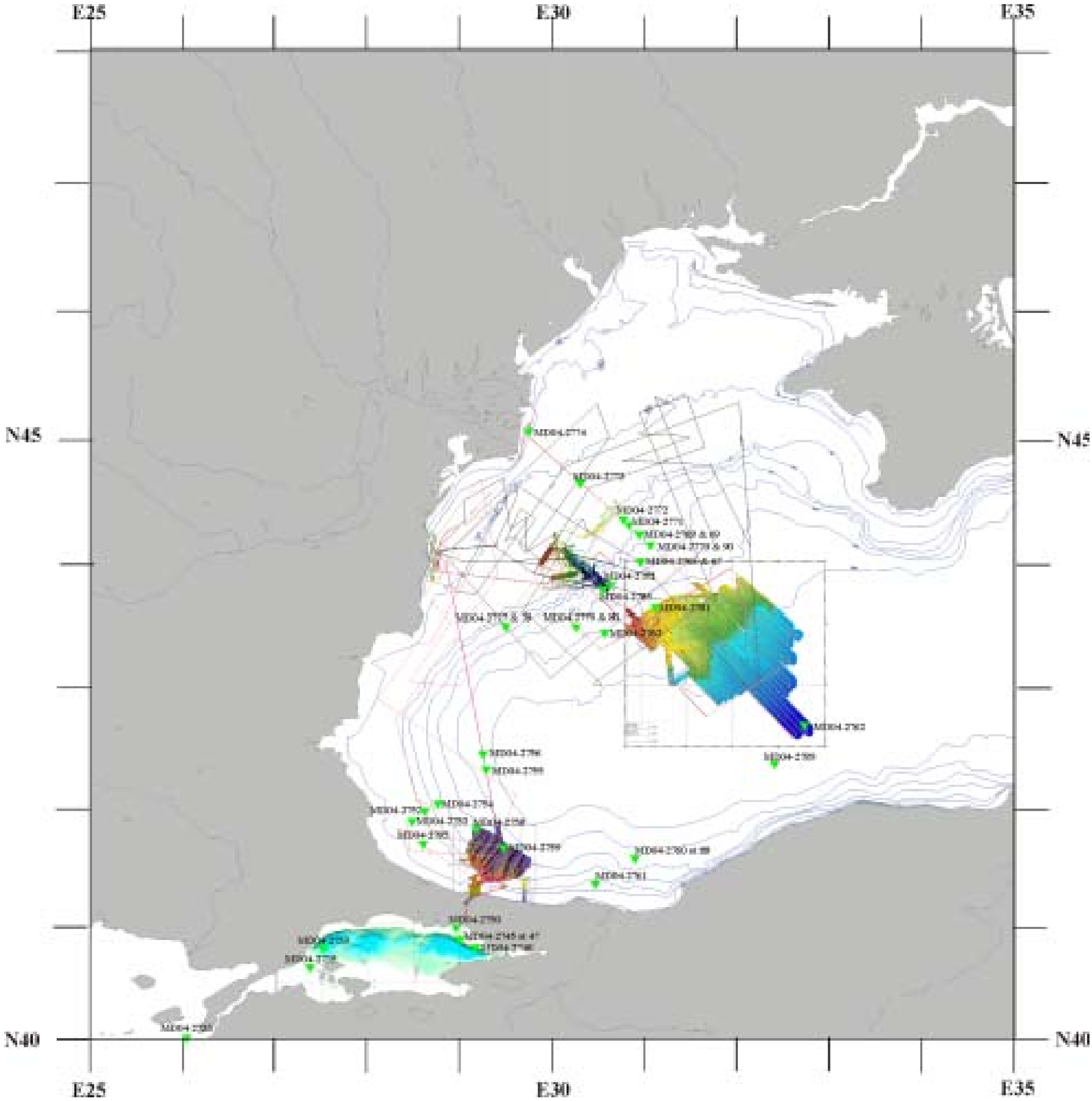

Figure 1.1: Location of the targets cored during the MD139-ASSEMBLAGE cruise presented with a synthesis of previous results

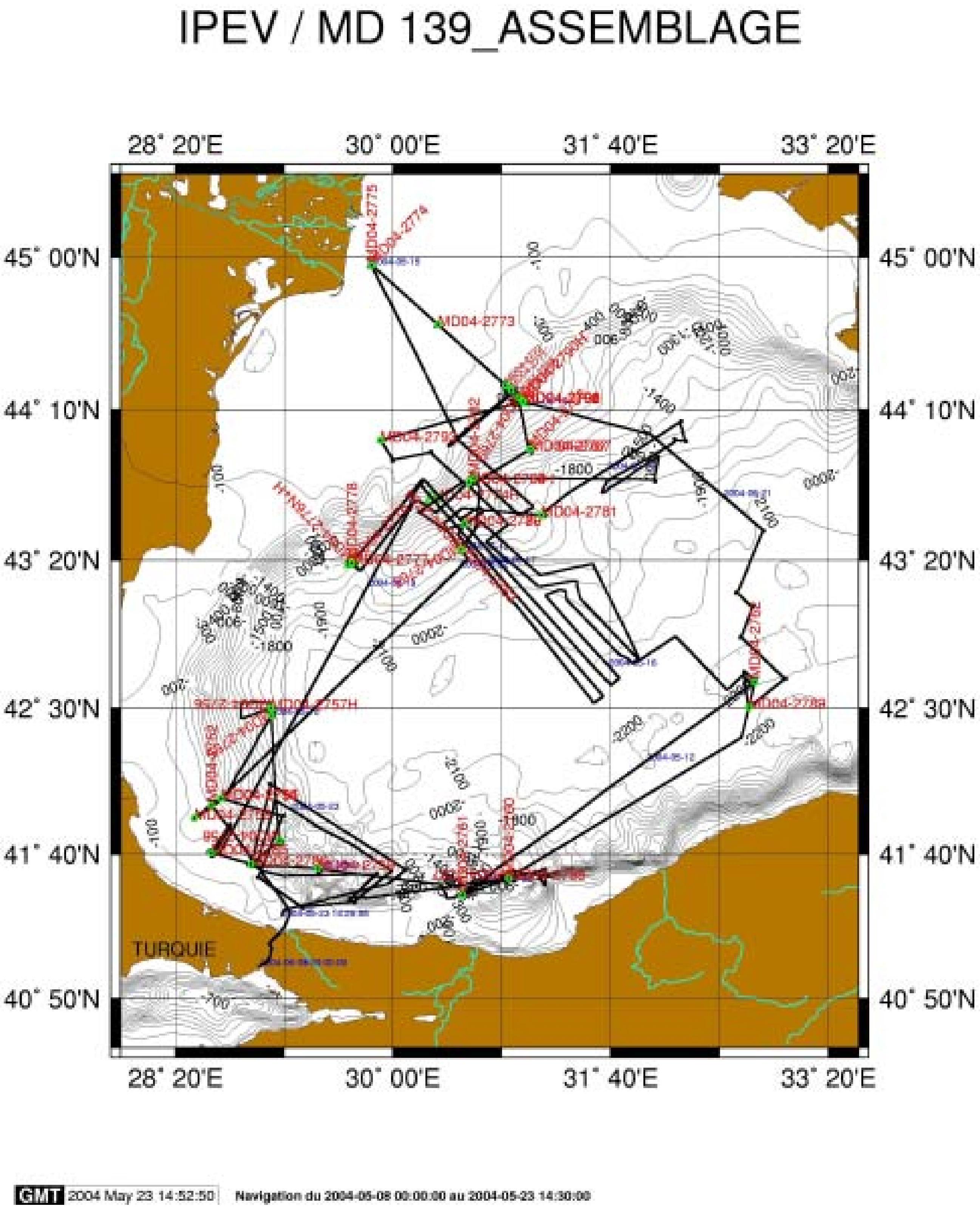

Figure 1.2: Routes and location of the targets cored during the MD139-ASSEMBLAGE cruise

MD04-139 ASSEMBLAGE 1

Scientific Team

2. SCIENTIFIC TEAM PARTICIPATING IN THE CRUISE

2.1. ASSEMBLAGE Partners

Name	Surname	Institution	Role	Country
2.1.1. Partner 1 : Ifremer				
Lericolais	Gilles	Ifremer/Dro/gm/LES	Chief Scientist	France
Rovere	Mickael	Ifremer/Dro/gm/LES	MST	France
Landure	Jean-Yves	Ifremer DRO/GM	core opener	France
Maltese	Laetitia	Ifremer/Dro/gm/LES	Reporting and Heat flow measurements	France
Barone	Sylvia	Ifremer/Dro/gm/LES	Reporting	France
2.1.2. Partner 2 & 12: UCBL / CNRS				
Suc	Jean-Pierre	Univ. Claude Bernard Lyon1	Palynology	France
Favre	Eric	Univ. Claude Bernard Lyon1	Palynology	France
2.1.3. Partner 3 & 13: LSCE /CEA				
Guichard	François	LSCE- Gif sur Yvette	Radiocarbon	France
Segueni	Farid	LSCE- Gif sur Yvette	Radiocarbon	France
Sotto	Mélina	LSCE- Gif sur Yvette	Radiocarbon	France
2.1.4. Partner 4: Uni HH (Hamburg University)				
Beckmann	Sabine	Univ. Hamburg	Geochemistry	Germany
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Koelle	Philip	Univ. Hamburg	Geochemistry	Germany
2.1.5. Partner 5: GeoEcoMar				
Oaie	Gheorghe	GeoEcoMar	Sedimentology	Romania
Secrieru	Dan	GeoEcoMar	Sedimentology	Romania
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Furtuna	Corina	GeoEcoMar	Sedimentology	Romania
2.1.6. Partner 6: University of Bucharest				
Ungureanu	Viorel Gheorghe	Univ. Bucarest	Geology	Romania
Stoica	Marius	Univ. Bucarest	Micropaleontology	Romania
2.1.7. Partner 7: IOBAS				
Dimitrov	Dimitar	IOBAS Varna (Bulgarie)	Geology	Bulgaria
Genov	Ivan	IOBAS Varna (Bulgarie)	Sedimentology	Bulgaria
Petrov	Petar	IOBAS Varna (Bulgarie)	Geochemistry	Bulgaria
2.1.8. Partner 10: CSIC- IACT				
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Gallego Torres	David	Univ. Grenade - CSIC-IACT	Geochemistry	Spain
2.1.9. Partner 11: University of Ancona				
Morigi	Caterina	Univ. Ancona (Italie)	Micropaleontology	Italy
Pancotti	Irene	Univ. Ancona (Italie)	Micropaleontology	Italy
Pucci	Francesca	Univ. Ancona (Italie)	Micropaleontology	Italy

2.2. Other Participants to the cruise

Name	Surname	Institution	Role	Country
Termois	Yann	CEREGE	Geochemistry	France
Leduc	Guillaume	CEREGE	Geochemistry	France
Algan	Oya	Istanbul University	Stratigraphy	Turkey
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Okay	Seda	IMST –Izmir	Sedimentology	Turkey
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Helge	Arz	GFZ Potsdam	Paleoclimatology	Germany

Lamy	Franck	GFZ Potsdam	Paleoclimatology	Germany
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Manske	Ann Katrin	MPI-Bremen	Biology	Germany
Boomer	Ian	University of Newcastle	Micropaleontology	U.K.
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Creach	Ronan	IPEV	Report	France
Guilbaud	Fanny	IPEV	VHR seismic	France
Rigaut	Frederic	IPEV	Sounders	France
Jaouen	Alain	IPEV	Sounders	France
Sangiardi	Pierre	IPEV	Sounders	France
Mellet	Martin	IPEV	Sounders	France
Balut	Yvon	IPEV	Chief of Operations	France

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Scientific Objectives

3. SCIENTIFIC OBJECTIVES

3.1. Background: *the Black Sea sedimentary system*

To date, we have a very limited and mostly classical knowledge about the recent sedimentology of the Black Sea although this is the largest semi-enclosed Basin at the eastern border of Europe.

- **The North-western Black Sea receives the water and sediment discharge of the largest European rivers** (Danube, Dniepr, Dniestr)**.** For example, the drainage basin of the river Danube is of 817,000 km^2. The Danube mean-annual water discharge into the Black Sea is estimated at 6,047 m^3 s^{-1} (almost 190 km^3 yr^{-1}), while its mean-annual sediment discharge at the mouth zone was about 51,7 million tons per year (t yr^{-1}) before the river damming (Bondar, 1998). After the damming in 1970 and 1983, one can estimate that the Danube's total average sediment discharge could not be larger than 30-35 million t yr^{-1}, out of which only 4-6 million t yr^{-1} was sandy material (Panin, 1997). During the glacial lowstands and especially at the beginning of interglacials, the sediment discharge of these rivers were probably much higher. The examination at an appropriate scale of sediment path-way transportation, deposition, compaction and/or possible sliding across the continental shelf towards the slope and the deep-sea zone represents a case study for a better understanding of the processes affecting sedimentation in inland basins during the Quaternary period.
- Beyond the continental shelf a complex system of canyons, channels, accumulating sedimentary bodies as deep-sea fans are developed. **The Danube deep-sea fan** which **can be considered as a potential hydrocarbon field**, developed in the North-western part of the Black Sea from sediments fed by the Danube but also by the northern rivers: the Dniepr, the Dniestr and the Bug. It extends for about 150 km downslope of the shelf-break, and the distal end of the fan reaches the abyssal plain at 2200 m water depth. Depositional processes are located essentially on the middle and lower slope. The surface of the fan is covered by a network of meandering channels. The southern system is controlled by the Danube sediment supply through the Viteaz canyon (Popescu et al., 2004), whereas the Dniepr, the Dniestr and the Bug probably built up the northern system (Wong et al., 1997). The Black Sea was a low salinity lake during most sea-level lowstands when fan deposition was active. Turbidite sedimentation in the deep North-western Black Sea was not well investigated before the 1990s (Popescu et al., 2001; Winguth et al., 2000). Recent and further contributions will improve considerably our understanding of the architecture and growth pattern of the Danube and Dniepr deep-sea fans.
- **The Black Sea is linked to the Mediterranean Sea only through the Bosphorus-Dardanelles system of straits**. The Bosphorus sill was responsible for a particular behaviour of the Black Sea during the global glaciations and deglaciations. Thus the Black Sea level followed the World Ocean level changes while it was higher than the sill. When global sea level was lower than the Bosphorus sill the variations of the Black Sea level reflected specific regional climate conditions without being coupled to the ocean changes. The Bosphorus is a rather narrow (0,76–3,6 km large) and shallow strait (32–34 m at the sill) restricting the two-way water exchange between the brackish Black Sea (the salinity of the Black Sea water is about 17‰ at the surface and 22 ‰ at the bottom) and the very saline Mediterranean Sea (38–39 ‰). The surface outflow of the less saline Black Sea water is estimated at about 600 km^3 yr^{-1}, while the under-current of saline Mediterranean water flows towards the Black Sea and supplies it with almost 300 km^3 yr^{-1} (Oguz et al., 2000; Ozsoy and Unluata, 1997).

Recent studies assume that a rapid flooding event could have occurred in the Black Sea during the Holocene (Figure 2)**.** The study area selected is the northern margin of the Black Sea where the shelf is sufficiently wide to preserve depositional sequences originating from sea level changes. Rapid flooding would have created a Bosphorus "waterfall" and would have obliterated the original ancient shoreline. Radiocarbon ages of the first sedimentation either on a desiccated gravel or on alluvium should be around 7,150 yr BP as noted by the R/V AQUANAUT (Ryan et al., 1997) and BLASON (1998) cores (Lericolais et al., 1999). Confirmation of a rapid flooding would open up the possibility of human settlement (Neolithic or Nautifian villages) on the shelf prior to the flooding event (Baruch and Bottema, 1991; Mellaart, 1967; Moore and Hillman, 1992; Özdogan, 1985) and is of significant interest for climate variability, the Black Sea having behaved differently from the main seas and oceans bordering Europe. However, there is also evidence which contradicts this hypothesis (Aksu et al., 1999) and the continuing study of the Black Sea sedimentary systems will help elucidate such catastrophic environmental changes together with related processes such as sedimentation, ecosystem changes and even human population migration.

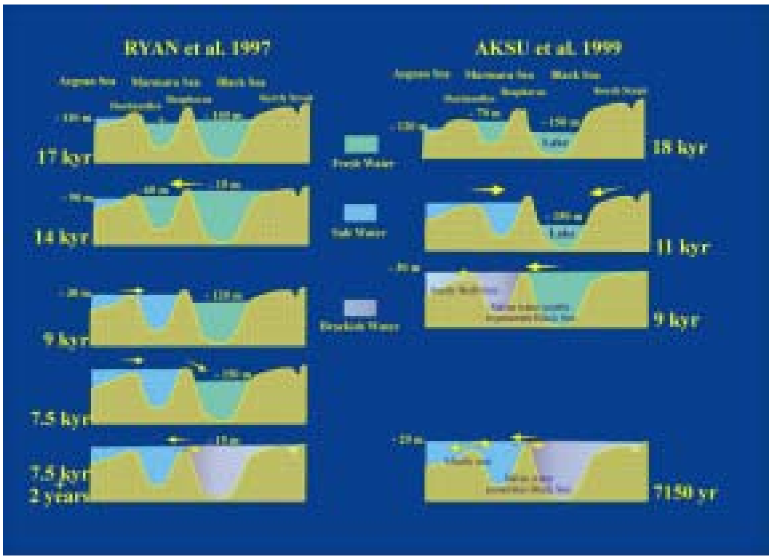


Figure 3.1.1 – Last re-connection between the Black Sea and Mediterranean Sea (from Ryan et al., 1997 and Aksu et al.,1999)

- **The Black Sea has restricted exchange through the Bosphorus Strait. As a result, a strong permanent halocline develops and prevents deep ventilation in the basin interior.** These restrictions are responsible for anoxia in 87 % of its volume. For all the Black Sea riparian countries, the shoaling of the oxic/anoxic interface which might occur as a response to a decrease in freshwater input due to intensive irrigation projects in the Former Soviet Union (Murray et al., 1989) might have a catastrophic effect, such as the devastating ecosystem alterations of the Black Sea witnessed in recent decades. The latter phenomenon, a response to changing anthropogenic inputs for the shelf area, is closely related to the intensity of the ventilation within the upper halocline for the open part of the sea. The Black Sea halocline is either ventilated due to rather slow vertical diffusion or through lateral injection of dense Marmara Sea water, coming with Bosphorus inflow, mixed with oxygenated water of the Cold Intermediate Layer.

- **This particular anoxic dominated environment is responsible for a widespread of sapropels** everywhere from the continental slope to the deep sea. The formation of sapropels can be related either to an increase of precipitation and freshwater run-off during glacial intervals or to changes in stratification and/or the chemistry of the water column, which are thought to lead to increased anoxia in the bottom water, increased primary productivity, and more complete preservation of organic matter (Calvert and Karlin, 1998; Rohling, 1994; Rossignol-Strick et al., 1982; Sancetta, 1999). Others (e.g. (Bosch et al., 1997) consider that sapropels are formed by anoxia in the photic zone. A number of sapropel layers have been observed in marine sedimentary sequences that extend over several glacial-interglacial cycles, which suggests that the conditions under which sapropels form are linked, directly or indirectly, to Quaternary climate forcing mechanisms.
- **Preliminary estimation of hydrate potential in this region is still required**. The Black Sea is one of the largest basins on the Earth with anoxic environment below 150 m water depth. In such conditions, with a large supply of organic matter from the tributary rivers and from the oxygenated surface layer, sulphate reduction, methanogenesis and methane oxidation are the dominant terminal processes of carbon flux in the sediments. The biogases are present in large quantities in the Black Sea sediments in different bathymetrical zones starting with the continental shelf. Within the deeper zones (more than 600 m) gas hydrate occurrence is reported. Nevertheless no reliable estimation of deep hydrate potential is available for the Black Sea. Combined expertise from relevant scientific fields i.e., geophysics, sedimentology, microbiology, geochemistry will allow the identification and investigation of gas occurrence in the sediments (vents, seeps, mud volcanoes) and associated structures (carbonates, bacterial mats), as well as the inventory of gas hydrate occurrence and potential estimation. The Black Sea represents a key region for understanding the significance of this greenhouse gas production and emission for global climatic changes.

These details emphasise the fact that the **Black Sea is a unique natural laboratory**. Thus, validation of the results from previous stratigraphic surveys and investigations must be undertaken. The opportunity to use a marine facility with the ability to core to a sediment depth of 50 meters presented a unique opening for the ASSEMBLAGE project.

3.2. Previous campaigns and brief references on the subject

Most of the previous work in the Black Sea was undertaken by scientific teams from the former USSR. The first bathymetric charts were published by Androsov (1893) and the first important compilation was published in the seventies by (Goncharov et al., 1972). Most of the publications concerning the Black Sea are written in Russian and we have access to it only through our Romanian, Bulgarian and Ukrainian colleagues. Specific surveys have been carried out by the Bulgarian Academy of Sciences on their own continental shelf (Kuprin, 1980; Kuprin et al., 1974). On the Romanian coast; it is principally the evolution of the recent part of the Danube delta which has been studied (Panin, 1972; Panin, 1974; Panin, 1983; Panin, 1989; Panin, 1995). In 1969, on board the Atlantis 2 Research vessel, American teams began their investigation in the area (Degens and Ross, 1974) and continued in 1988 on board the R/V Knorr (Murray, 1991). Some French scientists worked on samples collected during these surveys (Calvert and Fontugne, 1987; Guichard et al., 1993).

In 1975, DSDP leg 42B from the Glomar Challenger sampled the sedimentary deposits of the Black Sea Basin from the Upper Miocene through to the present (Ross and Neprochnov, 1978). Our group is associated to an ODP proposal presented by Roger Flood following the letter of intent prepared in 1996 in Malanas (Romania). The deep structure of the Black Sea basin has been studied within the Odyssée IV du CNEXO/CEPM (Letouzey et al., 1977) and also by a seismic survey using the R/V Nadir (campaign BLACKSIS 1997, C. Rangin chief scientist). Recent surveys have been carried out in the Black Sea with the Russian R/V Geledzhnik studying principally mud volcanoes and gas hydrates (Training Through Research UNESCO program 1992). The German expedition to study the Dnieper and Danube fans (Wong et al., 1994) as well as an American campaign in 1993 on the Ukrainian margin (Ryan et al., 1997) and the EROS 2000/EROS 21 (J.M. Martin, ENS, N. Panin et al.) European project sought to understand the origin of pollutants offshore of the Danube.

In 1998 and 2002, two research surveys in the frame of the BlaSON project were carried out. The Blason2 survey completed the results obtained in 1998 on the Danube deep sea fan in the Black Sea. Principal channels were mapped using a multibeam echo-sounder system together with high-resolution seismic reflection profiles and piston cores. The resulting mosaic provided an insight into the complete channel-levee system of the Danube fan (Figure 3). This fan probably developed in a low-salinity basin with a water level about 100 m lower than today. Sediments supplied by the Danube were transported to the basin through the Viteaz canyon. Channel avulsion was common in the middle fan. Each phase developed by breaching the thinner left levee, building of a unit of HARP (High-Amplitude Refection Packet), followed by the initiation of a new meandering leveed channel (Lericolais et al., 2002b; Popescu et al., 2002; Popescu et al., 2001).

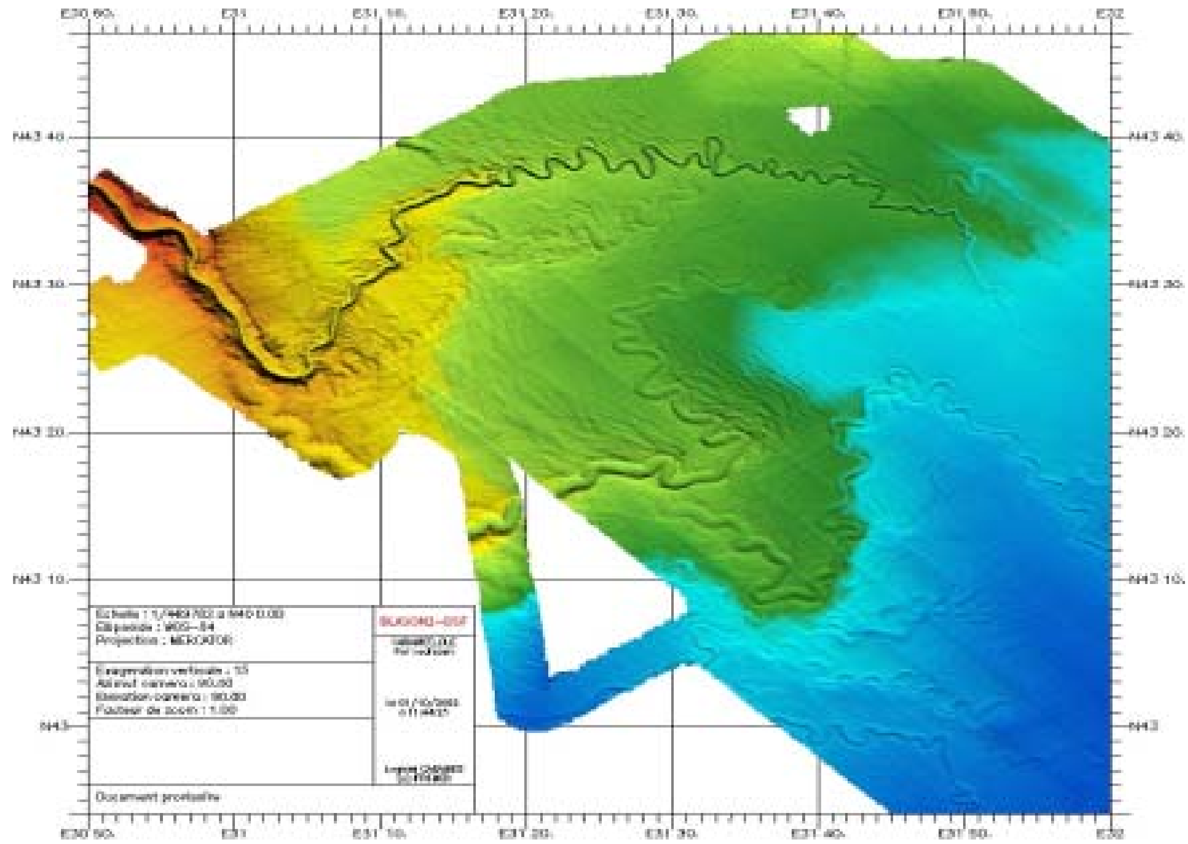


Figure 3.2.1 – The Danube Deep-Sea Fan mapped with multibeam EM 300 echo-sounder during BlaSON2 cruise

This system presents northward migration phases with successive bifurcations influenced by the asymmetry between levees. The location of HARPs and channels after bifurcation are controlled by the pre-existing bathymetry, confined between the high of the youngest channel-levee system to the south, and the steep relief of the Dniepr fan to the north. The HARP deposits consist of fine to very-fine sand with mud clasts. Sparse occurrences of reworked benthic foraminifers indicate a much shallower sediment source while the rare ostracod specimens characterize a low salinity to brackish water basin. It seems clear that sea level fluctuation is at the origin of the control of the Danube fan activity but the evolution of the last channel-levee system suggests that the primary control of channel avulsion and sand delivery is probably autocyclic and in that case (a large lake) only hyperpicnality operates.

