E-80400

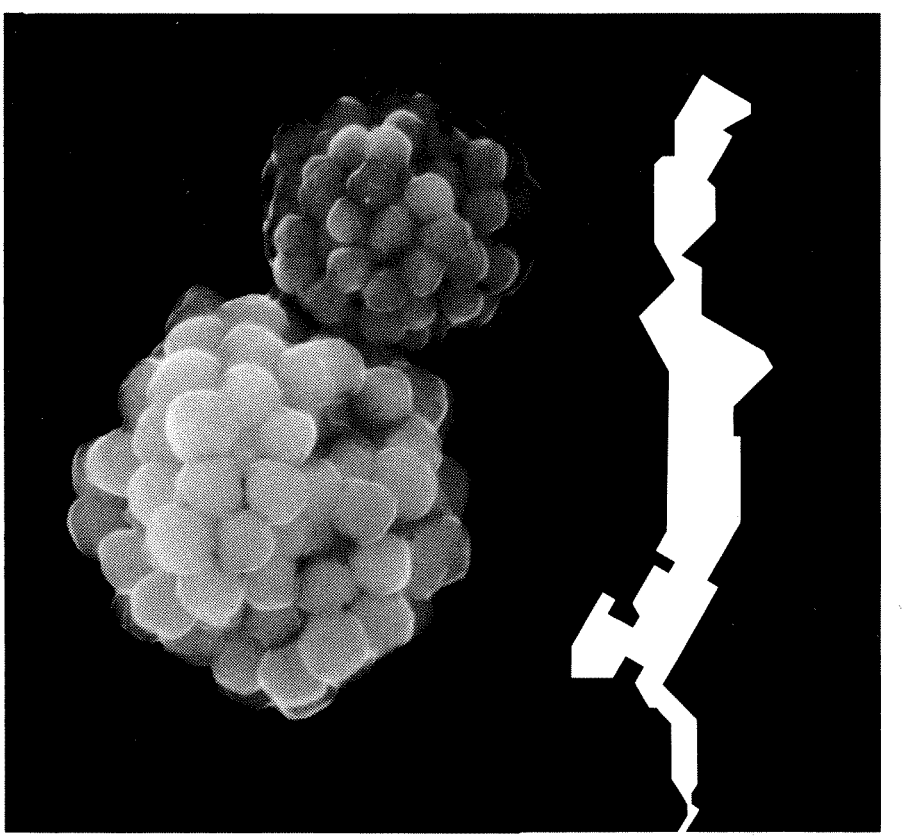
Framvaren

oceanographic expedition

Cruise summary report

"F/F Trygve Braarud", "F/F H.H. Gran"

May 29th - June 6th, 1989



Norwegian Institute for Water Research NIVA

NIVA – REPORT

Norwegian Institute for Water Research NIVA

Main Office
P.O.Box 33, Blindern
N-0313 Oslo 3
Norway
Phone (47 2) 23 52 80
Telefax (47 2) 39 41 29

Regional Office, Sørlandet
Grooseveien 36
N-4890 Grimstad
Norway
Phone (47 41) 43 033
Telefax (47 41) 42 709

Regional Office, Østlandet
Rute 866
N-2312 Ottestad
Norway
Phone (47 65) 76 752

Regional Office, Vestlandet
Breiviken 5
N-5035 Bergen - Sandviken
Norway
Phone (47 5) 95 17 00
Telefax (47 5) 25 78 90

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The Cruise Summary Report contains a list of participants, individual sampling programs and some preliminary results from a cruise carried out during May 29th - June 6th 1989 in Framvaren, South Norway.

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Project leader

Jens Skei

For the Administration

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E-80400

FRAMVAREN OCEANOGRAPHIC EXPEDITION

CRUISE SUMMARY REPORT

"F/F TRYGVE BRAARUD"
"F/F H.H. GRAN"

MAY 29th - JUNE 6th, 1989.

by

Jens Skei, Ph.D.
Chief Scientist.

Oslo, October 20th, 1989.

ABSTRACT

The Framvaren Expedition was conducted during the period May 29th - June 6th, 1989. Two research vessels were involved: "F/F Trygve Braarud" from the University of Oslo and "F/F H.H. Gran" from NIVA. Samples were carried by zodiacs between the two vessels. Laboratories were set up at both vessels and in the garden of a rented house!

This cruise report contains a list of participants, individual sampling programs and some preliminary results. Everybodys contribution is greatly appreciated.

LIST OF PARTICIPANTS AND AFFILIATIONS

Dr. Williard Moore
University of South Carolina
Dep. of Geology
Columbia S C 29208
USA

Dr. Jim Todd/Dr. Brent McKee
United States Department of Commerce
NOAA
Rockville, Md 20852
USA

Mr. Michael Blackburn
University College of N. Wales
Dep. of Oceanography
Marine Science Laboratories
Menai Bridge
GWYNEDD LL 595E4
Wales

Dr. Arthur L. Sanchez/Dr. Janine Gastaud
International Atomic Energy Agency
Int. Lab. of Marine Radioactivity
Musee Oceanographiqu
9800 MONACO

Dr. Frank Millero
Rosenstiel School of Marine Atmospheric Science
University of Miami
4600 Rickenbacher Causeway
Miami Fl 33149
USA

Mr. Kevin Mandernack
Marine Biology Research Div. A-002
Scripps Institution of Oceanography
L Jolla, CA 92093
USA

Dr. Graham Vaughan
Rosenstiel School of Marine Atmospheric Science
University of Miami
4600 Rickenbacher Causeway
Miami F 1 33149
USA

Dr. Ellis Holm/Dr. Per Roos/Dr. Kjell Åke Carlsson
Inst. for Radiofysik
Lasarettet
S-22185 LUND
Sweden

Dr. David Velinsky
Carnegie Institution of Washington
Geophysical Laboratory
2801 Upton Street
N.W. Washington DC 20008-3898
USA

Professor David Dyrssen/Dr. Margareta Wedborg/Dr. Katarina Abrahamsson/Dr. Silke Klick/Mr. Roger Lindegren/Miss Anneli Skoog
Department of Analytical and Marine Chemistry
Chalmers University of Gøteborg
S-41296 Gøteborg
Sweden

Dr. Dag Klaveness
Department of Biology
Division of Limnology
P.O.Box 1027 Blindern
N-0315 Oslo 3
Norway

Dr. Jens Skei/Miss Kari Nygaard/Mr. Kristoffer Næs/Mr. Kai Sørensen
Norwegian Institute for Water Research
P.O.Box 69 Korsvoll
0808 Oslo 8
Norway

CRUISE SUMMARY

The emphasis of the Framvaren Expedition was to study the oceanography and the biogeochemistry of a super-anoxic marine basin. Framvaren was first studied by Dr. K.M. Strøm in 1931 and it has been well known as a permanent anoxic basin for more than 50 years. Since 1979 Norwegian Institute for Water Research (NIVA) has continually been investigating Framvaren. A mini workshop held in Farsund in May 1986 resulted in a special volume in Marine Chemistry, summarizing the knowledge of Framvaren and comparisons with other anoxic systems.

The cruise in 1989 intended to supplement and partly repeat some of the earlier findings to better understand anoxic processes generally and super-anoxic basins specially.

The sampling program included general hydrography, sulfide systems, organics, nutrients, microbial processes, radionucleides and trace metals. Water, particulate matter, plankton and sediments were collected. The participants generally succeeded in their sampling. Technically, things went well although the vessels were small and the number of people large. And the weather was not too bad either. -

INDIVIDUAL SAMPLING PROGRAMS AND PRELIMINARY RESULTS

Contributors: Moore/Todd/McKee.

- Pb-210 Cs-137, Cs-134. Ra-226 and Ra-228 in sediment core from deep basin (F1) in Framvaren (some preliminary data included).

