Tokt Rapport

Fartøy/*Michael Sars*	**Toktleder**/*Thomas Noji*	**Tokt nr.**/*2000 104*
Avgangsdato/ *mandag, 10 April 2000*		**Avgangssted**/ *Kristiansand*
Ankomstdato/ *fredag, 14 April 2000*		**Ankomststed**/*Bergen*
Personell/*Thomas Noji, Grethe. Tveit, Martin. Dahl*		
Utstyr som er brukt, eventuelt med settinger og andre detaljer/*Equipment used*: *Sediment grab (Smøgen grab)*		
Antall innsamlingstasjoner/*Number of stations*: 18		**Redskap**/*Equipment*: Sediment grab
Innsamlet materiale/*Collected samples*: 270		

Materiale	Punchet (system)	Konservert (hvordan)	Når skal det evt. opparb.	Ansv. for opparb.
Sediment-Org kjemi		frosset	Høst 2000	J. Klungsøyr
Sediment-Radioaktiv.		frosset	Høst 2000	L. Føyn
Sediment-Part. Fordel.		frosset	Høst 2000	J. Klungsøyr
Sediment-Metaller		frosset	Høst 2000	J. Klungsøyr/NGU
Bunnfauna		formalin	Winter 2000	T. Noji

Kommentarer/*Comments:*
I tilleg utsetningen av sedimentfelle / strømmåler rig

Goals for the cruise

The purpose for the cruise was to collect data in compliance with the deliverables for the NFR project, "Contaminant Transport And Resuspension Modeling in the Skagerrak (CONTAMS)" (NFR project no. 134112/720) . The main goals and deliverables of the project are:

A. To elucidate the physical transport of contaminants in the Skagerrak. Of particular importance shall be the effect of near-bottom currents on the resuspension of contaminated sediments. By providing the necessary ground-truth data, the project aims to improve the present sediment-transport modules linked to the NORWECOM model (IMR, Bergen), which then can simulate the effect of near-bottom currents on resuspension and transport of sediments.

The project shall deliver:

- data on concentrations of selected PAHs (24 compounds), PCBs (12 congeners), and some less well documented organic contaminants like toxaphene from sediments and sediment traps in the Skagerrak.
- data on the effect of current speed and direction on the size and composition of particles collected in sediment traps near the sea floor in the Skagerrak,
- data on the effect of current speed and direction on the contaminant load of material collected in the same sediment traps,
- an implementation of findings into the existing sediment-transport module of NORWECOM (IMR, Bergen).

B. To assess ecological and socio-economic implications of the findings, and suggest ecological quality objectives for the Skagerrak. The findings shall provide the basis for recommendations on environmental management issues in the Skagerrak.

The project shall deliver:

- an assessment of the findings with respect to natural and anthropogenic disturbances, which could lead to mass resuspension events of the sediments and associated contaminants,
- a report establishing and describing possible ecological quality objectives[i] for the Skagerrak with respect to remobilization of contaminants in sediments.

During this cruise, samples were collected and equipment deployed for implementing goal no. 1, above. After the processing of data, they shall provide the basis for implementing goal no. 2.

Background

The Skagerrak is part of the North Sea ecosystem. The Skagerrak is a commercially imporant area for fisheries and recreation. Unfortunately, it is also a major route for agricultural and industrial wastes. 50 - 70% of the suspended matter in the North Sea reportedly accumulates in the Skagerrak. To aid responsible environmental management of the Skagerrak (and greater North Sea), it is necessary to understand the processes regulating the transport and distribution of contaminants. This knowledge can assist researchers to pinpoint sources of contaminants as well as to predict how long contaminants may continue to accumulate in some areas of the Skagerrak, even if input of contaminants to the North Sea ecosystem is stopped.

The findings from this cruise shall elucidate the danger that storms and bottom fishing may present for causing massive remobilization of "deposited" contaminants and silty sediments, which might enter coastal currents to affect local fish stocks, fish farms, kelp forests and the world's largest, cold-water coral reefs. The data from this cruise also shall help to understand the relationship between bottom currents and resuspension/transport of sediments and associated contaminants, and to improve contaminant-transport forecasting. The findings shall be useful for environmental and fisheries managers as well as public interest groups.

Implementation

Transport of sediment and contaminants; modeling

A depo-center for contaminants, the Norwegian Trench of the Skagerrak, is the main area for study of long-term patterns of sedimentation. During the cruise we deployed a mooring with sediment traps at approx. 40 m above the sea floor of the deep Skagerrak at one site (Fig. 1); same as in previous sediment-trap investigation reported by Noji and Noji, 1998[ii]). The trap samples shall provide data on size, composition, abundance and calculated sinking velocities of particles, as well as concentrations of associated organic contaminants. The mooring includes a current meter (Aanderaa, Bergen) at approx. 30 m above the sea floor (Fig. 2). The rig shall be deployed for approx. six months and continuously monitor 20 discrete sampling periods.

