BALTIC GAS cruise on Aarhus Bay

(Henrik Fossing, NERI, Aarhus University)

Preliminary results of CH_4 'in situ' measurements in gravity cores

Date: October 6 2009
Ship: Susanne A

Up to 580 cm long sediment cores were sampled by gravity coring at 10 stations along 600 m of (METROL)-transect 502110 starting about 400 m NW of a 'methane rich area' in Aarhus Bay – ending about 200 m into the area, that was defined by gas bubble formation in the seabed (see figure below).

The core liner was pulled out of the core barrel and sediment was immediately sampled for CH_4 concentration determination through holes drilled through the core liner at 33, 66, 100, 133, and 166 cm. Then the GC-core was sub-sectioned at 2 m. Additionally sediment was sampled at the top of each sub-core and from the core catcher. A 5 ml syringe with the luer-lock end cut off was used to sample 3 cm^3 sediment which was immediately transferred to a 20 ml glass vial containing 6.0 ml 2.5% NaOH and 2-3 glass beads. The container was closed with a butyl rubber stopper, crimp capped, and stored upside down to reduce loss of CH_4 from the headspace. Further the temperature was measured at the top of each subsection.

Preliminary results (see figures below)

Methane was observed at all stations, however only in trace amounts (< 0,3 Mm) at the very bottom of the cores at the two stations furthest away from the CH_4-rich area, Station M21 and M22, respectively.

At Station M23, 126 m NW of Station M26 (which was the boundary post of the methane rich area), a distinct methane front was observed about 400 cm from the top of the GC-core. The CH_4-front was observed closer to the sediment surface (i.e. the top of the GC-core) in direction towards Station M26 where the CH_4-front was observed at 370 cm depth. In the methane rich area the CH_4-front was observed at about 200 cm depth at Station M30 (relative to the top of the GC-core).

According to the seismic line 502110 the sediment was expected to be saturated with CH_4 at stations M27 – M30. This was indeed confirmed at Station M28, M29, and M30 where a first hand depth determination of the CH_4-saturation was estimated from the concentration gradient as shown on the figures. This showed saturation at about 400 cm, 380 cm, and 460 cm (form top of GC-cores) at Station M28, M29, and M30, respectively.

Station M27 was positioned 40 m into the methane rich area and CH_4-saturation was thus to be expected. Nevertheless, the CH_4 concentration at this station barely reached saturation. However, if a minor loss of CH_4 during recovery explained the methane loss, then a saturation depth of about 520 cm was anyway calculated based on an extension of the concentration gradient. Depending on the dynamic of CH_4 production and thus the 'physics and chemistry' of the 'methane rich area' it is questionable if the seismic line would remain unchanged since it was measured March 8, 2005. Also Core 9-111GC was sampled approx. 8 m west of Station M27 i.e. towards Station

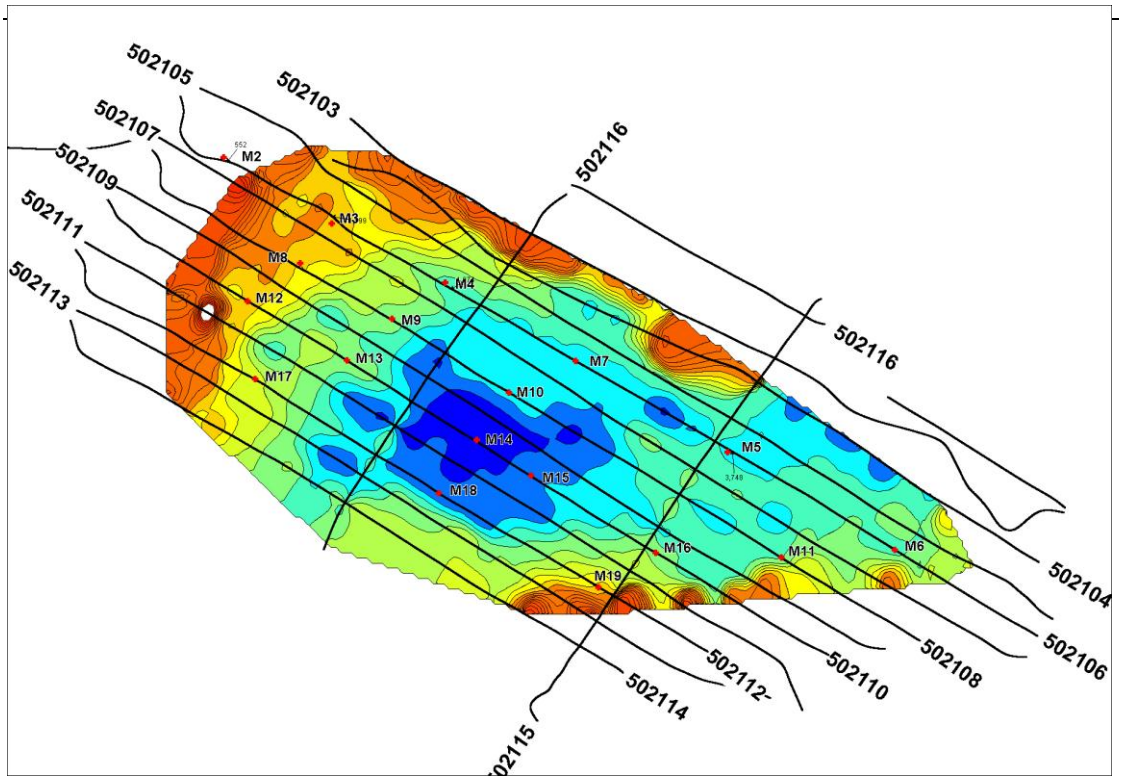
M26 (i.e. the boundary post of the methane rich area). Thus core 9-111GC was sampled very close to the 'rim' of the methane rich area as determined 4½ years ago. Core 9-107 was samples about 13 m west of Station M26 and are thus expected to be outside the methane rich area which was also confirmed by the concentration gradient. With this in mind it is argued that CH_4-saturation was not observed at Station M26.

