Hydrographical, Hydrodynamical and Coring-Results from the Hermes 1 Cruise in the Gulf of Lion (NW Mediterranean)

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HERMES
(HERMES 1 Cruise)

Summary

A network of short mooring lines equipped with currentmeters and sequential sediment traps was deployed at the beginning of the cruise along the axis of two canyons and one open slope of the southwestern end of the Gulf of Lion. The objectives of this observational effort are (i) to monitor the near-bottom sediment dynamics across the entire slope, (ii) to monitor the biweekly variability of downward particulate fluxes, and (iii) to evidence the spatial coherence of suspended sediment transport between canyons and open slope environments.

Distribution of water masses and turbid structures in the area were characterized along transects extending from the shelf edge to the rise. Near bottom water samples were collected for biogeochemical analyses (suspended sediment concentration, particulate organic and inorganic carbon, radioisotopes (C_{13}, N_{15}), sugars, and metals).

The primary objective of the seabed sampling was to identify the across-slope variation of benthic communities and sediment characteristics within canyons and on the adjacent open slopes (which are used as control stations). Cores were sub-sampled for biological, sedimentological and chemical analysis. Biological analysis of the superficial sediment (0-50 cm) included biochemical composition of organic matter, bacteria production, enzymatic activities, bacteria diversity, meio- and macro-fauna diversities. Sedimentological analysis included for radioisotopic dating (Pb_{210}), grain size analysis, porosity and specific surface. Chemical analysis included isotopic (H_3, C_{12}, C_{13}, N_{15}), organic (alkenones, alkanes, amino acids, particulate and dissolved organic carbon) and mineral (metals) characterization of sediment.

Scientific crew

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Sediment traps and Currentmeters Mooring Comments

Author: A. Sanchez

1. Mooring sites

Short mooring lines were deployed between 300 m and 2400 m depth along the axis of the Lacaze-Duthiers and Cap de Creus canyons, as well as across its southern open slope (Fig. 1). Their design is depicted in Fig. 2. Currentmeter sampling rates were set at 30 minutes and sediment trap were programmed to collect biweekly (15 days) downward particle fluxes Moorings lines in the head of he Cap de Creus canyon (at 300 and 1000 m depth), located in Spanish waters, were deployed from the R/V Garcia del Cid in mid-October 2005. The network of moorings will collect data at the same time than two additional lines, located at 1000 m deep in the NE (Planier Canyon) and SW (Lacaze-Duthiers Canyon) limits of the gulf. These lines, managed by CEFREM since October 1993, are used to monitor the seasonal and interannual variability of downward particulate fluxes, thus providing a temporal framework for the short term experiment. These lines were deployed from the R/V Tethys II in early October 2005.

