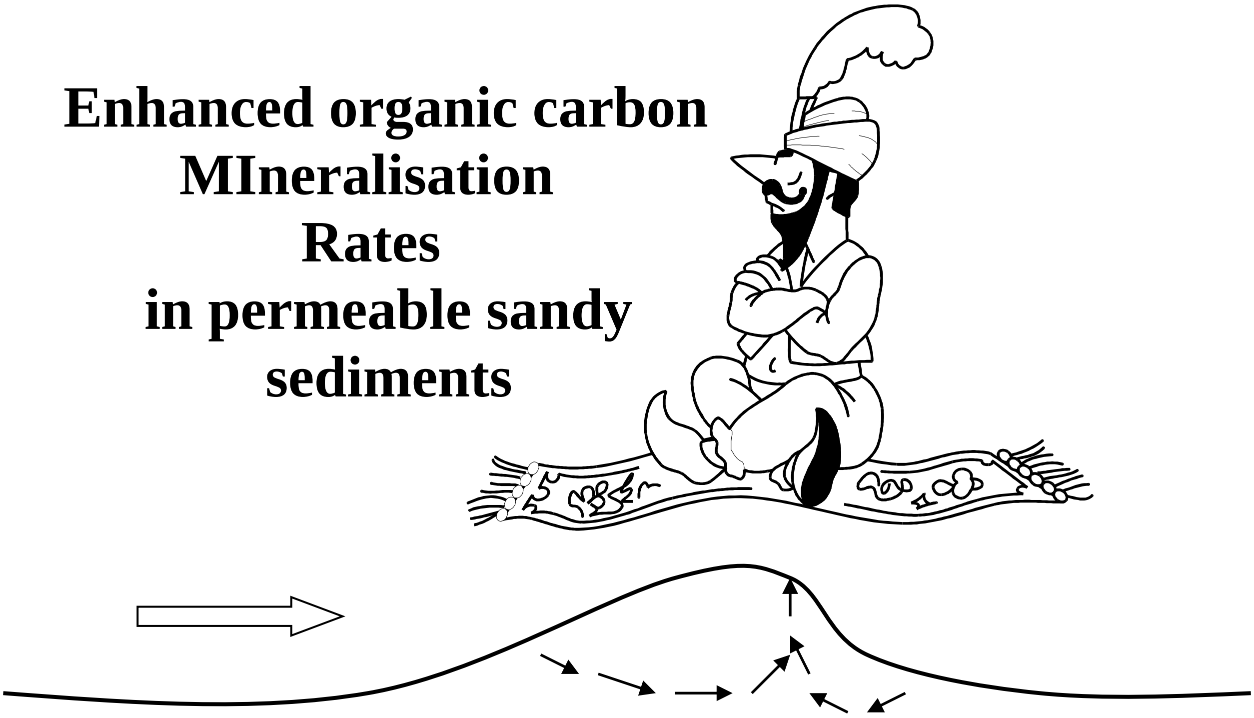
EMIR

Enhanced organic carbon
MIneralisation
Rates
in permeable sandy
sediments



Cruise Report
R/V Pelagia
Leg 2
3 June – 18 June 2002

EMIR: ENHANCED ORGANIC CARBON MINERALISATION RATES IN PERMEABLE SANDY SEDIMENTS.

SCIENTIFIC RATIONALE

The common view which says that sands can play only a minor role in carbon turn-over must be in error. Sands are the dominant type of sediments in the southern North Sea. Due to its shallowness and high productivity (Joint & Pomroy, 1993) considerable amounts of organic carbon should reach these sediments and be mineralised there. However, these sediments are subject to active resuspension and even erosion that prohibit the longer-term deposition of solids, which according to the current paradigm is necessary to allow for a significant contribution of the benthic realm to marine carbon cycling. This paradigm has been evidenced by the observation that sandy sediments have low concentrations of organic matter. For instance, organic carbon content at a station in the plume of the Rhine off Hoek van Holland is less than 0.1 % (Lohse *et al*, 1995). Jenness & Duineveld (1985), however, demonstrated that fresh organic matter was worked into sandy North Sea sediments under influence of tidal currents. For the Oyster Grounds, Van Raaphorst *et al*. (1998) calculated that fluff particles were deposited in the sediment for 1-2 weeks until their resuspension, which is sufficient for important decomposition of fresh organic matter. Bacon *et al*. (1994) observed that ^{210}Pb bound to fine particulates was trapped in non-accumulating sandy shelf sediments of the Middle Atlantic Bight due to benthic animals and estimated that retention in these sediments was as much as 4-10 years. We conclude that fluxes of organic carbon to sandy sediments may be sufficiently large to sustain substantial early diagenetic process rates (*cf*. Marinelli *et al.*, 1998). It was our hypothesis that the efficient transports of substrates and reactants enhance the mineralization rates of organic carbon in permeable sandy sediments. Because of the dominance of sands on most continental shelves they potentially have a large contribution to (global) carbon cycling.