Together and in comparison with the data reported by Noji and Noji (1998) [ii], the data collected during this cruise should aid to improve the sediment-transport module of NORWECOM[iii] (see below). (In turn, the transport module shall provide an indication of the magnitude of contaminant transport under typical and "extreme" conditions, related to meteorological events and trawling. The NORWECOM model presently includes the following modules:

(i) Hydrodynamic module with 3-D current field (including tides) to predict the transport and mixing of tracers. Together with a wave module this module also generates bottom stress;
(ii) Chemical-biological module simulating primary production, remineralization and transport of organic matter and inorganic nutrients;
(iii) Suspended sediment transport module for simulating resuspended sediment within the water column. Concentrations of particles are altered by various processes including resuspension sediments induced by bottom stress;
(iv) Benthic module addressing sediment processes regulating mixing, regeneration, release and burial of inorganic and organic particulate matter;
(v) Micropollutant pelagic transport module focusing on concentrations of micropollutants regulated by advection, mixing, exchange across the model boundaries and solid-solute phase transfer;
(vi) Micropollutant benthic module including sediment processes regulating regeneration, release and retention of the micropollutants in the sediments;
(vii) Contaminant module based on the results of the physical and biological module (full 3-D hydrodynamics are used to transport the contaminants). This module is an immature part of the model system that has a strong need for further development and testing.