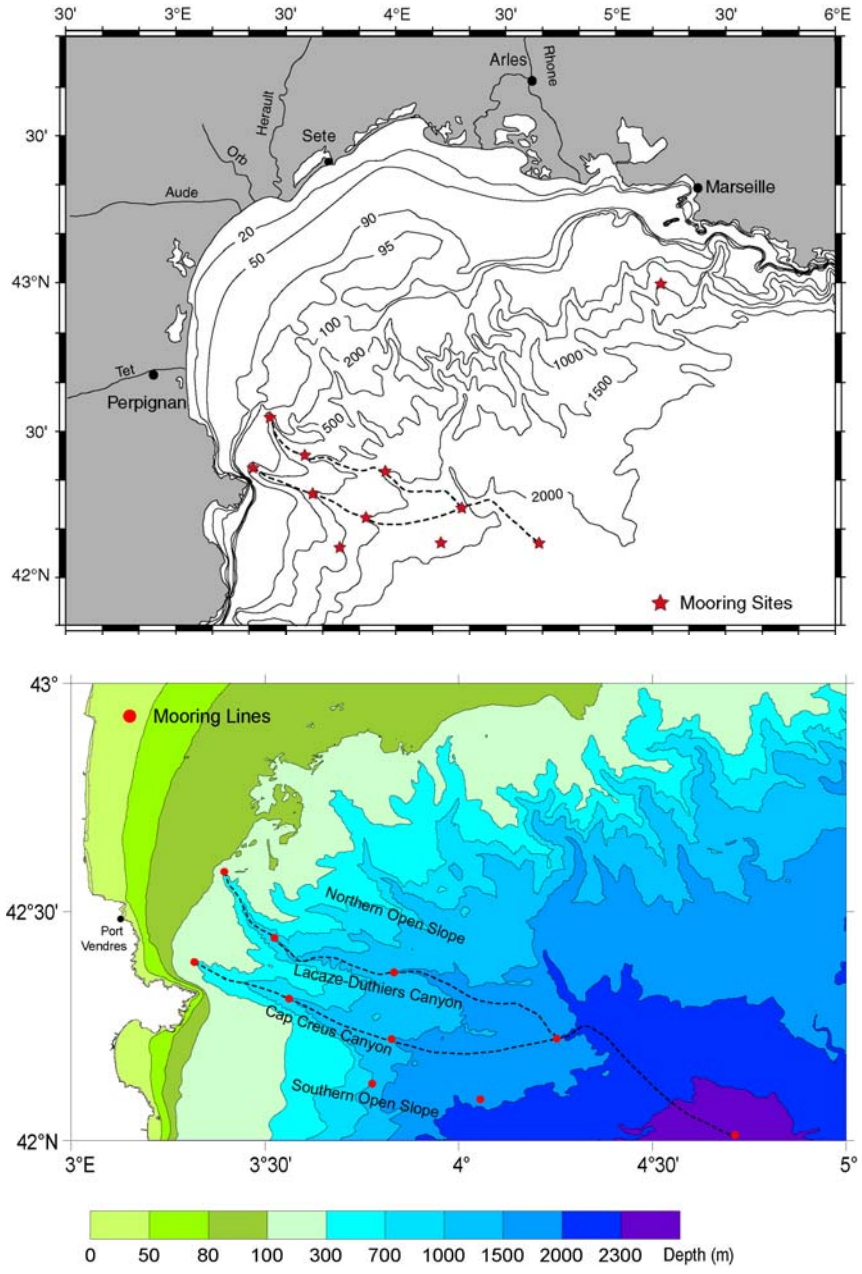

Fig. 1 Location of the shallow and deep moorings

Mooring Name & Type	Depth	Longitude	Latitude	Deploy. Time	Name
Canyon of Lacaze-Duthiers					
CLD 300 [Shallow]	300 m	42° 35.760 N	003° 23.800 E	15 Oct 2005 12:00 UTC	PPS Plate H1-4F RCM9 #551 AR 174 (I: 8153; R: 8154)
CLD 1000 [Intermediate]	1050 m	42° 25.620 N	003° 32.640 E	01 Oct 2005 14:00 UTC	PPS Plate: 04-74 (500 mab) RCM 7: #11862 (500 mab) PPS Plate: 04-073 (30 mab) RCM 8: #8544 (30 mab) RCM 9: #550 (5 mab) AR 137 (I: 83; R: 84)
CLD 1500 [standard]	1510 m	42° 22.000 N	003° 50.140 E	15 Oct 2005 16:56 UTC	PPS Plate: H1-5F (30 mab) RCM11: #166 (5 mab) AR 393 (I: B115; R: B116)
Canyon of Cap de Creus					
CCC 300 [Shallow]	310 m	42° 23.510 N	003° 19.200E	07 Oct 2005 08:34 UTC	PPS Plate : H1-F1 (30 mab) RCM 9 : #926 (5 mab) AR 227 (I: 9165; R: 9166)
CCC 1000 [Standard]	1000 m	42° 18.700 N	003° 33.900E	07 Oct 2005 05:53 UTC	PPS Plate : H1-F2 (30 mab) RCM 9 : #928 (5 mab) AR 228 (I: 9167; R: 9168)
CC 1500 [Standard]	1490 m	42° 13.440 N	003° 49.590 E	15 Oct 2005 19:16 UTC	PPS Plate: H1-3F (30 mab) RCM 11: #165 (5 mab) AR 391 (I: B111; R: B112)
CCC 1900 [Standard]	1920 m	42° 13.160 N	004° 15.680 E	16 Oct 2005 10:22 UTC	PPS Plate: H1-8F (30 mab) RCM 11: #167 (5 mab) AR 394 (I: B117; R: B118)