The present view on the biogeochemistry of sandy sediments is biased by the idea that large contents of sedimentary organic carbon are needed to drive large fluxes. Large fluxes, however, can also be sustained by relative small concentration gradients in combination with high transport rates, which can be much higher in sands than in clays and silts. Resuspension - deposition cycles favor solid-solute exchange (Fanning *et al*., 1982; Rutgers van der Loeff & Boudreau, 1997). Pore water advection and dispersion may exceed diffusional transport when permeability is sufficiently large and pressure gradients are generated (Lohse *et al*., 1996; Ziebis *et al.*, 1996; Hüttel *et al.*, 1998). Thus in permeable sands fluxes of reactants are large thereby keeping standing stocks low. Our knowledge of the biogeochemistry and physico-chemical processes in sands is meager, particularly regarding actual field data. It was the aim of the EMIR cruises to contribute to the filling-in of this gap by 1) unambiguously demonstrating the importance of advective transport in sandy pore waters, and 2) providing detailed data on carbon mineralization rates in sandy North Sea sediments.
It has been difficult in the past to collect undisturbed pore water profiles from sands with conventional coring and squeezing techniques. We were able to determine such profiles accurately by using optimal multi-coring devices in combination with semi-automated high-resolution slicing facilities and centrifugation procedures adapted for sandy sediments. Our benthic lander was equipped with microelectrodes that were manufactured just sufficiently robust for application in sandy sediments. The greatest difficulty, however, is that chemical distributions in sands are complex in response to the time variable 3-D pressure gradients induced by currents over moving sand waves and ripples. Thus, much from the a priori knowledge came from laboratory experiments (e.g. Hüttel *et al.*, 1998) and modelling (e.g. Shum, 1993; Hutchinson & Webster, 1998). EMIR was the first cruise in which such knowledge was collected from in situ observations in sandy shelf sediments.

PARTICIPANTS

Cannot be provided due to ‘AVG’ regulations 2018.

ACTIVITIES

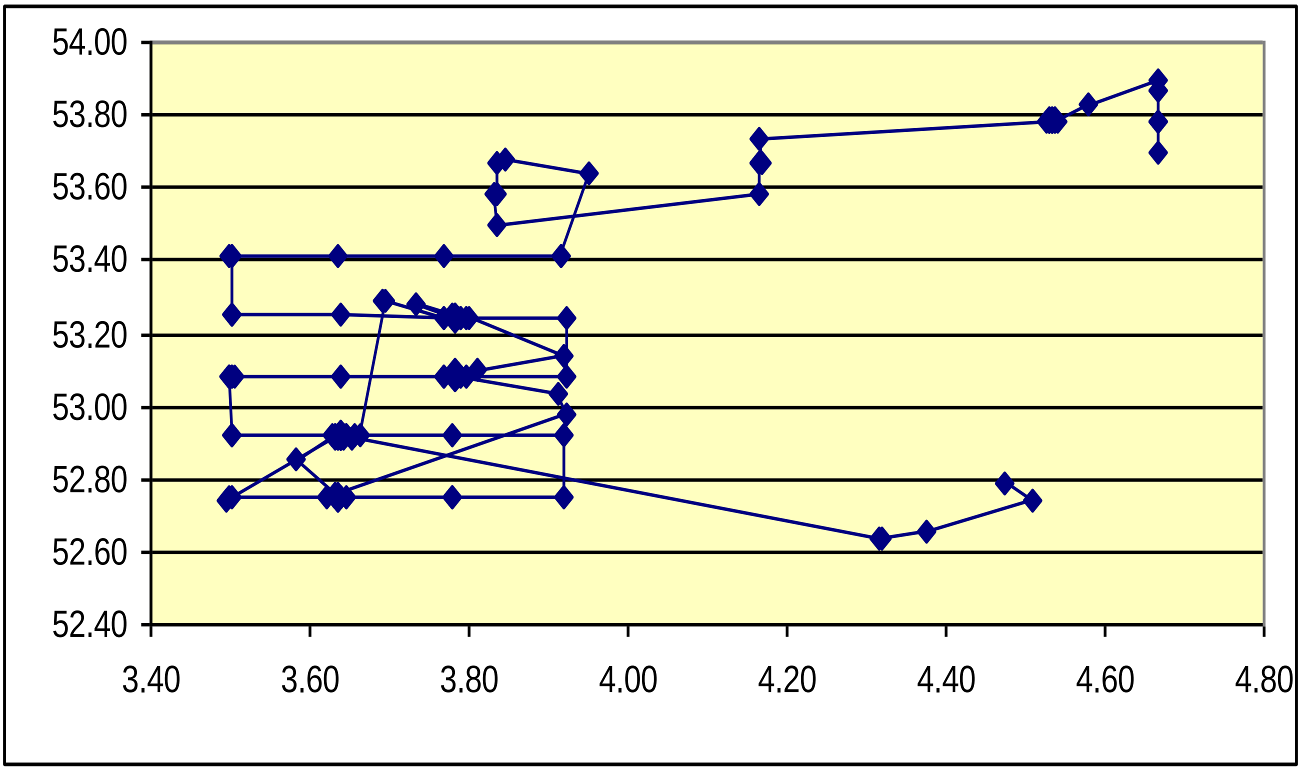
1. TROL lander. Deployment time 24 h. TROL used its resistivity probe to detect ripple movement during a full tidal cycle. ALBEX chambers of the lander were used to saturate underlying sediments with a bromide solution. Microprofling was done for oxygen profiles. In total, 6 lander stations were occupied.
2. PULS C-ADP video lander. Responsibility Stefan Forster. Mesasured detailed velocity profiles above the sediment. In total, 5 stations were occupied always together with the TROL.
3. Pore water profiling. Standard procedure with high-resolution core slicer and centrifugation in climatized container. Cores from multicorer. Analysis of Si, NH_4, NO_3, NO_2 on board; DIC at NIOZ after the cruise. In total, 11 stations were sampled ans analysed.
4. Sediment-water fluxes were measured on board using multicorer samples. Fluxes obtained represent diffusive conditions.
5. Nitrogen cycling, ammonification, nitrification, denitrification.. Incubations and handlings in climatized container. Samples from multicorer, sediment slices with high-resolution core slicer. In situ temperature. Analysis of NH_4, NO_3, NO_2 on board
6. Sediment oxygen consumption rates (Carlos Rocha). Incubations in slurries of sediment slices (upper layer) in special vials with oxygen electrodes. In situ temperature.
7. Sediment slicing for solid phase analysis (org. C,N, Biogenic Si, ^{234}Th, ^{210}Pb,…). Samples were sliced at high-resolution at in situ temperature. Silt/clay fraction will be separated from the sand fraction on board for radionuclides only (flotation in water, decantation, filtration of fine fraction) to optimize analysis at NIOZ. Other fractionation at the institute afterwards. Sediment samples were taken at 42 stations.
8. Bag incubations for the determination anoxic process rates. Incubation of slurries from sediment slices in Wurggler bags in climatized container at in situ temperature. Analysis of Si, NH_4, NO_3, NO_2 on board; DIC after the cruise. Samples were taken at the 6 stations occupied by the TROL lander.

