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Investigations of mercury during a survey near submarine U-864 outside Fedje in 2013

Norwegian Institute for Water Research

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REPORT

Main Office
Gaustadalléen 21
NO-0349 Oslo, Norway
Phone (47) 22 18 51 00
Telefax (47) 22 18 52 00
Internet: www.niva.no

Regional Office, Sørlandet
Jon Lilletuns vei 3
NO-4879 Grimstad, Norway
Phone (47) 22 18 51 00
Telefax (47) 37 04 45 13

Regional Office, Østlandet
Sandvikaveien 59
NO-2312 Ottestad, Norway
Phone (47) 22 18 51 00
Telefax (47) 62 57 66 53

Regional Office, Vestlandet
Thormøhlens gate 53 D
NO-5006 Bergen Norway
Phone (47) 22 18 51 00
Telefax (47) 55 31 22 14

Regional Office Central
Pirsenteret, Havnegata 9
P.O.Box 1266
NO-7462 Trondheim
Phone (47) 22 18 51 00
Telefax (47) 73 54 63 87

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Abstract

During a survey in January 2013 sediment samples were taken from the area near the wreck of submarine U-864 outside Fedje. The submarine is assumed to have had 67 tons of liquid mercury onboard, stored in carbon steel cans. When torpedoed, the mid-section of the submarine was blown up, and an unknown number of the stored mercury cans were destroyed and have polluted the seabed below. NIVA has analysed sediment samples for mercury in order to provide updated information about the area around the wreck that is polluted with mercury. Measurements for mercury vapour were done for safety reasons on deck and near sampling equipment during the survey. No high concentrations of mercury vapour were found.

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1. Ubåt U-864	1. Submarine U-864
2. Fedje	2. Fedje
3. Kvikksølv	3. Mercury
4. Sediment	4. Sediment

Sigurd Øxnevad	*Morten Schaanning*	*Kristoffer Næs*
Project Manager	Research Manager	Research director

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Preface

On request from DOF Subsea, NIVA has analysed mercury in sediment samples taken from the area around submarine U-864 outside Fedje. The survey was done in January 2013 on the anchor handling vessel Skandi Skolten from DOF Subsea. Analysis of mercury and reporting was done by Sigurd Øxnevad and Bjørnar Beylich. Agnete Strømme from DOF Subsea was our contact person during the project.

Oslo, 2.4.2013

Sigurd Øxnevad

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Summary

During a survey in January 2013 sediment samples were taken from the area near the wreck of submarine U-864 outside Fedje. The submarine is assumed to have had 67 tons of liquid mercury onboard, stored in carbon steel cans. When torpedoed, the mid-section of the submarine was blown up. During the event, an unknown number of the steel cans were destroyed which resulted in severe mercury pollution of the seabed around the wreck.

Pollution of mercury in the sediments around U-864 has been investigated on surveys in 2003, 2005 and 2006. During the cruise in January 2013 NIVA analysed sediment samples for mercury in order to provide updated information on pollution status in the area around the wreck. Some sediment stations north and west of the submarine were slightly more polluted with mercury than they were in 2006. Sediment stations east and southeast of the submarine had low concentrations of mercury and had not increased during the period 2006-2013.

Measurements for mercury vapour were done for safety reasons on deck and near sampling equipment during the survey. No high concentrations of mercury vapour were detected. All concentrations were lower than the administrative norm of 0.02 mg/m^3.

Sammendrag

På et tokt i januar 2013 ble det tatt sedimentprøver i området rundt vraket av ubåt U-864 utenfor Fedje. Det antas at ubåten hadde en last på 67 tonn kvikksølv om bord, og disse var lagret i beholdere av stål. Da ubåten ble torpedert ble midtseksjonen sprengt, og et ukjent antall kvikksølvbeholdere ble ødelagt. Det førte til at kvikksølv lakk ut og forurenset sjøbunnen.

Det har blitt utført undersøkelser av kvikksølvforurensning ved ubåten i 2003, 2005 og 2006. NIVA har i januar 2013 analysert kvikksølv i sedimentprøver fra området rundt ubåten for å få et oppdatert bilde av hvor stort område som er forurenset av kvikksølv. Noen stasjoner nord og vest for ubåtvraket var noe mer forurenset av kvikksølv enn ved forrige undersøkelse i 2006. Sedimentstasjoner øst og sørøst for ubåten var lite forurenset av kvikksølv og hadde ikke økt i konsentrasjon i perioden 2006-2013.

Av sikkerhetshensyn ble det målt for kvikksølvdamp på dekk og ved prøvetakingsutstyr. Det ble ikke funnet høye konsentrasjoner av kvikksølvdamp. Alle de målte konsentrasjonene var lavere enn administrativ norm på 0,02 mg Hg/m^3.