Canyon of Sete					
CS 2400 [Deep]	2400 m	42° 05.200 N	004° 39.970 E	17 Oct 2005 06:35 UTC	ADCP (100 mab) PPS Plate: H1-9C (30 mab) PPS Plate: H1-9D (10 mab) AR 392 (I: B113; R: B114)
Southern Open Slope					
SOS 1000 [Standard]	970 m	42° 07.690 N	003° 46.550 E	15 Oct 2005 21:40 UTC	PPS Plate: H1-6F (30 mab) RCM 9: #925 (5 mab) AR 226 (I: 9163; R: 9164)
SOS 1900 [Standard]	1900 m	42° 06.600 N	004° 02.930 E	16 Oct 2005 06:50 UTC	PPS Plate H1-7F (30 mab) RCM11 #168 (5 mab) AR 175 (I: 8155; R: 8156)
Canyon of Planier					
CPL 1000 [Intermediate]	1050 m	43° 01.400 N	005° 12.000 E	30 Sep 2005 20:00 UTC	PPS Plate: IC (500 mab) Aquadopp (500 mab) PPS Plate: AB (30 mab) Aquadopp (30 mab) AR Oceano #113

Table 1 Mooring coordinates, depths, and deployment time and instruments tally.
Aanderaa currentmeter settings were: Low temperature range, 0-74 mS conductivity range, 30 minutes sampling interval.

Period	1	2	3	4	5	6	7	8	9	10	11	12
Date	17 Oct 05 31 Oct 05	01 Nov 05 15 Nov 05	16 Nov 05 30 Nov 05	01 Dec 05 15 Dec 05	16 Dec 05 30 Dec 05	31 Dec 05 14 Jan 06	15 Jan 06 29 Jan 06	30 Jan 06 13 Feb 06	14 Feb 06 28 Feb 06	01 Mar 06 15 Mar 06	16 Mar 06 30 Mar 06	31 Mar 06 14 Mar 06
Date	24 Oct 05 31 Oct 05	Delayed start for mooring LD300, LD1500, CC1500, CC1900, CS2400, OS1000, OS 1900										

Table 2 Trap sampling intervals. Note that the start of the first sample was delayed for some of the traps.