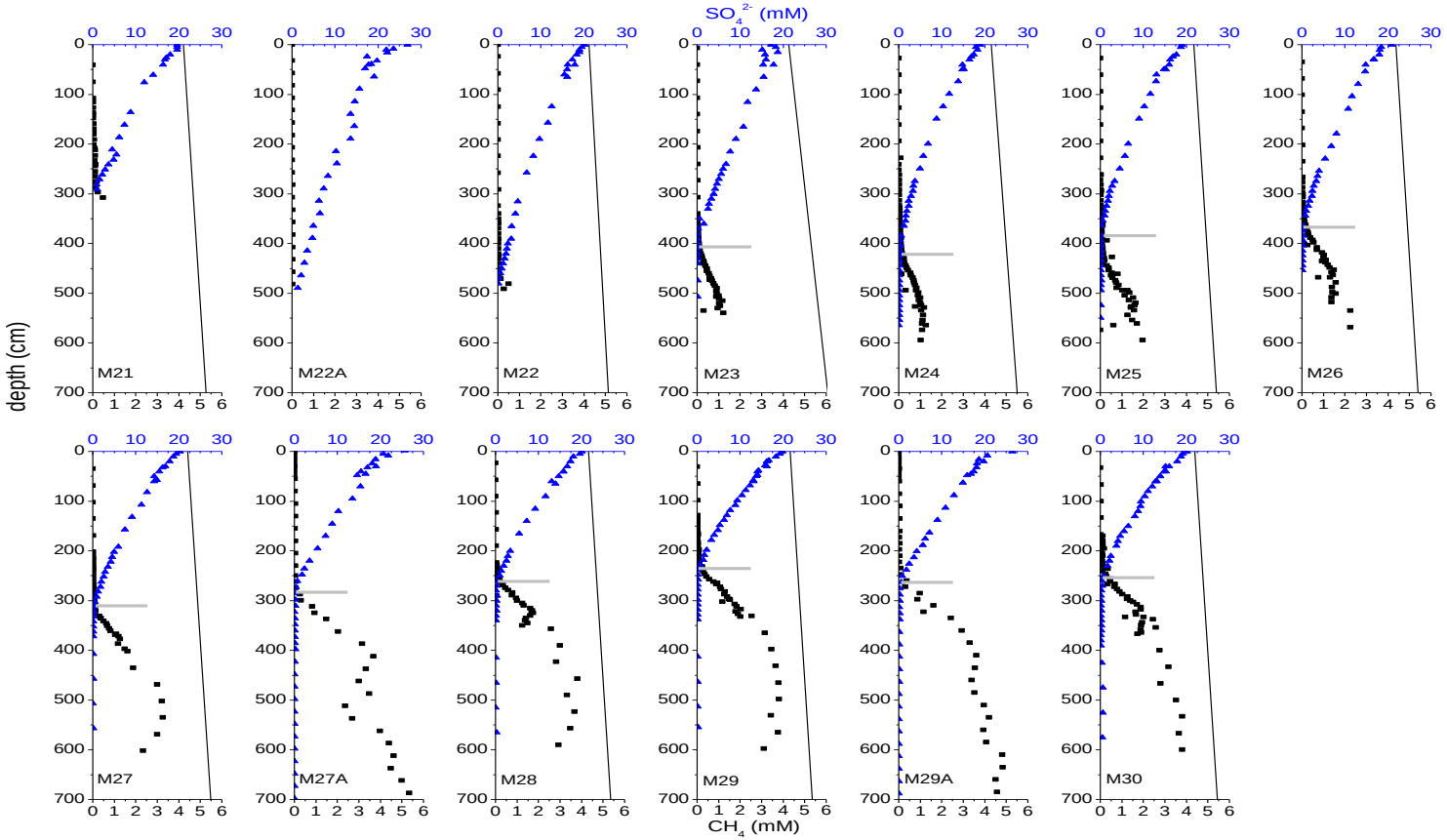
The concentration gradient allowed the CH_4 flux to be calculated. Porosities still wait to be measured, thus an average porosity of 0.6 was used for calculations based on earlier measurements in the area (METROL). For the flux calculations a seafloor temperature of 13,2 ^oC was used together with a salinity of 29‰ and a CH_4 diffusion coefficient of 1.408 x 10^{-5} cm^2 s^{-1}.