1. Background

In February 1945 the German submarine U-864 was sunk outside Fedje, on the south western coast of Norway. The submarine was torpedoed midship, broke in two and sank, and is located at 150 m depth. U-864 is assumed to have had 67 tons of liquid mercury onboard, stored in 1857 carbon steel cans in compartments inside the keel. When torpedoed, the mid-section of the submarine was blown up, and an unknown number of the steel cans were destroyed and mercury was spread to pollute the surrounding seabed. Mercury cans may also have corroded during the decades that have passed since the torpedition event and started to leak mercury to the seabed.
The authorities have decided to further evaluate two different methods of pollution abatement:

- Seal-in the polluted area, utilizing sand with special characteristics
- Retrieve the mercury cans from the keel section and seal-in the polluted area

In January 2013 a final data collecting campaign was performed in order to obtain additional information regarding the two alternatives.

During the survey in January 2013 sediment samples were collected from the area around the submarine in order to provide updated information about the area around the wreck that is polluted with mercury.

2. Materials and methods

2.1 Sediment sampling

Surface sediment samples were taken from a total of 35 stations. 16 of the stations were taken at the same stations as in 2006. However, sediment from stations 12 and 30B were taken respectively 14 and 28 meters away from the original positions. The surface sediment was sampled by operators from DOF Subsea using a ROV. The top 0-2 cm of the sediment was to be analysed for mercury. Long sediment cores were sampled using a Vibro corer. Sediment cores were cut into sections by personnel from Franzefoss and passed on to NGI and NIVA for further handling and analysis.

A  **B** 

Picture A and B. The ROV (A) and the Vibro corer (B) used for taking the sediment samples near U-864 at Fedje (Photos: Sigurd Øxnevad).

2.2 Measurements for mercury in air as part of HSE procedures

For safety reasons, equipment that had been used on the seabed or near the seabed was checked for mercury pollution when it was placed on deck. A Lumex RA-915+ Mercury Analyzer was used to check for mercury vapour. Survey equipment, the lab container and deck area was checked for mercury vapour during the survey operations and during and after the demobilization. The detection limit was 2 ng/m^3 in air. Administrative norm for mercury vapour is 0.02 mg/m^3 (20 000 ng/m^3) (http://www.arbeidstilsynet.no/artikkel.html?tid=78880). For a 12 hours shift the norm is 0.014 mg/m^3 (http://www.norskoljeoggass.no/no/Publikasjoner/Retningslinjer/Helse-arbeidsmiljo-og-sikkerhetHealth-working-environment-safety/Arbeidsmiljo/130-OLF-anbefalte-retningslinjer-for-helseovervaking-av-kjemikalieeksponerte-arbeidstakere/).

2.3 Preparations of sediment samples

Sediment samples were split into subsamples for analysis by NGI and NIVA. Sediment samples were put in 55 ml boxes, and subsamples of a few grams were then dried in a Termaks laboratory drying oven (60^{o} C for approximately 30 minutes).

2.4 Analysis of mercury in sediment samples

Sediment samples were analysed roughly on board, and more accurately in the NIVA laboratory after the cruise. A Lumex RA-915+ Mercury Analyzer with pyrolyzer PYRO-915+ was used for the analysis (picture C).

Picture C. The Lumex Mercury Analyzer with pyrolyzer unit (Photo: Sigurd Øxnevad).

The RA-915+ Mercury Analyzer is a portable multifunctional atomic absorption spectrometer with Zeeman background correction, which eliminates the effect of interfering impurities. It does not require gold amalgam pre-concentration and subsequent regeneration steps. This enables the user to conduct real time monitoring and detection of a mercury vapour. Combined with a two-chamber atomizer (PYRO-915+), the instrument can determine mercury content in solid samples such as sediment. The detection limit is 1.0 µg/kg in solid samples. A certified marine sediment reference material (MESS-3) was used as standard for the analysis of sediment samples.
The results were classified according to the classification system of the Norwegian Climate and Pollution Agency for classification of environmental quality in fjords and coastal water (Table 1) (Bakke et al. 2007).

Table 1. Classification system for concentration of mercury in marine sediments (from Bakke et al. 2007).

	Class I Background	Class II Good	Class III Moderately polluted	Class IV Bad	Class V Very bad
Mercury (mg/kg) dry weight	**<0.15**	**0.15 – 0.63**	**0.63 – 0.86**	**0.86 – 1.6**	**>1.6**

3. Results

3.1 Measurements for mercury vapour

Measurements of mercury in air are presented in Table 2. No high concentrations of mercury were detected in air near any equipment that was landed on deck. Quite high concentrations of mercury in air were detected in the lab container when some of the sediment samples were dried in the laboratory drying oven. The highest measurement (January 11th 22.00) was taken in the lab container after a longer period where the door had been shut. No personnel were in the container in that period.
The highest measurement was below the administrative norm for work environment. However protective masks with air filters were used in the laboratory container when the concentration was higher than 500 ng/m^3 and when working with the highly contaminated samples.

Table 2. Concentrations of mercury detected in air during the survey.