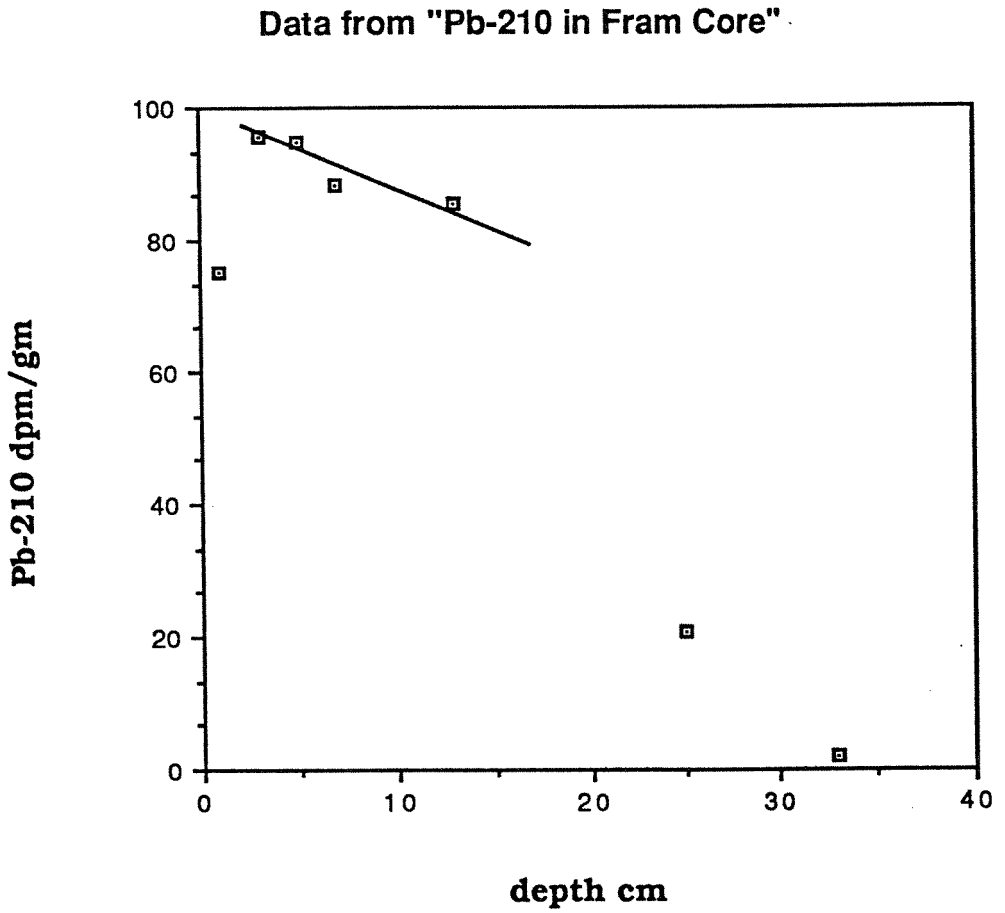
- Samples for dissolved and particulate U-238, U-234. Th-234. Th-228, Pb-210 and Po-210. Samples were taken at surface, 5, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170 and 175 m.

  Samples for dissolved Ra-226, Ra-228 and Ra-224 were taken at surface 5, 10, 12, 14, 16, 18, 20, 22, 24, 30, 40, 60, 80, 100, 120, 140, 160 and 175 m.

Framvaren Core Weights

Tue, Jul 18, 1989 12:05 PM

	interval	Depth	wt cup	cup+sam wet	cup+sam dry	wet wt	dry wt	wet-dry wt	Porosity	wt vial	vial+sam	sam+ salt	wt salt	wt sample
1	0-2	1	2.174	33.759	3.029	31.585	0.855	30.730	0.973	4.389	5.278	0.889	0.707	0.182
2	2-4	3	2.181	35.765	3.128	33.584	0.947	32.637	0.972	4.282	5.272	0.990	0.751	0.239
3	4-6	5	2.173	35.332	3.134	33.159	0.961	32.198	0.971	4.252	5.281	1.029	0.741	0.288
4	6-8	7	2.164	33.951	3.068	31.787	0.904	30.883	0.972	4.310	5.258	0.948	0.710	0.238
5	8-10	9	2.154	34.842	3.157	32.688	1.003	31.685	0.969	4.321	5.389	1.068	0.729	0.339
6	10-12	11	2.157	35.046	3.232	32.889	1.075	31.814	0.967	4.331	5.458	1.127	0.732	0.395
7	12-14	13	2.185	34.928	3.288	32.743	1.103	31.640	0.966	4.274	5.442	1.168	0.728	0.440
8	14-16	15	2.148	36.015	3.268	33.867	1.120	32.747	0.967	4.329	5.497	1.168	0.753	0.415
9	16-18	17	2.187	36.154	3.395	33.967	1.208	32.759	0.964	4.265	5.529	1.264	0.753	0.511
10	18-20	19	2.166	36.104	3.675	33.938	1.509	32.429	0.956	4.284	5.838	1.554	0.746	0.808
11	20-22	21	2.181	36.834	3.840	34.653	1.659	32.994	0.952	4.370	6.071	1.701	0.759	0.942
12	22-24	23	2.161	37.519	3.521	35.358	1.360	33.998	0.962	4.342	5.730	1.388	0.782	0.606
13	24-26	25	2.204	36.711	3.770	34.507	1.566	32.941	0.955	4.291	5.876	1.585	0.758	0.827
14	26-28	27	2.156	35.288	5.100	33.132	2.944	30.188	0.911	4.480	7.620	3.140	0.694	2.446
15	28-30	29	2.165	32.186	4.670	30.021	2.505	27.516	0.917	4.270	6.920	2.650	0.633	2.017
16	30-32	31	2.159	34.140	4.931	31.981	2.772	29.209	0.913	4.380	7.340	2.960	0.672	2.288
17	32-34	33	2.164	38.235	5.425	36.071	3.261	32.810	0.910	4.330	7.860	3.530	0.755	2.775
18	34-36	35	2.188	34.548	5.283	32.360	3.095	29.265	0.904	4.310	7.630	3.320	0.673	2.647
19	36-38	37	2.169	35.198	5.399	33.029	3.230	29.799	0.902	4.300	7.790	3.490	0.685	2.805
20	38-40	39	2.163	35.742	5.654	33.579	3.491	30.088	0.896	4.320	8.040	3.720	0.692	3.028
21	40-42	41	2.280	39.761	6.439	37.481	4.159	33.322	0.889	4.300	8.720	4.420	0.766	3.654
22	42-44	43	2.313	39.213	6.455	36.900	4.142	32.758	0.888	4.320	8.730	4.410	0.753	3.657
23	44-46	45	2.282	36.999	6.413	34.717	4.131	30.586	0.881	4.440	8.830	4.390	0.703	3.687
24	46-48	47	2.274	38.856	6.907	36.582	4.633	31.949	0.873	4.460	9.310	4.850	0.735	4.115
25	48-50	49	2.313	35.396	7.106	33.083	4.793	28.290	0.855	4.430	9.180	4.750	0.651	4.099
26	50-57	54	2.274	97.756	18.022	95.482	15.748	79.734	0.835	4.360	9.420	5.060	1.834	3.226
27	57-61	59	2.318	55.392	10.529	53.074	8.211	44.863	0.845	4.480	9.190	4.710	1.032	3.678
28	61-65	63	2.318	61.624	12.148	59.306	9.830	49.476	0.834	4.450	8.510	4.060	1.138	2.922



Pb-210 in Fram Core

	depth	Pb-210	log Pb-210
1	1	75.22	1.876
2	3	95.56	1.980
3	5	94.96	1.978
4	7	88.40	1.946
5	13	85.70	1.933
6	25	20.60	1.314
7	33	2.00	0.301

Contributor: Blackburn.

a) Column Profile

9 x 3 or 1.5 l samples were taken from different depths down - column. Each sample was filtered through a pre-conbusted 47 mm GF/F filter, and frozen.

Each filter was halved, and one half sampled for chlorophyll a, the other will be analysed for ^{15}N and ^{13}C. The ^{15}N, ^{13}C results will be ready in late October or November.

The chlorophyll results are presented below:

DEPTH (m)	VOLUME FILTERED (l)	CHLOROPHYLL A (µg/l)
1	3	1.3
1	3	1.2
8	2	0.7
17	1.5	17.6
20	1.0	0.6
22	1.5	0.7
25	1.5	1.0
50, 100, 150	1.5	-

Chlorophyll a was analysed by reverse-phase HPLC. All concentrations are accurate to ±15%.

b) Size-Fractionations

8 l samples from 1 & 20 m were filtered into three size fractions using a sieve-stack - >99 µm, 35-99 µm, 20-35 µm. Two samples were taken from each depth.