9. Shipboard diffusive oxygen profiles in sediment cores. Oxygen microprofiles were examined in cores directly after retrieval on deck. The profiles were allowed to adapt from the turbulent conditions in situ to the diffusive regime in the multicore-liner.
10. Sediment porosity and permeability. Samples from multicorer were sliced at high-resolution and stored for porosity analysis at NIOZ after the cruise. Permeability was measured using novel equipment of Carlos Rocha and with the falling head technique of last EMIR cruise (Stefan Forster).
11. Short-term moorings. Two moorings were used (surface buoy for recovery), one containing a RCM 8 current meter and a modified PPS 4/3 sediment trap, the other containing a RCM 8 current meter, a modified PPS 4/3 sediment trap and 2 OBS/tilt sensors. The traps operated sequentially at two 12x1h intervals. 6 Stations were occupied where TROL and PULS were active.
12. CTD-Rosette. Bottle samples for Si, NH_4, NO_3, NO_2, analysis on board. Suspended matter samples for calibration of the OBS sensors and analysis of POC, PON and if possible biogenic Si in the water column.
13. MEDUSA mapping of gamma natural radiation of the sediments. MEDESUSA was towed from the rear of the ship during the night

Data will be available from the EMIR website to be constructed in August/September 2002.

Cruise track:

ºN, ºE



EMIR

Cruise Summary Pelagia cruise 64PE196

Cast types and Parameters may be added from the "codes" sheet

Cast types:

CTD | ctd
ROS | ctd-rosette
BOX | boxcore
MUL | multicore
TROL | Trol lander
PULS | Puls ADP Lander
MED | Medusa track
MOR | mooring

Event codes:

BE	begin
BO	bottom
EN	end
DE	Deployment
RE	recovered

SHIP/CRS. EXPOCODE	STNNBR	STNLABEL	CASTNO	CAST TYPE	UTC dd MMM yyyy hh:mm CAST DATE (English abbrev.!!)	EVENT CODE	LATITUDE Deg.	LATITUDE Minutes	LONGITUDE Deg.	LONGITUDE Minutes	NAV	Uncorrected DEPTH	Measurement subject
64PE196	001		01	BOX	03/Jun/2002/14:27	BE	53	42.00 N	004	40.00 E	GPS	37	
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64PE196	002		03	MUL	03/Jun/2002/17:05	BE	53	47.00 N	004	40.01 E	GPS	38	
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64PE196	004		02	MED	04/Jun/2002/05:30	RE	53	49.77 N	004	34.70 E	GPS		
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64PE196	005		03	MOR	04/Jun/2002/08:44	DE	53	47.06 N	004	31.83 E	GPS	40.5	MOR2 without OBS
64PE196	005		04	MUL	04/Jun/2002/08:56	BE	53	46.99 N	004	31.76 E	GPS	40	failed
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64PE196	005		06	BOX	04/Jun/2002/09:20	BE	53	47.02 N	004	31.71 E	GPS	40.5	
64PE196	005		07	ROS	04/Jun/2002/09:41	BE	53	46.98 N	004	31.95 E	GPS	40.5	
64PE196	006		01	BOX	04/Jun/2002/11:28	BE	53	47.25 N	004	32.00 E	GPS	41	4 stations around st. 5
64PE196	007		01	BOX	04/Jun/2002/11:55	BE	53	47.01 N	004	32.43 E	GPS	41	
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64PE196	005	11	MED	04/Jun/2002/19:42	RE	53	47.40 N	004	31.70 E	GPS	40	
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64PE196	005	13	MOR	05/Jun/2002/06:40	RE	53	47.02 N	004	32.00 E	GPS	40	MOR1 with OBS
64PE196	005	14	TROL	05/Jun/2002/07:20	RE	53	46.90 N	004	32.20 E	GPS	40	
64PE196	005	15	MOR	05/Jun/2002/08:46	RE	53	47.10 N	004	31.80 E	GPS		MOR2 without OBS
64PE196	010	01	BOX	05/Jun/2002/11:12	BE	53	44.00 N	004	09.94 E	GPS	41.4	
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64PE196	017	01	BOX	06/Jun/2002/07:33	BE	53	25.00 N	003	55.00 E	GPS	27	start sediment survey
64PE196	017	02	BOX	06/Jun/2002/07:52	BE	53	24.99 N	003	54.98 E	GPS	27	
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64PE196	024	01	BOX	06/Jun/2002/15:51	BE	53	14.70 N	003	55.39 E	GPS	27	