Date	Time	Location for Hg measurement	Hg (ng/m^3)
January 5.	09.50	In ROV hangar, before deployment	20 -30
January 7.	12.35	In ROV hangar	15 - 25
January 8.	00.10	In ROV hangar	0
January 8.	16.05	In ROV hangar	4
January 9.	04.00	In ROV hangar	4
January 9.	20.50	Inside lab container	10
January 9.	21.50	In the area outside the lab container and by the vibro corer	0
January 10.	01.00	By vibro corer	0 - 8
January 10.	03.20	By vibro corer	0 - 10
January 10.	04.30	By vibro corer	0 - 9
January 10.	14.30	Inside lab container	0 - 22
January 11.		In ROV hangar	3 - 5
January 11.	07.50	By CPD	10
January 11.	09.30	By vibro corer	6
January 11.	16.10	By vibro corer	5
January 11.	16.20	Inside lab container	5500
January 11.	17.15	By vibro corer	8
January 11.	17.45	Inside lab container	700 – 1900
January 11.	18.10	By vibro corer	10
January 11.	18.15	Inside lab container	800 – 1800
January 11.	20.00	Inside lab container	700 – 2500
January 11.	22.00	Inside lab container	10000
January 12.	06.15	Inside lab container	480
January 12.	11.45	Inside lab container	120
January 12.		By gravity corer	4
January 12.	12.55	By gravity corer	6
January 12.	16.45	Inside lab container, after removal of sediment samples from drying oven	1 -13
January 12.	17.00	By ROV basket	0
January 12.	17.45	By Uzo retrieved from the submarine	0 - 5
January 13.	07.	Inside lab container	0 - 5
January 13.		On deck, and by equipment on deck	0 - 10

3.2 Mercury in the sediment surface

Results of the mercury analysis performed after the survey are presented in Table 3, Figure 1 and Figure 2. Some sediment stations north and west of the submarine were slightly more polluted with mercury than in 2006. This is in accordance with the direction of the water current which has been found to go in a north western direction (Uriansrud et al. 2006). On station 146 the concentration of mercury was substantially higher (Class V) compared to 2006 (Class II). The new samples taken south and west of the submarine were in Class I and II and had not increased since 2006. The results of mercury measurements for all years are shown in Figure 2. Data from earlier investigations have been taken from Skei (2003), Uriansrud et al (2005) and Uriansrud et al (2006). This gives an updated picture of the polluted area around the wreck of U-864.

Table 3. Concentrations of mercury in surface sediment (0-2 cm) on 35 stations around submarine U-864. Measurements from samples taken in 2006 are also presented. The results are presented in mg/kg dry weight and are classified according to the classification system of the Norwegian Climate and Pollution Agency (Bakke et al. 2007).

Station	Hg (mg/kg) 2013	Hg (mg/kg) 2006
28	0,28	0,44
31	0,05	-
32	0,11	0,07
34	0,26	0,22
35	1,23	1,30
36	0,33	-
38	0,41	0,07
83	0,04	-
87	0,33	0,07
88	0,89	0,35
142	0,07	0,02
146	1,62	0,20
155	0,03	-
204	0,07	0,04
206	0,08	0,04
210	0,03	0,03
211	0,06	0,20
213	0,12	0,25
301	0,89	-
302	0,60	-
306	0,04	-
308	0,07	-
312	0,70	-
313	0,06	-
315	0,11	-
316	0,09	-
317	0,58	-
320	0,08	-
324	0,11	-
331	0,18	-
332	0,08	-
333	0,15	-
334	0,05	-
30B	0,08	0,15
Sed-8	0,25	0,02