During the BlaSON expedition in May 1998, the French Research Vessel Le Suroit mapped the northwest continental shelf of the Black Sea and revealed a seabed populated by sand ridges and small depressions overlying and sculpted into the eroded remains of a former terrestrial floodplain. The ridges are located at the crest and landward of a shoreface recognized at depths of –85 to –100 m. They have stronger correspondence to aspect ratios of modern linear beach ridges than to those of underwater sand waves. The depressions are similar in size and shape to pans formed through wind deflation. The ridges and depressions sit on a surface exposed by a low stand of the Black Sea's glacial and post-glacial lake. Submergence without destruction and infilling suggests a rapid rise in the lake's surface (Lericolais et al., 2001; Lericolais et al., 2000a; Lericolais et al., 2000b).

In August 2002, the French research vessel “Le Suroit” equipped with a EM 300 multibeam echo-sounder and a TritonElics Chirp Sonar mapped the Bosphorus outlet at the shelf edge. The results show the existence of an important retrogressive canyon incised on the platform and two more recent canyon heads, the incision of which can be followed landward on the shelf in front of the Bosphorus outlet. The direction of these canyon heads being West-East is puzzling. One suggestion is that they may follow a tectonic direction. Coring should be undertaken on the platform and then in the canyon itself where some megaripples made of shell debris have been found witnessing a very recent activity (Lericolais et al., 2002a).

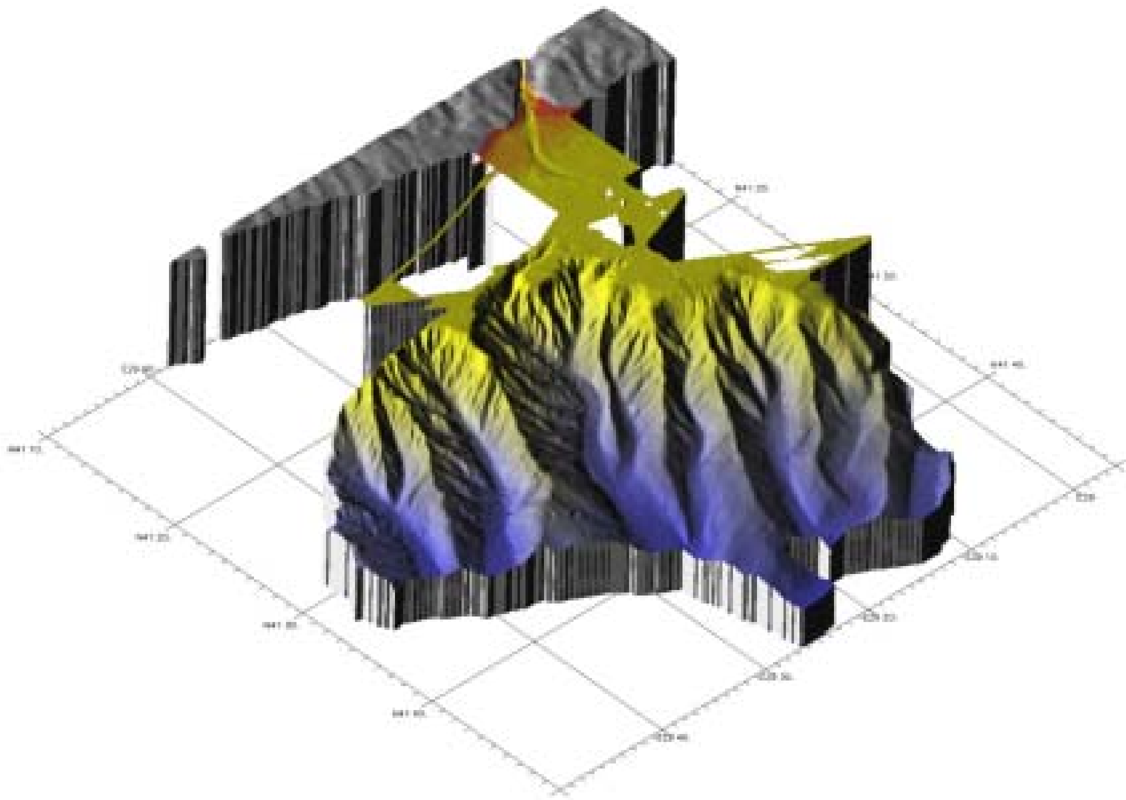


Figure 3.2.2 – 3D view of the Bosphorus outlet mapped with multibeam EM 300 echo-sounder during the BlaSON2 cruise

3.3. References for chapter 3

Aksu, A.E., Hiscott, R.N. and Yasar, D., 1999. Oscillating Quaternary water levels of the Marmara Sea and vigorous outflow into the Aegean Sea from the Marmara Sea Black Sea drainage corridor. Marine Geology, 153(1-4): 275-302.

Andrusov, N.I., 1893. Sur l'état du bassin de la Mer Noire pendant l'époque pliocène. Akad. Nauk St. Petersburg Bull., n.s., 3(35): 437-448.

Baruch, U. and Bottema, S., 1991. Palynological Evidence for Climatic Changes in the Levant ca. 17,000-9,000 B.P. In: O. Bar-Yosef and F.R. Valla (Editors), The Natufian Culture in the Levant. Ann Arbor: International Monographs in Prehistory, pp. 11-20.

Bondar, C., 1998. Hydromorphological relation characterizing the Danube river mouths and the coastal zone in front of the Danube delta. Geo-Eco-Marina, 3: 99-102.

Bosch, H.J., Sinninghe-Damste, J.S. and de Leeuw, J.W., 1997. Photic zone anoxia during eastern Mediterranean sapropel formation. Terra Nova, 9(Abstr. Suppl. N1): 401.

Calvert, S.E. and Fontugne, M.R., 1987. Stable carbon isotopic evidence for the marine origin of the organic matter in the Holocene Black Sea sapropel. Chemical Geology, 66(3-4): 315-322.

Calvert, S.E. and Karlin, R.E., 1998. Organic carbon accumulation in the Holocene sapropel of the Black Sea. Geology, 26(2): 107-110.

Degens, E.T. and Ross, D.A., 1974. The Black Sea - Geology, Chemistry and Biology, 20. Amer. Assoc. Petroleum Geol., Tulsa, 633 pp.

Goncharov, V.P., Nepozochnov, V.P. and Nepozchnova, A.F., 1972. Bottom relief and deep structure of the Black Sea Basin. Nauka, (Moscow), 157((in Russian)).

Guichard, F., Carey, S., Arthur, M.A., Sigurdsson, H. and Arnold, M., 1993. Tephra from the Minoan eruption of Santorini in sediments of the Black Sea. Nature, 363(17): 610-612.

Kuprin, P.N., 1980. Geological-geophysical investigations of the Bulgarian Black Sea sector. BAN (Sofia), 318((in russian)).

Kuprin, P.N., Scherbakov, F.A. and Morgunov, I.I., 1974. Correlation, age, and distribution of the postglacial continental terrace sediments of the Black Sea. Baltica, 5: 241-249.

Lericolais, G. et al., 2002a. Recent canyon heads evidenced at the Bosphorus outlet. EOS transactions.

Lericolais, G., Panin, N., Guichard, F., Popescu, I. and Ryan, W.B.F., 2001. Un évènement géologique majeur est-il à l'origine de la reconnection entre la Méditerranée et la mer Noire, il y a 7 500 ans ?, 8ème Congrès Français de Sédimentologie. Association des Sédimentologues de France, Orléans, pp. 219.

Lericolais, G. et al., 1999. Quaternary sea-level fluctuations in the Black-Sea, new discoveries during Blason survey on the North Western Black Sea Shelf. In: A. The Institute of Oceanography NCMR, Greece (Editor), Oceanography of the Eastern Mediterranean and Black Sea : Similarities and differences of two interconnected basins - EU, IO/NCMR, IOC/UNESCO. European Commission, Athens (Greece).

Lericolais, G. et al., 2000a. An abrupt transition 7500 years ago in the Black Sea results of the BlaSON survey (Romanian shelf). In: I.U.o.G.S. IUG (Editor), IGCP 396 - 31st International Geological Congress. IUGS and UNESCO, Rio de Janeiro (Brazil).

Lericolais, G. et al., 2000b. A major erosional surface recognized on Black Sea seismic data during Blason survey. In: N. Panin and C. Dinu (Editors), International Geophysical Conference & Exposition. SEG - EAEG - RSG, Bucharest (Ro).

Lericolais, G. et al., 2002b. Viteaz Canyon, The only sediment pathway of the Black Sea Shelf ? CIESM Workshop series, 17: 77-80.

Letouzey, J., Khristchev, K., Gonnard, R., Montadert, L. and Dorkel, A., 1977. Black Sea : Geological setting and recent deposits distribution from seismic reflection data. In: DSDP (Editor), Initial report of DSDP. U.S. Government Printing Office, Washington.

Mellaart, J., 1967. Çatal Hüyük - A Neolithic Town. McGraw Hill, New York, 232 pp.

Moore, A.M.T. and Hillman, G.C., 1992. The Pleistocene to Holocene transition and human economy in soutwest Asia: the impact of the Younger Dryas. American Antiquity, 57(3): 482-494.

Murray, J.W., 1991. The 1988 Black Sea oceanographic expedition: introduction and summary. Deep-Sea Research, 38(Supplement 2): S655-S661.

Murray, J.W. et al., 1989. Unexpected changes in the oxic/ anoxic interface in the Black Sea. Nature (London), 338(6214): Pages 411-413.

Oguz, T., Ducklow Hugh, W. and Malanotte Rizzoli, P., 2000. Modeling distinct vertical biogeochemical structure of the Black Sea; dynamical coupling of the oxic, suboxic, and anoxic layers. Global Biogeochemical Cycles, 14(4): Pages 1331-1352.

Özdogan, M., 1985. A surface survey for prehistoric and early historic sites in northwestern Turkey, National Geographic Research Reports for 1979, pp. 517-541.

Ozsoy, E. and Unluata, U., 1997. Oceanography of the Black Sea; a review of some recent results. Earth-Science Reviews, 42(4): Pages 231-272.

Panin, N., 1972. Quaternary history of the Danube delta. Cercetari marine, 4: 5-15.

Panin, N., 1974. Evolution of the Danube delta during the Holocene. Geologia Cuaternarului, H(5): 107-121.

Panin, N., 1983. Black Sea coastline changes in the last 10,000 years: a new attempt at identifying the Danube mouths as described by the ancients. Dacia N.S., 27: 175-184.

Panin, N., 1989. Danube delta: Genesis, evolution sedimentology. Rev. Roum. Géol. Géophys. Géogr., 33: 25-36.
Panin, N., 1995. Impact of global changes on geo-environmental and coastal zone state of the Black Sea, Geological and Geoecological Study of the danube Delta and the Black Sea Western Shelf Margin International Workshop, Tulcia, pp. 1-8.
Panin, N., 1997. On the geomorphologic and geologic evolution of the river Danube: Black Sea interaction zone. Geo-Eco-Marina, 2: 31-40.
Popescu, I. et al., 2002. Architecture and recent sedimentary evolution of the Danube deep-sea fan (Black Sea). CIESM Workshop series, 17: 81-84.
Popescu, I. et al., 2004. The Danube Submarine Canyon (Black Sea): morphology and sedimentary processes. Marine Geol., (Accepted).
Popescu, I., Lericolais, G., Panin, N., Wong, H.K. and Droz, L., 2001. Late Quaternary channel avulsions on the Danube deep-sea fan. Marine Geology, 179(1-2): 25-37.
Rohling, E.J., 1994. Review and new aspects concerning the formation of eastern Mediterranean sapropels. Marine Geology, 122(1-2): 1-28.
Ross, D.A. and Neprochnov, Y.P. (Editors), 1978. Initial Reports of the Deep Sea Drilling Project. Initial Rep. Deep Sea Drill. Proj., 42, part 2. US Govt. Print. Office, Washington, DC, 1178 pp.
Rossignol-Strick, M., Nesteroff, W., Olive, P. and Vergnaud-Grazzini, C., 1982. After the deluge; Mediterranean stagnation and sapropel formation. Nature, 295(5845): 105-110.
Ryan, W.B.F. et al., 1997. An abrupt drowning of the Black Sea shelf. Marine Geology, 138(1-2): 119-126.
Sancetta, C., 1999. The Mystery of Sapropels. Nature, 398(6722): 27-29.
Winguth, C. et al., 2000. Upper Quaternary water level history and sedimentation in the northwestern Black Sea. Marine Geology, 167(1-2): 127–146.
Wong, H.K., Panin, N., Dinu, C., Georgescu, P. and Rahn, C., 1994. Morphology and post-Chaudian (Late Pleistocene) evolution of the submarine Danube fan complex. Terra Nova, 6: 502-511.
Wong, H.K. et al., 1997. The Danube and Dniepr fans, morphostructure and evolution. GeoEcoMarina, 2: 77-102.

MD04-139 ASSEMBLAGE 1

Tools and Methods:

Multibeam echo-sounder and Sub-bottom profiler

Coring and core description on board

. *General Presentation of the Calypso Corer*
. *Description of the Ronanberg*
. *Core packaging*
. *Lithostratigraphic logs*
. *Digital Photography*
. *Color Spectrophotometry*
. *Multi-parameter measurements GEOTEK (MSCL)*
. Pore water extraction
. Gas Chromatograph
. Sampling

CTD, Hydrology and Plankton nets

4. TOOLS AND METHODS

4.1. Multibeam echo-sounder and Sub-bottom profiler

4.1.1. Multibeam echo-sounder (by Xavier Morin)

The deep water echo-sounder Thomson Seafalcon 11 was installed on board the oceanographic research vessel Marion-Dufresne in 1995. It has since then become an essential instrument, which is intensively used for cartography (bathymetry and imagery) and sediment profiling. The multibeam echo-sounder (MBES) Thomson Seafalcon 11 runs two modes of operation: the “bathymetry and imaging” mode and the “sub-bottom profiler” mode. Both modes can be run simultaneously.

Bathymetry and imagery are simultaneous information derived by the echo-sounder. Bathymetry provides the depth, travel time and propagation direction of a huge number of created soundings, regarding the ship’s attitude and sound velocity profile. Imagery is the reflectivity derived from the soundings signals and is related to backscattered energy. A seabed image is produced from this information, where grey levels are dependent of the sea floor nature. In this operating mode (bathymetry and imagery), the echo-sounder uses transmitted frequencies around a 12 kHz carrier. The range of depths on which this mode can operate is 50 to 11000 metres. Five spatially separated cross-track swaths are simultaneously created in order to generate a data redundancy (as if five multibeam echo-sounders were simultaneously used). These swaths are separated in the frequency domain by the use of digital active filters. Thus, measurement gaps are avoided. These five swaths are separated (along the boat-track axis) from each other by a 1.4-degree angle. The central swath is vertical. The large antenna 3 dB attenuation level (at transmission) and beam forming at reception allow images to be built and measure bathymetry at 120 degrees from the track axis of the boat (60 degrees to starboard and 60 degrees to portside). Actually, the swath angle depends on the depth and on the signal-to-noise ratio. It is always comprised between 120° and 140°. Concerning bathymetry, the across-track resolution depends upon the measured depth H. The across-track length of a resolution cell is typically equal to H/100. The number of created soundings for one measurement is typically equal to 2000 (400 per swath).

The imaging system uses the reflectivity extracted from the five separated frequency swaths. This representation is useful for the study of the seafloor texture and composition. In order to build images, a mosaic is created, geographically representing sea bottom level in the studied area. This mosaic is fed by the five sets of backscattered signal. The huge number of data for each swath (around 20.000 for a complete cycle of 5 emitted frequencies) and their redundancy allow a large geographic coverage and the relative increase of the signal-to-noise ratio.

4.1.2. Sub-Bottom profiler

The Seafalcon 11 echo-sounder also includes a sub-bottom profiler. This system is able to create reflectivity slices of the sub-bottom sea floor as a function of the geographical position of the boat. As described in the preceding paragraph, beam forming from many signals received on each sensor provides a very narrow antenna diagram (high directivity), during transmission (7.4 degrees) and reception (5.6 degrees). This beam formation also achieves a high acoustic signal level. Indeed, one of the main features of this profiler is the use of a large dedicated transmission array, and the use of the large bandwidth and long size multibeam reception array in order to create a high acoustic level signal and a very narrow beamwidth. While classical profilers beamwidths are usually wide (20° to 30°), the seafalcon 11 echo-sounder produces a 7.4° width beam. This feature prevents from interferences between different objects located in the illuminated scene, and achieves a very good along-track resolution. The central frequency used for this system is equal to 3.75 kHz. As for the "bathymetry and imaging" mode, the transmitted wave is linearly frequency modulated. The corresponding correlation gain is equal to 23 dB. The large transmitted bandwidth (1.6 kHz) achieves a small vertical resolution (0.45 metres). Five beams are created on reception (the central beam is vertical), separated from each other by 5 degrees. This diversity provides an opportunity to record good quality profiles when the across-track slope is steep. Typically, 100 metres penetrations are achieved for a 4000 metres depth. The maximal observed penetrations are around 200 metres. In any case, the ship's attitudes are used in order to determine the exact location of each sounding. Two high performance Heading and Vertical Reference Unit (HVRU) are installed on the Marion-Dufresne to measure the ship's attitudes.

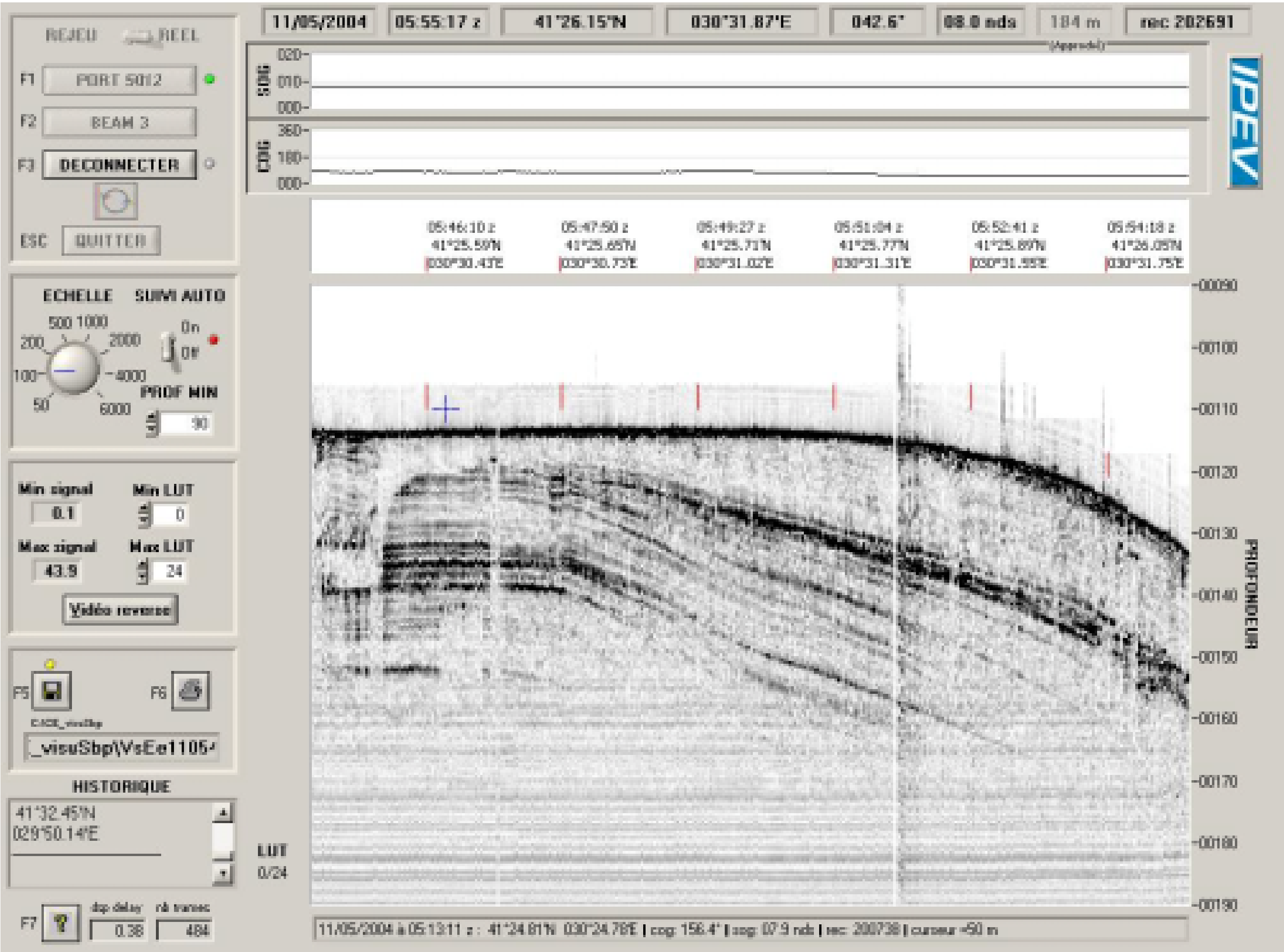


Figure 4.1.2.1: Example of Sub-bottom Profiler (SBP) profile acquired surveying a Lowstand prograding wedge on the Turkish coast.

4.1.3. Post-processing

The post-processing of bathymetry and imaging data is carried out with the “Caraibes” software, which has been developed by I.F.R.E.M.E.R. This image processing software enables the creation of geographical digital data grids for bathymetry. Contour extraction, “spline” curves filtering and bi-dimensional digital filtering are examples of tools that can be used to remove any possible artefact. 3-D representations are possible. The resolution cell size of the digital terrain Model can be chosen, as well as the vertical depth resolution. A version for real time display is also installed aboard the Marion Dufresne vessel. This tool is very useful, since it clearly shows the multibeam coverage during surveys. The ship’s routes can be adapted in real time in order to achieve the goals of the survey. In order to *a posteriori* view the sub-bottom profiles, the French Polar Institute has developed a unix-based software. This software uses GMT and is freely available to any scientist team who would ask for it.

4.1.4. Site Survey

Every coring site has been determined from previous geophysical surveys; essentially BlaSON1 and BlaSON2 surveys. Nevertheless a new site survey was carried out during the cruise using Marion Dufresne equipment; multibeam echo-sounder and Sub-bottom profiler. An accurate survey of the chosen site is essential to reach the core target. Due to the important morphology and thickness variations, the position and the nature of the sedimentary layer, it is important to know precisely the nature of the sedimentary cover on site to select the appropriate tube length and set the corer parameters.

Figure 4.1.1 Site survey routes

Echo-sounder data are linked to a D-GPS positioning system. The data are recorded and visualised with Caraïbes, (real-time cartography software – Ifremer)

Besides real time acquisition, a quality control is done using printed profiles. The chirp profiles are visualised on the SBP-visu interface and plotted on Dowty plotter.

4.2. Coring and cores study on board

4.2.1. General presentation of the corer

The corer used during the mission is the Calypso piston-coring system, developed by IPEV and dedicated to the "Marion Dufresne".

This corer can be equipped with a tube up to 75 m long (limitation due to the length of the gangway where the corer is installed). The corer is deployed using a cable made of kevlar, virtually weightless in water. This significantly enhances the traction security margin and weight lifting capacity of the winch. During the cruise, the longest tube used was 55meters.

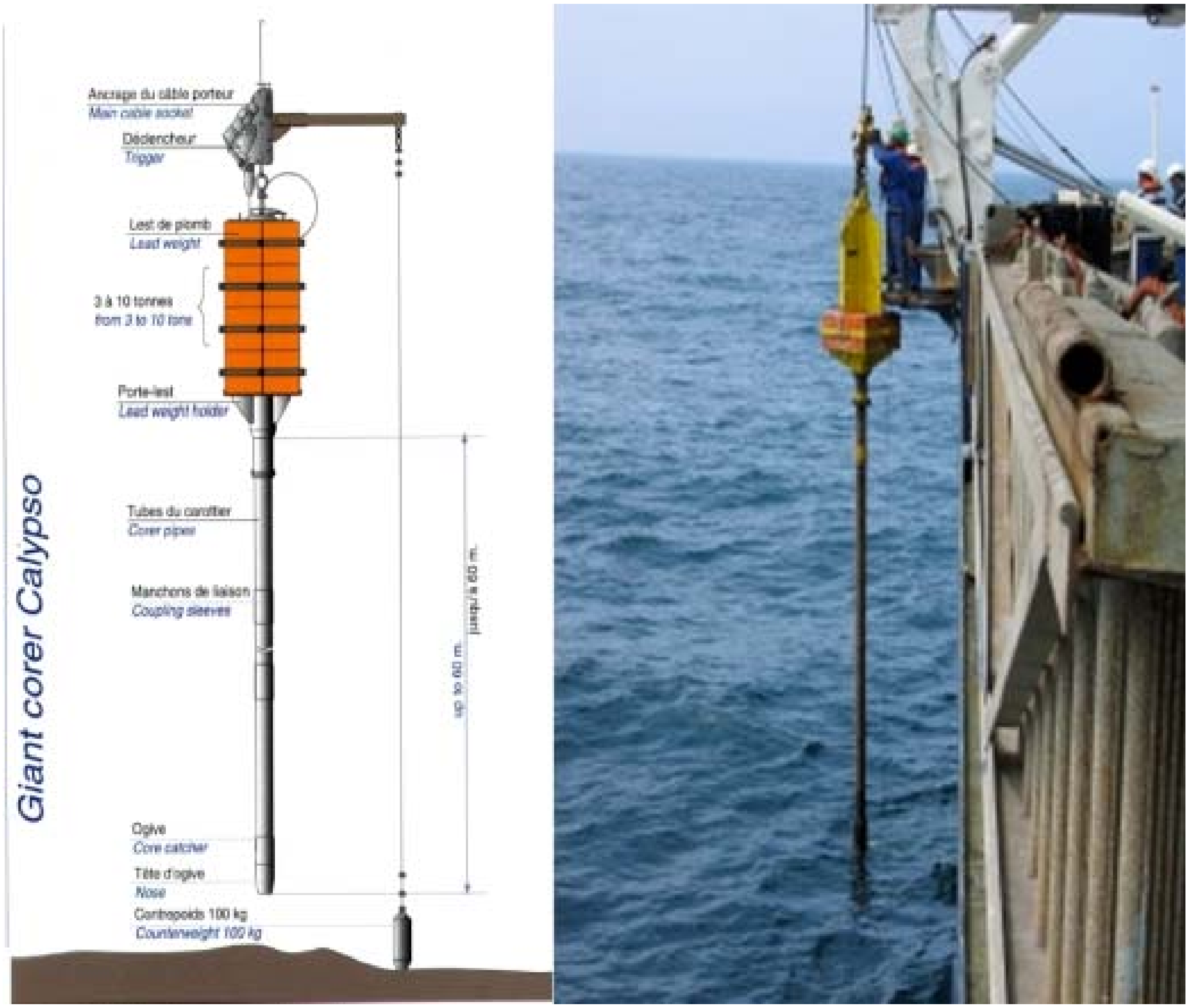


Figure 4.2.1 Giant corer Calypso

4.2.2. Core packing

The core is recovered in its PVC liner. Once extracted from the steel casing, the core is graduated in cm from the top to the base. According to this graduated scale, the core is sectioned from the top in 1.5 m parts. The top and base of each section is marked with a "Top" (Top) and "Base" (Bottom).