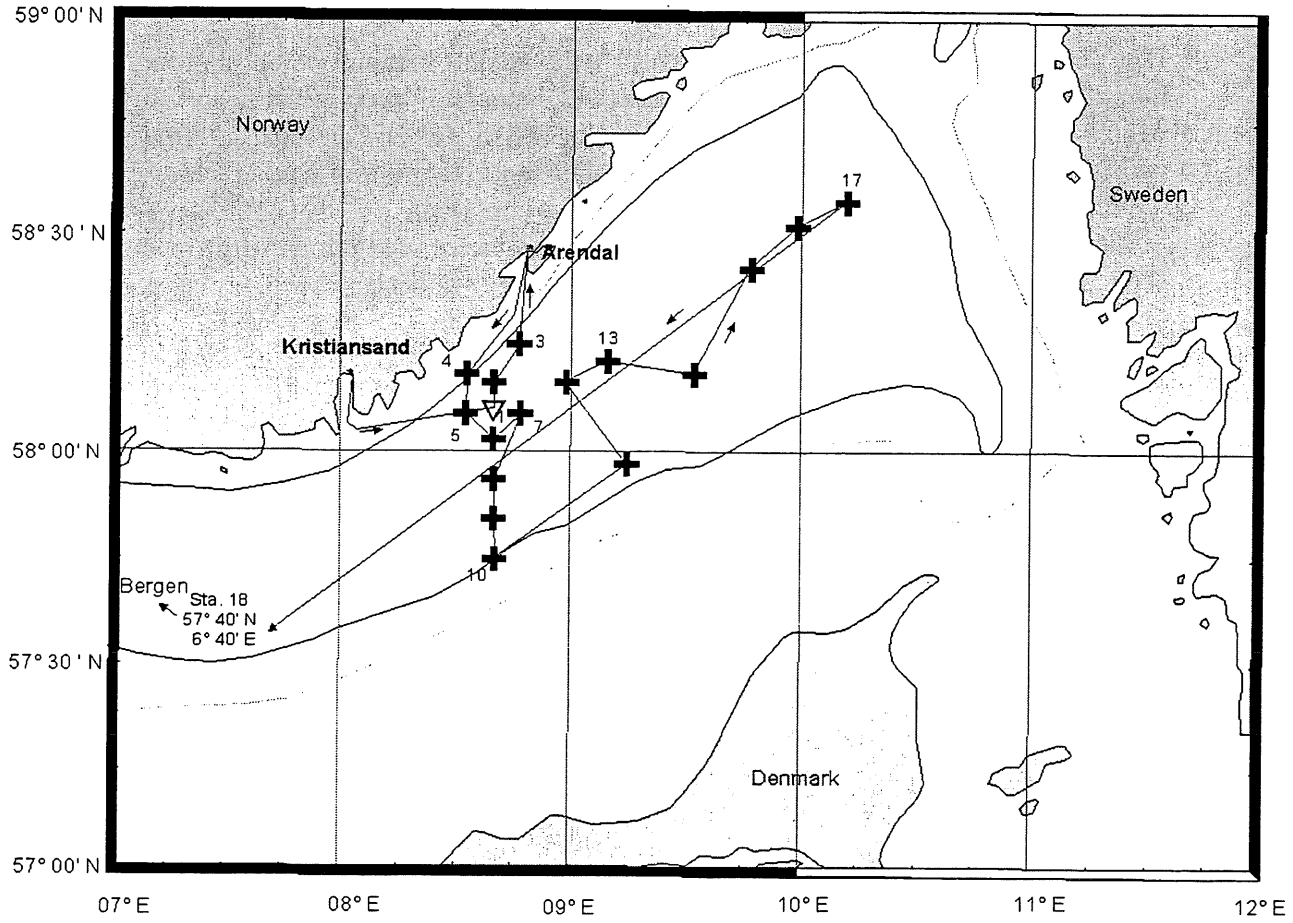

Figure 1. Cruise track and location of stations during M. Sars cruise 2000104. At all stations 6 sediment grabs were taken (3 for chemical analyses and 3 for benthic taxonomic identification). Triangle indicates location of the sediment-trap/current-meter mooring.

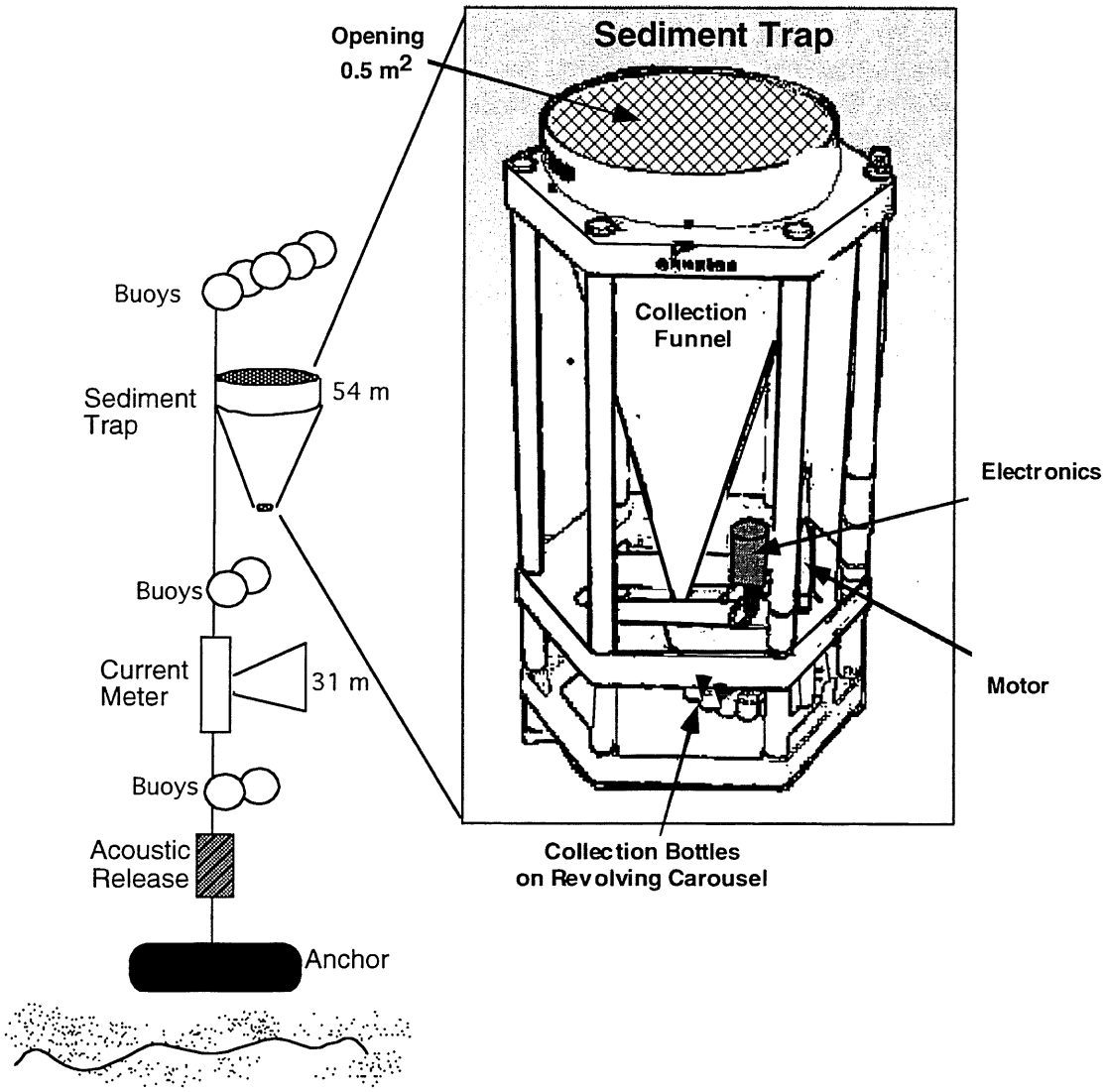

Figure 2. Sediment-trap / Current-meter mooring deployed in the deep Skagerrak. Echo depth at the site of deplyment is 534 m.