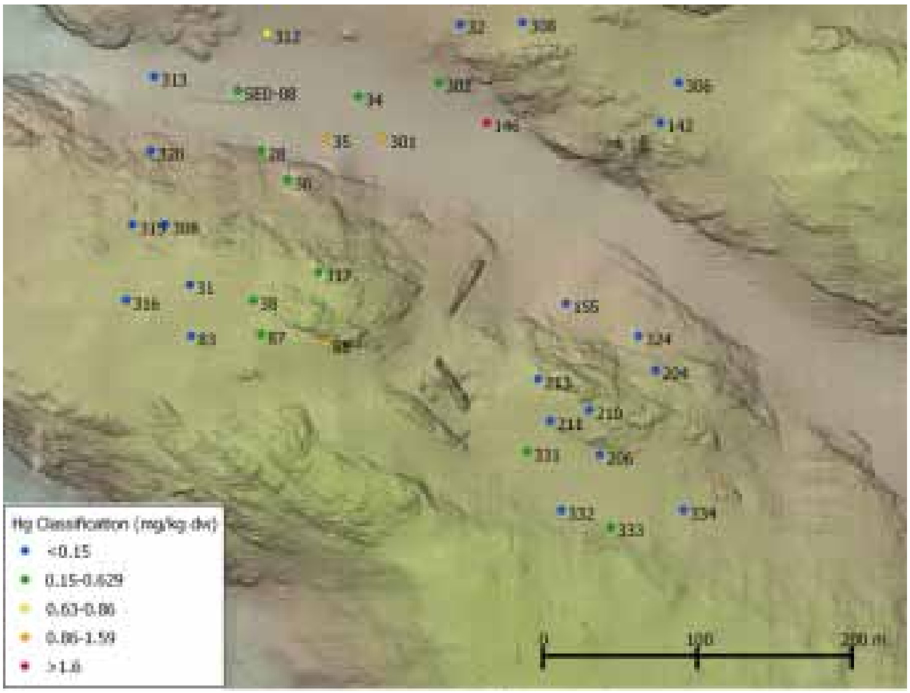

Figure 1. Concentrations of mercury in the surface sediment (0-2 cm) near the wreck of U-864 outside Fedje. The samples were taken in January 2013. The results are classified according to the classification system of the Norwegian Climate and Pollution Agency (Bakke et al. 2007).

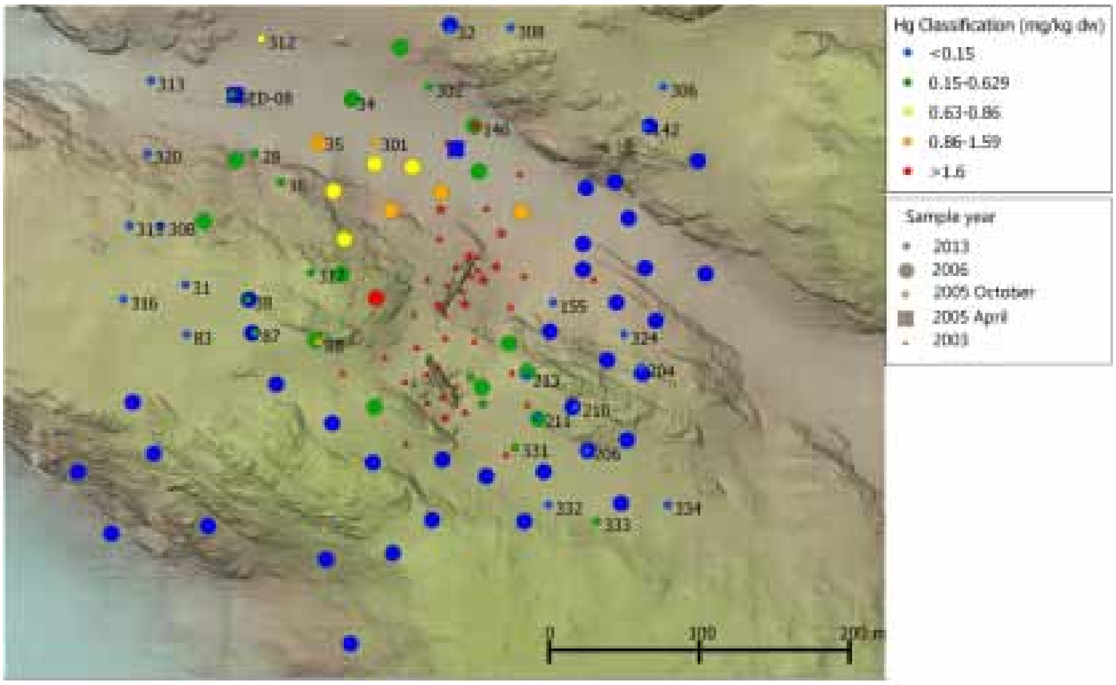

Figure 2. Concentrations of mercury in the sediment around U-864 outside Fedje. Results for all years are presented on the map. The results are classified according to the classification system of the Norwegian Climate and Pollution Agency (Bakke et al.2007). Because of the revision of the classification system, some of the observations may have been classified one class higher (worse) than they were in previous reports.

3.3 Mercury in the sediment cores

The core samples were all taken just a few meters from the wreck. In general they show a high surface concentration, with decreasing concentrations down in the sediment. The area around station 403 and 404 was dredged in 2006, removing the surface sediment. This could explain the low concentrations seen at these two stations. Station 402 is just a few meters from the dredged area.

In cores 406 and 407 liquid mercury were found (picture D). Sections of the sediment cores with visible liquid mercury were not analysed for mercury. In the cores from station 405 and 407 mercury was found down to the end of the core at respectively 3.2 and 2.2 meters. However the lack of mercury from 1.0 to 3.1 meters in the core from station 405 indicates that the deep samples might have been polluted with mercury from the top part of the core. This could also be the case for the core from station 406, but no samples between 0.2 and 2.1 meters have been analysed. It is our guess that the potential contamination of the deep samples could have occurred during cutting of the core or by the core catcher (a metal structure inside the core liner that keeps the sediment in the core from falling out). The results are shown in table 4.

Picture D. Sediment sample with liquid mercury (photo: Sigurd Øxnevad).

Table 4. Concentrations of mercury in core samples close to submarine U-864.