Each section is then cut longitudinally into an Archive half (marked as "A") and a Working half ("W").

The "A" part is stowed in a waterproof plastic sheath and stored in a cold chamber in a PVC box-tube. The "W" half is submitted to several analyses onboard.

This chain is made in a work order described on the following pages. For the preservation of the fleeting mineral phases, highly sensitive to decompression or to oxidation, it is preferable to make digital photographs before other operations.

Core labelling and cutting the 1.50 m sections

Core splitting

4.2.3. Lithostratigraphic description

The description of the lithostratigraphy of every core section is an important stage. This enables us to obtain a total log description of the core recovered. Data sheets similar to the ODP type are completed according to the visual description of the work sections. A first microscopic exam, using a binocular magnifying glass (sands) or with a smear glued with Canadian balsam (for muds) can be helpful.

The stratigraphic log provides information on the sedimentary structures (primary or linked to sediment deformation due to the coring), granularity (which give standard sediment lithology), specific observations (clasts, erosion surfaces, etc), colour (eventually with a colorimetric chart such as the Munsell, sampled positions (smear, etc…). Then, in order to complete the log analysis, data description is made on board using Adobe-Illustrator (Figure 4.4.1)

Core description: Logging

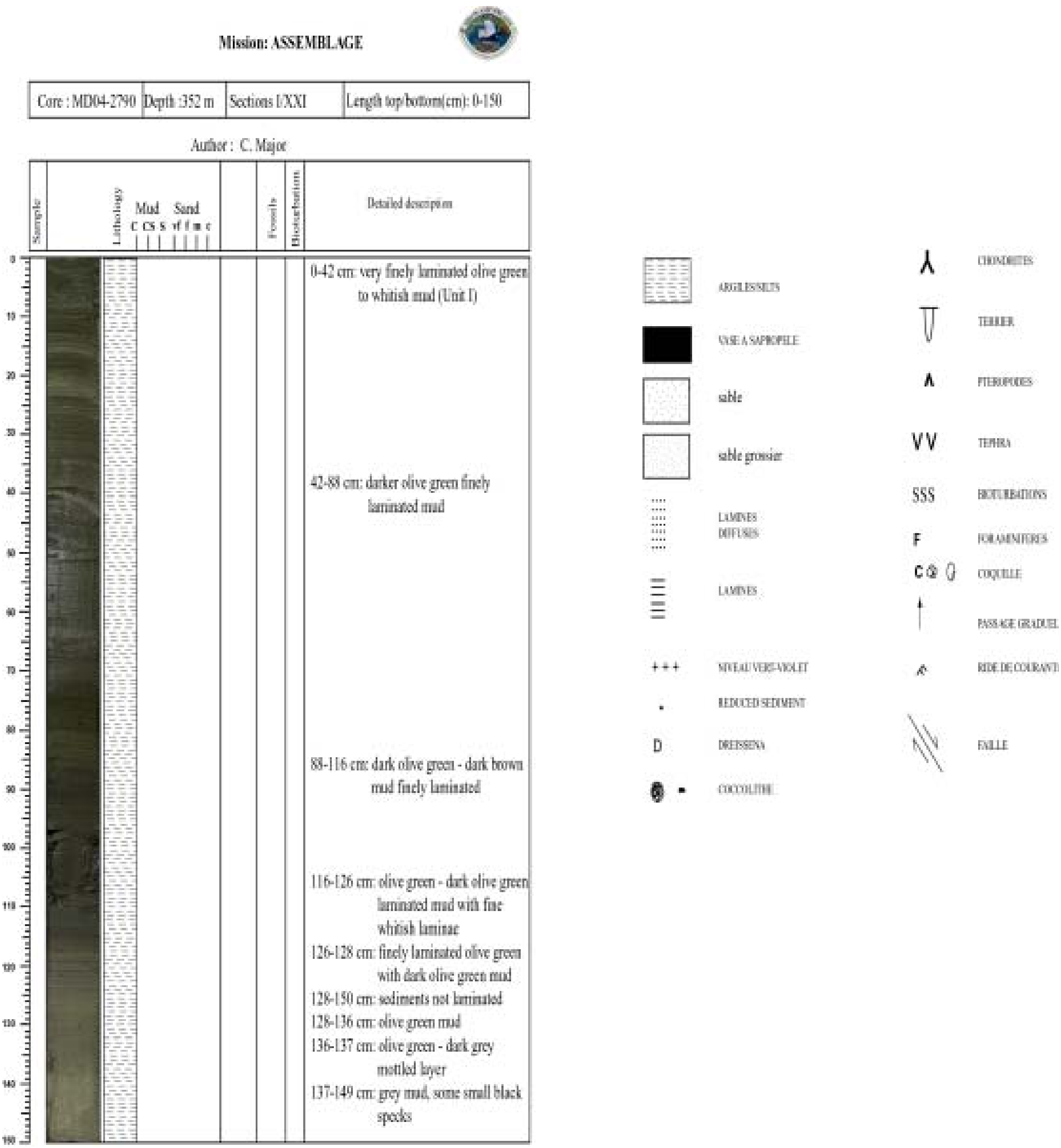
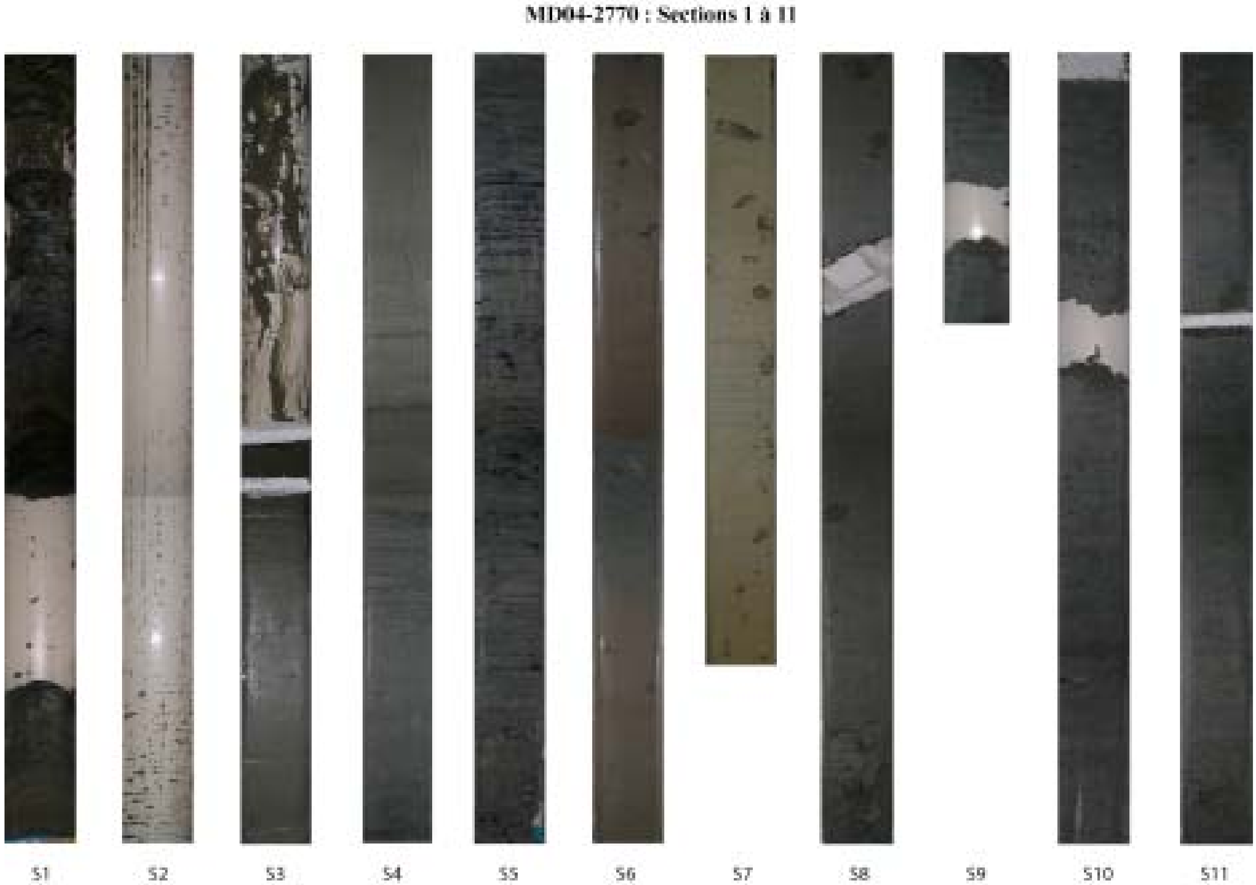


Figure 4.4.1: symbols used and an example of log are illustrated on the following pages.

4.2.4. Digital photography

All sections described have been photographed using a commercial digital camera and these photographs were incorporated into the core log sheets. High resolution scanning was also performed on the MST rack



Example of Core MD04-2770 digital photographs of the First 11 sections

The section photographs provide high-quality sediment images in the state immediately after opening. Pictures have always been taken as soon as possible after the core opening in order to avoid the rapid degradation of the mono-sulphur colours. High resolution scanning was also performed on the GEOTEK MST rack.

Photo-Scanner on the GEOTEK MST rack

4.2.5. Colour spectrophotometry

The spectrophotometer enables us, in some case, to obtain a preliminary stratigraphic log based on sediment colour variation along the sections.

The light-coloured tints could correspond in some cases to a more carbonate-rich sediments formed during relatively warmer periods, while dark ones may correspond to periods of a colder climatic environment. The measure is undertaken when the work sections are covered by a transparent plastic film (to avoid pollution of the sensor in contact with the sediment). Since the equipment was not set up properly at the beginning of the cruise, only a few of last cores were studied on board using the Spectro-colorimeter.

The spectrophotometer used is a Minolta CM-508i, using an 8 mm diameter disk sensor. Measurements are made continuously every 5cm. A colour spectrum (400-700 nm divided into sixteen 20 nm classes) is recorded.

4.2.6. GEOTEK Multi Sensor Core Logger (MSCL)

Gamma density, magnetic susceptibility and P-Wave Velocity are measured continuously every 2 cm on the core working section by the MSCL (Multi-Sensor Core Logger)

The detectors worked automatically after the calibration of the thickness of the section on the MSCL, which requires a perfect horizontal sediment surface to guarantee the continuity of the records, particularly for the susceptibility and the velocity of the P-waves.

GEOTEK - Multi Scanner Core logger

The Gamma attenuation is also calibrated with a standard with different aluminium cylinders of different diameters submerged in water in the same type of PVC tube as the one used for the cores.

The aluminium had a density of 2.71, identical to the mean density of the alumino-silicates minerals, the major component of the sediments recovered during coring. The immersion of the standard allows the system to be close to the attenuation characteristics, which corresponds to sediments saturated in water (60 to 80% of the total volume). The calibration analyses are integrated during 10 seconds and the sediment ones during 2 seconds. The measure of the P-waves speed (PTO : P-wave Travel time Offset) is done across the acoustic transducers and the PVC. It is based on the difference between the theoretical duration of the sound in 4 cm of water at a given temperature, and the duration in the part of the gamma density standard without aluminium. The transducer used measures the impulsion velocity with a 50 ns resolution. This permits the determination the PTO in the medium with a 1.5 m/s resolution. The magnetic susceptibility analysis is calibrated on a measure in the void (zero).

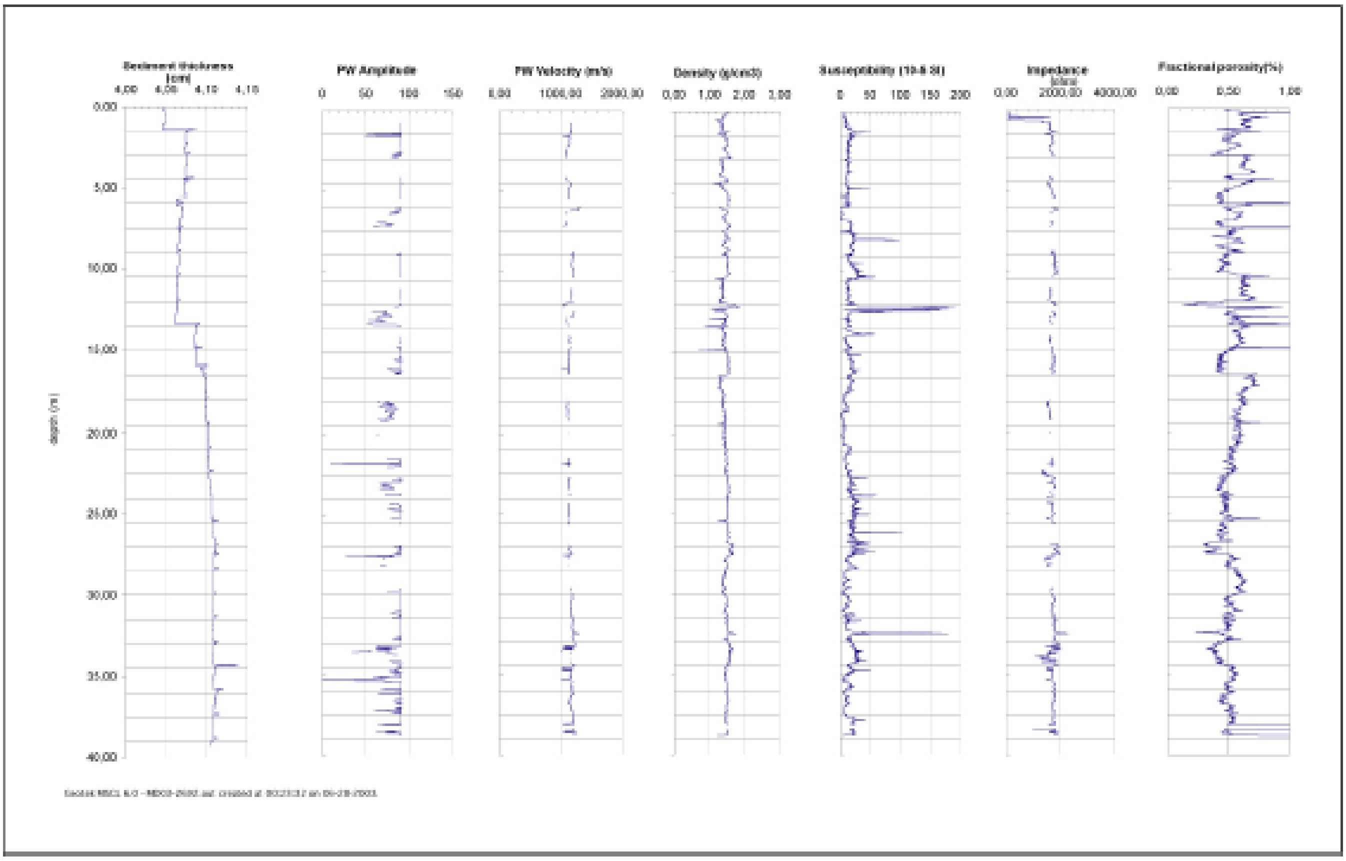


Figure 4.2.6.1: Example of MSCL measurements

4.2.7. Pore Water extraction

Sediment sampling for pore fluid extraction was performed on Core MD04-2770. A pore water squeezer was used in a cold room at 4°C. A first sampling session was performed on deck while the cores were cut in sections. Systematic sampling of sediment for porosity was performed simultaneously. Additional sampling in selected intervals was performed later on split sections. All samples were wrapped in parafilm and stored in the cold room before squeezing. The typical volume of extracted pore fluid ranged between 5 and 25 ml.

Pore water extraction

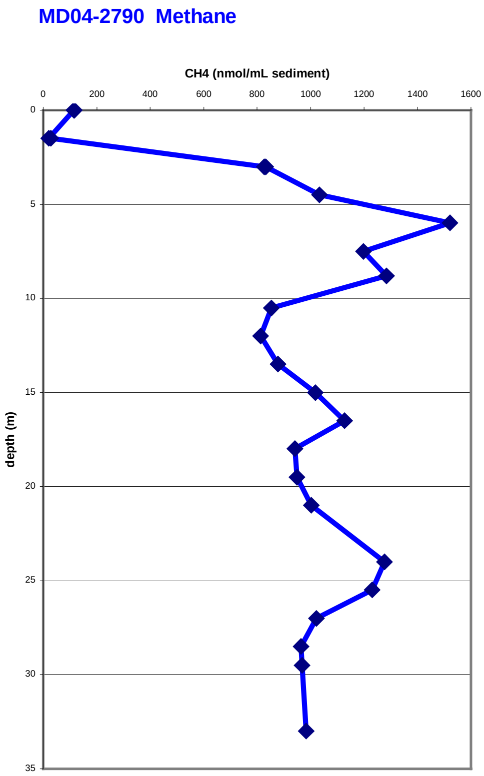
The MPI (Max Planck Institute of Bremen) represented onboard by Friederike Ebersbach participated in the cruise having a special interest in studying the biogeochemical cycles (iron-sulfur) in the Black Sea. Sediment sampling as well as pore water analyses will be undertaken to determine the influence of Mediterranean waters mainly in the sulfidization front below sapropel layers. The sediment samples will be taken for analyses of sulfur and iron species including AVS, pyrite, greigite, organic sulfur, reactive iron and stable sulfur isotope signatures of the sulfur fractions. We want to look for sulfidization events below brackish-marine sapropels especially the development and preservation of geochemical signals for the sulfur cycle. On the splits of pore water measurements of sulfate, chloride, Na, K, Mg, Ba and Mn(II) will be made by the MPI.

Additionally, microbiological studies were proposed by Ann Manske from the University of Munich (Dept. I, Microbiology, Prof. J. Overmann). The uplifting and the stable layering of the Black Sea chemocline (as defined by the depth at which oxygen disappears and hydrogen sulfide first appears in the water column) created a habitat for photosynthetically active anoxygenic bacteria. Although the light intensities are very low in the chemocline, in the years 1988 and 2002, a brown coloured green sulfur bacterium (GSB) was enriched from the Black Sea chemocline at 80 m depth. First growth experiments indicated that this strain was extremely well-adapted to low-light conditions.

From the sediment layers, brown coloured *Chlorobiaceae* were isolated but not characterised further. Pigments of *Chlorobiaceae* have been detected in the Black Sea sediments. Subfossil 16S rRNA gene sequences of GSB were recovered from deep-sea sediments up to the depth of the first sapropel layer and compared to those of the extant population. With the sediment samples retrieved at the ASSEMBLAGE cruise we want to investigate long term sedimentation of GSB. With the knowledge that species of GSB can be assigned to freshwater and saltwater species, respectively, new samples will provide further information on the paleoceanography of the Black Sea.

4.2.8. Gas Chromatograph (Partner 4)

Measurements for the content of methane in the sediment were performed onboard using a Finnigan Trace Gas Chromatograph. The sediment was sampled directly after the cutting of the sections every 1.5 m. 5 ml sediment were transferred to a vial and a headspace of Helium was added. After the ultrasonic extraction the headspace was injected into the GC and measured by using a mole sieve column to separate H_2, N, O_2 and CH_4. Preliminary results show a low concentration of methane at the top of the cores, increasing rapidly at a depth of 4-6 m, which probably relies to the reduction of the sulphate content in this depth.



Gas chromatograph procedure for Methane analysis

4.2.9. Sampling Ostracods (*Ian Boomer* University of Newcastle)

This contribution focuses on the potential application of Ostracoda (calcareous microfossils) to reconstruct past environmental conditions in the Black Sea as well as providing material that may be utilised for radiocarbon dating.

The Ostracoda (or ostracods) are an abundant and diverse group of small, aquatic crustaceans (0.3-3.0mm long as adults) which live in the oxic zone of the Black Sea today but are also known as fossils in many of the pre-Holocene sediments. Each individual provides an important source of biogenic, low-magnesium, carbonate, which can be used, for stable-isotope analysis, trace-element geochemistry and carbon-14 studies.

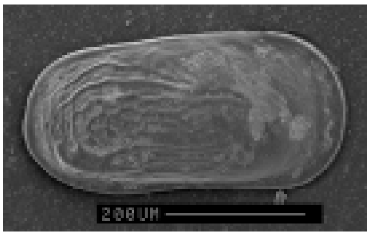
Following reconnaissance studies of previous cruises (BLASON 1 and 2) it is known that ostracods are the only significant carbonate microfossil group present in many sedimentary sequences of the Black Sea and it is therefore important to understand the ecology of individual species (salinity, temperature and depth range) and establish the relationship between their carbonate shell chemistry and environmental parameters.

To achieve this, ostracod subsamples have been recovered from the core-top interface at shallow sites and from one box-core. A number of living specimens have already been identified immediately after sample collection and further studies of the samples will take place post-cruise. Three cores have initially been targeted for detailed stratigraphic analysis (MD04-2760, 2761, 2783) while ogive (core-catcher) subsamples have been taken at each site.

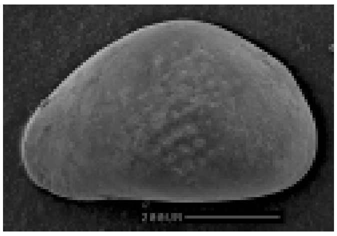
This work is complimentary to that of Partner 11 (Univ. of Ancona, Italy) who are studying benthic foraminifera. Whereas the benthic foraminifera have a lower salinity limit at about 12psu the ostracods range from fresh to marine waters and even into hypersaline conditions (with changing species composition). Thus a combined micropalaeontological approach permits palaeoenvironmental reconstruction across the full salinity range.

The ostracod work will be developed with the assistance of partners 5 (GeoEcoMar) and 6 (University of Bucharest) with whom it is planned to undertake detailed modern sampling of a range of environments around the Black Sea coastline and in shallow water offshore settings.

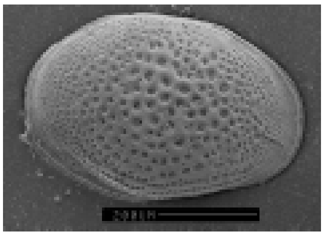
This work, planned for Autumn 2004, will establish a training set of species occurrence and environmental parameters which will allow us to quantitatively reconstruct past bottom-water conditions in the Black Sea. A selection of the most abundant Black Sea Ostracoda is illustrated below.



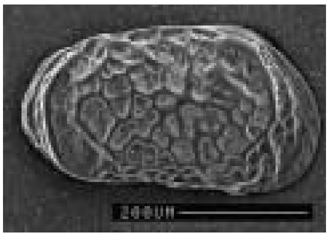
Leptocythere sp



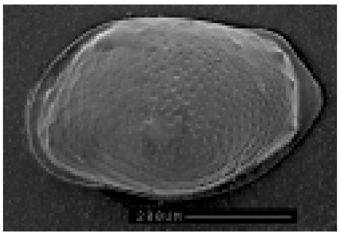
Xestoleberis sp.



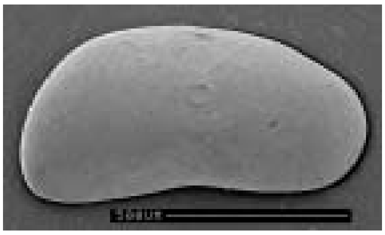
Loxoconcha lepida



Callistocythere sp.



Loxoconcha sp.



Candona sp.

Figure 4.2.9.1 Selection of the most abundant Black Sea Ostracoda

4.2.10. Sampling for geochemical and mineralogical analyses (Partner 10: IACT-CSIC)

Cores MD04-2750, MD04-2754 and MD04-2770 were sampled onboard. A low resolution sampling was carried out for preliminary geochemical and mineralogical analyses. These same cores will be sampled at higher resolution during the sampling party to be held in Brest at Ifremer. Additionally cores MD04-2733, MD04-2739, MD04-2748, MD04-2752, MD04-2759, MD04-2770, MD04-2789, MD04-2790 and MD04-2791 will be sampled at high resolution with special input on sapropel layers. Analyses for paleoenvironmental reconstruction will focus on:

Productivity proxies: Total Ba, Ba/Al ratios and barite accumulation rates (BARs) will be used to determine paleoproductivity fluctuations and organic carbon fluxes. CTD stations and interface sediments from Ronanberg cores were also sampled to perform Ba analyses on the interface and obtain Ba water-column profiles. Water samples will be also used for microbiological experiments focused on bacterial biomineralization to further understand the Ba biogeochemical cycle.

Oxygen proxies: Pyrite framboid textures, degree of pyritization (DOP), authigenic uranium concentration (Ua) and trace-element ratios (e. g., U/Th, Co/Ni, V/Cr, etc.) will allow us to constrain oxygen conditions at time of deposition.

Sedimentary regime: Detrital-element ratios (e. g., Ti/Al, Si/Al, Zr/Al etc.) and bulk mineral composition as well as that of the clay mineral assemblages will focus on source areas and provenance.

Postdepositional alteration: Analyses of redox-sensitive elements and mineralogical analyses will also be performed to evaluate trace-element remobilization, preservation of original signatures and diagenetic conditions.

Methods: X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), and High Resolution Transmission Electron Microscopy (HRTEM) will be used for mineralogical analyses; and X-ray Fluorescence (XRF), Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) and Atomic Absorption (AA) for geochemical analyses.

4.2.11. Sampling methodology used during the cruise MD139 by Partner 11 – (University of Ancona; Caterina Morigi)

Partner 11 collected different type of samples during the cruise to attain the different objectives of our working unit.

4.2.11.1. Water samples

Water samples were collected to analyse the presence and to identified the different species of phytoplankton (coccoliths and diatoms) living at present in the Black Sea. Different water depth from the surface to the sea bottom was selected to determine the presence of the living community and to determinate carbonate dissolution along the water column. To analyse the coccolith assemblage 1 –3 litres of seawater are collected by Niskin bottle and stored in plastic bottle added to formaline 4% buffered by sodium borate. The water will be filtered through a 0.45 micron Millipore filters (polycarbonate membranes, 50 mm diameter) at 200 mbar, dried at 20°C and stored in petri dishes. Analyses will be performed with a light microscope at 1250U by counting at least 300 specimens/sample. For diatoms assemblages 250 ml of seawater are collected, stored in plastic bottle and fixed with formaline 4% buffered by sodium borate.

4.2.11.2. Recent sediment samples

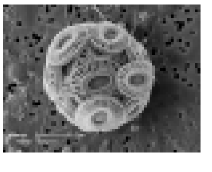
We collected recent sediment samples using Ronenberg core and box-corer to investigate the living benthic community. In detail we study benthic foraminiferal community and the associated meiofaunal assemblage. For each Ronenberg core we sampled a short core. Immediately this core was sub sampled each 1 centimetre form the top of the core until the 5 centimetres. About 10 cc of sediment for each sample was stored in centrifuge vials and fixed with formaline 4% buffered with sodium borate. We will evaluate surface sediment foraminiferal content using standard meiofaunal techniques. Rose Bengal stained fauna was differentiated from the death assemblage. Analyses expected: Standing stock (n/cm2), taxonomic composition, species diversity, vertical distribution in the sediment.

4.2.11.3. Sediment cores

Calcareous nannofossils are largely used to obtain biostratigraphy for the Holocene sediments of the Black Sea, where as the analysis of the benthic foraminifera assemblage could be improved our knowledge of the paleoenvironment in the shallower part (delta, prodelta area of the Danube delta) of the Black Sea.

On board we sampled 3 cores MD04-2750, MD04-2754, MD04-2770. The 3 cores of different sedimentary setting are chosen to have a first insight of the biostratigraphy and paleoenvironment conditions.