The average CH_4-flux in the methane rich area (i.e. station M28 – M30) was 79 ± 15 µmol CH_4 m^{-2} d^{-1}. This was approx. 2,6 ± 0,4 times higher than the flux outside the area with an average methane flux of 30 ± 2 µmol CH_4 m^{-2} d^{-1} at station M23 – M25.

The results of this investigation will be further refined based on detailed measurements of CH_4 concentrations at sediments depths where methane does not exceed saturation at 1 atm. Also the CH_4 front and saturation depth will be calculated relative to the sea floor, when the loss of sediment during GC-coring has been estimated based on the SO_4^{2-} gradient in the top of the GC cores and in a Rumohr Lot (also sampled at all stations).

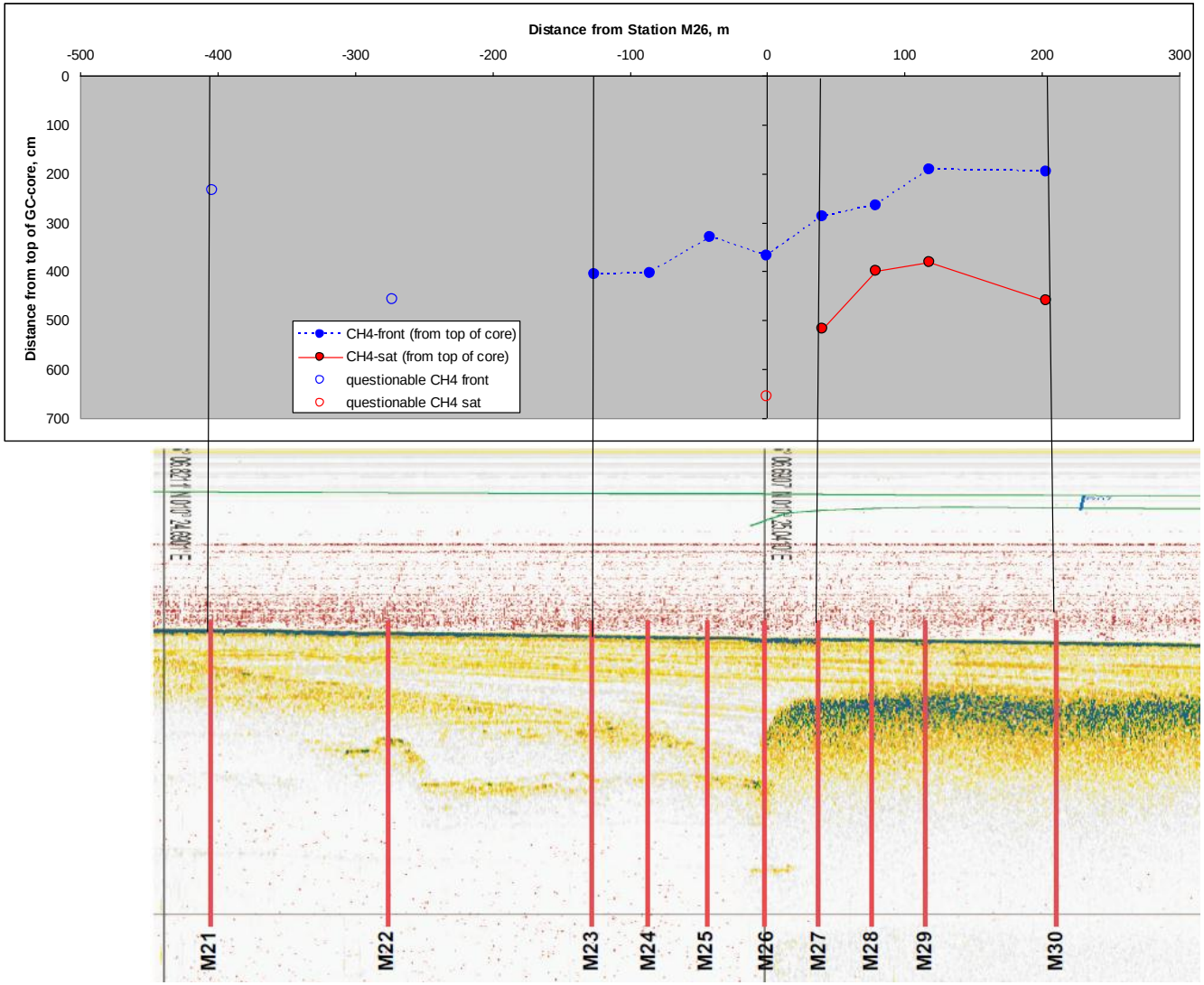
----------FIGURES----------

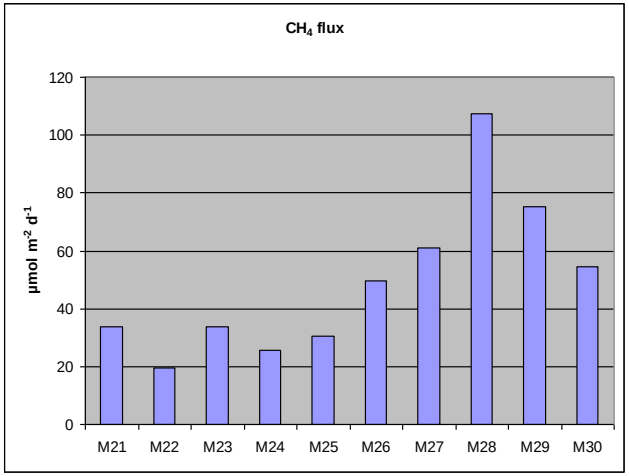




CH_4 and SO_4^{2-} profiles along the transect. M21-M26 are in the gas-free area with M26 ca. 12 m from the transition and M27-M30 are in the gassy sediment area. The gray line represents the peak of the SMT (defined as $[CH_4]=[SO_4^{2-}]$), the fine solid black line is *in situ* CH4 saturation.

CH_4 saturation depth, front and flux at 10 stations along Transect 502110





Sediment sampling along transect 502110 October 6, 2009

Presition of position: ± 3 m

Station	Planed position Lat/Lon hddd°mm,mmm Datum: WGS 84		Distance from Station M26	depth at station	bottom water temp		Sampling position Lat/Lon hddd°mm'ss.s" Datum: WGS 84		distance from station	bearing from station	length of core	remarks
			m	m	°C	core label	LAT	LONG	m		cm	