Station	sample	Hg mg/kg dry weight
402	0-10 cm	1,490
402	10-20 cm	0,018
402	50-60 cm	0,120
402	100-110 cm	0,092
402	110-120 cm	0,030
402	200-210 cm	0,039
402	210-220 cm	0,012
401	0-10 cm	3,6
401	10-20 cm	0,406
401	50-60 cm	0,365
401	100-110 cm	0,153
401	110-120 cm	0,103
401	200-210 cm	0,057
401	210-220 cm	0,137
403	0-10 cm	0,067
403	10-20 cm	0,014
403	50-60 cm	0,006
403	100-110 cm	0,012
403	110-120 cm	0,036
404	0-10 cm	0,205
404	10-20 cm	0,209
404	80-90 cm	0,013
404	90-100 cm	0,002
405	0-10 cm	87,6
405	50-60 cm	0,837
405	100-110 cm	0,128
405	110-120 cm	0,132
405	200-210 cm	0,075
405	210-220 cm	0,131
405	300-310 cm	0,060
405	310-320 cm	8,2
407	0-10 cm	37,4
407	10-20 cm	18,4
407	50-60 cm	1,8
406	0-10 cm	3,0
406	10-20 cm	34,0
406	210-220 cm	23,8

4. Main conclusions

Some sediment stations north and west of the submarine were slightly more polluted with mercury than in 2006. This is in accordance with the direction of the water current which has been found to go in a north western direction (Uriansrud et al. 2006). On station 146 the concentration of mercury was substantially higher (Class V) compared to 2006 (Class II). The new samples taken south and west of the submarine were in Class I and II and had not increased since 2006.

Core samples were taken just a few meters away from the wreck. In two of the cores mercury was found down to the end of the core at 2.2 and 3.2 meters. Liquid mercury was found in two of the sediment cores.

Measurements for mercury vapour were done for safety reasons on deck and near sampling equipment during the survey. No high concentrations of mercury vapour were detected. All concentrations were lower than the administrative norm of 0.02 mg/m3.

5. References

Bakke, T., Breedveld, G., Källqvist, T., Oen, A., Eek, E., Ruus, A., Kibsgaard, A., Helland, A., Hylland, K. 2007. Veileder for klassifisering av miljøkvalitet i fjorder og kystvann. Revidering av klassifisering av metaller og organiske miljøgifter i vann og sediment. Guidelines on classification of environmental quality in fjords and coastal waters – A revision of the classification of water and sediments with respect to metals and organic contaminants. TA-2229-2007.

Skei, J. 2003. Analyse av sedimentprøver rundt vrak av ubåt (U-864) utenfor Fedje, Hordaland. NIVA-notat 2003.

Uriansrud, F., Skei, J. & Schøyen, M. 2005. Miljøkonsekvensvurdering av kvikksølv ved sunket ubåt U-864, Fedje i Hordaland. Fase 1. Kvikksølvkartlegging. NIVA rapport 5022-2005.

Uriansrud, F., Skei, J., Mortensen, T., Dahl, I. & Wehde, H. 2006. Miljøovervåking, strømundersøkelser, sedimentkartlegging og vurdering av sedimenttildekking – Fase 2 kartlegging ved U-864 høsten 2006. NIVA rapport 5279-2006.

Appendix A. Hg measured in the sediment surface in 2013

Station	Sediment	Hg ng pr gram	Hg mg pr kg	Hg mg pr kg dry weight - average
317	Surface 0-2 cm	663	0,663	0,580
317	Surface 0-2 cm	553	0,553	
317	Surface 0-2 cm	525	0,525	
313	Surface 0-2 cm	52	0,052	0,059
313	Surface 0-2 cm	45	0,045	
313	Surface 0-2 cm	81	0,081	
204	Surface 0-2 cm	78	0,078	0,073
204	Surface 0-2 cm	67	0,067	
204	Surface 0-2 cm	73	0,073	
213	Surface 0-2 cm	129	0,129	0,119
213	Surface 0-2 cm	110	0,11	
213	Surface 0-2 cm	117	0,117	
210	Surface 0-2 cm	36	0,036	0,033
210	Surface 0-2 cm	38	0,038	
210	Surface 0-2 cm	24	0,024	
206	Surface 0-2 cm	87	0,087	0,076
206	Surface 0-2 cm	66	0,066	
206	Surface 0-2 cm	74	0,074	
142	Surface 0-2 cm	66	0,066	0,066
142	Surface 0-2 cm	88	0,088	
142	Surface 0-2 cm	43	0,043	
31	Surface 0-2 cm	54	0,054	0,052
31	Surface 0-2 cm	49	0,049	
31	Surface 0-2 cm	52	0,052	
87	Surface 0-2 cm	323	0,323	0,327
87	Surface 0-2 cm	329	0,329	
87	Surface 0-2 cm	328	0,328	
88	Surface 0-2 cm	869	0,869	0,886
88	Surface 0-2 cm	898	0,898	
88	Surface 0-2 cm	890	0,89	
334	Surface 0-2 cm	57	0,057	0,053
334	Surface 0-2 cm	44	0,044	
334	Surface 0-2 cm	58	0,058	
308	Surface 0-2 cm	71	0,071	0,067
308	Surface 0-2 cm	72	0,072	