Ammonia beccarii



Emiliania huxley

Benthic foraminifera specimens and coccolith (phytoplankton) living at present in the Black Sea.

4.3. CTD, Hydrology and Plankton nets

Several tools have been used in order to collect water at various depths (Fig. 4.3.1- 4.3.2), water-sediment interface (Fig. 4.3.3- 4.3.4), surface sediment (Fig. 4.3.5-4.3.6), living microplankton (Fig. 4.3.7-4.3.8-4.3.9). These records concern Partners 2, 3, 10 and 11.

Fig.4.3.1: Niskin bottle ready for submersion

Fig.4.3.2: "Rosette" bottles

Fig. 4.3.3. Interface core sampler.

4.3.1. Water sampling.

Water samples have been taken at various depths for several targets:

- to establish a vertical profile of some chemical elements (Barium, Radium, etc.) using the "Rosette" bottles in order to have a present-day reference in the Black Sea;
- to obtain vertical and longitudinal measurements (in front of the Danube delta for example) of $\delta^{13}C$, $\delta^{18}O$ and ^{14}C as a present-day reference to calibrate the influence of water depth and/or terrigenous material transport;
- to record living microplankton organisms (foraminifers, coccoliths, diatoms, dinoflagellates) in order to appreciate their distribution according to bathymetry, salinity, river input, etc., being also a present-day reference essential for paleoenvironmental reconstructions in the area.

4.3.2. Water-sediment interface and surface sediment.

Several sites have been sampled according to their location (on the shelf, deep basin, coastal or distal position, proximity of the Danube delta or of the Bosphorus Strait) and cored. Similar goals are pursued with a special focus on relationships between water and sediment.

Fig.4.3. 4. Interface core

Fig.4.3.5. Box core

Fig. 4.3 6. Sediment section.

4.3.3. Living microplankton.

In addition to collecting using bottles, a microplankton net has been used because it was able to provide larger quantities of organisms (independently of any relation to water and/or sediment quantity).

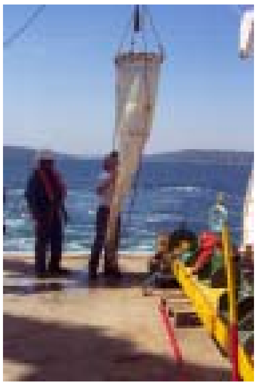


Fig.4.37. Plankton net

Fig.4.3.8 Plankton net recovered from sea

Fig. 4.3 9 Processing of net after collect. in front of the Bosphorus Strait.

To summarise, we have sampled a wide range of present-day to recent material (water and sediment). These samples will allow us to develop a modern frame of reference, essential to our studies on sediment and for reliable paleoenvironmental reconstructions, relating to, for example, the influence of the Danube, oxic and anoxic events related to Marmara Sea – Black Sea water exchanges.

MD04-139 ASSEMBLAGE 1

Time Log

Time log of ASSEMBLAGE Cruise

Date	Station	Time (TU)	Latitude N	Longitude E	Depth	Operations
09/05/2004		**06:00**				**Depart d'Istambul (port de Galata)**
	MD04-2751N	07:55	041°13.90	029º08.99	**52**	Mise à l'eau du Filet **MD04-2751N.** Longueur filée 59m.
		08:17	041°14.30	029°09.53		Filet à bord
		09:07	041°25.04	029°08.44		Survey S1 3.5Khz en croix autour du site MD04-2752
		12:41	041°56.82	028°36.47		Arrivée sur station **MD04-2752**
	MD04-2752	**13:01**	**041°56.76**	**028°36.56**	**169**	**Déclenchement (longueur filée) 24.50m récupérés**
						Survey S2 vers le point MD04-2753
		14:32				Arrivée en station **MD04-2753**
	MD04-2753	**14:56**	**041°52.46**	**028°28.57**	**86**	**Déclenchement (longueur filée) 11m récupérés**
		15:50				Route vers le point MD04-2754
		15:52				Mixte survey M1 (12 et 3.5 KHZ) jusqu'au site MD04-2754
		18:37	041°59.23	028°40.99		Arrivée en station **MD04-2754**
	MD04-2754	**19:02**	**041°59.23**	**028°40.99**	**453**	**Déclenchement (longueur filée) 32.17m récupérés**
		20:02				Départ de la station
		20:27				Début du profil Multifaisceaux
						B1:41°58.59N / 28°42.10N
		23:33				Fin du profil Multifaisceaux.
						B2:43°26.58N / 29°03.39N
		23:27				Survey S3 à 3.5 Khz jusqu'au site MD04-2755

10/05/2004		04:34				Arrivée en station **MD04-2755**
	MD04-2755	**05:19**	**042°27.54**	**029°04.19**	**1916**	**Déclenchement (longueur filée) 44,10m récupérés**
	MD04-2756N	**06:40**	**042°29.45**	**029°01.80**		**Mise à l'eau du Filet MD04-2756N. Longueur filée 25m.**
		07:06	042°29.60	029°02.29		Filet à bord
		07:08				Survey S4 à 3,5 KHZ vers le site MD04-2756
		07:27	042°29.98	029°04.17		Arrivée en station **MD04-2756**
	MD04-2756	**08:15**	**042°30.02**	**029°03.77**		**Déclenchement (longueur filée) 42,88m récupérés**
		09:29				Carotte sur le pont
	MD04-2757-I	**09:49**	**042°29.99**	**029°03.77**	**1927**	**Ronanberg MD04-2757-I**
		11:20				Carotte sur le pont
	MD04-2757-H	**11:29**				**Bouteille Niskin MD04-2757-H pour un prélèvement d'eau à 25m**
		11:40				Mixte survey M2 (12 et 3.5 KHZ) jusqu'au site MD04-2758
		15:21	041°44.81	021°07.85		Arrivée sur le site **MD04-2758**
	MD04-2758	**16:19**	**041°44.82**	**029°07.88**	**1915**	**Déclenchement (longueur filée) 43.21m récupérés**
		17:24				Carotte sur le pont
		17:48				Début du survey S5 3,5 KHZ vers le site MD04-2759
		23:05	041°35.07	029°25.49		Arrivée en station **MD04-2759**
	MD04-2759	**23:59**	**041°35.02**	**029°25.45**	**1540**	**Déclenchement (longueur filée) 23,78m récupérés**
11/05/2004		01:09				Carotte sur le pont
						Profil 3,5KHZ en transit vers les points
		01:36				S6: 41°34.39N / 29°29.37E
		05:16				S7: 51°24.67N / 30°25.16E
		05:50				S8: 41°25.76N / 30°31.31E
		06:14				S9: 41°28.18N / 30°34.37E
		08:14				S10: 41°34.36N / 31°09.94E

		08:39				S11: 41°29.62N / 31°10.05E
		09:02				S12: 41°33.14N / 31°07.55E
		09:23				S13: 41°32.09N / 31°12.65E
		10:52				S14: 41°33.72N / 30°53.30E
		11:02				S15: 41°35.65N / 30°53.00E
		11:07				S16: 41°29.16N / 30°52.79E
						Survey S17 vers le site MD04-2760
		11:50				Arrivée sur le site **MD04-2760**
	MD04-2760	**13:05**	**041º31.67**	**030º53.09**	**1925**	**Déclenchement (longueur filée) 42.04m récupérés**
		14:08				Carotte sur le pont
						Carottier tordu à 13m de tube
						Profil 3,5 KHZ vers les points
		14:16				S18: 41°32.72N / 30°49.50E
		15:13				S19: 41°32.72N / 30°56.00E
		15:29				S20: 41°30.56N / 30°56.00E
		15:55				S21: 41°30.56N / 30°49.50E
						Profil multifaisceaux (12 KHZ) aux point suivants
		16:51				B3: 41°25.90N / 30°31.39E
		17:00				B4: 41°25.74N / 30°31.60E
		17:09				B5: 41°25.99N / 30°31.90E
		17:19				B6: 41°26.20N / 30°31.40E
		17:20				Survey S22 3,5KHZ vers le site MD04-2761
		17:41	041º25.97	030º31.65		Arrivée sur le **MD04-2761**
	MD04-2761	**18:00**	**041º25.95**	**030º31.66**	**123**	**Déclenchement (longueur filée) 26,34m récupérés**
		18:28				Carotte sur le pont
		18:45				Mixte survey M3 (12 et 3.5 KHZ) jusqu'au site MD04-2762
12/05/2004		03:37	042º38.89	032º45.94		Arrivée sur le site **MD04-2762**

	MD04-2762	**04:12**	**042º38.89**	**032º45.94**	**2210**	**Déclenchement (longueur filée) 52,32m récupérés**
		06:02				Carotte sur le pont
						Carottier tordu sur toute sa longueur
		06:07				Profil multifaisceaux (12 KHZ) aux point suivants
		06:18				B7: 42°38.00N / 32°45.00E
		06:36				B8: 42°41.20N / 32°40.60E
		07:07				B9: 42°36.20N / 32°33.50E
		09:06				B10: 42°54.40N / 32°09.50E
		10:15				B11: 42°46.20N / 31°53.00E
		13:01				B12: 43°18.80N / 31°31.40E
		14:24				B13:43°15.00N / 31°07.30E
		16:26				B14:43°33.00N / 30°40.00E
		17:18				B15:43°23.99N / 30°31.00E
		17:19				Survey S23 3.5KHZ vers le site MD04-2763
		18:02				Arrivée sur le site **MD04-2763**
	MD04-2763	**18:50**	**043º23.50**	**030º31.00**	**1604**	**Déclenchement (longueur filée) 34.49m récupérés**
		20:08				Carotte sur le pont.
						Carottier tordu. Liner cassée au niveau de la XVIe section à 23.08m
		20:45				Mise à l'eau du Gravité **MD04-2764** + sonde (flux de chaleur)
	MD04-2764	**21:27**	**043º23.46**	**030º30.98**	**1594**	**Touché à 1594m . 5.75m récupérés**
		22:30				Gravité sur le pont sur le pont.
13/05/2004		01:56				Mise à l'eau du Ronenberg **MD04-2765-I**
	MD04-2765-I	**02:17**	**043º23.51**	**030º30.98**	**1602**	**Déclenchement (longueur filée) 0.16m récupérés**
		03:06				Carottier sur le pont
	MD04-2765-H	**04:04**	**043º23.99**	**030º30.98**		**Début du profil hydro MD04-2765-H**
						4 prélèvements à 1500m

						4 prélèvements à 250m
						2 prélèvements à 100m
						4 prélèvements à 50m
						2 prélèvements à 32m (max du fluorimétrie)
						7 prélèvements en surface
		06:08	043º23.42	030º30.83		Fin du profil hydro
	MD04-2765-N	**06:29**	**043º23.40**	**030º30.63**		**Mise à l'eau du filet MD04-2765-N. Longueur filée 37m.**
		06:59	043º22.86	030º30.02		Réception du filet
		07:05				Profil multifaisceaux 12KHZ des points
		08:51				B16: 43°44.00N / 30°40.00E
		08:58				B17: 43°46.00N / 30°38.00E
		10:41				B18: 43°46.00N / 30°38.00E
		10:42				Survey S24 3.5KHZ en croix jusqu'au site MD04-2766
		11:54				Arrivée sur le site **MD04-2766**
	MD04-2766	**12:13**	**043º56.99**	**031º02.94**	**899**	**Déclenchement (longueur filée) 26.11m récupérés**
		12:57	043º57.10	031º02.57		Carotte sur le pont.
		13:53				Mise à l'eau du gravité **MD04-2767** +flux de chaleur
	MD04-2767	**14:15**	**043º56.99**	**031º03.13**	**903**	**Touché à 888 m, stoppé à 907m. 7.03m récupérés**
		15:11				carotte sur le pont
		15:18				Survey S25 3.5 KHZ en croix jusqu'au site MD04-2768
		17:54	044º14.20	030º57.50		Arrivée sur le site **MD04-2768**
	MD04-2768	**18:22**	**044º14.15**	**030º57.12**	**216**	**Déclenchement (longueur filée) 39.95m récupérés**
		19:05	044º14.35	030º57.54		Carotte sur le pont.
						Carottier tordu
		19:40	044º14.13	030º57.60		Surveys 3.5 KHZ aux points

		19:55				S26:44°12.72N / 30°50.73E
		21:26				S27:44°12.72N / 30°50.73E (retour au site précédent)
		21:51				Mise à l'eau du Ronenberg **MD04-2769-I**
	MD04-2769-I	**22:00**	**044º14.19**	**030º57.53**	**206**	**Déclenchement (longueur filée) 1m récupéré**
		22:16				Carotte sur le pont
		22:24	044º14.09	030º57.64		Profil multifaisceaux des points
		22:36				B19: 44°13.41N / 30°59.07E
		22:53				B20: 44°17.79N / 30°56.95E
		23:04				B21: 44°13.50N / 30°56.25E
		23:37				B22: 44°13.20N / 30°55.28E
14/05/2004		00:03				B23: 44°11.83N / 30°57.67E
		00:17				B24: 44°12.59N / 30°59.13E
		00:20	044º12.60	030º59.20		Survey du site MD04-2770
		00:33	044º12.80	030º59.60		Arrivée sur le site **MD04-2770**
	MD04-2770	**01:42**	**044º12.88**	**030º59.65**	**358**	**Déclenchement (longueur filée) 41.18m récupérés**
		02:23				Carotte sur le pont
						Profils multifaisceaux au points
		04:00				B25 : 44°16.74N / 30°56.00E
		06:03				B26 : 44°12.50N / 30°10.00E
		09:13				B27 : 44°16.09N / 30°53.19E
						Survey S28 3.5 KHZ jusqu'au site MD04-2771
		10:07	044º16.43	030º54.73		Arrivée sur le site **MD04-2771**
	MD04-2771	**10:43**	**044º16.53**	**030º54.29**	**168**	**Déclenchement (longueur filée) 12.38m récupérés**
		11:10				Carotte sur le pont
		11:12				Survey S29 3.5 KHZ jusqu'au site MD04-2772
		12:30				Arrivée sur le site **MD04-2772**

	MD04-2772	**13:08**	**044°18.07**	**030°51.56**	**120**	**Déclenchement (longueur filée) 7.51m récupérés**
		13:27				Carotte sur le pont
		13:34				Survey S30 3.5 KHZ jusqu'au site MD04-2773 + survey en croix
		17:07	044°37.82	030°20.37		Arrivée sur le site **MD04-2773**
	MD04-2773	**17:54**	**044°37.96**	**030°20.57**	**68**	**Déclenchement (longueur filée) 3.63m récupérés**
		18:04				Carotte sur le pont
		18:15				Survey S31 3.5 KHZ jusqu'au site MD04-2774 + survey en croix
		21:39				Arrivée sur le site MD04-2774
	MD04-2774-H	**21:48**	044°57.47	029°50.12		**Début du profil hydro MD04-2774-H**
		21:59				4 prélèvements à 30m
		22:03				4 prélèvements à 15m
		22:05				4 prélèvements en surface
		22:10	044°57.46	029°50.13		Fin du profil hydro
		22:27	044°57.45	029°50.11		Mise à l'eau du Calypso **MD04-2774**
	MD04-2774	**22:38**	**044°57.45**	**029°50.11**	**30**	**Déclenchement (longueur filée) 7.30m récupérés**
		23:16				Mise à l'eau du Ronenberg **MD04-2775-I**
	MD04-2775-I	**23:20**	**044°57.45**	**029°50.11**	**30**	**Déclenchement (longueur filée) 7.30m récupérés**
	MD04-2775-N	**23:47**	**044°57.46**	**029°50.21**		**Mise à l'eau du filet MD04-2775-N. Longueur filée 18m pour 15m**
15/05/2004		00:07	044°57.50	029°50.21		Réception du filet
						Profils multifaisceaux au points
		05:31				B28 : 43°59.50N / 30°30.72E
		08:13				B29 : 43°37.85N / 31°04.60E
		09:55				B30 : 43°34.82N / 30°57.56E
		10:00				B31 : 43°46.90N / 30°39.92E
		10:18				B32 : 43°44.59N / 30°35.45E

		11:46				B33 : 43°31.80N / 30°52.74E
		12:12				B34 : 43°28.24N / 30°46.60E
		14:15				B35 : 43°11.06N / 31°06.86E
		15:21				B36 : 43°12.95N / 31°23.71E
		15:48				B37 : 43°07.15N / 31°25.96E
		17:53				B38 : 42°46.43N / 31°52.94E
		18:02				B39 : 42°44.98N / 31°49.86E
		20:53				B40 : 43°09.87N / 31°17.24E
		21:21				B41 : 43°07.15N / 31°11.04E
16/05/2004		00:32				B42 : 42°40.28N / 31°43.80E
		00:50				B43 : 42°37.50N / 31°40.00E
		08:20				B44 : 43°47.00N / 30°14.00E
		11:18				B45 : 43°19.00N / 29°41.00E
		11:20				Survey S32 3.5 KHZ jusqu'au site MD04-2776 + survey en croix
		12:11				Arrivée sur le site MD04-2776-I
		12:16				Mise à l'eau du Ronenberg **MD04-2776-I**
	MD04-2776-I	**12:47**	**043º18.98**	**029º40.95**	**1275**	**Déclenchement (longueur filée) 0.92m récupérés**
		13:19				Carotte sur lepont
	MD04-2776-H	**13:20**	**043º18.99**	**029º40.99**		**Début du profil hydro MD04-2776-H**
						2 prélèvements à 28m
		13:25				Fin du profil hydro
		13:37				Mise à l'eau du Calypso **MD04-2777**
	MD04-2777	**14:00**	**043º18.99**	**029º41.02**	**1279**	**Déclenchement (longueur filée) 34.97m récupérés**
	MD04-2776-N	**15:00**	**043º18.91**	**029º40.83**		**Mise à l'eau du filet MD04-2776-N. Longueur filée 28m.**
						Mise à l'eau du gravité **MD04-2778** +flux de chaleur
	MD04-2778	**16:35**	**043º18.99**	**029º41.00**	**1279**	**Touché à 1266m, stoppé à 1292m. 6.40m récupérés**

		17:32				Carotte sur lepont
						Profils multifaisceaux au points
		18:06				B46 : 43°16.35N / 29°44.89E
		21:30				B47 : 43°46.14N / 32°13.80E
17/05/2004		04:54				B48 : 42°34.31N / 31°36.40E
		05h17				B49 : 42°31.97N / 31°31.66E
		10:56				B50 : 43°28.45N / 30°29.76E
		11:51				B51 : 43°36.10N / 30°40.99E
		12:30				Survey S34 3.5 KHZ jusqu'au site MD04-2779
		13:04				Arrivée sur le site MD04-2779-I
						Mise à l'eau du Ronenberg **MD04-2779-I**
	MD04-2779-I	**13:35**	**043º31.99**	**030º32.67**	**1208**	**Déclenchement (longueur filée) 0.87m récupérés**
		14:00				Carotte sur lepont
						Mise à l'eau du Calypso **MD04-2780**
	MD04-2780	**14:50**	**043º32.00**	**030º32.69**	**1217**	**Déclenchement (longueur filée) 34.02m récupérés**
						Carotte sur lepont
		14:52				Survey S35 3.5 KHZ jusqu'au site MD04-2781
		20:00				Mise à l'eau du Calypso **MD04-2781**
	MD04-2781	**20:29**	**043º35.00**	**031º07.98**	**1636**	**Déclenchement (longueur filée) 35.63m récupérés**
		21:35				Carotte sur lepont
						Profils multifaisceaux au points
		23:10				B51 : 43°42.20N / 31°20.00E
18/05/2004		02:26				B52 : 44°06.00N / 32°12.00E
		03:07				B53 : 43°59.84N / 32°14.06E
		03:46				B54 : 44°00.00N / 32°10.00E
		07:04				B55 : 43°43.00N / 31°36.00E

		07:44				B56 : 43°55.00N / 32°02.30E
		08:24				B57 : 43°47.00N / 32°00.00E
		12:27				B59 : 43°47.51N / 30°35.75E
		13:48				B60 : 43°47.50N / 30°37.27E
		13:55				B61 : 43°46.76N / 30°36.07E
		14:01				B62 : 43°46.00N / 30°34.80E
		14:57				Mise à l'eau du Calypso **MD04-2782**
	MD04-2782	**15:16**	**043°47.41**	**030°36.98**	**1009**	**Déclenchement (longueur filée) 35.63m récupérés**
		16:03				Carotte sur lepont
						Carottier tordu
						Survey S36 3.5 KHZ jusqu'au site MD04-2783
		17:14				Mise à l'eau du Calypso **MD04-2783**
	MD04-2783	**17:28**	**043°35.98**	**030°34.73**	**661**	**Déclenchement (longueur filée) 34.71m récupérés**
		18:23				Carotte sur lepont
						Carottier tordu sur toute la longueur du premier tube
		18:40				Mise à l'eau du Ronenberg **MD04-2784-I**
	MD04-2784-I	**18:57**	**043°35.98**	**030°34.73**	**661**	**Déclenchement (longueur filée) 1m récupéré**
		19:43				Carotte sur lepont
		20:00				Passage en mode mixte (3,5 et 12 KHZ)
		20:51				M4: 43°43.00N / 30°20.00E
		21:45				M5 : 43°37.07N / 30°07.70E
19/05/2004		08:21				M6 : 41°40.00N / 28°40.00E
		08:24	041°40.09	028°38.87		Passage en mode 3.5 KHZ
						Survey S37 3.5 KHZ jusqu'au site MD04-2785+ Survey en croix
		11:38	041°40.42	028°36.40		Arrivée sur le site MD04-2785
		11:42				Mise à l'eau du Gravité **MD04-2785**

	MD04-2785	**11:48**	**041°40.42**	**028°36.40**	**81**	**Touché 72m. 13.70m récupérés**
		12:05				Carotte sur lepont
						Survey S38 3.5 KHZ jusqu'au site MD04-2786+ Survey en croix
		13:58				Arrivée sur le site MD04-2786
		14:14				Mise à l'eau du Calypso **MD04-2786**
	MD04-2786	**14:17**	**041°46.60**	**028°54.79**	**131,5**	**Déclenchement (longueur filée) 28.03m récupéré**
		14:45				Carotte sur lepont
						Profil multifaisceaux aux points
		15:16				B63 : 41°34.00N / 29°00.00E
		15:49				B64 : 41°32.50N / 29°09.00E
		17:04				B65 : 41°33.00N / 29°52.00E
		18:25				B66 : 41°24.00N / 29°40.00E
		18:39				B67 : 41°24.00N / 29°40.00E
20/05/2004		00:24				B68 : 41°31.31N / 30°50.66E
		00:41				Survey S39 3.5 KHZ jusqu'au site MD04-2787+ Survey en croix
		01:06				Arrivée sur le site MD04-2787
		01:20				Mise à l'eau du Ronenberg **MD04-2787-I**
	MD04-2787-I	**01:44**	**041°31.63**	**030°63.04**	**1224**	**Déclenchement (longueur filée) 1m récupéré**
						Carotte sur lepont
		03:03				Mise à l'eau du Gravité **MD04-2788**
	MD04-2788	**03:24**	**041°31.67**	**030°53.00**	**1224**	**Touché 1910m, stoppé 1230m. 6m récupérés**
		04:05				Carotte sur lepont
						Profil multifaisceaux aux points
		10:48				B69 : 42°20.00N / 32°40.00E
		12:02				B70 : 42°30.30N / 32°43.40E
		13:40				Passage en 3.5 KHZ

		13:54				Arrivée sur le site MD04-2789
		14:00				Mise à l'eau du Gravité **MD04-2789** + flux de chaleur
	MD04-2789	**14:40**	**042°30.30**	**032°43.38**	**2191**	**Touché 2182m, stoppé 2216m. 6.75m récupérés**
		15:55				Carotte sur lepont
						Profil multifaisceaux aux points
		16:26				B71 : 42°30.28N / 32°43.58E
		17:32				B72 : 42°40.00N / 33°00.00E
		18:59				B73 : 42°54.00N / 32°40.00E
		20:10				B74 : 43°09.00N / 32°38.00E
		22:36				B75 : 43°30.00N / 32°50.00E
21/05/2004		02:37				B76 : 44°00.00N / 31°50.00E
		05:49				B77 : 44°12.16N / 31°03.00E
						Passage en 3.5 KHZ
		06:10	044º12.71	030º59.60		Arrivée sur le site **MD04-2790**
	MD04-2790	**06:39**	**044º12.79**	**030º59.61**	**352**	**Déclenchement (longueur filée)30.31m récupéré**
		06:47	044°12.83	030°59.64		Carotte sur le pont
		06:55				Profil hydro CTD pendant la préparation du gravité/flux de chaleur
		08:03	044°12.80	030°59.64		Top 330 pour 5 bouteilles (1 à 5)
		08:10	044°12.81	030°59.63		Top 250 pour 5 bouteilles (6 à 11)
		08:16	044°12.80	030°59.64		Top 100m pour 2 bouteilles (12 à 13)
		08:23	044°12.80	030°59.64		Top 50m pour 5 bouteilles (14 à 18)
		08:27	044°12.81	030°59.66		Top 40m pour 2 bouteilles (19 à 20)
		08:29	044°12.81	030°59.66		Top 2m pour 4 bouteilles (21 à 24)
		08:38				CTD à bord
		09:07	044°12.79	030°59.59		Mise à l'eau du Gravité **MD04 2791**
	MD04 2791	**09:18**	**044°12.79**	**030°59.59**	**357**	**346m touché, stoppé à 362m filés, 7.4m récupérés**

		09:42				Carotte sur le pont
	MD04 2791N	09:51				Mise à l'eau du filet **MD04 2791N** pendant 20 min à 57m filés
		10:21	044°12.68	030°59.10		Filet à bord
		10:56				Mise à l'eau du Ronenberg **MD04 2792 I**
	MD04 2792 I	**11:03**	**044°12.82**	**030°59.61**	**358**	**Déclenchement (longueur filée) 0.87m récupéré**
		11:17				Mixte survey M4 (12 et 3.5 KHZ) jusqu'au site MD04-2793
		15:23	**044°00.06**	**029°54.46**		Arrivée sur le site MD04 2793Bc
		15:44				Mise à l'eau du box-core **MD04 2793Bc**
	MD04 2793Bc	**15:46**	**044°00.00**	**029°54.00**	**67**	**Déclenché à 70m, 71.8 m filés, 0.47m récupérés**
		15:57				Box core à bord
		15:59				début du Profil hydro
	MD04 2793H	16:16				Top 0 de la CTD **MD04 2793H**
		16:23				Top 60 pour 3 bouteilles
		16:26				Top 5m
		16:29				Rosette à bord
	MD04 2793N	**16:34**	**044°00.00**	**029°54.04**		**Mise à l'eau du filet MD04 2793N 6m filés, 0.8Nds**
		16:55				Fin de pêche
		16:57				Filet à bord
		17:14	043°58.48	029°55.53		Passage en mode mixte survey aux points
		17:44				M5: 43°43.40N / 30°00.00E
		18:57				M6: 43°55.80N / 30°17.20E
		20:18				M7: 43°46.00N / 30°32.00E
		21:45				M8: 43°36.00N / 30°12.00E
		22:51				M9: 43°29.00N / 30°26.00E
		23:42				M10: 43°20.00N / 30°34.50E
22/05/2004		08:32	042°00.06	028°42.16		Passage en 3.5 KHZ