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64PE196	027	01	BOX	06/Jun/2002/18:33	BE	53	04.99 N	003	38.40 E	GPS	28	
64PE196	027	02	MED	06/Jun/2002/18:40	DE	53	05.10 N	003	38.40 E	GPS	28	track with medusa along transects
64PE196	027	03	MED	07/Jun/2002/06:46	RE	53	05.02 N	003	30.30 E	GPS	28	
64PE196	028	01	ROS	07/Jun/2002/07:00	BE	53	04.97 N	003	30.01 E	GPS	29.5	continue sediment survey
64PE196	028	02	MUL	07/Jun/2002/07:13	BE	53	04.97 N	003	30.00 E	GPS	29.5	
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64PE196	036		03	MUL	07/Jun/2002/17:31	BE	52	44.99 N	003	30.00 E	GPS	27.3	end sediment survey
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64PE196	036		05	MED	08/Jun/2002/06:37	RE	52	54.90 N	003	37.90 E	GPS	31	
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64PE196	037		03	MUL	08/Jun/2002/08:20	BE	52	54.90 N	003	38.20 E	GPS	31	
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64PE196	037		06	MOR	08/Jun/2002/09:37	BE	52	55.00 N	003	38.00 E	GPS	30	MOR2 without OBS
64PE196	037		07	ROS	08/Jun/2002/10:03	BE	52	54.87 N	003	38.30 E	GPS	31	
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64PE196	037		14	MUL	08/Jun/2002/14:15	BE	52	54.89 N	003	38.35 E	GPS	31.4	
64PE196	037		15	ROS	08/Jun/2002/15:02	BE	52	54.88 N	003	38.32 E	GPS	31.3	
64PE196	037		16	MED	08/Jun/2002/15:24	DE	52	54.57 N	003	39.13 E	GPS	31.4	MEDUSA circles around st. 37
64PE196	037		16	MED	09/Jun/2002/06:12	RE	52	54.80 N	003	38.30 E	GPS	32	
64PE196	037		17	ROS	09/Jun/2002/06:15	BE	52	54.80 N	003	38.20 E	GPS	32	
64PE196	037		18	TROL	09/Jun/2002/07:27	RE	52	54.96 N	003	38.60 E	GPS	31	
64PE196	037		19	PULS	09/Jun/2002/09:05	RE	52	55.00 N	003	38.20 E	GPS	29.5	
64PE196	037		20	MOR	09/Jun/2002/09:33	RE	52	54.96 N	003	38.40 E	GPS	30	MOR1 with OBS
64PE196	037		21	MOR	09/Jun/2002/10:02	RE	52	54.98 N	003	37.98 E	GPS	29	MOR2 without OBS
64PE196	037		22	MUL	09/Jun/2002/11:24	BE	52	54.89 N	003	38.32 E	GPS	30.7	
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64PE196	037		24	MUL	09/Jun/2002/11:46	BE	52	54.87 N	003	38.33 E	GPS	30.9	
64PE196	037		25	PULS	09/Jun/2002/12:17	BE	52	54.88 N	003	38.32 E	GPS	30.8	short deployment for video
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64PE196	37b	E of 37	01	MUL	09/Jun/2002/13:55	BE	52	55.02	N	003	39.44 E	GPS	31.3	
64PE196	37b		02	MUL	09/Jun/2002/14:01	BE	52	55.01	N	003	39.46 E	GPS	31.4	
64PE196	37c	S of 37	01	MUL	09/Jun/2002/14:17	BE	52	54.40	N	003	38.41 E	GPS	30.9	
64PE196	37c		02	MUL	09/Jun/2002/14:22	BE	52	54.40	N	003	38.43 E	GPS	31	
64PE196	37d	W of 37	01	MUL	09/Jun/2002/14:39	BE	52	55.02	N	003	37.66 E	GPS	30.5	
64PE196	37d		02	MUL	09/Jun/2002/14:45	BE	52	55.01	N	003	37.66 E	GPS	30.6	
64PE196	037		27	MED	09/Jun/2002/14:56	DE	52	55.08	N	003	37.85 E	GPS	31.3	track with medusa along transects
64PE196	037		27	MED	10/Jun/2002/05:35	RE	52	51.35	N	003	34.95 E	GPS	29.1	
64PE196	038		01	MOR	10/Jun/2002/06:41	DE	52	45.00	N	003	38.01 E	GPS	30	MOR1 with OBS
64PE196	038		02	MOR	10/Jun/2002/07:19	DE	52	45.01	N	003	38.21 E	GPS	29	MOR2 without OBS
64PE196	038		03	TROL	10/Jun/2002/07:41	DE	52	45.01	N	003	38.41 E	GPS	27	
64PE196	038		04	MUL	10/Jun/2002/08:21	BE	52	45.00	N	003	37.79 E	GPS	28.5	
64PE196	038		05	MUL	10/Jun/2002/08:28	BE	52	45.00	N	003	37.79 E	GPS	28.5	
64PE196	038		06	PULS	10/Jun/2002/08:52	DE	52	45.00	N	003	37.80 E	GPS	28.5	
64PE196	038		07	ROS	10/Jun/2002/09:19	BE	52	44.90	N	003	38.10 E	GPS	31	
64PE196	038		08	MUL	10/Jun/2002/09:26	BE	52	44.90	N	003	38.10 E	GPS	31	
64PE196	038		09	ROS	10/Jun/2002/11:14	BE	52	44.91	N	003	38.10 E	GPS	30.9	
64PE196	038		10	MUL	10/Jun/2002/11:26	BE	52	44.92	N	003	38.16 E	GPS	30	
64PE196	038		11	MUL	10/Jun/2002/11:35	BE	52	44.94	N	003	38.09 E	GPS	30.9	
64PE196	038		12	ROS	10/Jun/2002/13:06	BE	52	44.92	N	003	38.13 E	GPS	30.8	
64PE196	038		13	MUL	10/Jun/2002/13:13	BE	52	44.92	N	003	38.13 E	GPS	31.5	
64PE196	038		14	ROS	10/Jun/2002/15:03	BE	52	44.93	N	003	38.10 E	GPS	31.5	
64PE196	038		15	MED	10/Jun/2002/15:16	DE	52	44.83	N	003	37.86 E	GPS	31.3	MEDUSA circles around st. 38
64PE196	038		15	MED	11/Jun/2002/04:45	RE	52	45.84	N	003	37.82 E	GPS	28.4	
64PE196	038		16	ROS	11/Jun/2002/06:45	BE	52	45.10	N	003	38.20 E	GPS	27.5	
64PE196	038		17	MUL	11/Jun/2002/06:51	BE	52	45.10	N	003	38.20 E	GPS	27.5	
64PE196	038		18	MUL	11/Jun/2002/07:00	BE	52	45.10	N	003	38.20 E	GPS	27.5	
64PE196	038		19	TROL	11/Jun/2002/08:13	RE	52	45.10	N	003	38.40 E	GPS	27.5	
64PE196	038		20	PULS	11/Jun/2002/09:21	RE	52	44.99	N	003	37.79 E	GPS	28	
64PE196	038		21	MOR	11/Jun/2002/09:50	RE	52	45.00	N	003	38.00 E	GPS	29.5	MOR1 with OBS
64PE196	038		22	MOR	11/Jun/2002/11:15	RE	52	45.01	N	003	38.19 E	GPS	28	MOR2 without OBS
64PE196	038		23	MUL	11/Jun/2002/11:30	BE	52	44.93	N	003	38.08 E	GPS	30.9	