Station	Sediment	Hg ng pr gram	Hg mg pr kg	Hg mg pr kg dry weight - average
308	Surface 0-2 cm	59	0,059	
32	Surface 0-2 cm	63	0,063	0,107
32	Surface 0-2 cm	224	0,224	
32	Surface 0-2 cm	80	0,08	
32	Surface 0-2 cm	62	0,062	
331	Surface 0-2 cm	179	0,179	0,184
331	Surface 0-2 cm	228	0,228	
331	Surface 0-2 cm	153	0,153	
331	Surface 0-2 cm	177	0,177	
83	Surface 0-2 cm	37	0,037	0,040
83	Surface 0-2 cm	42	0,042	
83	Surface 0-2 cm	42	0,042	
306	Surface 0-2 cm	46	0,046	0,044
306	Surface 0-2 cm	43	0,043	
306	Surface 0-2 cm	44	0,044	
302	Surface 0-2 cm	611	0,611	0,596
302	Surface 0-2 cm	568	0,568	
302	Surface 0-2 cm	609	0,609	
155	Surface 0-2 cm	36	0,036	0,030
155	Surface 0-2 cm	28	0,028	
155	Surface 0-2 cm	26	0,026	
315	Surface 0-2 cm	101	0,101	0,111
315	Surface 0-2 cm	120	0,12	
315	Surface 0-2 cm	112	0,112	
324	Surface 0-2 cm	122	0,122	0,113
324	Surface 0-2 cm	109	0,109	
324	Surface 0-2 cm	108	0,108	
34	Surface 0-2 cm	401	0,401	0,264
34	Surface 0-2 cm	208	0,208	
34	Surface 0-2 cm	231	0,231	
34	Surface 0-2 cm	217	0,217	
146	Surface 0-2 cm	1720	1,72	1,623
146	Surface 0-2 cm	1500	1,5	
146	Surface 0-2 cm	1650	1,65	
35	Surface 0-2 cm	1210	1,21	1,225
35	Surface 0-2 cm	1180	1,18	
35	Surface 0-2 cm	1370	1,37	
35	Surface 0-2 cm	1140	1,14	
30B	Surface 0-2 cm	78	0,078	0,077
30B	Surface 0-2 cm	86	0,086	

Station	Sediment	Hg ng pr gram	Hg mg pr kg	Hg mg pr kg dry weight - average
30B	Surface 0-2 cm	68	0,068	
38	Surface 0-2 cm	422	0,422	0,408
38	Surface 0-2 cm	431	0,431	
38	Surface 0-2 cm	372	0,372	
312	Surface 0-2 cm	817	0,817	0,705
312	Surface 0-2 cm	594	0,594	
312	Surface 0-2 cm	680	0,68	
312	Surface 0-2 cm	728	0,728	
36	Surface 0-2 cm	376	0,376	0,330
36	Surface 0-2 cm	351	0,351	
36	Surface 0-2 cm	262	0,262	
320	Surface 0-2 cm	61	0,061	0,076
320	Surface 0-2 cm	55	0,055	
320	Surface 0-2 cm	95	0,095	
320	Surface 0-2 cm	93	0,093	
316	Surface 0-2 cm	155	0,155	0,092
316	Surface 0-2 cm	70	0,07	
316	Surface 0-2 cm	74	0,074	
316	Surface 0-2 cm	68	0,068	
28	Surface 0-2 cm	267	0,267	0,277
28	Surface 0-2 cm	198	0,198	
28	Surface 0-2 cm	367	0,367	
28	Surface 0-2 cm	277	0,277	
211	Surface 0-2 cm	68	0,068	0,063
211	Surface 0-2 cm	61	0,061	
211	Surface 0-2 cm	59	0,059	
332	Surface 0-2 cm	62	0,062	0,085
332	Surface 0-2 cm	46	0,046	
332	Surface 0-2 cm	169	0,169	
332	Surface 0-2 cm	61	0,061	
301	Surface 0-2 cm	976	0,976	0,894
301	Surface 0-2 cm	952	0,952	
301	Surface 0-2 cm	753	0,753	
SED8	Surface 0-2 cm	222	0,222	0,250
SED8	Surface 0-2 cm	234	0,234	
SED8	Surface 0-2 cm	295	0,295	
333	Surface 0-2 cm	163	0,163	0,145
333	Surface 0-2 cm	119	0,119	
333	Surface 0-2 cm	144	0,144	
333	Surface 0-2 cm	155	0,155	