Each sample was analysed for chlorophyll a, but in all cases values below the HPLC limit of detection were found.

All samples will be analysed for ^{15}N & ^{13}C.

c) Decay Experiment

10 litres of surface water were taken, stored at the fjord surface in a bottle and subsampled over 4 days. However, any results were vitiated by the leakage of fresh water into the bottle.

d) Sediment Work

Sedimentary material will be analysed for ^{15}N & ^{13}C, and these values compared with those for down-column particulates.

Contributors: Sanchez/Gastaud/Holm/Roos/Carlsson.

	ANTICIPATED ANALYSES				
	Pu	Cs	Tc-99	Pb-210	Am-241
Framvaren water-profile: 2, 10, 20, 40, 60, 80, 110, 140, 175 m	x	x	x		x
Framvaren: 2, 10, 20, 40, 60 m	x oxid.states	x			
Helvikfjord: 1, 7, 11, 18, 25 m	x	x	x		x
Helvikfjord: 1, 7, 11, 18, 25 m	x oxid.states	x			
Lichensamples (~1/4 m^2) Framvaren area 4 carpets		x			
Fucus vesiculosus samples from Framvaren and Helvikfjord 15 samples. From Farsund to Framvaren	x	x	x		x
Sedimentprofile: Framvaren and Helvikfjord	x	x	x	x	x
Framvaren water-profile: 10, 20, 40, 60, 80, 140 m		x			
Particulate material Hellviksfjord 2, 11, 18, 22 m	x				x

to be cont.

cont.

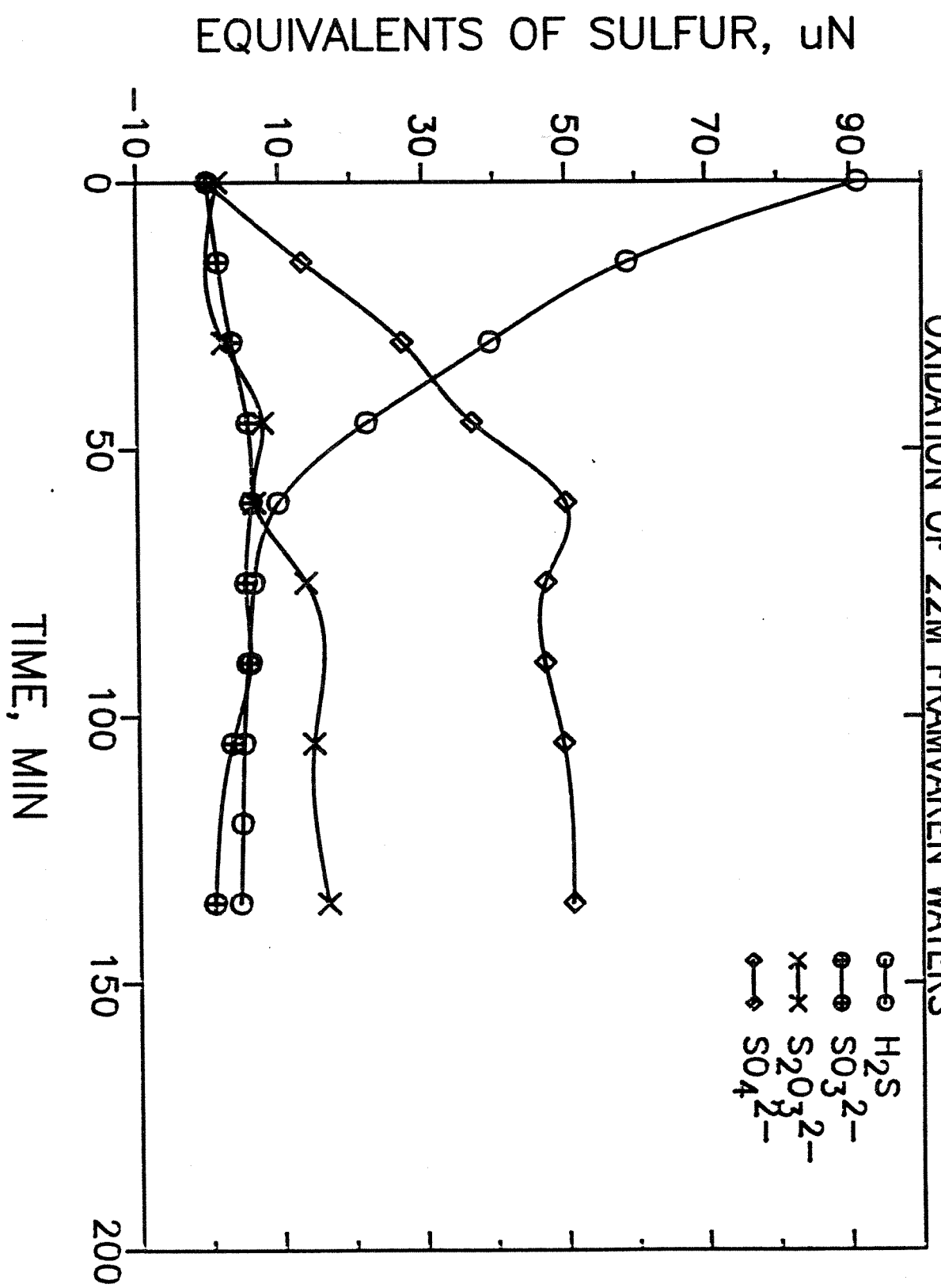
Particulate material Framvaren 2, 10, 20, 40, 60, 80, 140 m	x				x

Pu = Pu isotopes Pu-239 + 240, Pu-238, Pu-241.
Cs = Cs-134, Cs-137.

Contributor: Millero.

Measurements of sulfide speciation by a HPLC technique and kinetic experiments.

Depth	$[H_2S]$
19 m	0.6 μM
20	5.
21	62.
22	74.
25	245.
30	456.
40	791.
50	1146.
60	1523.
70	1892.
80	2915.
90	3195.
100	4583.
110	4536.
120	4460.
130	4813.
140	4675.
150	5044.
160	5228.
170	5705.


EQUIVALENTS OF SULFUR, uN
−10
0
10
30
50
70
90
0
50
100
150
200
TIME, MIN
OXIDATION OF 22M FRAMVAREN WATERS
H2S
SO3 2−
S2O3 2−
SO4 2−

Contributor: Mandernack.

Measurements of Microbial Sulfide Oxidizing Activity at the O_2/H_2S Interface, Framvaren Fjord

Kevin W. Mandernack
Dr. Bradley Tebo
Scripps Institution of Oceanography
Marine Biology Curricular Group, A-002
La Jolla, California, 92093; U.S.A.
October 5, 1989

Rate measurements of microbial sulfide oxidation and CO_2 fixation (via ^{14}C-bicarbonate uptake) were made from water samples collected at the O_2/H_2S interface at Framvaren fjord in order to reveal whether sulfide oxidation is coupled to bacterial primary production. Since the O_2/H_2S interface at Framvaren is within the photic zone, light and dark incubations were made on deck at in situ temperatures (10°C). In addition, DCMU, an inhibitor of oxygenic photosynthesis, was added to one set of on deck incubations, and azide, a inhibitor of respiration,was added to another. The poison controls provide only a qualitative assessment of the relative contribution to primary production by certain organisms. The results of the on deck incubations will be compared with measurements made using an in situ incubator positioned at the interface through use of a hydrowire and triggered by release of a messenger. Analysis of the in situ measurements are in progress.