		08:46	041°52.32	028°41.04		Arrivée sur le site MD04 2794
		09:18				Mise à l'eau du Calypso **MD04 2794**
	MD04 2794	**09:32**	**041°59.12**	**028°41.03**	**456**	**Déclenchement (longueur filée) 31.52m récupéré**
		09:52				Carotte sur le pont
		10:36	041°59.22	028°40.99		Mise à l'eau du Ronenberg **MD04 2795-I**
	MD04 2795-I	10:44	**041°59.22**	**028°40.99**	**454**	**Déclenchement (longueur filée)1m récupéré**
		10:54				Carotte sur le pont
		11:01				Mise à l'eau du Gravité **MD04 2796**
	MD04 2796	11:16	**041°59.23**	**028°40.99**	**454**	**439m touché, stoppé à 450m. 7.70m récupérés**
						Carotte sur le pont
						Profil multifaisceaux aux points
		13:54				B78 : 41°52.90N / 29°09.00E
		15:58				B79 :41°32.00N / 28°60.00E
		17:27				B80 :41°21.50N / 29°18.00E
		19:08				B81 :41°24.00N / 29°42.00E
		20:50				B82 :41°34.00N / 29°59.00E
		21:43				B83 :41°40.75N / 29°46.16E
23/05/2004		00:37				B84 :41°50.13N / 29°23.90E
		02:26				B85 :41°38.00N / 28°58.00E
		02:49				B86 :41°38.00N / 28°55.00E
		05:13				B87 :42°04.00N / 29°03.80E
		17.00				Survey complément mosaique BlaSON sortie du Bosphore
		19.00	**Fin des Opérations ASSEMBLAGE ISTANBUL**			

MD04-139 ASSEMBLAGE 1

Core List

5. Core List

Core	Type	Site N°	Latitude	Longitude	Tube Length (m)	Sediment recovery (m)	On site bathymetry
MD04-2752	Calypso	ASSMD34	41°56.76N	28°36.56E	24,50	24,50	169 m
MD04-2753	Calypso	ASSMD35	41°32.464N	28°28.566E	20,78	11	63 m
MD04-2754	Calypso	ASSMD33	41°59.23N	28°40.99E	41,9	32,17	453 m
MD04-2755	Calypso	ASSMD8	42°27.55' N	29°04.17' E	42,80	44,10	1920 m
MD04-2756	Calypso	ASSMD7	42°29.98'N	29°03.75'E	42,80	42,88	1927 m
MD04-2757-I	Ronanberg	ASSMD7	42°29.99N	29°.03.77E	1	0,94	1515 m
MD04-2758	Calypso	ASSMD9	41°44.9N	29°07.64E	42,80	43,21	1915 m
MD04-2759	Calypso	ASSMD30	41°35.03N	29°25.45E	42,80	23,78	1540 m
MD04-2760	Calypso	ASSMD31	41°32.1'N	31°10.05E	44,70	42,04	1226 m
MD04-2761	Calypso	ASSMD32	41°25.97N	30°31.65E	30,43	26,34	120 m
MD04-2762	Calypso	ASSMD37	42°38.870N	32°45.973E	52,30	52,32	2210 m
MD04-2763	Calypso	ASSMDA1	43°23,5N	30°31E	42,80	34,5	1604 m
MD04-2764	Gravity/HF	ASSMDA1	43°23.5N	30°31E	14,14	5,76	1602 m
MD04-2765-I	Ronanberg	ASSMDA1	43°23.5N	31°31E	1	0,16	1602 m
MD04-2766	Calypso	ASSMDC1	43°57.00N	31°03.00E	31,26	26,11	900 m
MD04-2767	Gravity/HF	ASSMDC1	43°57.00N	31°03.04E	14,14	7,03	903 m
MD04-2768	Calypso	ASSMD40	44°14.19N	30°57.53E	42,48	39,95	216 m
MD04-2769	Ronanberg	ASSMD40	44°14.19N	30°57.53E	1	1 - E	205 m
MD04-2770	Calypso	ASSMD41	44°12.80N	30.59.6E	42,75	41,82	358 m
MD04-2771	Calypso	ASSMD28	44°16.32N	30°54.24E	21,88	12,38	168 m
MD04-2772	Gravity/HF	ASSMD29	44°18.05N	30°51.56E	14,88	7,51	117 m
MD04-2773	Gravity	ASSMD23	44°37.97N	30°20.6E	11,85	3,63	68 m
MD04-2774	Gravity	ASSMD24	44°57.47N	29°50.12E	11,80	7,3	30 m

MD04-2775-I	Ronanberg	ASSMD24	44°57.45N	29°50.11E	1	0,12	30 m
MD04-2776-I	Ronanberg	ASSMDB1	43°18.98N	29°40.95E	1	0,92	1275 m
MD04-2777	Calypso	ASSMDB1	43°18.98N	29°40.93E	34,97	34,97	1279 m
MD04-2778	Gravity/HF	ASSMDB1	43°18.99N	29°41.00E	14,14	6,5	1279 m
MD04-2779-I	Ronanberg	ASSMD42	43°31.99N	30°32.71E	1	0,86	1208 m
MD04-2780	Calypso	ASSMD42	43°32.00N	30°32.69E	42	34,02	1217 m
MD04-2781	Calypso	ASSMDE	43°35.00N	31°07.98E	35,6	35,63	1642 m
MD04-2782	Calypso	ASSMDF2	43°47.41N	30°36.98E	35,6	35,63	1009 m
MD04-2783	Calypso	ASSMDF4	43°46.00N	30°34.00E	41,2	34,71	661 m
MD04-2784-I	Ronanberg	ASSMDF4	43°45.99N	30°34.75E	1	1,01	661 m
MD04-2785	Gravity	ASSMD15	41°40.42N	28°36.40E	13,7	4,75	72 m
MD04-2786	Calypso	ASSMD16	41°36.60N	28°54.79E	29,32	28,03	131,5 m
MD04-2787-I	Ronanberg	ASSMD31	41°31.63N	30°53.04E	1	1	1224 m
MD04-2788	Gravity	ASSMD31	41°31.67N	30°53.00E	14,14	6	1224 m
MD04-2789	Gravity/HF	ASSMD38	40°30.30N	32°43.38E	14,14	6,75	2191 m
MD04-2790	Calypso	ASSMD41	44°12.79N	30°59.61E	35,15	30,31	352 m
MD04-2791	Gravity	ASSMD41	44°00.00N	30°59.61E	14,14	7,4	358 m
MD04-2792 I	Ronanberg	ASSMD41	44°12.82N	30°59.61E	1	0,87	67 m
MD04-2793-I	Ronanberg		44°00.00N	29°54.00E	1	0,47	456 m
MD04-2794	Calypso	ASSMD33	41°59.12N	28°41.03E	35,15	31,52	452 m
MD04-2795 I	Ronanberg	ASSMD33	41°59.22N	28°40.99E	1	1	453 m
MD04-2796	Gravity	ASSMD33	41°59.23N	28°40.99E	14,14	7,7	453 m

MD04-139 ASSEMBLAGE 1

Core Description

6. DESCRIPTION OF CORE MD04-2761

6.1. Site Presentation

In collaboration with the University of Istanbul, one core was recovered from the shelf edge in the vicinity of the Sakarya Delta. The core MD04-2761 with a length of 26 m was collected. On the basis of previous data and subbottom profiling during the cruise, the location of the core reflects a lowstand sediment wedge formed during lowstands of the Black Sea. The main purpose of obtaining a core in such a location is to investigate the deposition during the last 20 ky BP. For determining the changing sea levels and paleoenvironment of the Black Sea the following analyses are planned:

Major and minor element distribution: Bulk sediment subsamples in various depth intervals will be analyzed l for their major and minor element concentrations (ICP) by the University o Istanbu, in order to provide some information about the influence of terrigenic inputs and chemical properties and conditions of the deposition conditions.

Foraminiferal assemblage: Identification and counting of foraminifera along the core will provide the changing conditions throughout the time span of 26 m long sedimentary column.

Mollusk assemblage: mollusks will be identified in various depth intervals

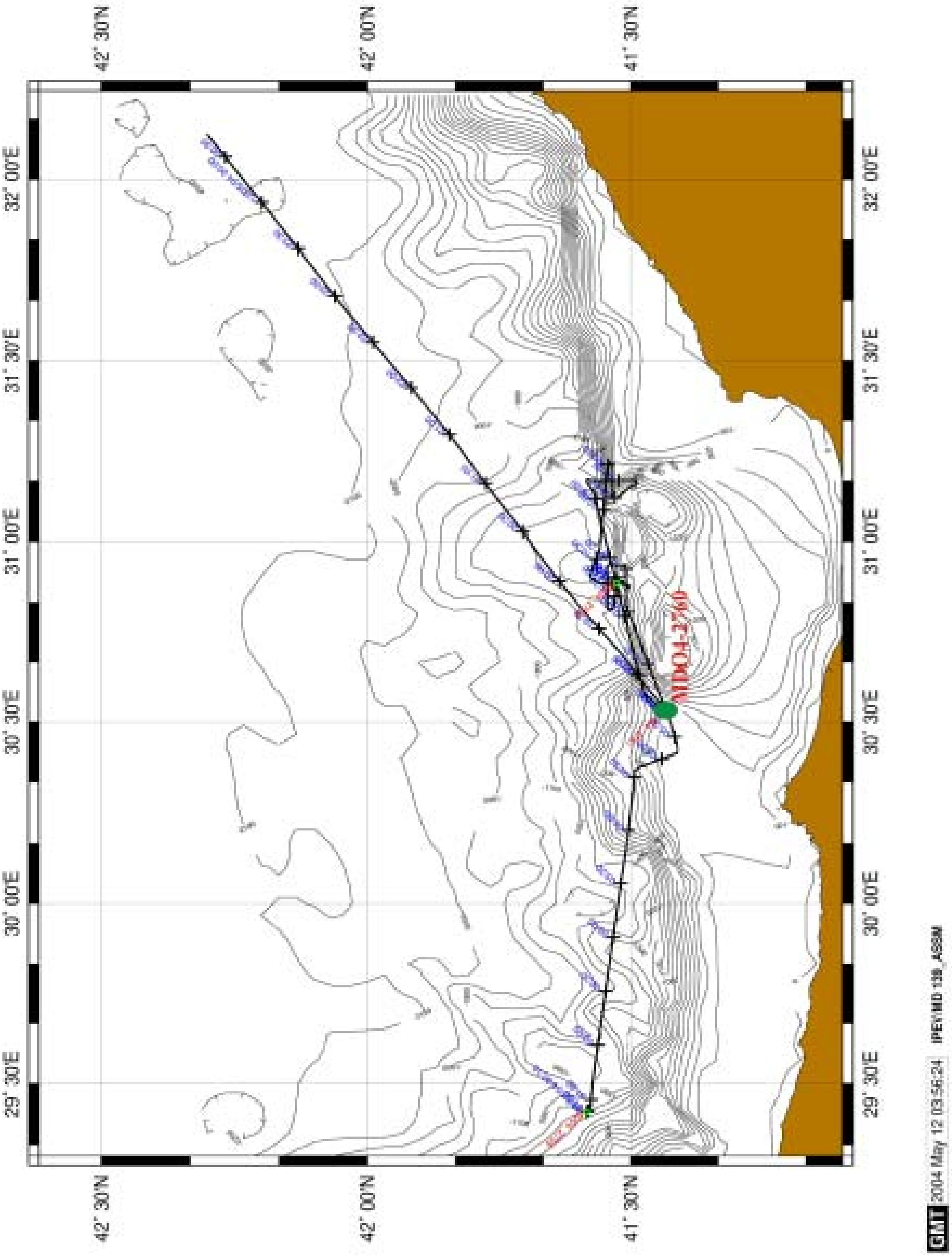
Ostracoda assemblage: Ostracoda will be identified in various depth intervals. This part of the study will be carried out by Ian Boomer from New Castle University.

Palynology : Pollen and dinoflagellat analysis will be performed by J. P. Suc and S. Popescu; Partner 2 of the ASSEMBLAGE project

Oxygen isotopes and radiocarbon age determination: These analysis will be carried out by Francoise Guichard, partner 3 of the Assemblage project

In addition to core MD04-2761, core MD04-2752 will be planned to investigate in the same context. However in this core, Istanbul University, Institute of Marine Sciences and Management will carry out only Foraminiferal analysis under the supervision of partner 11.

6.2. Location map for core MD04-2761



6.3. MD04-2761 Site Survey

For this location, no previous prospecting from the project has been carried out. Eventhough, University of Istanbul gave us an idea about the location, le Marion Dufresne undertook surveying along the coring site to specify correctly the target.

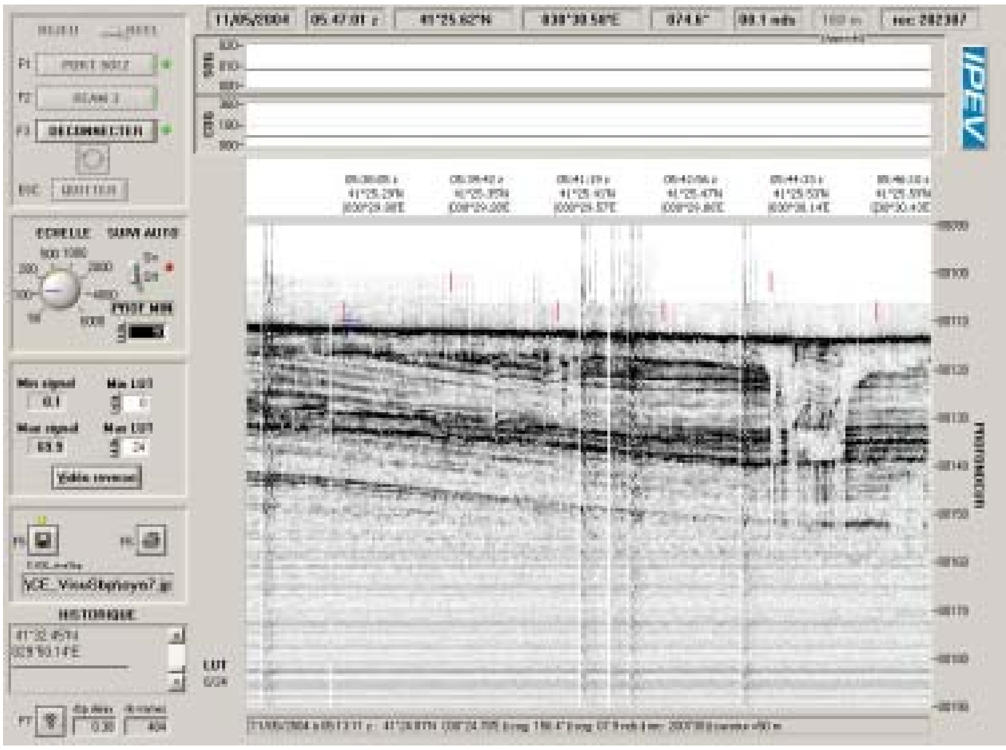


Figure 5.3.2 Paleovalley landward the Lowstand wedge on the Turkish shelf edge surveyed to determine core MD04-2761

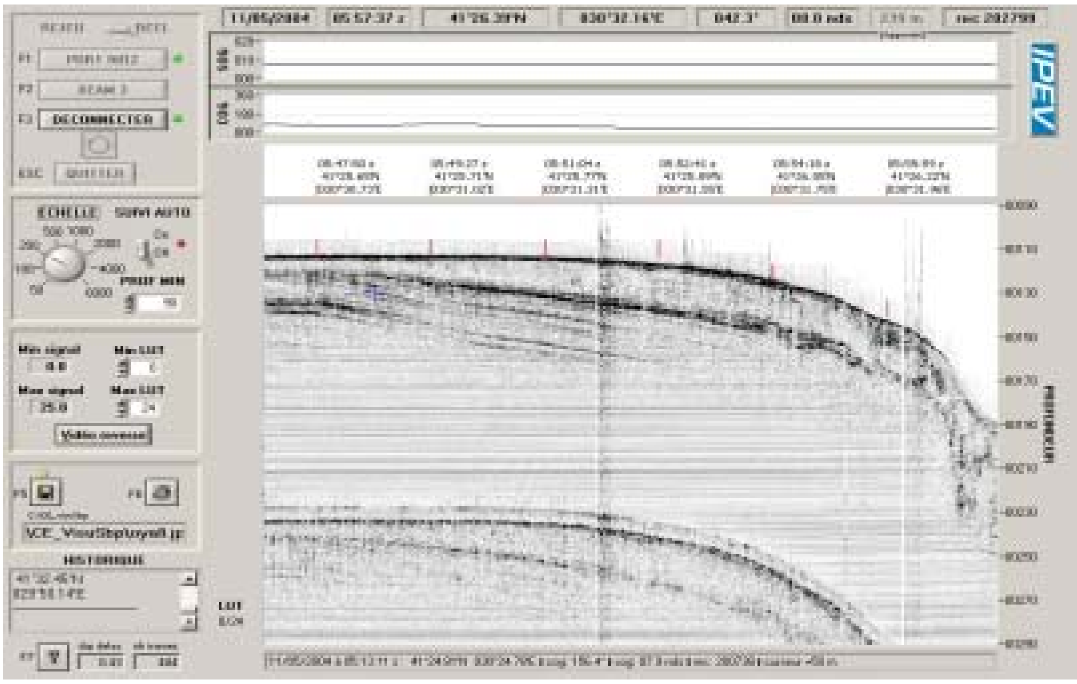


Figure 5.3.2 Lowstand wedge on the Turkish shelf edge surveyed to determine core MD04-2761

6.4. MD04-2761 Coring form

INSTITUT PAUL EMILE VICTOR MARION DUFRESNE

NOM DE LA CAMPAGNE
MD 139 ASSEMBLAGE

Date : 11-05-2004
N° de station ASSMD32

Météo : (force) / Direction
Vent :
Mer :
Variation tension (maxi) :

CAROTTE (N°) :
MD 04-2761
(MD - année - milieu - centaines)

CAROTTE (longueur) :
26,34 m

POSITION :
Latitude : 41°25'95N
Longitude : 30°31'66E

CAROTTIER (type) (1) : CALYPSO II
Poids total (air) : 4,4 t
Poids total (eau) : 4,4 t

RÉGLAGES :
Tubes (longueur) : 30,43 m
Câbles :
Chute libre : m
Boucle : 1,60 m
LC poids : m

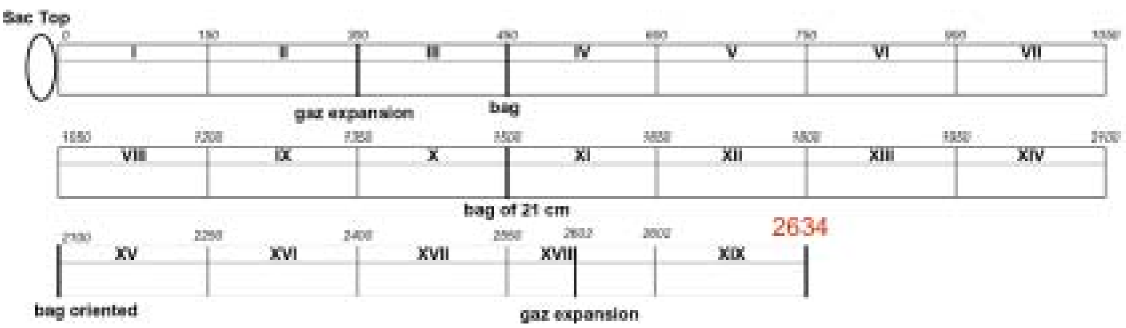
CONTREPOIDS :
Type (2) :
Longueur PVC : 35.13 m
Pénétration : m
Longueur de carotte m

PARAMETRES MESURES :
Sonde corrigée : m
Sonde apparente 120
Ligne filée : m
Arrachement/total (tonne) : t
Arrachement/différentiel (tonne) : t
Pénétration/apparente (m) : 26 m
Pénétration/fansiomètre (m) : m

HEURES (GMT)
En station : 17h42
Début manœuvre : 17h53
Déclenchement : 18h00
Fin de manœuvre : 18h28
Durée de manœuvre : 0h35
Départ station : 18h31

INSTRUMENTATION OPERATIONS ANNEXES
Pinger :
Flux de chaleur :
CTD (hydro) :
CTD (bouteilles) :
Filet à plancton :
Autres :

Description / incidents :



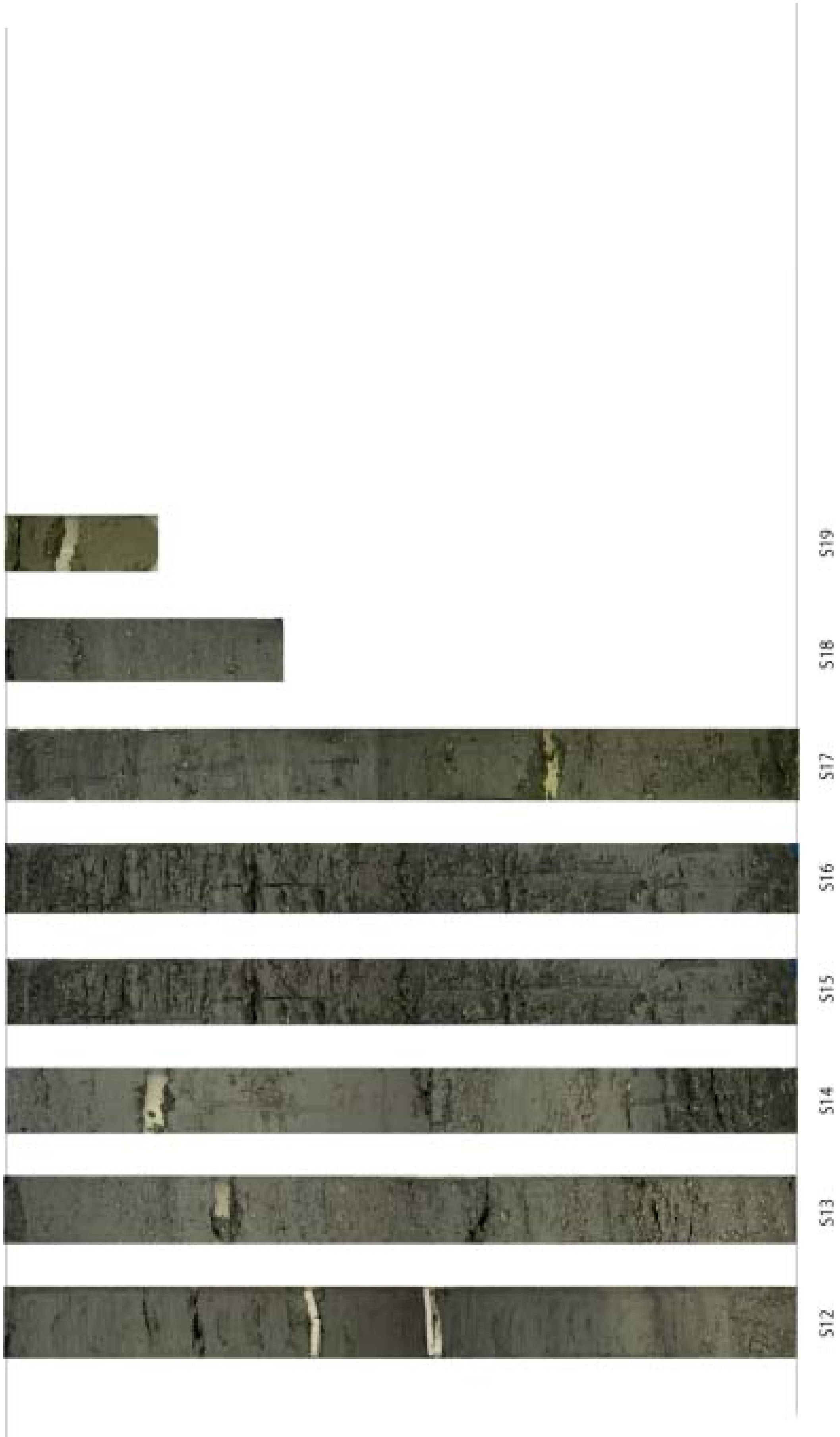
(1) CALYPSO - CALYPSO GRAVIFLUX - BOX CORER 1/4m ou carré géant

(2) Cylindrique 100 kg / Plat / Préleveur

6.5. MD04-2761 Photograph Tables

MD04-2761 : Sections 1 à 11

MD04-2761 : Sections 12 à 19

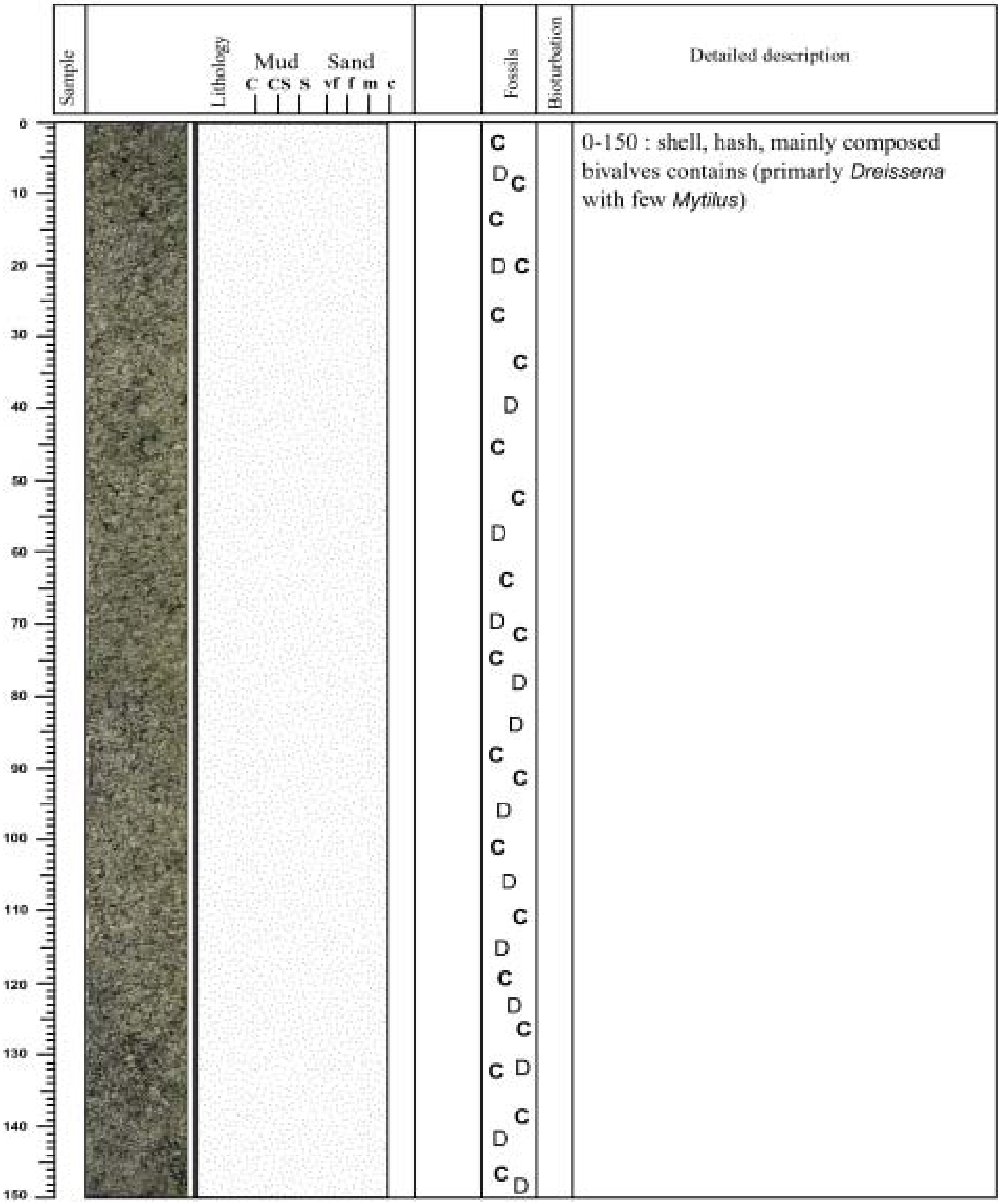


6.6. MD04-2761 Log Description

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : I/XIX	Length top/bottom(cm): 0-150