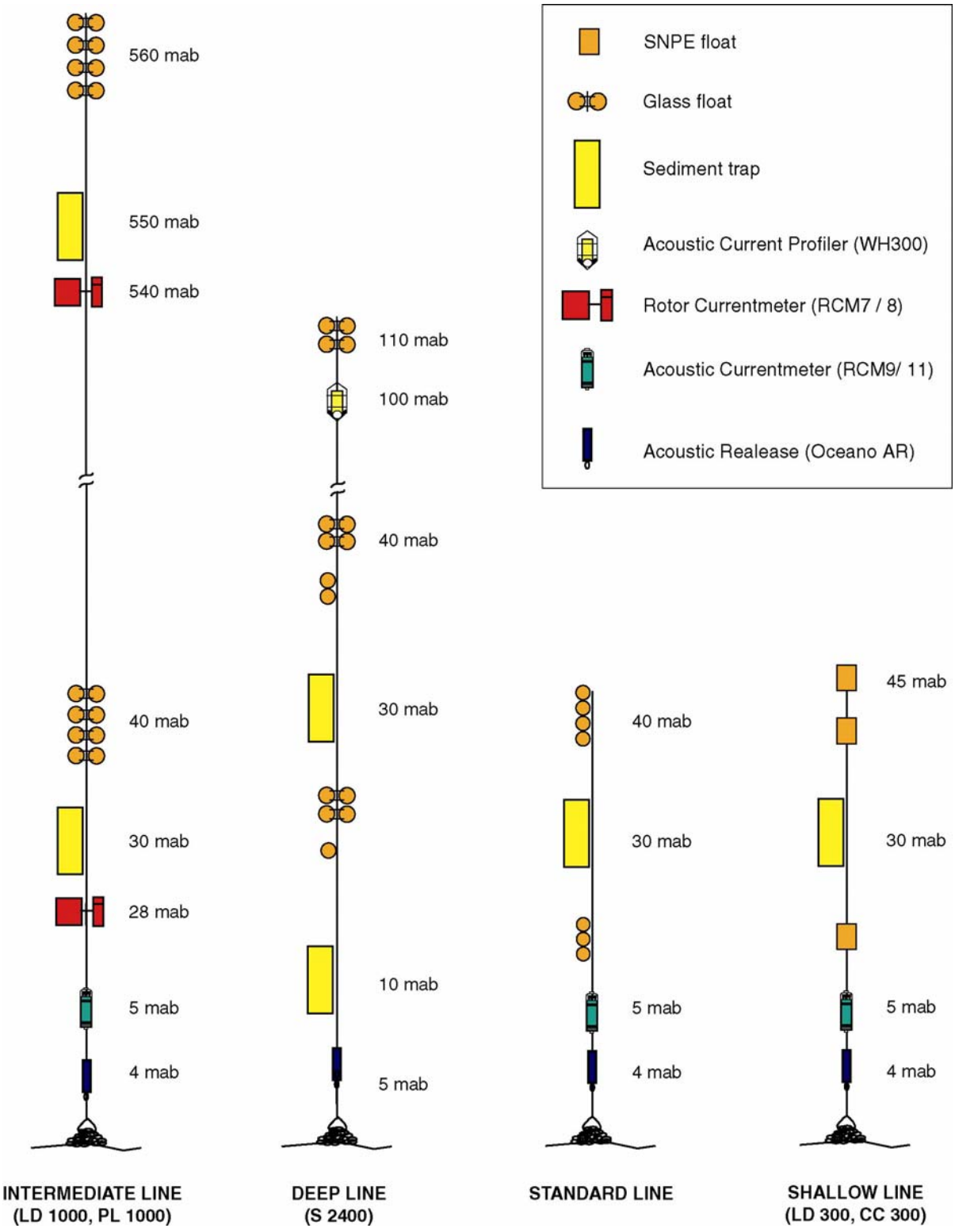

Fig. 2 Sediment trap and currentmeters mooring lines design

2. Methods

Sediment trap sample processing is described in detail in Heussner et al. (1990). Large swimming organisms were removed by wet sieving through a 1mm nylon mesh, while organisms <1mm were hand-picked under a microscope with fine-tweezers. Samples were repeatedly split into aliquots using a high precision peristaltic pump robot to obtain 20-50 mg sub-samples. Sample dry weights, from which total mass fluxes were calculated, were determined on four subsamples filtered onto 0.45mm Millipore cellulose acetate filters and dried at 40ºC for 24h.