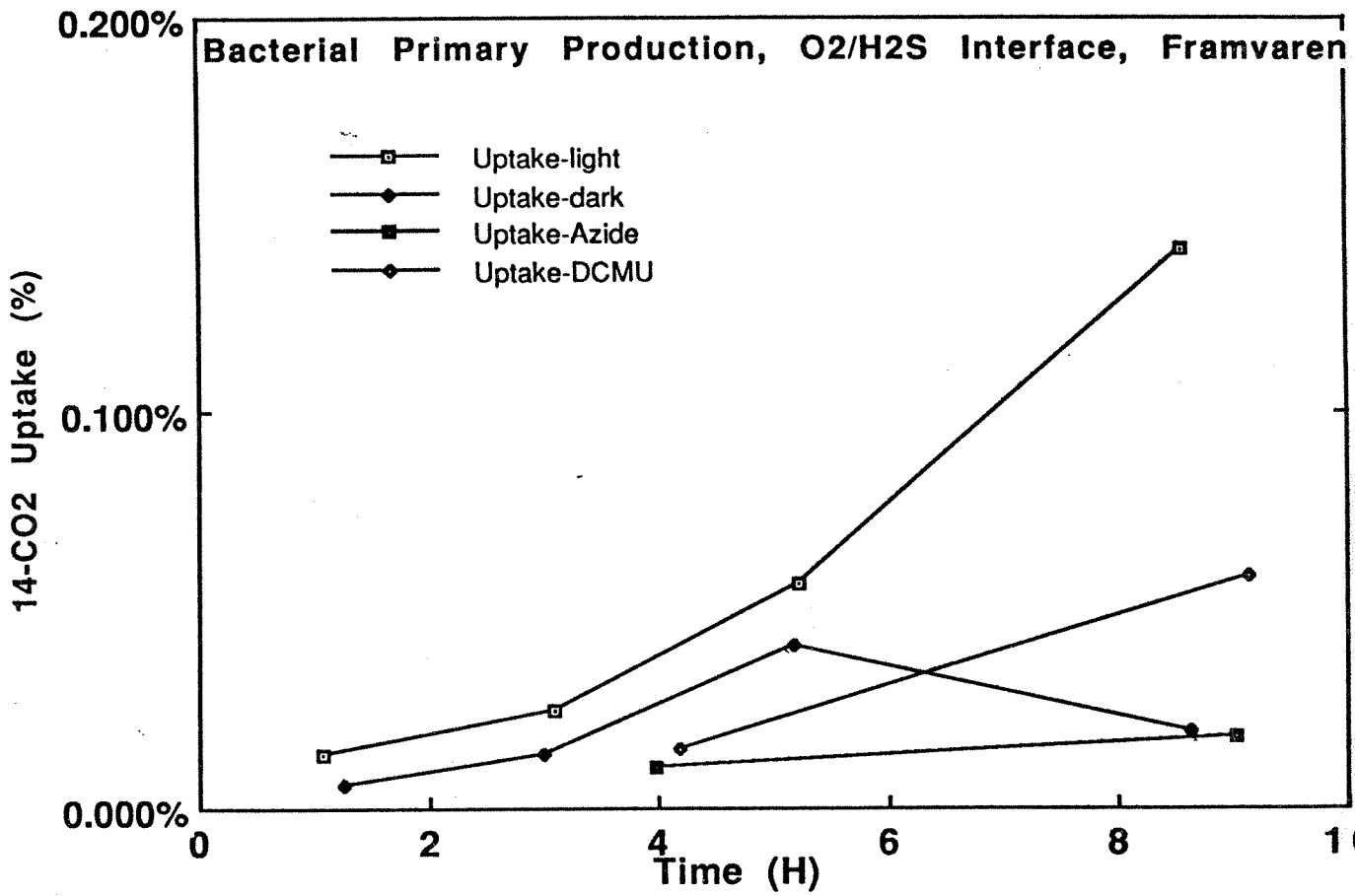
At the beginning of the cruise, the depth of the O_2/H_2S interface was located at 20.75 m as determined from measurements made of chlorophyll (which corresponded with the photosynthetic bacterial layer) and H_2S. Consecutive and precise sampling at this depth was achieved by tying a rope, which had been pre-measured and calibrated, to a raft from where all water samples for on deck and in situ incubations were collected. Although the tide is <1 m within Framvaren, samples for individual incubations were consistently collected in the afternoon, thereby minimizing differences due to tidal variations.

For the on deck incubations, a 5 litre niskin bottle was lowered from the raft to collect the water from the interface. Upon retrieval, the water was immediately placed into individual acid washed 70ml glass serum vials. To minimize contamination with oxygen, each vial was flushed with the water and crimp sealed without any air

bubbles. During preparation and subsequent incubation, the vials were kept in a 10°C water bath. For each experiment, four vials were set up for each time point. Additions of the poison and ^{14}C labeled bicarbonate solutions were made by injection through the rubber septum with a sterile 1cc needle fitted syringe; the volume displaced exiting via a second syringe placed through the septum. 70ul of N_2 purged 1M azide solution (pH 7.0) was added to one set of vials (1mM final) and 30ul of 4.8mM DCMU (in ethanol) was added to another set (2uM final). Following this, approximately 10uCi of the ^{14}C was added as a radiotracer to all of the vials and samples were filtered with time.

At the beginning, and at each time point during the incubations, 1.5ml subsamples were collected from each vial and derivitized with 30ul of 100mM monobromobimane thiolyte reagent (Calbiochem Corp., La Jolla, CA; U.S.A.), dissolved in acetonitrile, for subsequent analysis of H_2S, thiosulfate, and sulfite by HPLC. After a 20 minute dark reaction with the thiolyte reagent the samples were acidified by addition of 3 ul of concentrated methane sulfonic acid (MSA). Addition of MSA stabilizes and preserves the samples until they can be analyzed later by HPLC. All samples collected for sulfur determination during the Framvaren cruise await analysis. 10M NaOH was added to the remaining contents of each vial in order to bring the final pH to 9.5 -10.5 prior to filtering, thus assuming that the radiolabeled ^{14}C-bicarbonate will not be lost as gaseous CO_2 during filtration. 100ul aliquots of the filtrate were sampled for scintillation counting to determine the total ^{14}C added to each vial. Samples, of known volume, were filtered through 0.2uM nuclepore MF membrane filters. The filters were fumed with HCl in a dessicator to remove the excess ^{14}C-bicarbonate, and then air dried before placing them in scintillation vials for subsequent counting.

Measurements of CO_2 uptake (ie. fixation) were expressed as % ^{14}C-bicarbonate incorporated into cells, as measured from the filter counts, versus the toal amount of ^{14}C added. Preliminary results from one on deck incubation experiment are shown in the figure. Conversion of these results (and similair results from in situ experiments) to an absolute amount of fixed organic matter will be provided from carbonate alkalinity measurements of the interface water to be made by Dr. David Dearson. Further interpretation of the CO_2 fixation studies will be obtained from the sulfide oxidation measurements, which ought to indicate how closely coupled the two processes are at the O_2/H_2S interface.


Bacterial Primary Production, O2/H2S Interface, Framvaren
Uptake-light
Uptake-dark
Uptake-Azide
Uptake-DCMU
14-CO2 Uptake (%)
0.200%
0.100%
0.000%
0
2
4
6
8
Time (H)

Contributor: Vaughan.

Overview of samples taken for HPCL analysis:

Carbonyls)
Flavins) 1m, 4m, 8m, 12m, 15m, 17m, 18, 19m, 20m, 21m, 22m,
Fatty acids) 25m, 30m, 40m, 60m, 90m, 120m, 150m, 170 m.
Thiols)
Sugars)

for biological uptake:

^{14}C-Acetate)
^{14}C-Lactate) 1m, 20m, 22m, 40m.
^{14}C-Formaldehyde)
^{14}C-Glucose)

Contributors: Velinsky/Cutter.

I) Samples taken:

a) At station F1, water samples were collected at depths (m): 1,4,8,10,12,14,15,17,16,18,19,20,21,25,30,40,60,90,130,160,170
At these depths , approximately 5 liters of water were filtered and the particulate material collected on (0.7 μm) glass fiber filters. Two liters of the filtrate were kept and frozen from each depth. These samples are being analyzed for the isotopic composition of dissolved ammonium, nitrate and inorganic carbon and particulate nitrogen and carbon. Also, samples were analyzed for the concentration of dissolved nitrate, nitrite and ammonium (data enclosed).

b) Surface plankton tow using 300 μm mesh net near station F1. This sample will be analyzed for its stable carbon and nitrogen isotopic composition.

c) Sediment core (approximately 50 cm in length) obtained near station F1. This core was cut in 5 cm sections and frozen. This core will be analyzed for porewater ammonium-nitrogen isotopic composition and solid phase nitrogen and carbon isotopes. Also, the concentration of porewater ammonium and percent nitrogen and carbon will be determined.