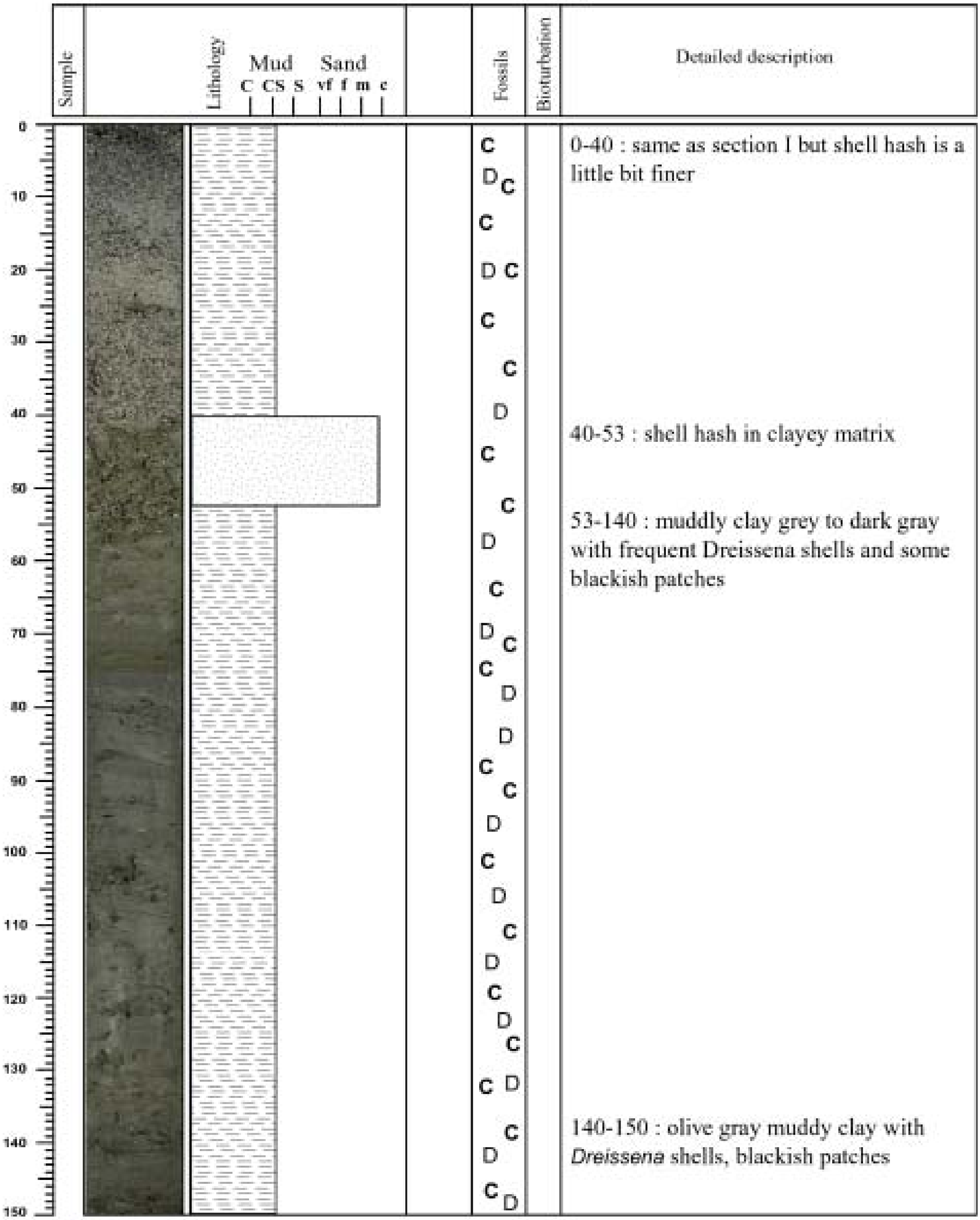
Author : H. Arz & F.Lamy



Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : II/XIX	Length top/bottom(cm): 150-300

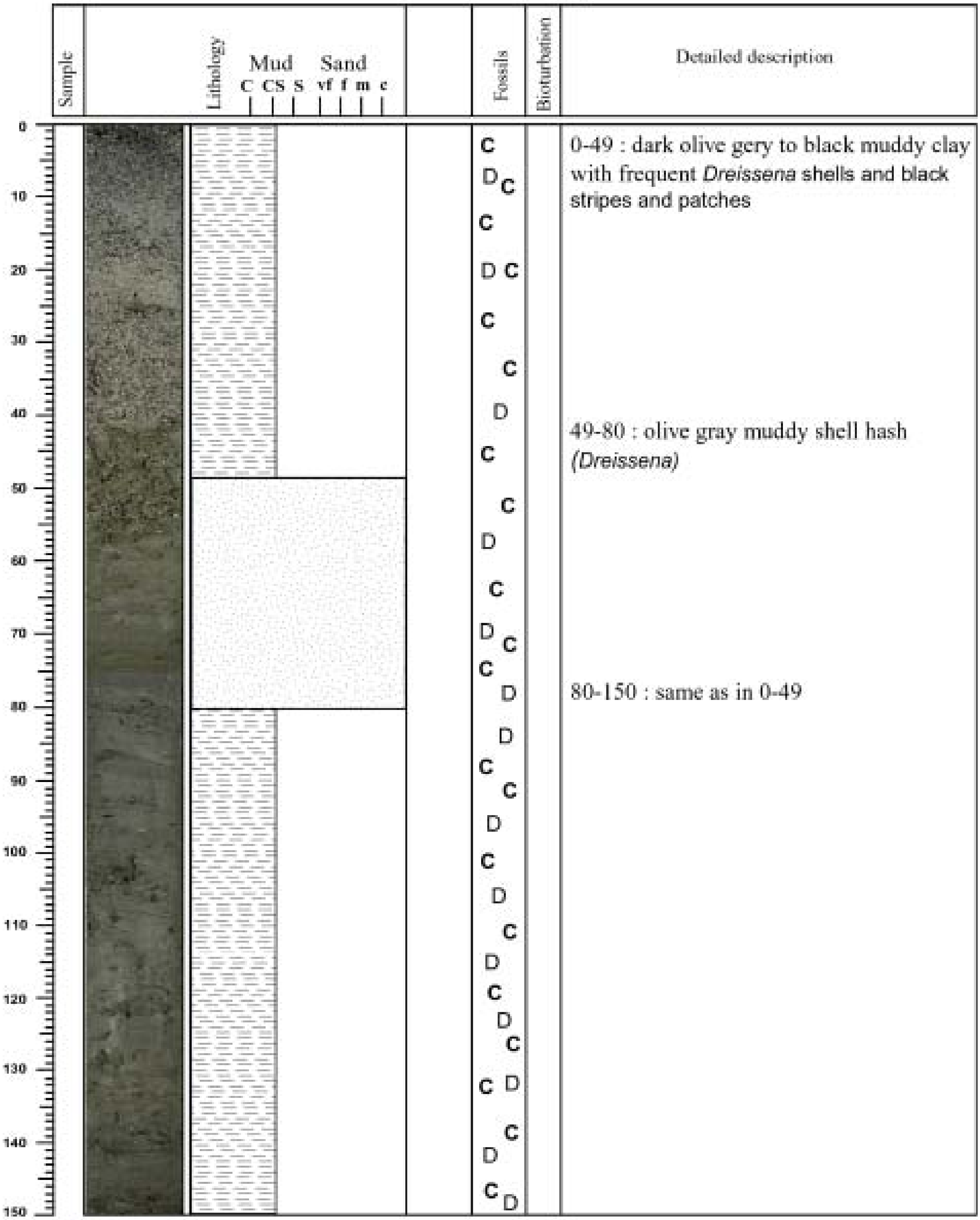
Author : H. Arz & F.Lamy



Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : III/XIX	Length top/bottom(cm): 300-450

Author : H. Arz & F.Lamy

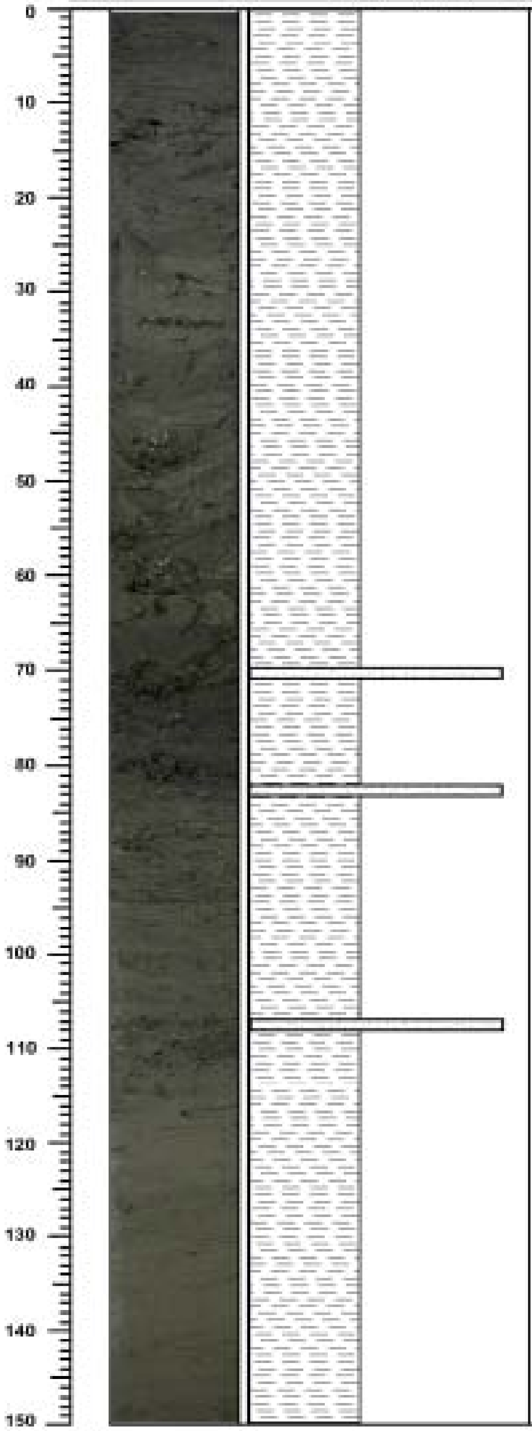


Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : IV/XIX	Length top/bottom(cm): 450-600

Author : H. Arz & F.Lamy

Sample		Lithology Mud C CS S Sand vf f m c		Fossils	Bioturbation	Detailed description



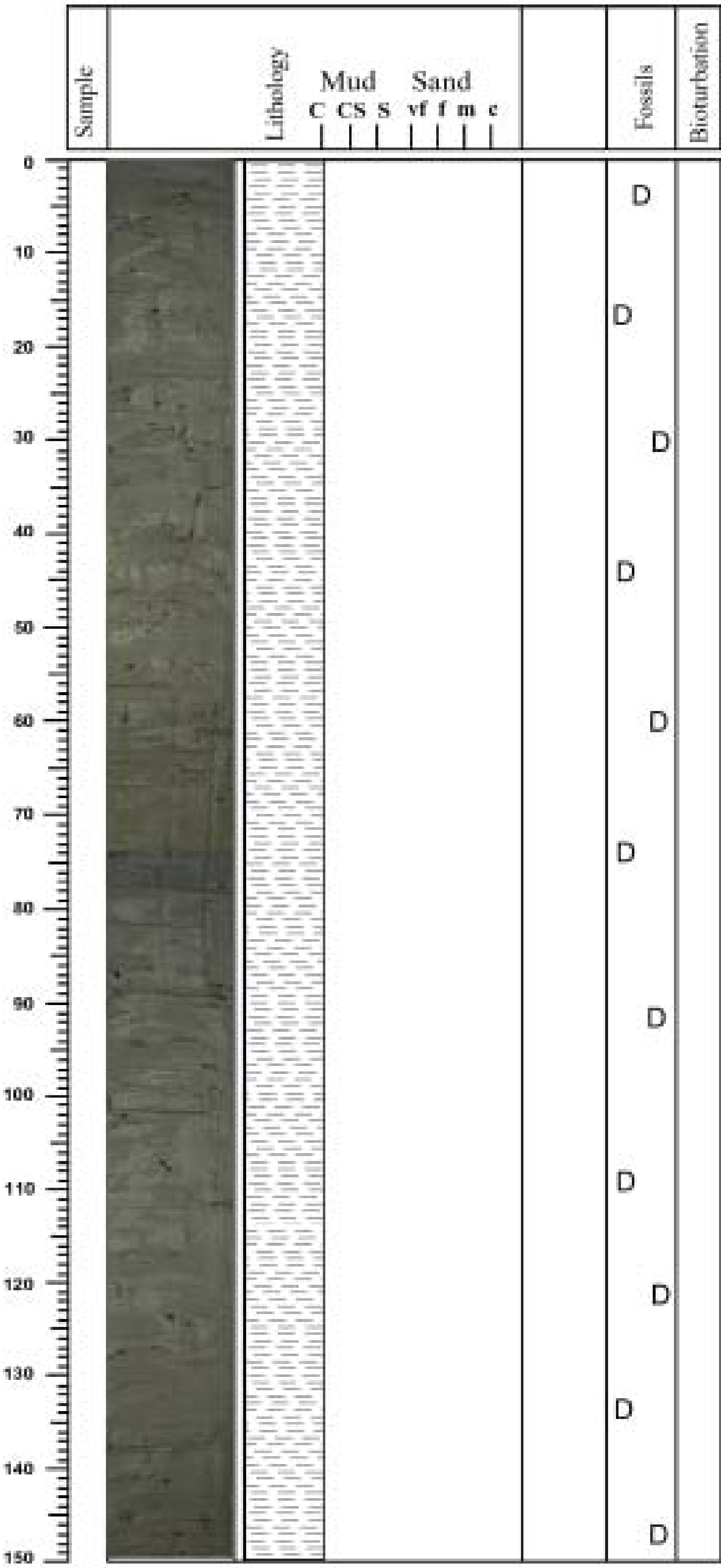
0-115 : dark olive grey to black clay with frequent *Dreissena* and black stripes and spots intercalation of shell hash layer at 70,82,108.

115-150 : dark grey clay with some shells (fragment and complete) of *Dreissena* and black spots

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : V/XIX	Length top/bottom(cm): 600-750

Author : H. Arz & F.Lamy



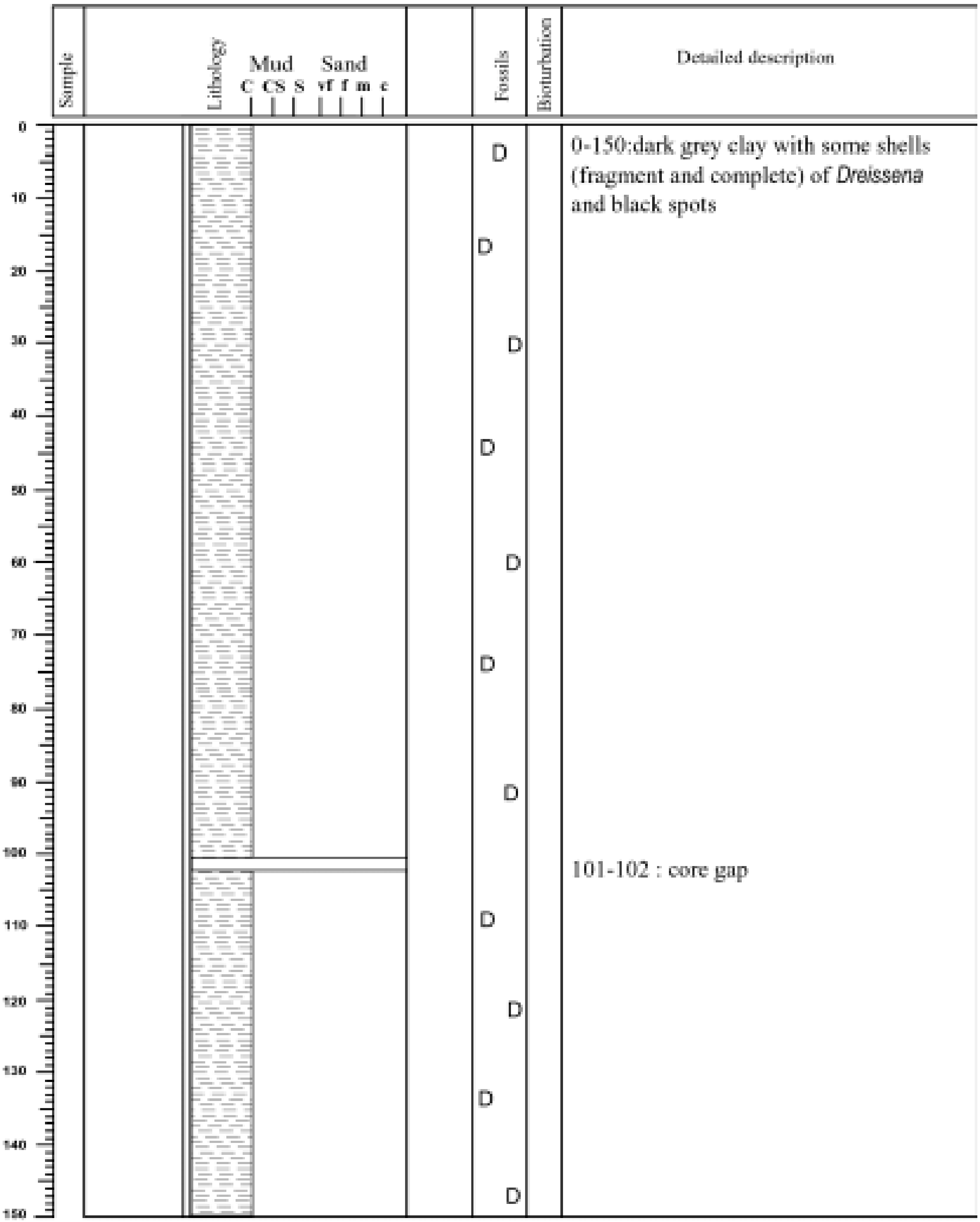
Detailed description

0-150 :dark grey clay with some shells (fragment and complete) of *Dreissena* and black spots

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : VI/XIX	Length top/bottom(cm): 750-900

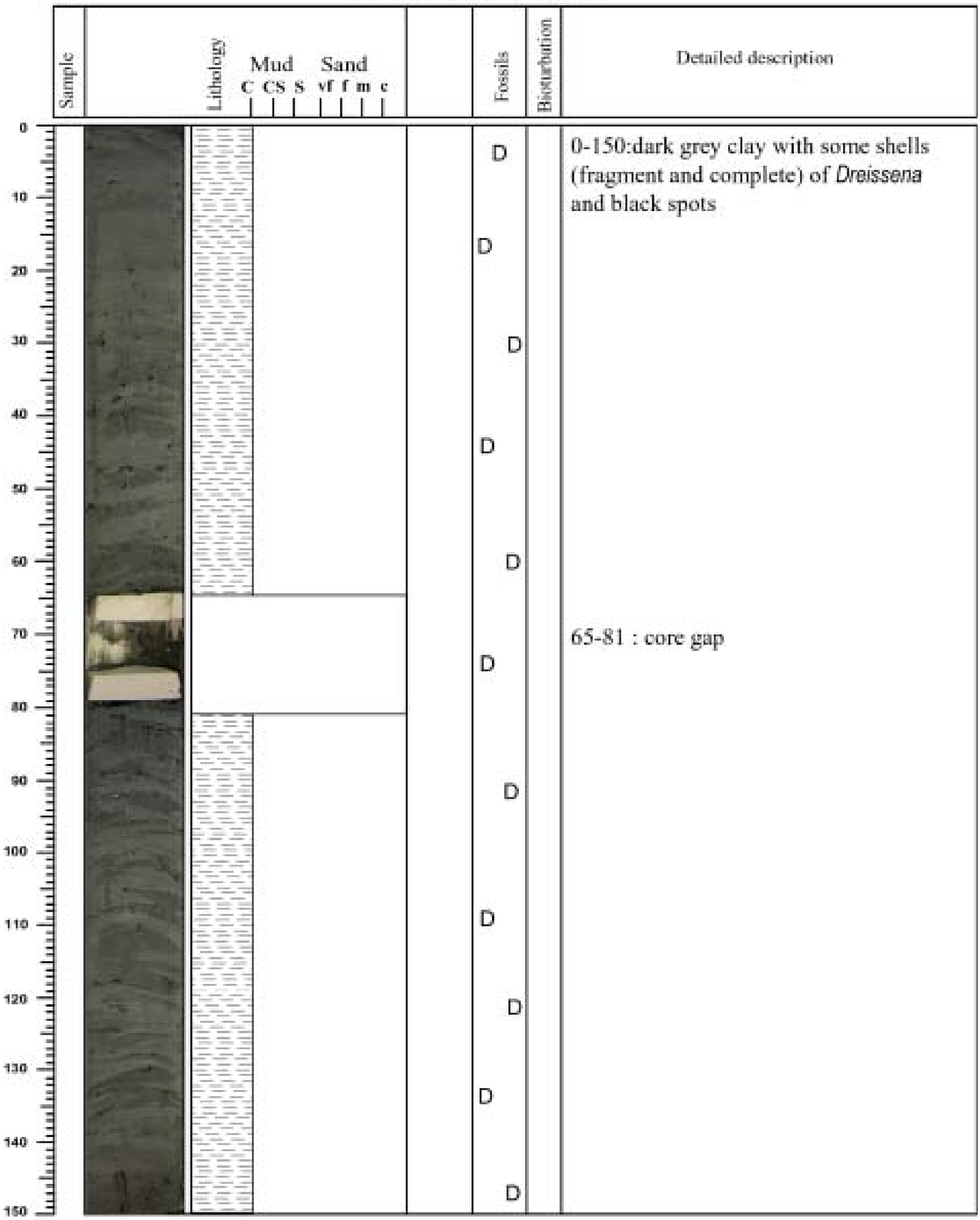
Author : H. Arz & F.Lamy



Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : VII/XIX	Length top/bottom(cm): 900-1050

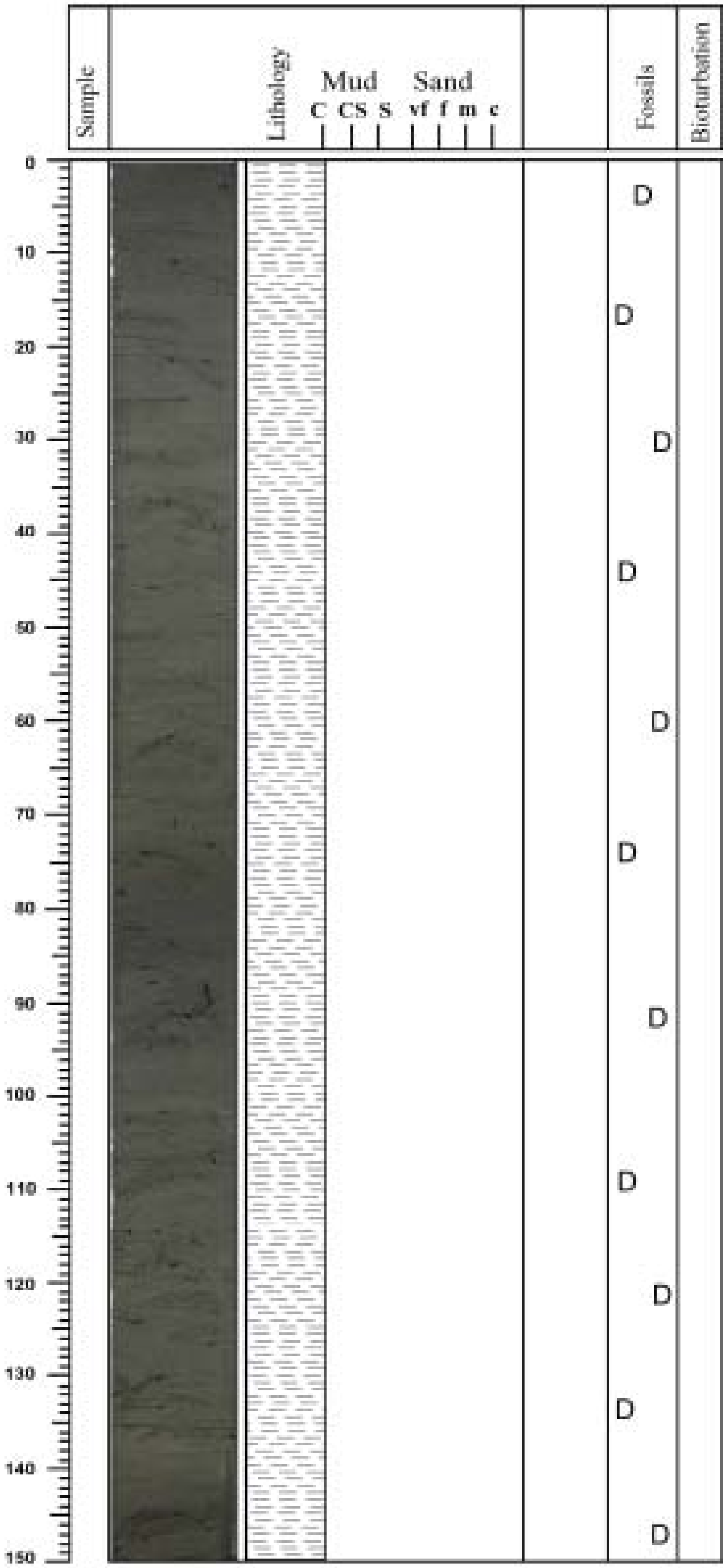
Author : H. Arz & F.Lamy



Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : VIII/XIX	Length top/bottom(cm): 1050-1200