Sub-samples (20 to 50 mg) for organic carbon and nitrogen isotopic analyses were freeze-dried and ground to a fine powder. Samples for organic carbon isotopic analyses were first decarbonatated using repeated additions of 2N HCl. Stable isotopic compositions of OC (δ13COC) and TN (δ15N) were measured with an Eurovector elemental analyzer coupled to a GVI-Isoprime mass spectrometer at the CEntre de Formation et de Recherche sur l'Environnement Marin (CNRS-University of Perpignan). Uncertainties were lower than 0.2‰ as determined from routine replicate measurements of the IAEA reference samples CH-3 for δ13C and N-1 for δ15N. Isotopic data are expressed in the δ notation, with (-) indicating depletion and (+) indicating enrichment of the heavier isotopes (13C, 15N) compared to the lighter ones (12C, 14N) relative to standard materials (Pee Dee Belemnite for C, atmospheric N2 for N):

$\delta X = (R_{sample}/R_{standard} - 1) \times 1000$, where X is 13C or 15N, Rsample the isotopic ratio (13C/12C or 15N/14N) of the sample and Rstandard the isotopic ratio of the standard materials.

REFERENCE

Heussner, S., C. Ratti, and J. Carbonne, 1990. The PPS 3 time-series sediment trap and the trap sample processing techniques used during the ECOMARGE experiment. Cont. Shelf Res. 10, 943-95

Conductivity/Temperature/Pressure/
Light transmission data Processing Comments

Author: X. Durrieu de Madron

1. Hydrographic Data Acquisition

11 CTD casts were completed using the Seabird 911Plus CTD probe. Six data channels (pressure, temperature, conductivity, elapsed time, light transmission, and altimetry) were measured at a data rate of 24 Hz and averaged every second during the data acquisition. Light transmission was measured with a 25 cm optical pathlength Cstar transmissometer.

CTD casts were performed from the surface down to ~ 1 m above the bottom. Water samples were taken between 2 and 5 m above the seabed using a rosette equipped with 12 liters Niskin bottles. Water samples of 15 l were filtered on pre-weighted GF/F filter of 0.7 µm mean porosity to measure particulate organic carbon, stable isotope (C_{13}, N_{15}), and sugars concentrations. Their solid residue weights also yielded suspended sediment concentration (SSC). Finally, a water sample of 15 litres was also filtered on Millipore filter of 0.45 µm pore size to measure metals composition.

The raw binary data were then converted into engineering units using the laboratory calibration coefficients, generating pressure series data sets.