II) Preliminary Data:

	(μM)		
Depth (m)	NH_4^+	NO_3^-	NO_2^-
1	0.8	6.8	0.2
4	0.8	9.8	0.2
8	0.4	7.7	0.2
10	0.1	5.6	0.2
12	0.1	5.1	0.1
14	0.1	2.6	0.1
15	0.1	2.4	0.2
16	0.3	2.0	0.2
17	1.6	1.2	0.2
18	2.8	0.5	0.2
19	3.8	0.3	0.2
20	11.5	0.1	0.1
21	24.2	<0.1	<0.1
25	91.3	"	"
30	145	"	"
40	250	"	"
60	463	"	"
70	527	"	"
90	977	"	"
130	1690	"	"
160	1720	"	"
170	1730	"	"

Framvaren Samples

Station F1

Depth (m)	Analyses		
1	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
4	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
8	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
12	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
15	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
17	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
18	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
19	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
20	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
21	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
22		particulate C,N,S	particulate sulfur speciation
25	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
30	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
40	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
50		particulate C,N,S	particulate sulfur speciation
60	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
90	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
130	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
160	As & Sb speciation	particulate C,N,S	particulate sulfur speciation
170	As & Sb speciation	particulate C,N,S	particulate sulfur speciation

Contributors: Dyrssen/Wedborg/Abrahamsson/Klick/Lindegren/Skoog.

Water was sampled in oxygen flasks at the following depths 4, 25, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160 and 170 m on May 31, 1989 between 10 and 13 and on June 2, 1989 between 10 and 12. The latter samples were protected in N_2-bubbled aq. dest.

In a N_2 atmosphere glove box samples from May 31 were subjected to the following procedures for S-34 isotope analysis:

1. Precipitation of the sulfate with barium chloride.

2. Precipitation of the sulfide with zinc chloride (170, 150, 130, 110, 90, 70 and 50 m).

3. Acidification of the sample with 3% HCl and transfer of the hydrogen sulfide into a dilute solution of silver nitrate. Dr. Brian Fry at the Ecosystems Center, Maine Biological Laboratory, Woods Hole, MA 02543, USA will be approached for a suggested cooperation regarding the S-34 determination on the 100-200 mmole precipitates.

The other samples will be subjected to determination of sulfide and tiols by titration, alkalinity by titration and total carbonate by coulometry.

Upon discussion with Dr. Gøte Østlund at the Tritium Laboratory, University of Miami a sample of the main fresh water source was taken from the Lyngdal river below the bridge west of Lyngdal on June 1, 1989 at 16. Furthermore, a sample at 160 m in Framvaren was collected on June 2, 1989 at 12. These samples will be analyzed for tritium in order to decide whether further HTO determinations are worthwhile.

An experiment was made to extract humic material from the deep water mass. Water from about 130 m was pumped with a peristaltic pump through a plexiglass chamber containing an anion exchanger. The main problem was the increase of pressure within the chamber which caused it to leak after some time. Consequently, the amount of material extracted was very small. It will be necessary to go back to Framvaren again in order to get enough material to work with.

Water from a depth of 110-130 m was collected on May 31 for experiments with dehalogenation of chloro- and bromophenols. In addition a grab sample of sediment was taken for similar experiments.

Contributor: Klaveness.

During our days at Framvaren, 6-7th June, the following depths were sampled for analysis of phytoplankton, bacterial counts, heterotrophic flagellates and ciliates:

Depth m: 5, 8, 12, 116, 18, 19, 20, 21, 22 and 100.

Further, there were taken close-interval samples at the chemocline, for the same purpose.

The samples will be processed by state-of-the-art microscopical methods, fluorescence microscopy and electron microscopy.

Contributors: Skei/Nygaard/Næs/Sørensen.

- Sediment sampling in the deep basin of Framvaren and in Helvikfjorden (28 m depth).

- S-T profiles in Framvaren, Helvikfjorden and eastern and western Kjørrevikbukt.

- Exact determination of S and T in the deep water of Framvaren.

- Filtration of water through preweighed Nuclepore membrane filters (0.4 μm) for analyses of total suspended matter and particle studies (SEM/EDAX and microprobe) (15 depts).

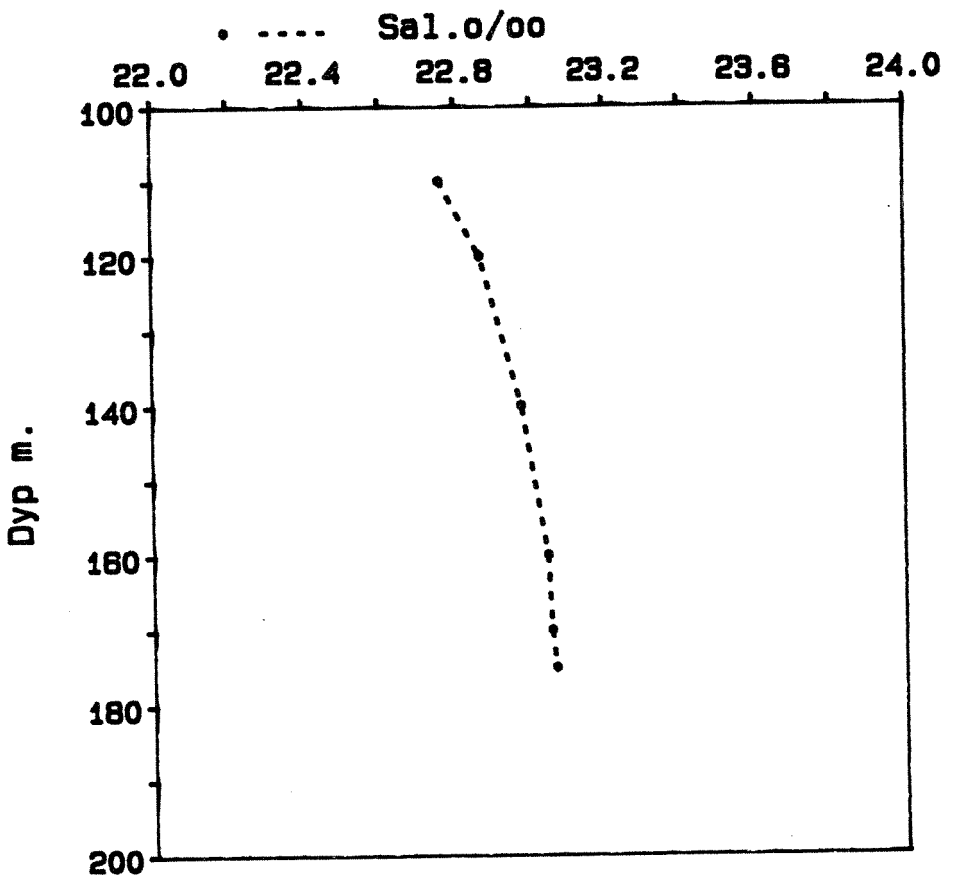
- Analyses of nutrients (tot-N, NO_3-N, NH_4-N, tot-P, PO_4-P and org-C) on filtered and unfiltered samples (19 depths).

- Analyses of total Zn, Cd, Cu, Ni, Co and Fe at 17 depths and dissolved (filtered) Hg at 10 depths.

Some depth profiles are shown.