Author : H. Arz & F.Lamy



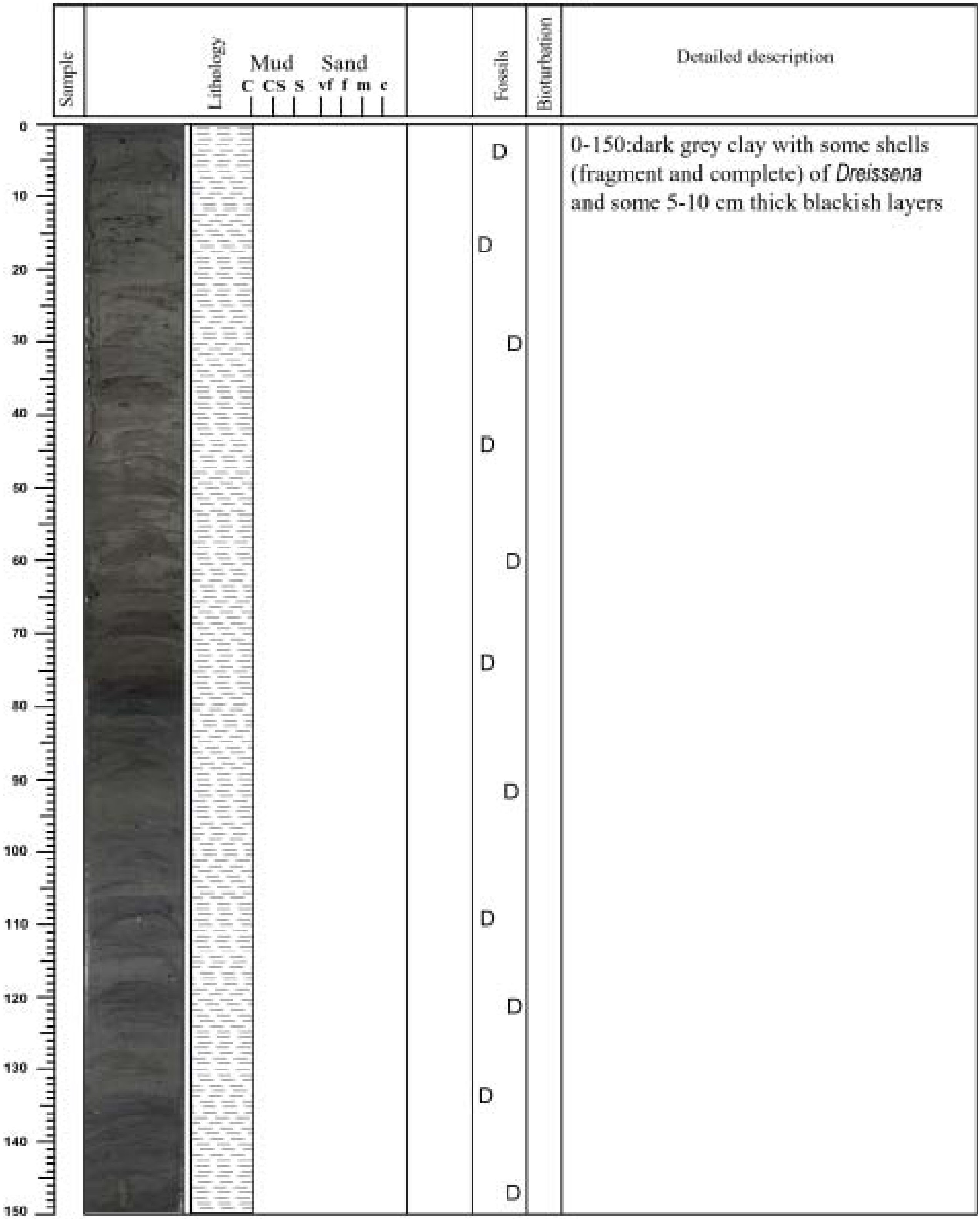
Detailed description

0-150:dark grey clay with some shells (fragment and complete) of *Dreissena* and black spots

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : IX/XIX	Length top/bottom(cm): 1200-1350

Author : H. Arz & F.Lamy



Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : X/XIX	Length top/bottom(cm): 1350-1500

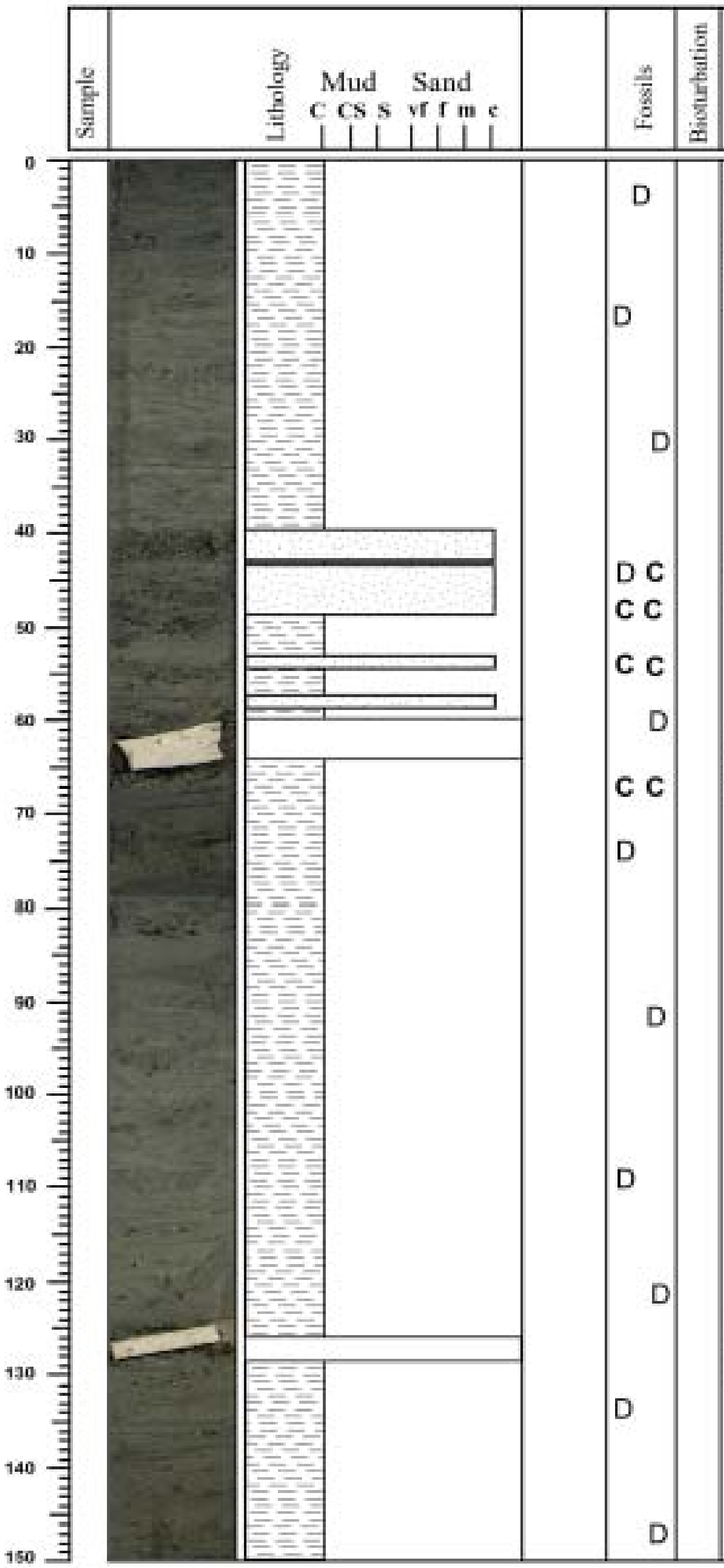
Author : H. Arz & F.Lamy

Sample	Lithology	Mud C CS S	Sand vf f m c		Fossils	Bioturbation	Detailed description
					D D D D D D D D D D D		0-80:dark grey clay with some shells (fragment and complete) of *Dreissena* and some 5-10 cm thick blackish layers 80-150 : very dark gray to black clay with frequent shell fragments

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : XI/XIX	Length top/bottom(cm): 1500-1650

Author : H. Arz & F.Lamy



Detailed description

0-150: grey green mud with a lot of dark grey to black/iron monosulfate(?)mottling Shells dispersed throught and also concentrated in layers

39-41.5,43.5-49,53-54,57-58 : thick shell layers

60-64 : void
64-65 : shell layer

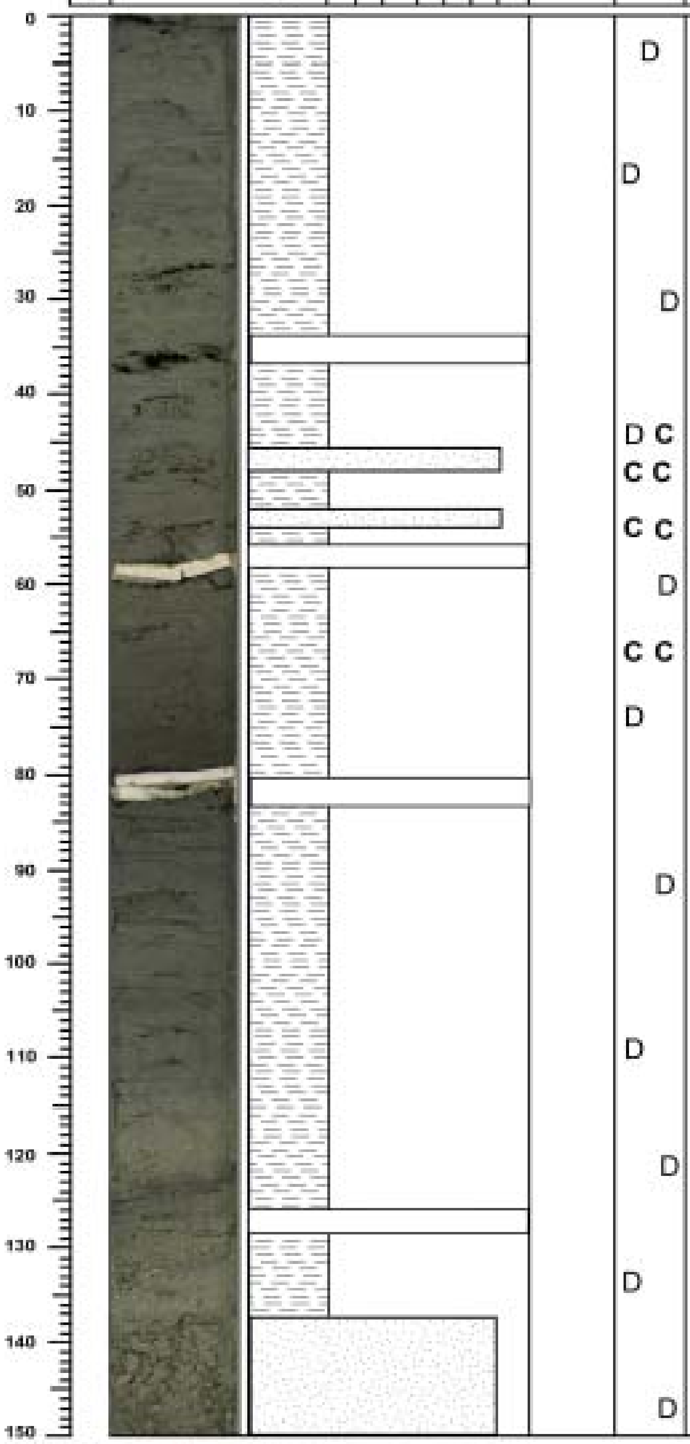
124-126.5 : void
126.5 : shells on the side of the void

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : XII/XIX	Length top/bottom(cm): 1650-1800

Author : C.Major & C.Stretchie

Sample	Lithology (Mud: C CS S; Sand: vf f m c)	Fossils	Bioturbation	Detailed description



0-150: grey green mud with abundant shell material dispersed and in layers
Abundant black specks (FeS?)

34.5-36.5 : void which breaks shelly layers

Shelly layers : 46-47,52-53

56-58.5 : void

68-114 : dark gray-green (colour change gradually from the top to the bottom of this layer)

80-83.5 : void

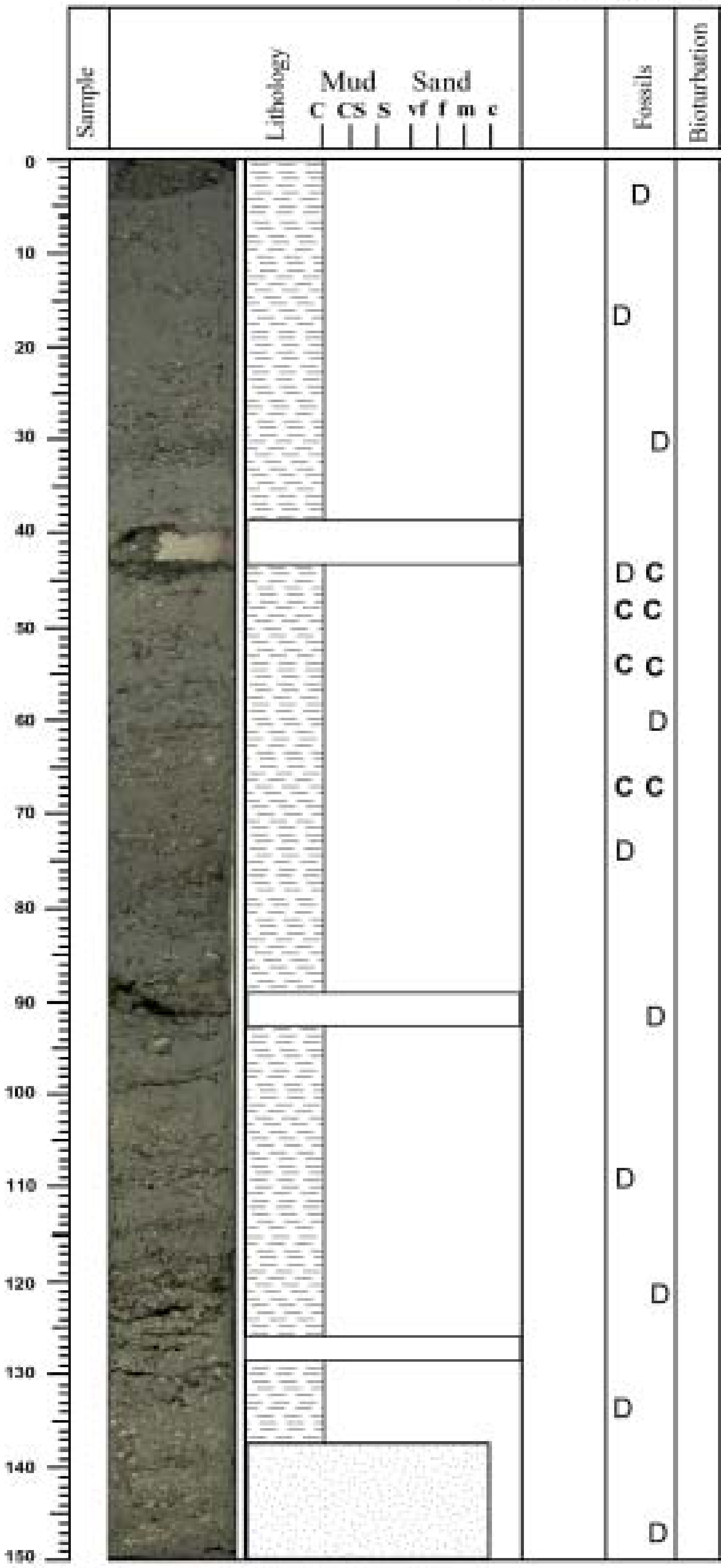
123-126 : dark grey green layer

137-150 : very abundant shell debris with intact shells mainly *Dreissena*

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : XIII/XIX	Length top/bottom(cm): 1650-1800

Author : C.Major & C.Stretchie



Detailed description

0-150: light grey green mud with very abundant shell material (predominant *Dreissena* (shell up to 80% of the sediment
Several large intact *Dreissena* with both valvs together (95-96; 123-124).
The shell goes up to 2 cm long

38-43 : void

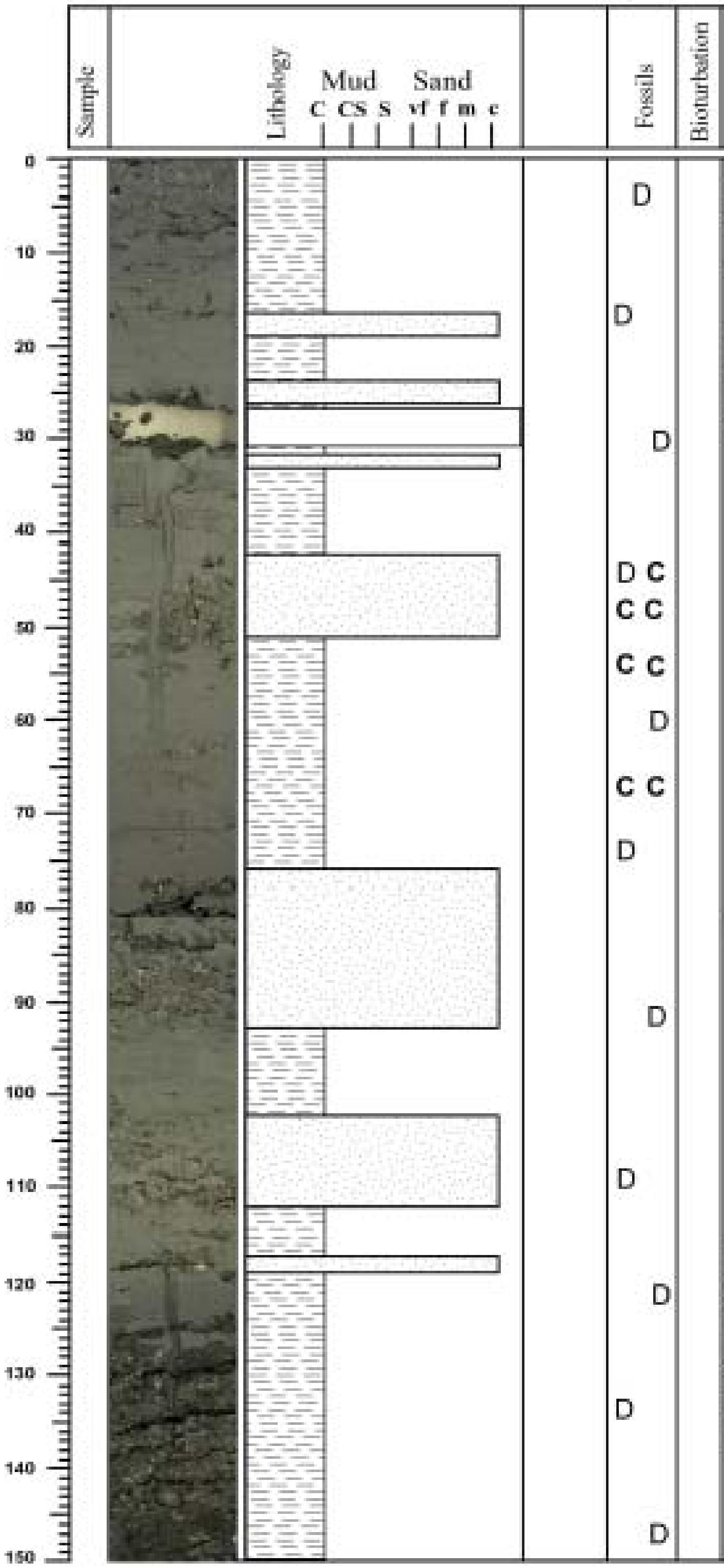
89-92 : void

Several cracks between 120-130

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : XIV/XIX	Length top/bottom(cm): 1950-2100

Author : C.Major & C.Stretchie



Detailed description

0-8: light grey green shelly clay
8-118 : light gray green clay with shells dispersed and some thick shell layers at

16-17, 24-26,31-32,42-51,76-93, 102-111.5,117-118
26-31 : void

77-81 : cracks

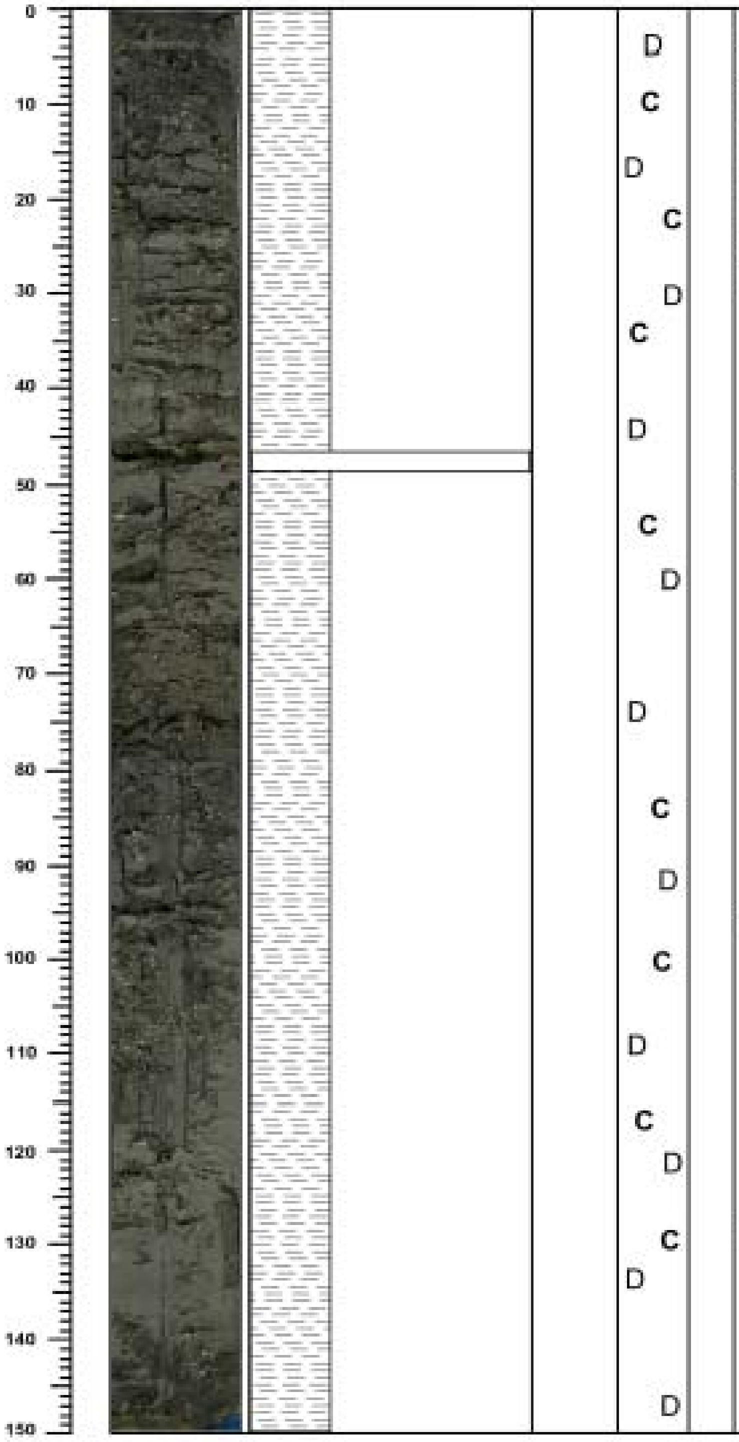
118 -123 : colour transition from gray green to dark and very dark gray mud
126-140 : some cracks with very abundant Dreissena including one very big specimen with 2 valvs 140-142, 2cm long

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : XV/XIX	Length top/bottom(cm): 2100-2250

Author : C.Major & C.Stretchie

Sample	Lithology Mud (C CS S) Sand (vf f m c)		Fossils	Bioturbation	Detailed description



0-150: light grey green mud with very abundant shells, several intact *Dreissena* with both valves (i.e. 31-33) up to 2cm long
16-25, 96-100 : some extension cracks (The shells are less abundant than in the previous section)

46-48 : void

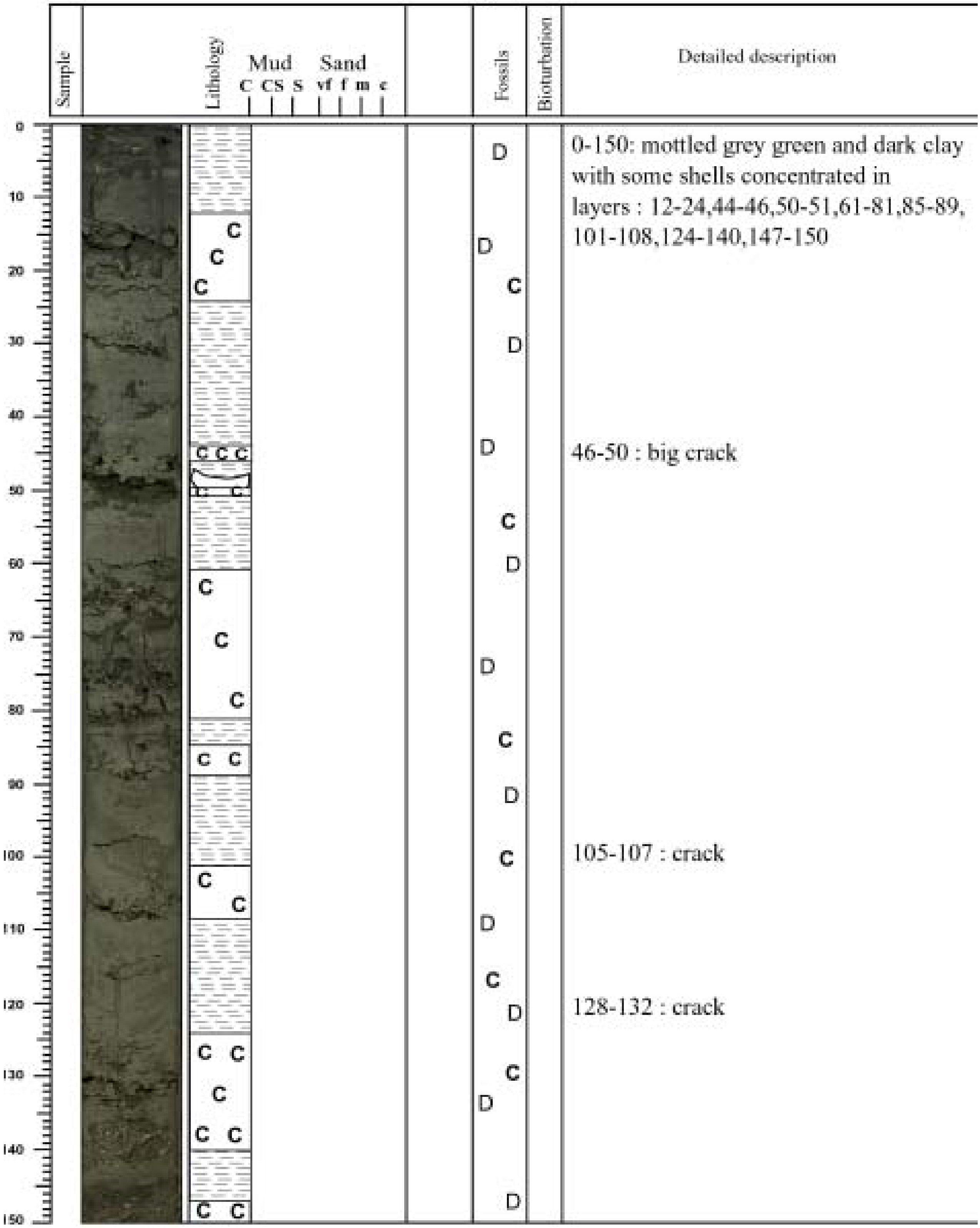
96-99: cracks

130-150 : fewer shells

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : XVI/XIX	Length top/bottom(cm): 2250-2400