64PE196	038		24	MUL	11/Jun/2002/11:37	BE	52	44.92	N	003	38.11 E	GPS	30.6	
64PE196	038		25	BOX	11/Jun/2002/12:01	BE	52	44.91	N	003	38.12 E	GPS	30.7	
64PE196	038		26	PULS	11/Jun/2002/12:27	BE	52	45.01	N	003	37.80 E	GPS	28.4	short deployment for video
64PE196	38a	N of 38	01	MUL	01/Jun/2002/13:22	BE	52	45.52	N	003	38.02 E	GPS	28.4	
64PE196	38a		02	MUL	11/Jun/2002/13:28	BE	52	45.53	N	003	37.98 E	GPS	28.2	
64PE196	38b	E of 38	01	MUL	11/Jun/2002/13:44	BE	52	45.04	N	003	38.82 E	GPS	29.1	
64PE196	38b		02	MUL	11/Jun/2002/13:50	BE	52	45.03	N	003	38.82 E	GPS	29.1	
64PE196	38c	S of 38	01	MUL	11/Jun/2002/14:05	BE	52	44.51	N	003	38.01 E	GPS	30.1	
64PE196	38c		02	MUL	11/Jun/2002/14:12	BE	52	44.52	N	003	38.01 E	GPS	29.8	
64PE196	38d	W of 38	01	MUL	11/Jun/2002/14:26	BE	52	45.00	N	003	37.17 E	GPS	29	
64PE196	38d		02	MUL	11/Jun/2002/14:37	BE	52	45.01	N	003	37.16 E	GPS	29.1	
64PE196	038		27	MED	11/Jun/2002/16:30	DE	52	58.80	N	003	55.33 E	GPS	27.1	track with medusa along transects
64PE196	038		27	MED	12/Jun/2002/06:00	RE	53	01.90	N	003	54.80 E	GPS	29	
64PE196	039		01	MOR	12/Jun/2002/07:17	DE	53	05.00	N	003	46.91 E	GPS	29	MOR1 with OBS
64PE196	039		02	MOR	12/Jun/2002/07:42	DE	53	05.00	N	003	46.12 E	GPS	29	MOR2 without OBS
64PE196	039		03	PULS	12/Jun/2002/08:44	DE	53	05.00	N	003	47.30 E	GPS	28.5	
64PE196	039		04	ROS	12/Jun/2002/09:00	BE	53	05.07	N	003	47.00 E	GPS	28.5	
64PE196	039		05	TROL	12/Jun/2002/09:31	DE	53	05.00	N	003	46.71 E	GPS	29	
64PE196	039		06	MUL	12/Jun/2002/09:40	BE	53	05.10	N	003	47.00 E	GPS	28.5	
64PE196	039		07	MUL	12/Jun/2002/09:46	BE	53	05.10	N	003	47.00 E	GPS	28.5	
64PE196	039		08	MUL	12/Jun/2002/09:54	BE	53	05.05	N	003	47.09 E	GPS	28.5	
64PE196	039		09	ROS	12/Jun/2002/11:10	BE	53	05.05	N	003	46.99 E	GPS	28.2	
64PE196	039		10	MUL	12/Jun/2002/11:18	BE	53	05.06	N	003	47.00 E	GPS	28	
64PE196	039		11	MUL	12/Jun/2002/11:26	BE	53	05.05	N	003	47.05 E	GPS	27.9	
64PE196	039		12	ROS	12/Jun/2002/13:02	BE	53	05.05	N	003	47.05 E	GPS	27.6	
64PE196	039		13	MUL	12/Jun/2002/13:11	BE	53	05.06	N	003	47.04 E	GPS	28.6	
64PE196	039		14	ROS	12/Jun/2002/15:03	BE	53	05.77	N	003	47.03 E	GPS	28.2	
64PE196	039		15	MED	12/Jun/2002/15:35	DE	53	05.77	N	003	48.62 E	GPS	26.5	
64PE196	039		15	MED	13/Jun/2002/06:39	RE	53	05.50	N	003	47.20 E	GPS	28.5	MEDUSA circles around st. 39
64PE196	039		16	ROS	13/Jun/2002/06:56	BE	53	05.10	N	003	47.10 E	GPS	29	
64PE196	039		17	MUL	13/Jun/2002/07:08	BE	53	05.10	N	003	47.10 E	GPS	29	
64PE196	039		18	MUL	13/Jun/2002/07:15	BE	53	05.10	N	003	47.10 E	GPS	29	