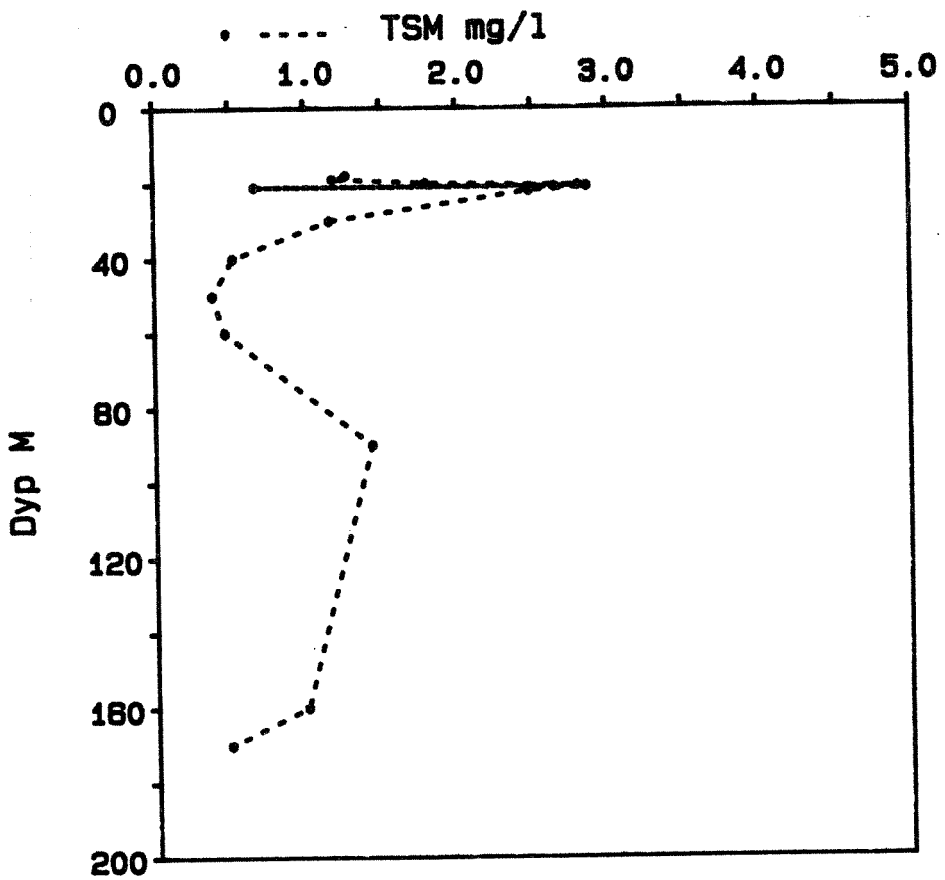
NIVA: 1988-8 -31

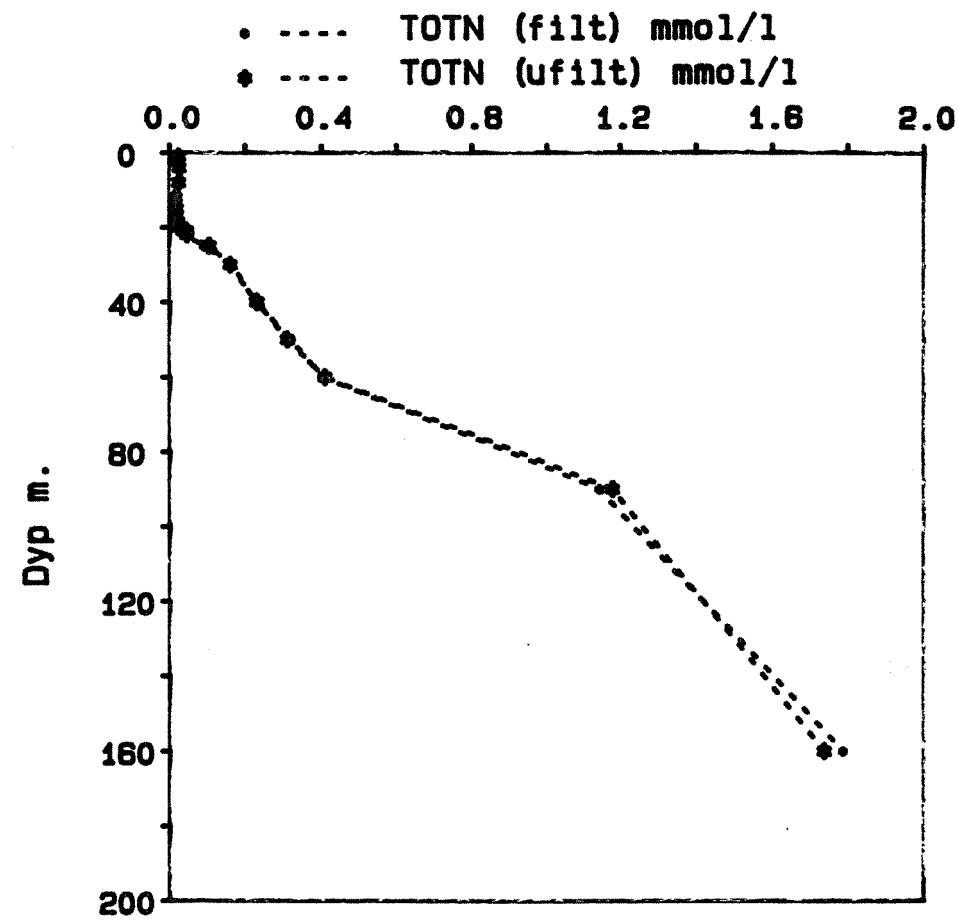
FRAMVAREN 1989

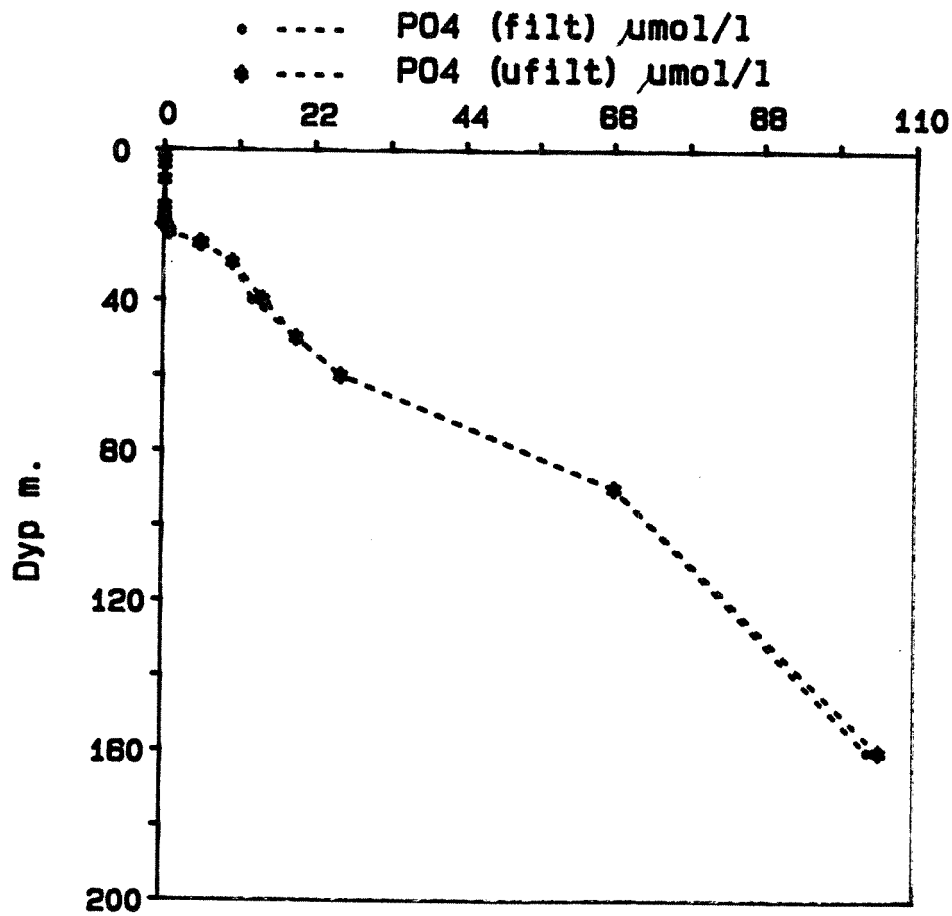


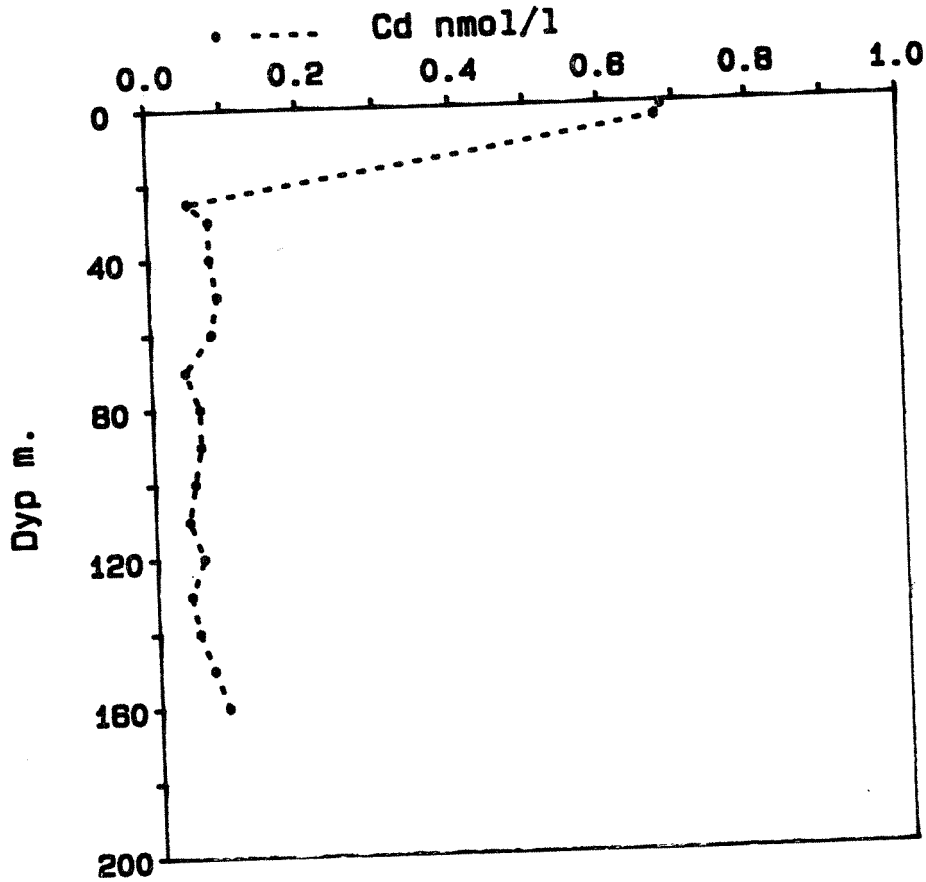
NIVA: 1888-8 -31

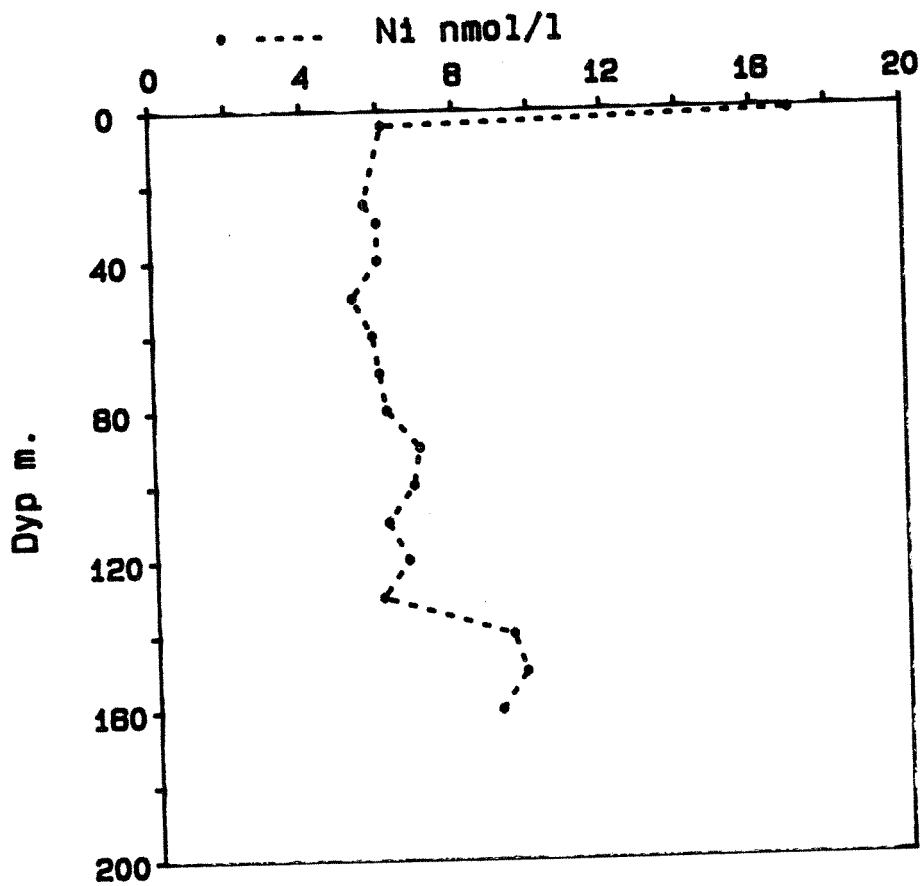
TSM Framvaren juni 89

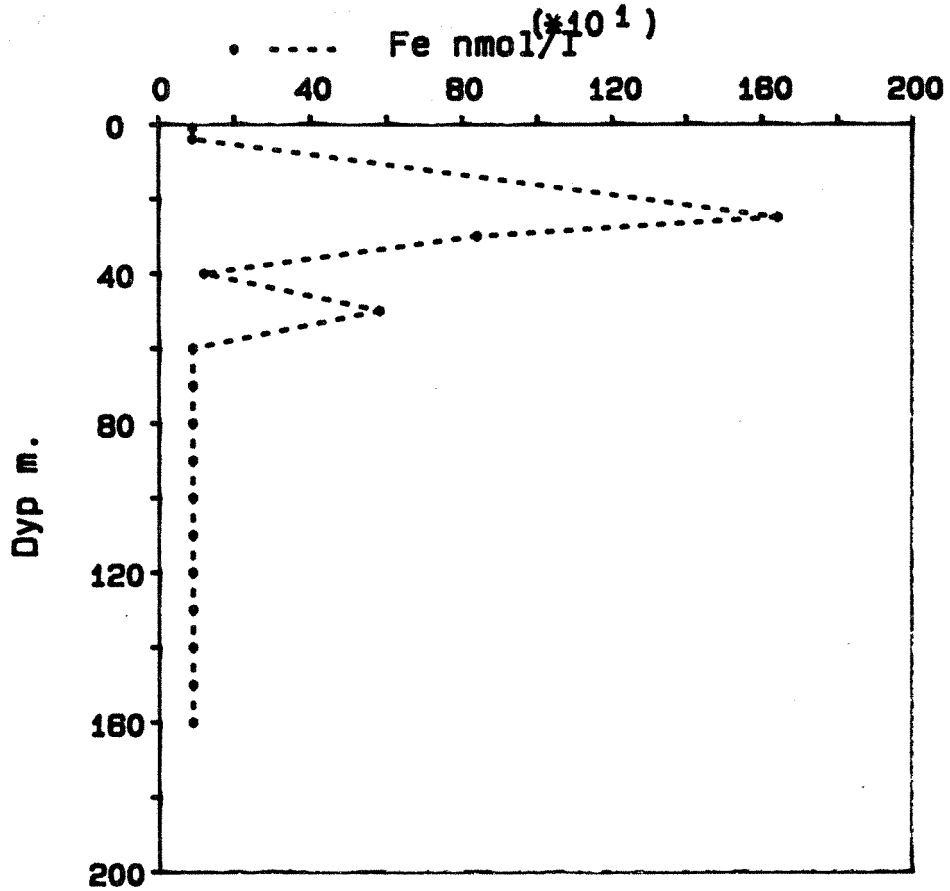


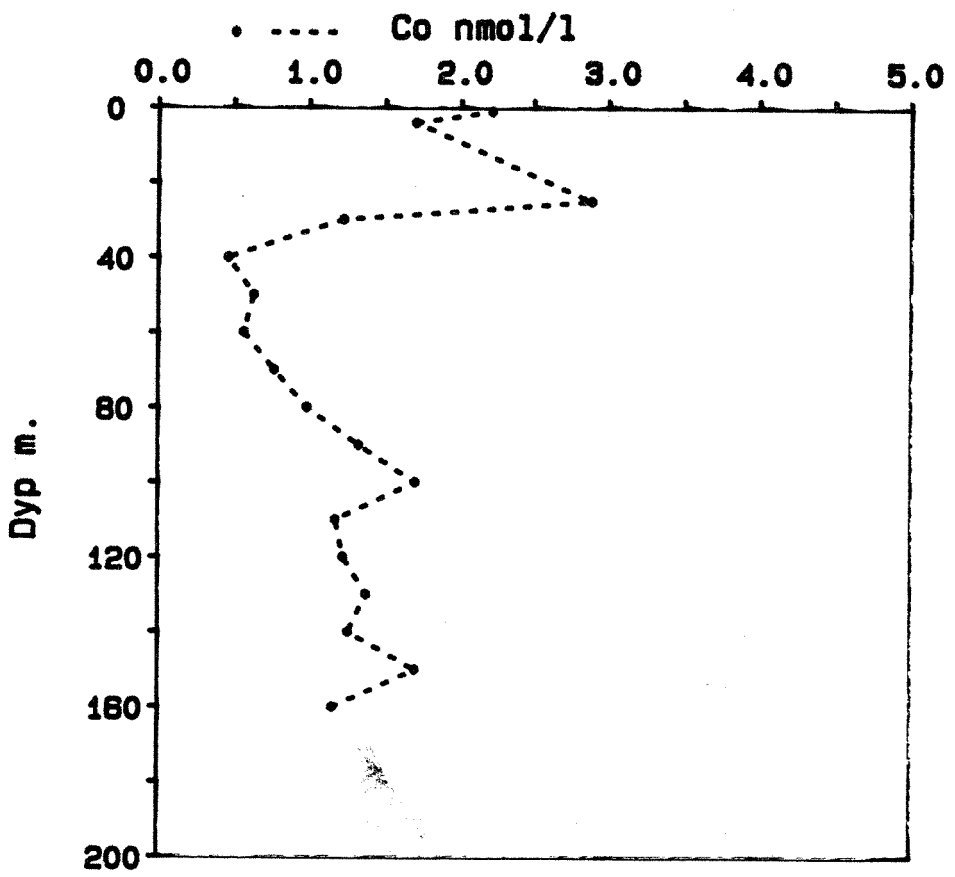

TOTN (filt) mmol/l
TOTN (ufilt) mmol/l
0.0
0.4
0.8
1.2
1.6
2.0
0
40
80
120
160
200
Dyp m.


PO4 (filt) µmol/l
PO4 (ufilt) µmol/l
0
22
44
66
88
110
0
40
80
120
160
200
Dyp m.


Cd nmol/l
0.0
0.2
0.4
0.6
0.8
1.0
0
40
80
120
160
200
Dyp m.

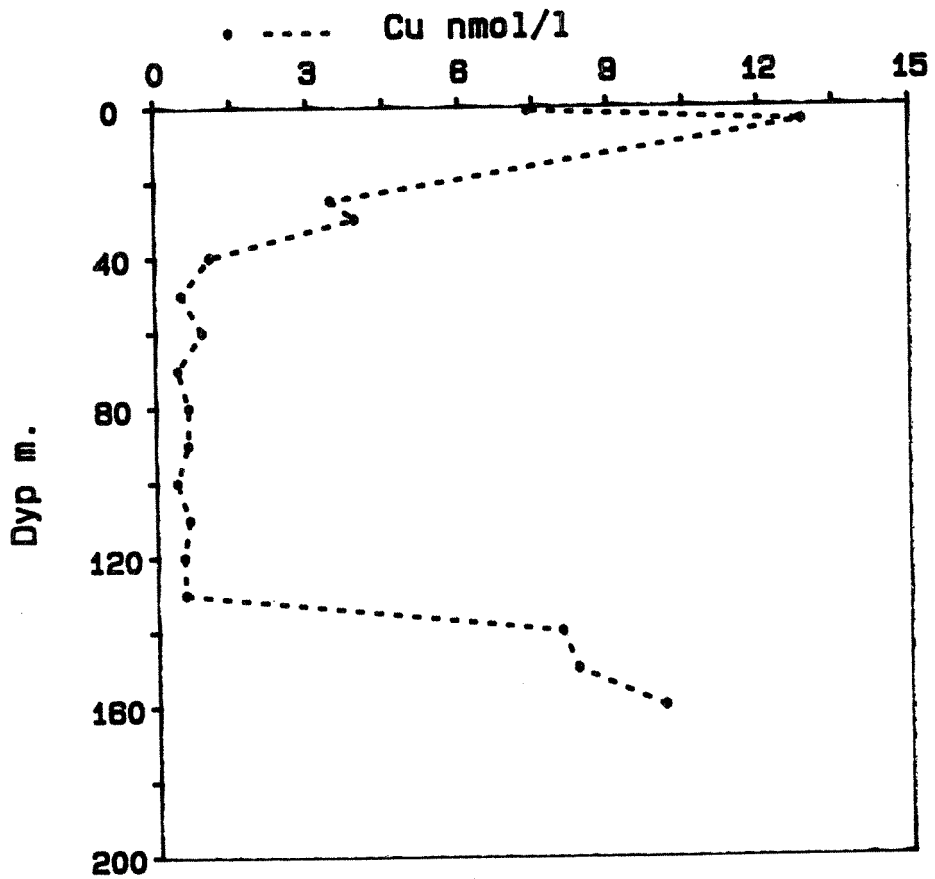

Ni nmol/l
0
4
8
12
16
20
0
40
80
120
160
200
Dyp m.


Fe nmol/l (*10 1)
0
40
80
120
160
200
Dyp m.


Co nmol/l
0.0
1.0
2.0
3.0
4.0
5.0
0
40
80
120
160
200
Dyp m.

NIVA: 1989-6 -31

FRAMVAREN 1989



Overview of samples taken and analysis planned/done, by:

Dr. Dag Klaveness
Dep. of biology, div. limnology