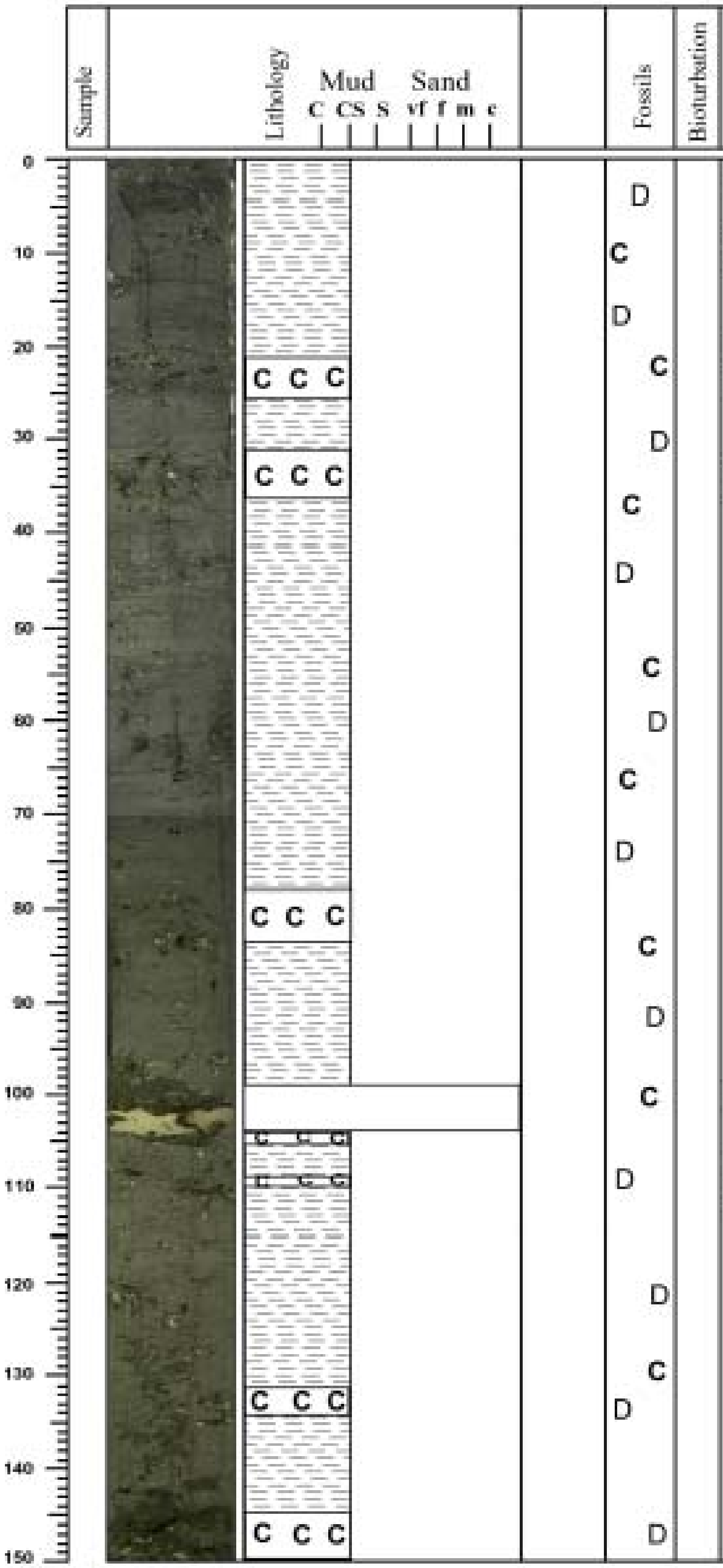
Author : C.Major & C.Stretchie



Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : XVII/XIX	Length top/bottom(cm): 2400-2550

Author : C.Major & C.Stretchie



Detailed description

0-150: grey green to dark clay mottled silty mud with shells dispersed throught the sediment and concentrated in layers at

20.5-25,31-36,78-83,104-105,109-110, 131-134,145-150

20-120 : some very faint colour banding of 2 to 10 cm thickness

99-103.5 : void

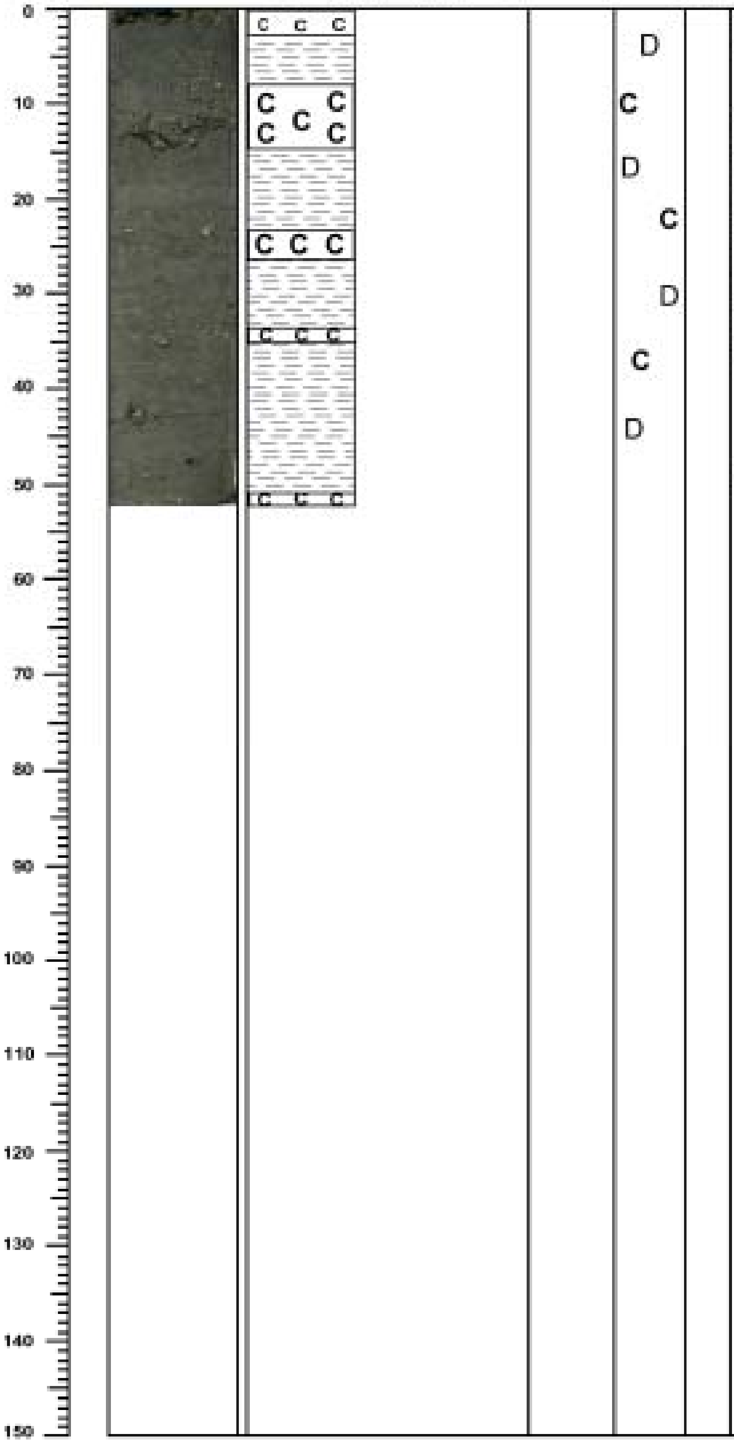
Colour becomes darker toward the bottom of the core

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections :XVIII/XIX	Length top/bottom(cm): 2550-2602

Author : C.Major & C.Stretchie

Sample	Lithology — Mud (C CS S), Sand (vf f m c)		Fossils	Bioturbation	Detailed description



0-2 : crack

0-52 : mottled grey green to dark gray silty mud highly disturbated with *Dreissena* shells
Some dispersed and concentrated in layers at : 0-2.5, 8-15 *(Dreissena* with both valvs together,1.5cm long), 23-26,34-35,51-52

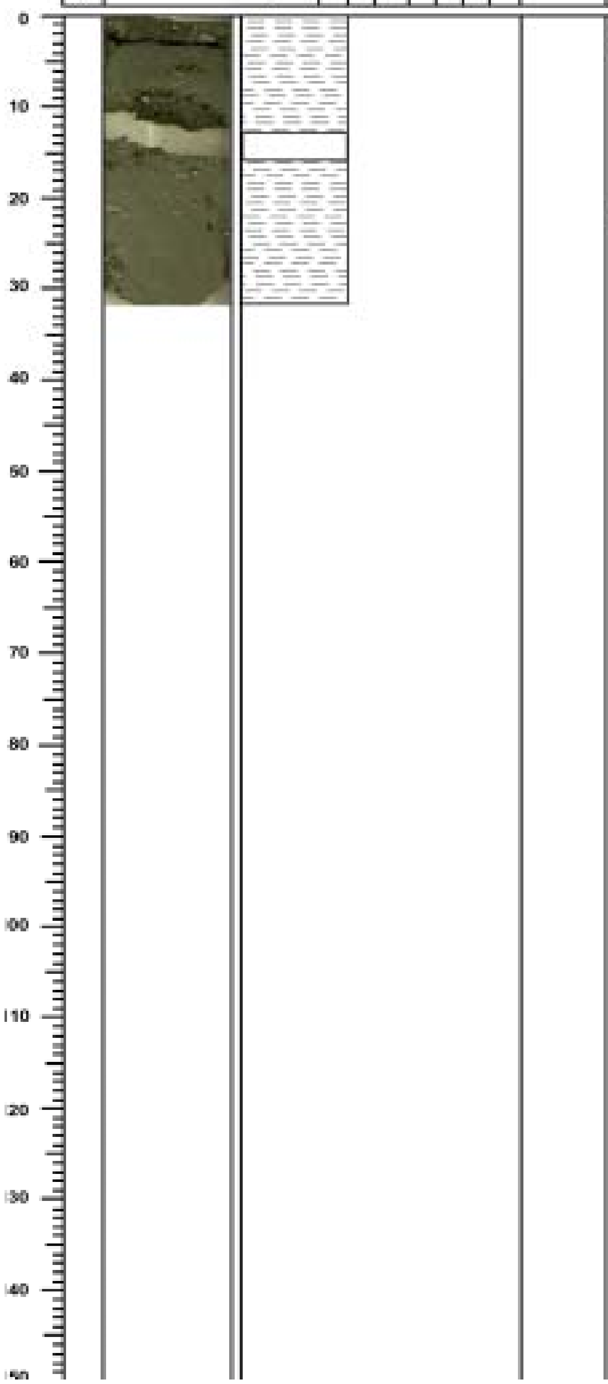
Overall fewer shells between 15-52

Mission: ASSEMBLAGE

Core : MD04-2761	Depth :120m	Sections : XIX/XIX	Length top/bottom(cm): 2602-2634

Author : C.Major & C.Stretchie

Sample	Lithology (Mud: C CS S; Sand: vf f m c)	Fossils	Bioturbation	Detailed description
		D C D C		0-32 : gray clay rich in *Dreissena* shells, the both fragments and complete shells. No lamination is to be seen on this clay Note : expansion



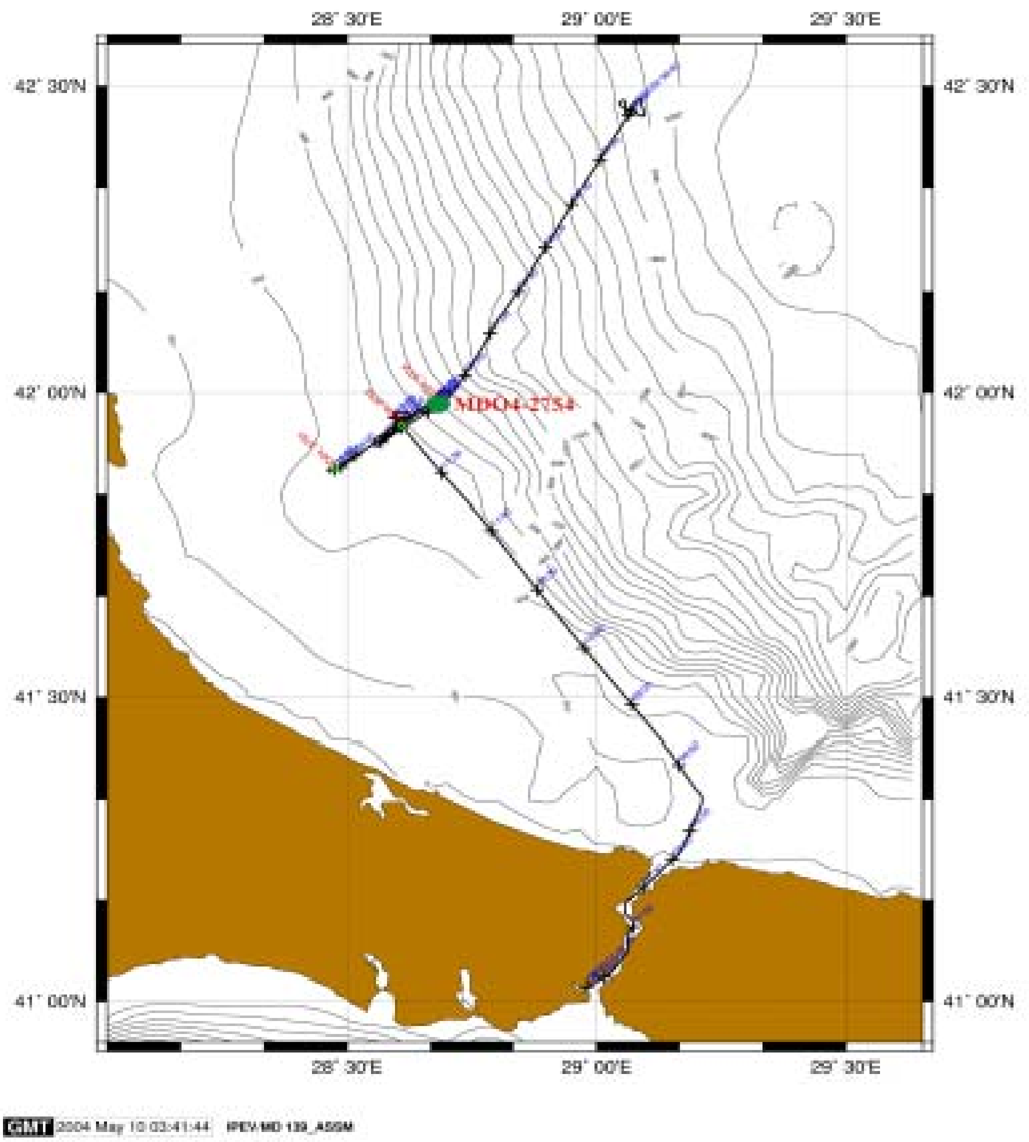
Energy, Environment and Sustainable Development

7. Description of Core MD04-2754

7.1. Site presentation

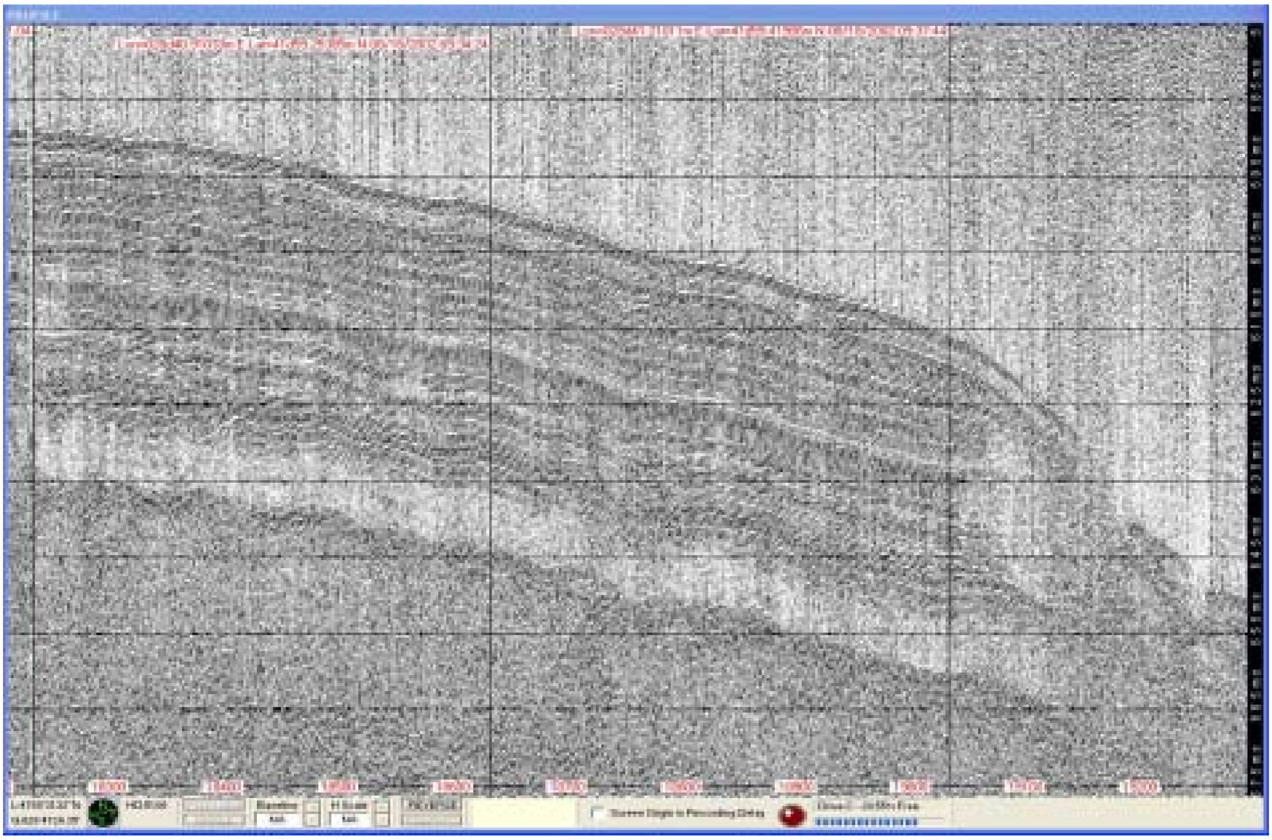
Core MD04-2754 was recovered on a transect profile shot during BlaSON2 survey in 2002. The target has been chosen on the base of the seismic interpretation of the Ifremer Chirp sonar system hull mounted on "Le Suroit". The target is located at the foot of the shelf slope in the western part of the Black Sea at the border between Turkey and Bulgaria. It has been chosen for it important sediment sequence presenting an important succession of seismic layer not deformed or structured by tectonic. This core seems to be a good candidate for paleoenvironmental and paleoclimatic studies.

7.2. Location map for core MD04-2754

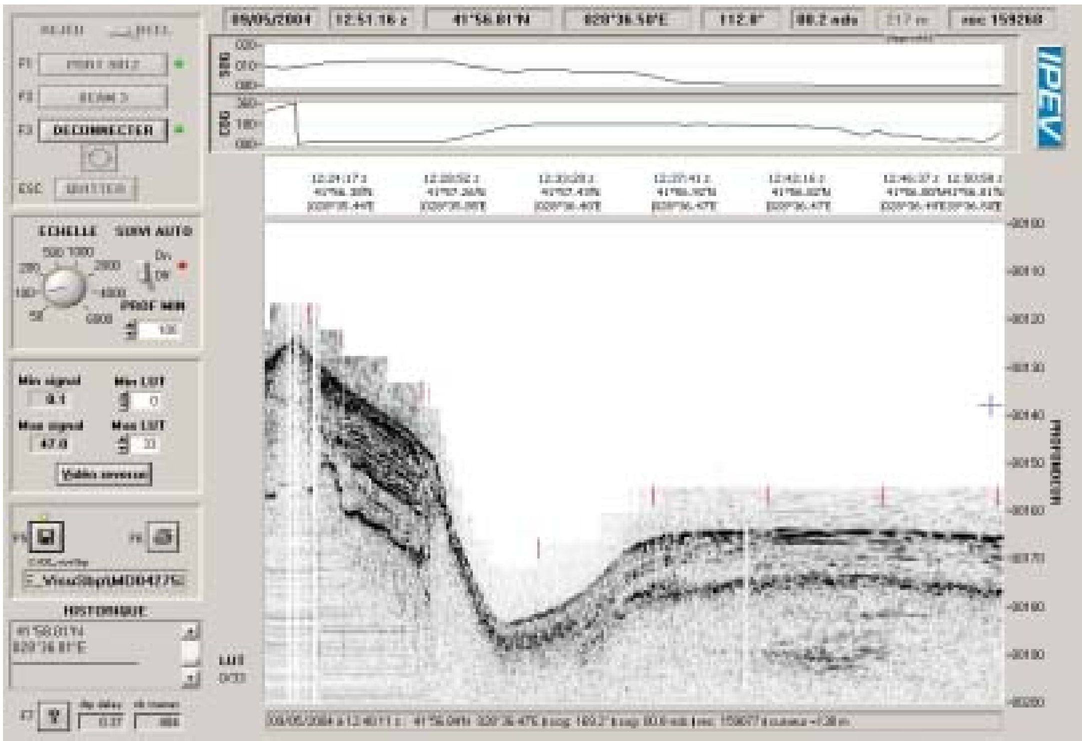


7.3. MD04-2754 precise Site Survey

7.3.1. Profile acquired during BlaSON2



7.3.2. MD04-2761 Site Survey



7.4. MD04-2754 Coring Form

INSTITUT PAUL EMILE VICTOR — MARION DUFRESNE

NOM DE LA CAMPAGNE
MD 139 ASSEMBLAGE

Date : 09-05-2004
N° de station ASSMD33

Météo : (force) / Direction
Vent :
Mer :
Variation tension (max) :

CAROTTE (N°) :
MD 04-2754
(MD - année - milieu - centaine)

CAROTTE (longueur) :
32,17 m

POSITION :
Latitude : 41°59.23N
Longitude : 28°40.99E

CAROTTIER (type) (1) : CALYPSO II
Poids total (air) : t
Poids total (eau) : 4.5 t

REGLAGES :
Tubes (longueur) : 41,9 m
Câbles :
Chute libre : 1,5 m
Boucle : 1,6 m
LC poids : m

CONTREPOIDS :
Type (2) :
Longueur PVC : m
Pénétration : m
Longueur de carotte : m

PARAMETRES MESURES :
Sonde corrigée : 453 m
Ligne filée : 414 m
Arrachement/total (tonne) : 10.5 t
Arrachement/différentiel (tonne) : t
Pénétration/apparente (m) : 30 m
Pénétration/tensiomètre (m) : 30 m

HEURES (GMT)
En station : 18h37
Début manoeuvre : 18h49
Déclenchement : 19h02
Fin de manoeuvre : 19h50
Durée de manoeuvre : 1h01
Départ station :

INSTRUMENTATION OPERATIONS ANNEXES
Pinger :
Flux de chaleur :
CTD (hydro) :
CTD (bouteilles) :
Filet à plancton :
Autres :

Description / incidents :

Bag 1, Bag 2, Bag 3, Bag 4, Bag 5
Base — Top

0	150	300	450	600	750	900
I	II	III	IV	V	VI	VII

(1050)

1050	1200	1350	1500	1650	1800	1950
VIII	IX	X	XI	XII	XIII	XIV

(2100)

2100	2250	2400	2550	2700	2850	3000
XV	XVI	XVII	XVIII	XIX	XX	XXI

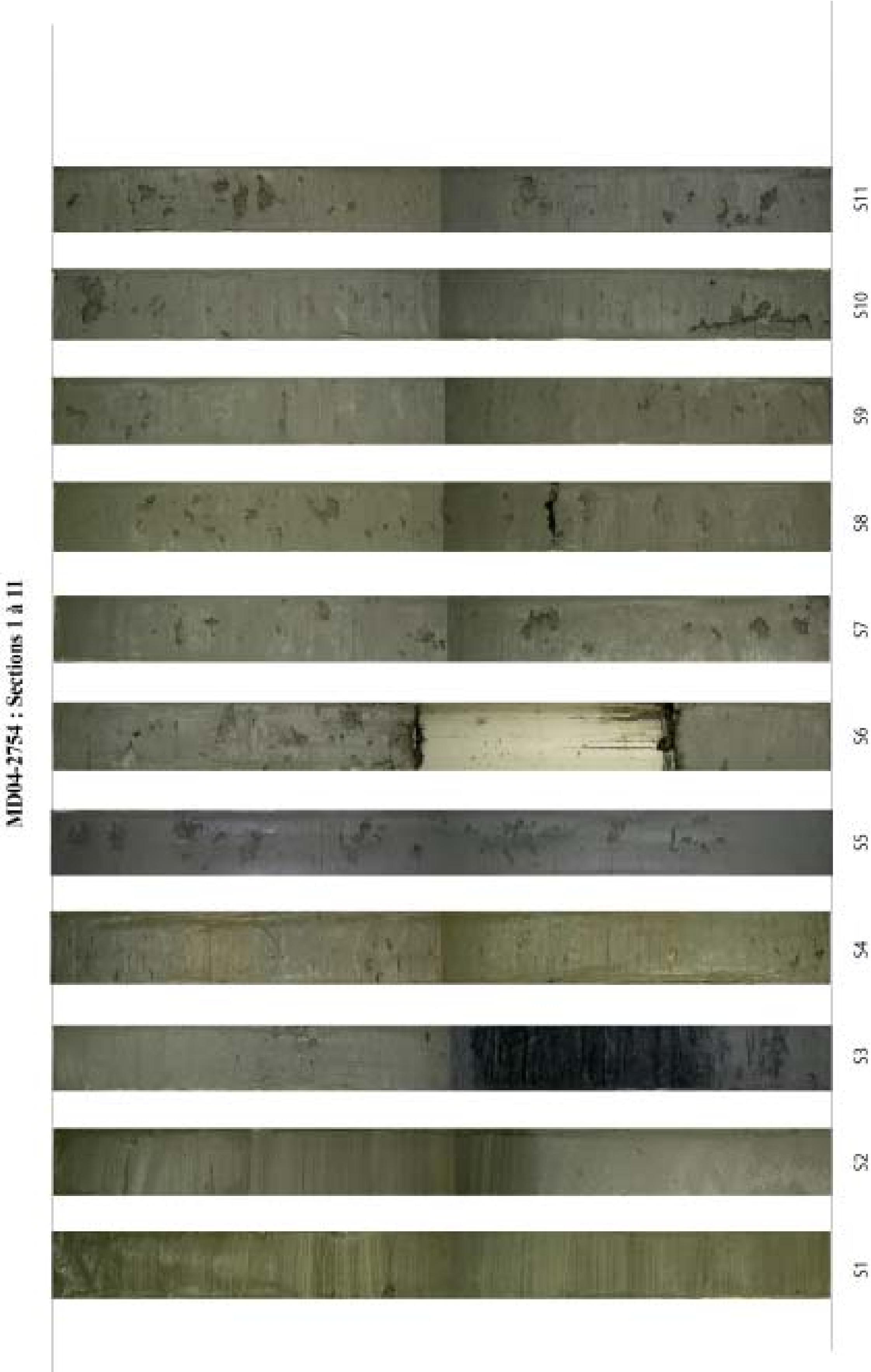
(3150)

3150 3217

(1) CALYPSO - CALYPSO GRAVITY - BOX CORER 1X1m ou carré géant

(2) Cylindrique 180 kg / Plat / Préleveur

7.5. MD04-2754 Photography table



MD04-2754 : Sections 12 à 22