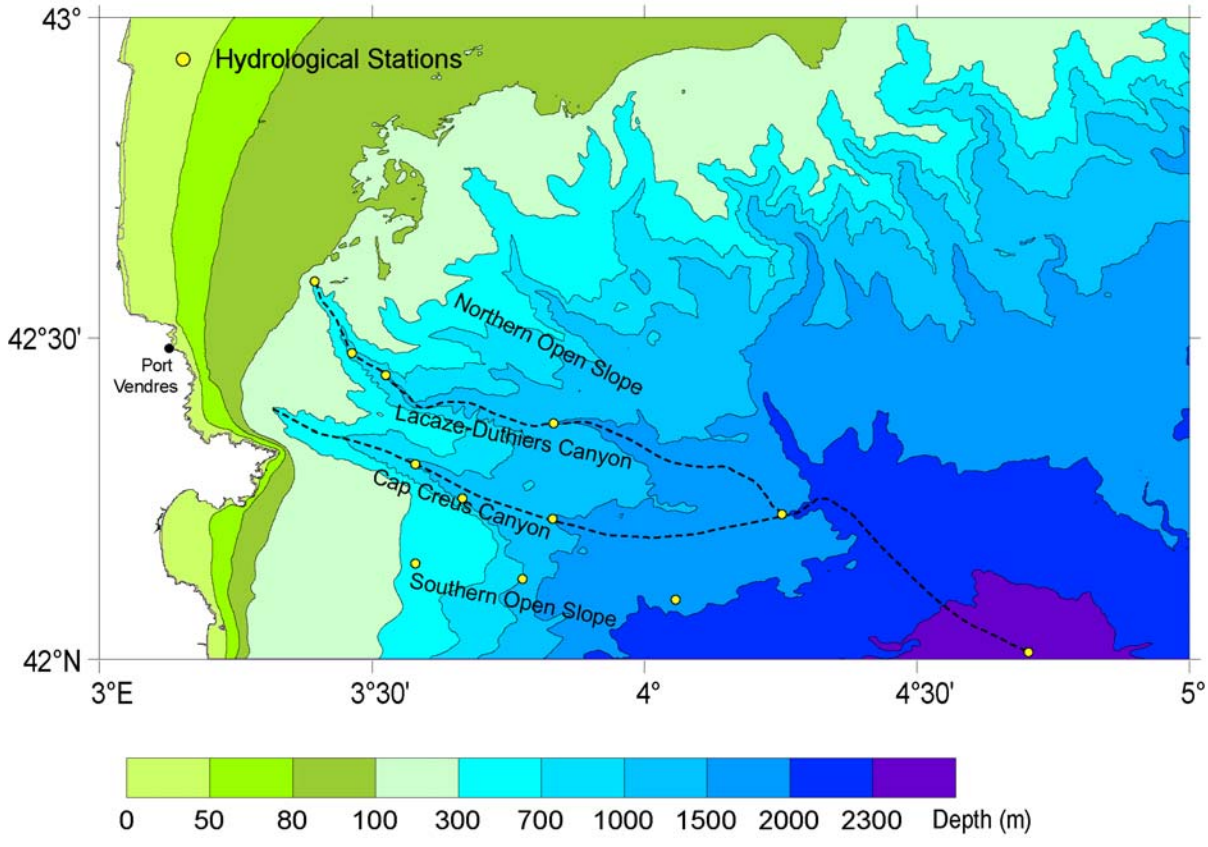

Fig. 3 Location of the hydrological stations
in the southwestern part of the Gulf of Lion

2. Processing of profiles

A low-pass filter was used to compensate for the different time response of the sensors and to remove the salinity spikes. A ship-roll and minimum probe velocity filter (< 0.05 m/s) was applied to each cast to disallow pressure slowdowns and reversals. After filtering, the downcast portion of each cast was pressure-averaged and sequenced into 1 decibars pressure intervals. Recorded surface values were rejected only when it appeared that the drift was caused by sensors adjusting to the in-water transition. The 0-decibar level of some casts was then extrapolated considering homogeneous thermohaline characteristics in the first meters of the water column. Near bottom values of beam attenuation coefficient were rejected when the measurement appear to be contaminated with the impact of the CTD frame with the seabed. Spurious and spiky data from the transmissometer between 250 and 350 m depth (probably due to a pressure-related electrical problem) were removed. Missing bins were replaced by measures collected during the upcast.

The one decibar pressure, temperature and conductivity data were used to compute the following hydrographic parameters depth, potential temperature (θ), salinity, potential density anomalies (σ_θ, σ_2, σ_4), sound velocity, specific volume anomaly, dynamic height, spiciness, density ratio and buoyancy frequency. Temperature is ITS-68, salinity is PSS-78, density is calculated based on the equation of state of seawater (EOS80; Fofonoff and Millard, 1983), buoyancy frequency is calculated using the adiabatic leveling method (Fofonoff, 1985).

4. References

Fofonoff N.P. and Millard R.C. 1983. Algorithms for computation of fundamental properties of seawater. UNESCO report 44, 15-24.

Fofonoff N.P. 1985. Physical properties of seawater: a new salinity scale and equation of state for seawater. Journal of Geophysical Research, *90*, 3332-3342.