64PE196	039		19	PULS	13/Jun/2002/07:48	RE	53	04.97 N	003	47.30 E	GPS	29	
64PE196	039		20	TROL	13/Jun/2002/08:43	RE	53	04.97 N	003	46.70 E	GPS	29	
64PE196	039		21	MOR	13/Jun/2002/09:24	RE	53	05.01 N	003	46.90 E	GPS	29	MOR1 with OBS
64PE196	039		22	MOR	13/Jun/2002/09:52	RE	53	05.00 N	003	47.09 E	GPS	28.5	MOR2 without OBS
64PE196	039		23	MUL	13/Jun/2002/11:21	BE	53	05.10 N	003	47.11 E	GPS	28.2	
64PE196	039		24	MUL	13/Jun/2002/11:27	BE	53	05.10 N	003	47.14 E	GPS	27.8	
64PE196	039		25	BOX	13/Jun/2002/11:48	BE	53	05.11 N	003	47.12 E	GPS	28.1	
64PE196	039		26	BOX	13/Jun/2002/12:12	BE	53	05.11 N	003	47.10 E	GPS	28.2	
64PE196	39a	N of st 39	01	MUL	13/Jun/2002/13:10	BE	53	05.51 N	003	46.91 E	GPS	27.9	
64PE196	39a		02	MUL	13/Jun/2002/13:15	BE	53	05.51 N	003	46.92 E	GPS	27.9	
64PE196	39b	E of st 39	01	MUL	13/Jun/2002/13:32	BE	53	05.00 N	003	47.73 E	GPS	26.4	
64PE196	39b		02	MUL	13/Jun/2002/13:39	BE	53	05.01 N	003	47.74 E	GPS	26.3	
64PE196	39c	S of st 39	01	MUL	13/Jun/2002/13:55	BE	53	04.52 N	003	46.93 E	GPS	28.2	
64PE196	39c		02	MUL	13/Jun/2002/14:03	BE	53	04.50 N	003	46.89 E	GPS	28.2	
64PE196	39d	W of st 39	01	MUL	13/Jun/2002/14:16	BE	53	05.00 N	003	46.08 E	GPS	28.1	
64PE196	39d		02	MUL	13/Jun/2002/14:22	BE	53	05.00 N	003	46.06 E	GPS	28	
64PE196	039		27	MED	13/Jun/2002/15:33	DE	53	08.24 N	003	55.12 E	GPS	25.1	track with medusa along transects
64PE196	039		27	MED	14/Jun/2002/06:00	RE	53	14.62 N	003	47.98 E	GPS	27.3	
64PE196	040		01	MOR	14/Jun/2002/06:35	DE	53	14.60 N	003	46.90 E	GPS	27	MOR1 with OBS
64PE196	040		02	MOR	14/Jun/2002/07:01	DE	53	14.64 N	003	47.11 E	GPS	27.8	MOR2 without OBS
64PE196	040		03	MUL	14/Jun/2002/07:12	BE	53	14.64 N	003	47.30 E	GPS	27.5	
64PE196	040		04	TROL	14/Jun/2002/07:40	DE	53	14.65 N	003	47.32 E	GPS	27.3	
64PE196	040		05	PULS	14/Jun/2002/08:11	DE	53	14.70 N	003	46.70 E	GPS	27.5	
64PE196	040		06	MUL	14/Jun/2002/08:25	BE	53	14.72 N	003	47.07 E	GPS	27.6	
64PE196	040		07	MUL	14/Jun/2002/08:41	BE	53	14.72 N	003	47.05 E	GPS	27.5	
64PE197	040		08	MUL	14/Jun/2002/08:45	BE	53	14.72 N	003	47.06 E	GPS	27.5	
64PE198	040		09	MUL	14/Jun/2002/08:54	BE	53	14.72 N	003	47.06 E	GPS	27.5	
64PE199	040		10	MUL	14/Jun/2002/09:02	BE	53	14.70 N	003	47.05 E	GPS	27.5	