Appendix B. Hg in surface sediment, 2003 - 2013

station	year	UTMZone	E	N	Hg mg/kg dry weight
28	2013	32North	261428	6745232	0,28
31	2013	32North	261382	6745145	0,05
32	2013	32North	261557	6745314	0,11
34	2013	32North	261491	6745267	0,26
35	2013	32North	261470	6745240	1,23
36	2013	32North	261445	6745213	0,33
38	2013	32North	261423	6745135	0,41
83	2013	32North	261383	6745112	0,04
87	2013	32North	261428	6745113	0,33
88	2013	32North	261470	6745107	0,89
142	2013	32North	261686	6745250	0,07
146	2013	32North	261574	6745250	1,62
155	2013	32North	261625	6745133	0,03
204	2013	32North	261683	6745090	0,07
206	2013	32North	261647	6745035	0,08
210	2013	32North	261640	6745064	0,03
211	2013	32North	261615	6745057	0,06
213	2013	32North	261607	6745084	0,12
301	2013	32North	261507	6745240	0,89
302	2013	32North	261543	6745276	0,60
306	2013	32North	261698	6745276	0,04
308	2013	32North	261597	6745315	0,07
312	2013	32North	261432	6745308	0,70
313	2013	32North	261359	6745280	0,06
315	2013	32North	261345	6745184	0,11
316	2013	32North	261341	6745135	0,09
317	2013	32North	261465	6745153	0,58
320	2013	32North	261357	6745232	0,08
324	2013	32North	261672	6745112	0,11
331	2013	32North	261600	6745037	0,18
332	2013	32North	261622	6744999	0,08
333	2013	32North	261654	6744988	0,15
334	2013	32North	261701	6744999	0,05
30B	2013	32North	261366	6745184	0,08
Sed-8	2013	32North	261413	6745271	0,25
28	2006	32North	261415	6745227	0,44
30	2006	32North	261394	6745187	0,15
31	2006	32North	261383	6745144	
32	2006	32North	261557	6745317	0,07

station	year	UTMZone	E	N	Hg mg/kg dry weight
33	2006	32North	261524	6745302	0,23
34	2006	32North	261492	6745268	0,22
35	2006	32North	261470	6745239	1,3
36	2006	32North	261447	6745211	
37	2006	32North	261438	6745173	
38	2006	32North	261424	6745135	0,07
41	2006	32North	261507	6745225	0,7
42	2006	32North	261480	6745207	0,7
43	2006	32North	261485	6745152	0,6
44	2006	32North	261459	6745132	
45	2006	32North	261551	6745206	1
46	2006	32North	261532	6745223	0,8
47	2006	32North	261518	6745194	1,5
48	2006	32North	261487	6745175	0,8
49	2006	32North	261508	6745136	2,5
68	2006	32North	261311	6745021	0,05
69	2006	32North	261333	6744980	0,02
70	2006	32North	261365	6744939	
71	2006	32North	261405	6744902	
72	2006	32North	261444	6744878	0,01
73	2006	32North	261492	6744855	
74	2006	32North	261540	6744846	0,04
76	2006	32North	261347	6745067	0,04
77	2006	32North	261361	6745033	0,02
78	2006	32North	261397	6744985	0,03
79	2006	32North	261419	6744962	
80	2006	32North	261456	6744933	
81	2006	32North	261491	6744907	0,07
82	2006	32North	261540	6744882	0,04
83	2006	32North	261381	6745112	
84	2006	32North	261395	6745079	
85	2006	32North	261418	6745039	
86	2006	32North	261442	6745079	0,08
87	2006	32North	261426	6745113	0,07
88	2006	32North	261468	6745108	0,35
90	2006	32North	261475	6744963	0,03
92	2006	32North	261552	6745029	0,08
93	2006	32North	261507	6745064	0,21
94	2006	32North	261479	6745053	0,08
95	2006	32North	261506	6745027	0,02
96	2006	32North	261469	6745051	
97	2006	32North	261480	6745020	

station	year	UTMZone	E	N	Hg mg/kg dry weight
98	2006	32North	261514	6744992	
99	2006	32North	261545	6744989	0,06
100	2006	32North	261519	6744967	0,04
142	2006	32North	261689	6745250	0,02
143	2006	32North	261721	6745227	0,04
144	2006	32North	261721	6745188	
145	2006	32North	261726	6745152	0,05
146	2006	32North	261573	6745250	0,2
147	2006	32North	261576	6745220	0,5
148	2006	32North	261609	6745250	
149	2006	32North	261647	6745209	0,05
150	2006	32North	261666	6745213	0,1
151	2006	32North	261675	6745189	0,04
152	2006	32North	261686	6745156	0,1
153	2006	32North	261645	6745172	0,1
154	2006	32North	261604	6745193	0,9
155	2006	32North	261624	6745133	
156	2006	32North	261667	6745133	0,05
157	2006	32North	261645	6745155	0,06
200	2006	32North	261670	6745000	0,05
201	2006	32North	261638	6744989	
202	2006	32North	261606	6744988	0,05
203	2006	32North	261693	6745121	0,025
204	2006	32North	261684	6745086	0,04
205	2006	32North	261674	6745042	0,02
206	2006	32North	261648	6745035	0,04
207	2006	32North	261619	6745021	0,07
208	2006	32North	261581	6745018	0,04
209	2006	32North	261661	6745095	0,05
210	2006	32North	261638	6745064	0,03
211	2006	32North	261615	6745056	0,2
212	2006	32North	261623	6745114	0,01
213	2006	32North	261608	6745087	0,25
214	2006	32North	261596	6745106	0,22
215	2006	32North	261578	6745077	0,4
01 FS	2005	32North	261594	6745032	134,5
02 FS	2005	32North	261608	6745065	13,6
03 FS	2005	32North	261573	6745107	33,3
04 FS	2005	32North	261597	6745130	66,5
05 FS	2005	32North	261652	6745148	14
06 FS	2005	32North	261606	6745150	49,7
07 FS	2005	32North	261622	6745174	0,72