P.O.Box 1927 Blindern
Norway

and Ms. Kari Nygaard MSc.
Norwegian Institute for
Water Research
P.O.Box 69 Korsvoll
Norway

Program planned and accomplished

According to our plans we wanted to describe the system through quantitative and qualitative studies. We are especially interested in the nano- and micro-community. We therefore sampled for studies of bacteria (quantitative), nano- and micro-plankton (qualitative and quantitative).

All samples were/are counted in Epi-fluorescent microscope, using fluorescent staining techniques.

Qualitative studies were/shall be done by using electron-microscope.

Grazing rates on bacteria by eucaryotes, were measured for each sampling depth, using fluorescent-stained bacteria and radio-labelled bacteria.

Sampling depths (m): 8, 12, 16, 17, 18, 19, 20, 21, 22.

Hellevik: May 28th 10 p.m.

- O_2-profile
- CTD
- Chlorophyll fluorescence profiles
- Turbidity profiles

Hellevik: May 30th 9 a.m.

- Chlorophyll fluorescence
- Turbidity profiles
- T/S-profile (every 1 m down to 25 m)
- Filtration through GF/F-filters

Framvaren: May 29th 9 a.m.

- T/S-profiles (0-25 m)
- O_2-profiles
- Chlorophyll
- Turbidity

Repeated measurements until 7 p.m.

Framvaren: May 30th 11 p.m.

Continued profiling of chlorophyll and turbidity.

C/N/P-analyses of particulate matter.

- Measurements of sea level fluctuation in Framvaren and Helvikfjorden

- Deployment of Anderaa current meeters of 2 m depth in Hellvikfjorden and 5 and 15 m depth in Framvaren (speed, direction, temperature, conductivity every 10 mins.)

- Retrievment of sediment traps deployed April 21st at 15, 40, 80, 120, 160 and 175 m depth in Framvaren.

- Short time (May 29th - June 5th) flux measurements by sediment traps at 25 m. Samples filtered through 0.4 µm Nuclepore filters to measure TSM and to do chemical analyses (microprobe, SEM/EDAX).

- Deployment of new sediment traps for retrival in August 1989.