64PE200	040		11	ROS	14/Jun/2002/09:12	BE	53	14.70 N	003	47.05 E	GPS	27.6	
64PE201	040		12	MUL	14/Jun/2002/09:24	BE	53	14.70 N	003	47.05 E	GPS	27.3	
64PE202	040		13	ROS	14/Jun/2002/11:28	BE	53	14.70 N	003	47.07 E	GPS	26.7	
64PE203	040		14	MUL	14/Jun/2002/11:35	BE	53	14.70 N	003	47.07 E	GPS	26.7	
64PE204	040		15	MUL	14/Jun/2002/11:41	BE	53	14.70 N	003	47.07 E	GPS	26.8	
64PE205	040		16	ROS	14/Jun/2002/13:09	BE	53	14.70 N	003	47.04 E	GPS	26.4	
64PE206	040		17	MUL	14/Jun/2002/13:17	BE	53	14.71 N	003	47.05 E	GPS	26.3	
64PE207	040		18	ROS	14/Jun/2002/15:06	BE	53	14.70 N	003	47.03 E	GPS	25.8	
64PE208	040		19	MED	14/Jun/2002/15:22	DE	53	15.15 N	003	46.83 E	GPS	25.9	medusa circles around st 40
64PE209	040		19	MED	14/Jun/2002/18:40	RE	53	17.10 N	003	44.00 E	GPS	27.3	
64PE210	040		20	ROS	15/Jun/2002/06:41	BE	53	14.75 N	003	47.08 E	GPS	27.1	
64PE211	040		21	MUL	15/Jun/2002/06:49	BE	53	14.75 N	003	47.08 E	GPS	27.1	
64PE212	040		22	MUL	15/Jun/2002/06:54	BE	53	14.75 N	003	47.07 E	GPS	27.1	
64PE213	040		23	PULS	15/Jun/2002/07:28	RE	53	14.60 N	003	46.70 E	GPS	27.1	
64PE214	040		24	TROL	15/Jun/2002/08:24	RE	53	14.61 N	003	47.33 E	GPS	27.5	
64PE215	040		25	MOR	15/Jun/2002/09:05	RE	53	14.65 N	003	46.94 E	GPS	27.5	MOR1 with OBS
64PE216	040		26	MOR	15/Jun/2002/09:33	RE	53	14.60 N	003	47.10 E	GPS	27.6	MOR2 without OBS
64PE217	040		27	MUL	15/Jun/2002/09:48	BE	53	14.60 N	003	47.00 E	GPS	27.4	
64PE218	040		28	MUL	15/Jun/2002/11:10	BE	53	14.65 N	003	47.00 E	GPS	26.9	
64PE219	040		29	BOX	15/Jun/2002/11:31	BE	53	14.65 N	003	47.00 E	GPS	26.8	failed
64PE220	040		30	BOX	15/Jun/2002/11:59	BE	53	14.64 N	003	46.97 E	GPS	26.7	
64PE221	40a	0.5 m N of 40	01	BOX	15/Jun/2002/12:32	BE	53	15.15 N	003	47.02 E	GPS	26.8	
64PE222	40a		02	MUL	15/Jun/2002/13:05	BE	53	15.15 N	003	47.01 E	GPS	26.9	
64PE223	40b	0.5 m E of 40	01	BOX	15/Jun/2002/13:23	BE	53	14.66 N	003	47.89 E	GPS	26.4	
64PE224	40b		02	MUL	15/Jun/2002/13:30	BE	53	14.64 N	003	47.87 E	GPS	26.9	
64PE225	40c	0.5 m S of 40	01	BOX	15/Jun/2002/13:50	BE	53	14.13 N	003	47.02 E	GPS	26.5	
64PE225	40c		02	MUL	15/Jun/2002/13:57	BE	53	14.15 N	003	47.01 E	GPS	26.4	
64PE225	40d	0.5 m W of 40	01	BOX	15/Jun/2002/14:16	BE	53	14.64 N	003	46.16 E	GPS	26.3	