station	year	UTMZone	E	N	Hg mg/kg dry weight
08 FS	2005	32North	261637	6745203	0,9
09 FS	2005	32North	261581	6745195	4,32
10 FS	2005	32North	261528	6745039	7,25
11 FS	2005	32North	261555	6745238	2,61
12 FS	2005	32North	261550	6745175	5,75
13 FS	2005	32North	261603	6745218	4,78
14 FS	2005	32North	261561	6745156	58
15 FS	2005	32North	261571	6745150	185,5
16 FS	2005	32North	261565	6745140	194
16 FS	2005	32North	261565	6745140	181
17 FS	2005	32North	261555	6745144	28,3
18 FS	2005	32North	261542	6745148	21,3
19 FS	2005	32North	261533	6745125	21,8
20 FS	2005	32North	261598	6745086	1,76
21 FS	2005	32North	261535	6745103	29,4
22 FS	2005	32North	261514	6745096	21,1
23 FS	2005	32North	261554	6745109	24
24 FS	2005	32North	261527	6745080	60,7
25 FS	2005	32North	261542	6745085	107800
26 FS	2005	32North	261549	6745090	17,7
27 FS	2005	32North	261561	6745077	8,05
28 FS	2005	32North	261552	6745070	62,3
29 FS	2005	32North	261542	6745066	134,4
30 FS	2005	32North	261567	6745060	25,2
31 FS	2005	32North	261486	6745086	7,65
32 FS	2005	32North	261575	6745163	268,6
33 FS	2005	32North	261579	6745148	949,5
34 FS	2005	32North	261554	6745125	130,1
35 FS	2005	32North	261575	6745154	89,2
Sed-1	2005	32North	261898	6745027	0,023
Sed-2	2005	32North	262195	6745450	0,026
Sed-3	2005	32North	261745	6745836	0,017
Sed-4	2005	32North	260770	6745128	0,016
Sed-5	2005	32North	261101	6744903	0,015
Sed-6	2005	32North	261473	6744569	0,016
Sed-7	2005	32North	261561	6745235	0,034
Sed-8	2005	32North	261415	6745271	0,022
Sed-9	2005	32North	262375	6744587	0,019
Sed-10	2005	32North	262873	6744314	0,025
Sed-11	2005	32North	263075	6745708	0,026
Sed-12	2005	32North	262848	6746246	0,034
Sed-13	2005	32North	261688	6746858	0,038

station	year	UTMZone	E	N	Hg mg/kg dry weight
Sed-14	2005	32North	260921	6746319	0,023
Sed-15	2005	32North	260966	6745424	0,097
Sed-16	2005	32North	260229	6745677	0,02
Sed-17	2005	32North	260502	6744727	0,018
Sed-18	2005	32North	261047	6744367	0,013
Sed-19	2005	32North	261621	6744053	0,015
Sed-20	2005	32North	263627	6743549	0,037
Sed-21	2005	32North	264065	6744914	0,029
Sed-22	2005	32North	264525	6745163	0,017
Sed-23	2005	32North	263962	6745644	0,025
Sed-24	2005	32North	263500	6747069	0,017
Sed-25	2005	32North	262624	6747553	0,032
Sed-26	2005	32North	261598	6747469	0,019
Sed-27	2005	32North	261250	6748202	0,024
Sed-28	2005	32North	259877	6746722	0,026
Sed-29	2005	32North	258601	6745399	0,027
Sed-30	2005	32North	260135	6743780	0,019
1	2003	32North	261554	6745057	1,94
2	2003	32North	261571	6745084	0,56
3	2003	32North	261579	6745067	0,41
4	2003	32North	261567	6745133	96,5
5	2003	32North	261579	6745149	1653
6	2003	32North	261588	6745157	139
7	2003	32North	261591	6745179	10,2
8	2003	32North	261570	6745164	3,23
9	2003	32North	261549	6745132	2,96
10	2003	32North	261551	6745195	2,11

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Norwegian Institute for Water Research

Gaustadalléen 21 • NO-0349 Oslo, Norway
Telephone: +47 22 18 51 00 • Fax: 22 18 52 00
www.niva.no • post@niva.no