CTD STATION DESCRIPTIONS

HERMES 1 **R/V UNIVERSITATIS 12 Oct 2005 - 24 Oct 2005**

Cast	Station	Date	Local Time (UT+1)	Latitude	Longitude	Maximum Sampling Depth (m)	Distance above Bottom (m)
HERM1_01	CLD300	15 Oct 2005	12:40	42°N 35.180	003°E 23.920	373	2
HERM1_02	CCC1900	16 Oct 2005	20:35	42°N 13.080	004°E 15.480	1885	2
HERM1_03	CS2400	17 Oct 2005	15:00	42°N 04.940	004°E 39.470	2334	2
HERM1_04	CLD1500	20 Oct 2003	19:15	42°N 21.940	003°E 49.050	1484	2
HERM1_05	SOS400	21 Oct 2003	08:15	42°N 09.180	003°E 34.980	408	2
HERM1_06	SOS1000	21 Oct 2003	11:50	42°N 07.730	003°E 46.610	990	2
HERM1_07	SOS1900	21 Oct 2003	16:25	42°N 07.430	003°E 02.480	1884	2
HERM1_08	CCC1500	22 Oct 2003	09:55	42°N 13.070	003°E 49.770	1462	3
HERM1_09	CCC1000	22 Oct 2003	18:30	42°N 18.310	003°E 36.710	1021	3
HERM1_10	CLD1000	22 Oct 2003	20:15	42°N 26.000	003°E 31.000	989	2
HERM1_11	CLD400	23 Oct 2003	08:05	42°N 34.280	003°E 24.070	457	1

Sediment Cores Processing Comments

Author: R. Buscail

1. Sediment Cores Acquisition

Sediment samples were collected along the axes of the Lacaze-Duthiers and Cap de Creus canyons, and along two across-shelf transects (Figure 4) with a box corer ((box size of 20 x 30 cm cross-section, 50 cm height) or a multi corer (tube of 60 cm long and 10 cm diameter). A total of X box box cores and Y multicores were collected. The canyons were sampled near the shelf break (~150-m water depth) and near the mooring instrumentation sites (~300-m water depth). All locations were surveyed prior to sampling using the shipboard seabeam depth sounder, to identify sample locations within the canyon thalwegs.