64PE225	40d		02	MUL	15/Jun/2002/14:23	BE	53	14.64 N	003	46.15 E	GPS	25.9	
64PE225	40e	MEDUS A st.	01	BOX	15/Jun/2002/15:03	BE	53	17.21 N	003	41.49 E	GPS	29.3	
64PE225	40e		02	MUL	15/Jun/2002/15:09	BE	53	17.21 N	003	41.50 E	GPS	29.1	
64PE225	40e		03	MED	15/Jun/2002/15:22	DE	53	17.43 N	003	41.68 E	GPS	29	
64PE225	40e		03	MED	16/Jun/2002/04:40	RE	52	55.17 N	003	39.78 E	GPS	30.6	
64PE225	041		01	MOR	16/Jun/2002/06:40	DE	52	55.01 N	003	38.33 E	GPS	31	MOR1 with OBS
64PE225	041		02	MOR	16/Jun/2002/07:07	DE	52	55.00 N	003	38.50 E	GPS	31	MOR2 without OBS
64PE225	041		03	MUL	16/Jun/2002/07:27	BE	52	55.00 N	003	38.71 E	GPS	32.8	
64PE225	041		04	TROL	16/Jun/2002/07:40	DE	52	55.00 N	003	38.70 E	GPS	32.6	
64PE225	041		05	PULS	16/Jun/2002/08:27	DE	52	55.02 N	003	38.12 E	GPS	31.9	
64PE225	041		06	MUL	16/Jun/2002/08:41	BE	52	55.14 N	003	38.47 E	GPS	32	
64PE225	041		07	MUL	16/Jun/2002/08:47	BE	52	55.13 N	003	38.46 E	GPS	32	
64PE225	041		08	MUL	16/Jun/2002/08:50	BE	52	55.14 N	003	38.48 E	GPS	32	
64PE225	041		09	ROS	16/Jun/2002/09:03	BE	52	55.12 N	003	38.46 E	GPS	32	
64PE225	041		10	BOX	16/Jun/2002/09:34	BE	52	55.12 N	003	38.49 E	GPS	32	birthday box with little lander
64PE225	041		11	ROS	16/Jun/2002/11:48	BE	52	55.10 N	003	38.45 E	GPS	31.9	
64PE225	041		12	MUL	16/Jun/2002/12:00	BE	52	55.10 N	003	38.45 E	GPS	31.8	
64PE225	041		13	MUL	16/Jun/2002/13:11	BE	52	55.10 N	003	38.49 E	GPS	30.6	
64PE225	041		14	ROS	16/Jun/2002/13:18	BE	52	55.10 N	003	38.50 E	GPS	30.4	
64PE225	041		15	ROS	16/Jun/2002/15:04	BE	52	55.11 N	003	38.46 E	GPS	31	
64PE225	041		16	ROS	17/Jun/2002/06:26	BE	52	55.10 N	003	38.40 E	GPS	31.4	
64PE225	041		17	MUL	17/Jun/2002/06:33	BE	52	55.10 N	003	38.30 E	GPS	30.9	
64PE225	041		18	MUL	17/Jun/2002/06:56	BE	52	55.10 N	003	38.30 E	GPS	30.8	
64PE225	041		19	PULS	17/Jun/2002/07:32	RE	52	55.05 N	003	38.15 E	GPS	33	
64PE225	041		20	TROL	17/Jun/2002/08:21	RE	52	55.01 N	003	38.73 E	GPS	30.3	
64PE225	041		21	MOR	17/Jun/2002/09:03	RE	52	54.96 N	003	38.21 E	GPS	32	MOR1 with OBS
64PE225	041		22	MOR	17/Jun/2002/09:30	RE	52	55.02 N	003	38.54 E	GPS	32	MOR2 without OBS
64PE225	041		23	MUL	17/Jun/2002/09:45	BE	52	55.01 N	003	38.40 E	GPS	32	
64PE225	042		01	MUL	17/Jun/2002/13:21	BE	52	38.39 N	004	19.20 E	GPS	20.9	MEDUSA calibration
64PE225	042		02	MED	17/Jun/2002/13:35	DE	52	38.25 N	004	19.05 E	GPS	20.9	MEDUSA coastal section
64PE225	042		03	MED	18/Jun/2002/07:04	RE	52	39.50 N	004	22.60 E	GPS	22.1	

64PE225	043	01	MUL	18/Jun/2002/07:56	BE	52	44.70 N	004	30.50 E	GPS	20.9	samples for MEDUSA
64PE225	044	01	MUL	18/Jun/2002/08:33	BE	52	47.20 N	004	28.50 E	GPS	23	samples for MEDUSA

PULS Coherent ADP results:

Benthic boundary layer flow was measured using a pulse-coherent acoustic doppler profiler mounted at 2 m above the seafloor pointing downwards. The PCADP (Sontek is mounted on the front side of a frame turning itself into the flow for undisturbed flow determinations). It is also equipped with a video camera taking images of the seafloor. Velocities at 100 cm above sea bed reached 40 and 60 cm s^{-1} at ebbing and flooding tides, respectively, depicting the tidal cycle. Flow above these sandy beds never was smaller than 10-20 cm s^{-1} owing to the residual currents. The seafloor is covered by current ripples of different shapes.
Ammonia production rates and nitrification rates using a chlorate blocker were determined in laboratory incubations. Rates of ammonia production seem very high compared to the standing stock NH_4^+-concentrations. Conversely, nitrification rates appear to be moderate and do not show an excessively high nitrate production.
Except for station 40 where number of *Echinocardium spec.* was 35 m^{-2}, the biomass of macrofauna is low at all sandy stations, with tube-building polychaetes constituting the most abundant feeding type.

The achievements of the Medusa crew during the EMIR II cruise

With a last minute check-in Medusa Explorations BV was added to the EMIR program.
The mission of the Medusa crew was diverse.

1. Generate *grainsize maps* by using known fingerprints of Dutch coast sediment.
2. Look at the *mud fraction* in the region of interest to the other perticipators of the EMIR cruise.
3. Educate Richard Newman, a South African scientist, who will be deploying the Medusa technique in is home country.
4. Get acquainted with other techniques used in the program and see if the company can be of any importance to help solving the other participants problems.

4 out of 5 sub-missions where carried out quite successfully. One mission is worth some extra effort. That is to look for overlap in the different techniques used for unravelling the secrets of the seafloor.
During the entire cruise Medusa was deployed for 120 hours. In that time we have travelled 1074 km in three different areas. The area in the vicinity of the “The Broudfourteens”, as large as 2000 km^2, was covered in a total of only 72 hours spread over a 9 day period of witch Medusa was deployed during 6 nights. The maximum distance of two different legs is no more then 4 km.
We will take home a number of 60 seabed samples which will be analysed on grainsize by the NIOZ and radiometric characterisations by Medusa Explorations BV.

All these achievements wouldn’t have been made possible without the support, enthusiasm and co-operation of the entire crew, boatsmen and scientists.

Thanks for giving us a great time,

The Medusa crew.