M21	N56 06.808	E10 24.713	-404	18,4	13,4	9-121 GC	N56 06.810	E10 24.714	3	22	297,0	
						9-122 RL	N56 06.812	E10 24.720	10	47	???	
M22	N56 06.769	E10 24.818	-273	18,6	13,6	9-119 GC	N56 06.770	E10 24.825	7	71	491,0	
						9-120 RL	N56 06.773	E10 24.814	8	324	???	
M23	N56 06.728	E10 24.938	-126	18,8	13,6	9-101 GC	N56 06.719	E10 24.940	16	172	540,0	
						9-102 RL	N56 06.728	E10 24.936	2	260	44,5	
M24	N56 06.716	E10 24.973	-85	18,8	13,1	9-103 GC	N56 06.713	E10 24.981	10	127	580,0	
						9-104 RL	N56 06.704	E10 24.983	25	156	51,5	
M25	N56 06.703	E10 25.008	-42	19,0	13,0	9-105 GC	N56 06.704	E10 25.004	5	295	580,0	
						9-106 RL	N56 06.698	E10 25.005	10	198	64,0	
M26	N56 06.691	E10 25.041	0	19,1	13,1	9-107 GC	N56 06.693	E10 25.029	13	284	554,0	
						9-108 RL	N56 06.681	E10 25.044	18	170	63,0	
						9-118 RL	N56 06.690	E10 25.038	4	231	???	
M27	N56 06.679	E10 25.074	40	19,0	12,3	9-109 GC	N56 06.682	E10 25.066	10	303	670,0	not used: probably dubble coring at station
						9-111 GC	N56 06.678	E10 25.066	8	253	580,0	
						9-110 RL	N56 06.674	E10 25.067	12	219	66,0	
M28	N56 06.668	E10 25.106	79	19,1	13,5	9-113 GC	N56 06.671	E10 25.107	5	16	580,0	
						9-112 RL	N56 06.665	E10 25.112	8	131	64,0	
M29	N56 06.657	E10 25.138	118	19,1	13,4	9-115 GC	N56 06.657	E10 25.132	7	263	580,0	13 cm in 4th section lost, i.e. not sampled
						9-114 RL	N56 06.657	E10 25.139	1	116	62,0	
M30	N56 06.632	E10 25.206	203	19,3	13,1	9-117 GC	N56 06.636	E10 25.208	8	12	580,0	18 cm in 4th section lost, i.e. not sampled
						9-116 RL	N56 06.632	E10 25.210	4	102	???	