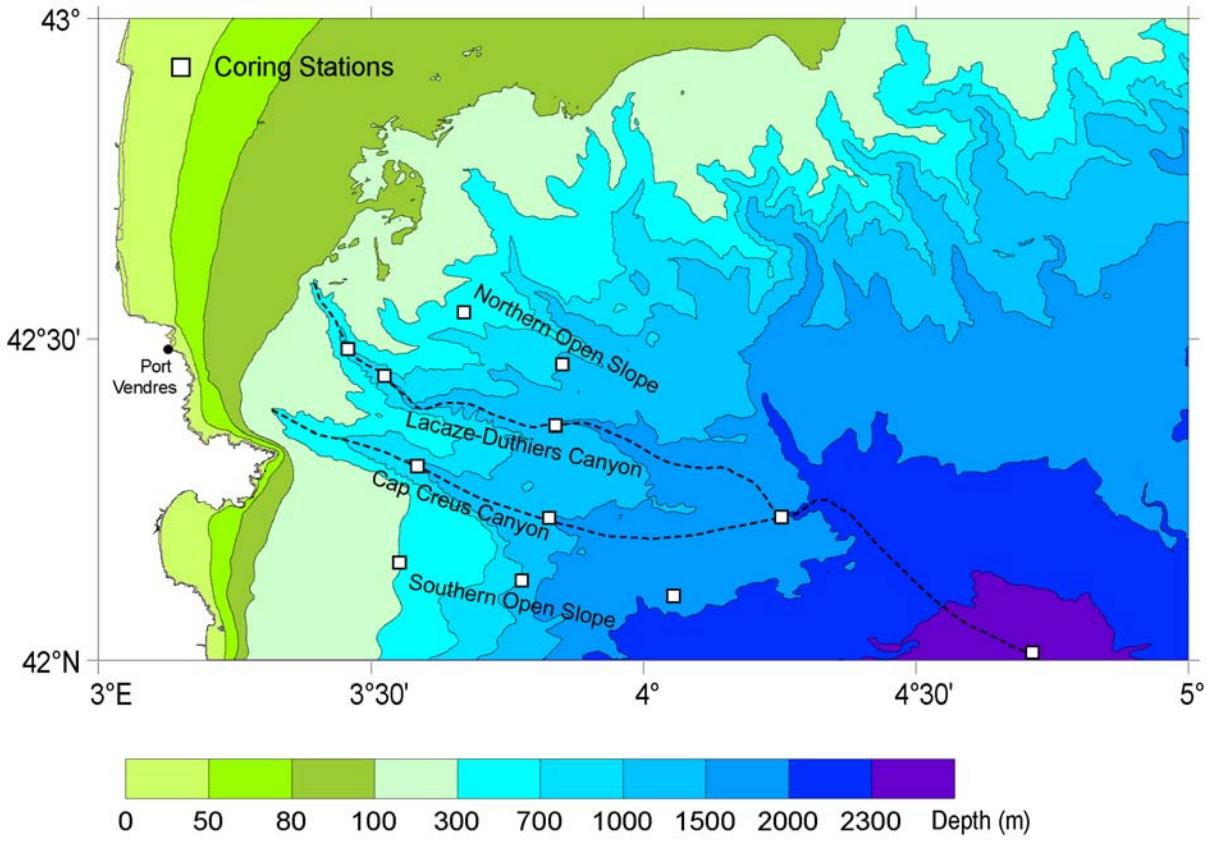

Figure 4. Location of core samples

2. Processing of cores

A portion of each box core was sub-sampled using thin walled PVC tubing (X-cm diameter.), which was then extruded and sliced in 1-cm vertical intervals for detailed radiochemical and textural analysis. The sediment will be analyzed for ...

CORING STATION DESCRIPTIONS

HERMES 1 **R/V UNIVERSITATIS** **12 Oct 2005 - 24 Oct 2005**

Station	Corer	Date	Local Time (UT+1)	Latitude	Longitude	Seabed Depth (m)
Northern Open Slope						
NOS 450 MTC A	Multicorer 1	23 Oct 2005	13:36	42°N 34.13	003°E 39.19	334 m
NOS 1000 MTC B	Multicorer 1	23 Oct 2005	15:48	42°N 26.49	003°E 51.13	1022 m
Lacaze-Duthiers Canyon						
CLD 450 MTC D	Multicorer 1	23 Oct 2005	09:43	42°N 34.44	003°E 24.04	434 m
CLD 1000 MTC E	Multicorer 1	20 Oct 2005	15:22	42°N 26.56	003°E 31.83	990 m
CLD 1500 MTC F	Multicorer 1	20 Oct 2005	21:30	42°N 21.96	003°E 49.41	1497 m
CLD 2000 MTC I	Boxcorer 1	16 Oct 2005	21:00	42°N 12.88	004°E 15.43	1874 m
Cap de Creus Canyon						
CCC 1000 MTC G	Multicorer 1	22 Oct 2005	19:50	43°N 18.47	003°E 36.60	960 m
CCC 1500 MTC H	Multicorer 2	22 Oct 2005	11:20	42°N 13.14	003°E 49.15	1492 m
CCC 1500 MTC H	Multicorer 3	22 Oct 2005	15:49	42°N 13.51	003°E 49.45	1473 m
Sete Canyon						
CS 2300 MTC L	Boxcorer 1	17 Oct 2005	10:20	42°N 04.78	004°E 40.90	2342 m
CS 2300 MTC L bis	Boxcorer 3	17 Oct 2005	16:10	42°N 04.75	004°E 40.05	2330 m
Southern Open Slope						
SOS 450 MTC M	Multicorer 1	21 Oct 2005	09:50	42°N 08.85	003°E 35.06	398 m

SOS 1000 MTC N	Multicorer 1	21 Oct 2005	12:35	42°N 07.72	003°E 46.63	985 m
SOS 1900 MTC O	Multicorer 2	21 Oct 2005	20:55	42°N 07.02	004°E 02.84	1902 m
SOS 1900 MTC O	Multicorer 3	21 Oct 2005		42°N 06.98	004°E 03.02	1892 m