Sediment contamination

Sampling of surface sediments with a box corer was conducted at several sites near the mooring, along one east-west transect and one north-south transect (Fig. 1; Table 1). Biochemical and mineralogical analyses of interest shall be measured from these samples. The parameters of measurement include ^{137}Cs, PAHs, PCBs as well as toxaphene, heavy metals and particle size distribution.

Table 1. Station list, R.V. Michael Sars, 10 - 14 April 2000 Skagerrak

				Lat North		*Long East*			*Sediment Samples*	
		Time		*Degr*	*Min*	*Degr*	*Min*	*Depth (m)*	*Chem.*	*Biology*
Note	*Date*	*(local)*	*Sta.*							
Kristiansand	10-Apr	18:05	Depart							
Mooring	10-Apr	21:09	1	58	2.9	8	41.4	534		
	10-Apr	23:57	1	58	2.8	8	41.4	550	3xgrab	3xgrab
	11-Apr	3:12	2	58	6.5	8	41	490	3xgrab	3xgrab
	11-Apr	06:12	3	58	12	8	43	300	3xgrab	3xgrab
Arendal	11-Apr	10:15	Arrive							
Arendal	11-Apr	10:56	Depart							
	11-Apr	12:58	4	58	7.5	8	33	330	3xgrab	3xgrab
	11-Apr	15:04	5	58	3	8	34	490	3xgrab	3xgrab
	11-Apr	18:10	6	57	59.4	8	40.5	540	3xgrab	3xgrab
	11-Apr	21:49	7	58	3	8	48	600	3xgrab	3xgrab
	12-Apr	1:55	8	57	52	8	41	520	3xgrab	3xgrab
	12-Apr	4:21	9	57	47	8	41	370	3xgrab	2xgrab
	12-Apr	7:02	10	57	41.5	8	40.8	185	3xgrab	3xgrab
	12-Apr	10:45	11	57	55	9	15	250	3xgrab	3xgrab
	12-Apr	13:16	12	58	6.5	8	59	600	3xgrab	3xgrab
	12-Apr	17:11	13	58	9	9	11	640	3xgrab	3xgrab
	12-Apr	21:00	14	58	8.2	9	31.8	570	3xgrab	3xgrab
	13-Apr	1:42	15	58	28	9	46	670	3xgrab	3xgrab
	13-Apr	5:40	16	58	32	9	59	560	3xgrab	3xgrab
	13-Apr	8:24	17	58	35	10	14.5	325	3xgrab	3xgrab
	13-Apr	19:43	18	57	39.9	6	39.9	310	3xgrab	3xgrab
Bergen	14-Apr	16:00	Arrive							

"Chem." = 1 sample / grab for ^{137}Cs, organic contaminants, heavy metals and particle size distribution. "Biology" = 1 sample / grab for benthos (>1mm; upper 20 cm of sediment x 30 x30 cm). Grab used was a Smøgen grab (box corer; 50 x 30 x 30 cm)

Dissemination, comparison and discussion of project findings

Along with national and international publications and participation in relevant conferences, the dissemination, comparison and discussion of results shall be implemented through the internet. The findings from this cruise, once available, shall be accessible via IMR's website (www.imr.no). Presently, a homepage for the CONTAMS project is being set up at IMR.

Preliminary results and general comments

The sampling was conducted without any notable difficulties. Sediments in the box cores were usually relatively undisturbed and subsampling of the uppermost 20 cm of sediment from the cores was a useful method to standardize volumes and depth of sampled sediments. Able assistance from the crew enabled sampling to be carried out by one scientist per shift. All samples are now in storage or being prepared for analysis.

With respect to deployment of the mooring, it is noted that the activity was conducted very easily from R.V. "Micahel Sars." Good weather conditions facilitated this smooth operation. This was due to the arrangement of winches and cranes on the ship, the good maneuverability of the ship, the good view of the operation from the bridge, and the very good cooperation and capability of the captain and crew. I wish to thank them for a successful research expedition.

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[i] as described in Lanters R., Skjoldal H.R., Noji T.T., Daan N., Offringa H., van Gool S. (1999). Ecological Quality Objectives (EcoQOs) for the North Sea. A Work Document for the 5th International Conference on the Protection of the North Seas, Scheveningen, The Netherlands, 1-3 September 1999.

[ii] Noji T.T., Noji C.I.-M. (1998). Sediment transport in relation to the concentrations of environmental contaminants in the Skagerrak. Final Report, State Pollution Control Authority (SFT), 79 pp.

[iii] Aksnes D. *et al.* (1995). Ecological modelling in coastal waters: towards predictive physical-chemical-biological simulation models. Ophelia 41: 5-36.