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REPORT

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Title: Technical report for cruise 0206 – sampling for environmental geochemistry and sediment instability in fjords of Western Norway

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Summary:

A sampling cruise with NGU's research vessel "Seisma" to selected fjords in Møre and Romsdal and Sogn and Fjordane, western Norway was undertaken in June-July, 2002. The objective of this cruise was to obtain sample material to study the fate of heavy metals and to gain understanding of their transport mechanisms, carrier phases, bioavailability, budgeting and provenances. Fjords occurring both in areas with relatively high and low natural heavy-metal background were sampled. Sample material from fjords with significant industrial activities was also obtained. To facilitate the link between inorganic sediment geochemistry and metal abundances in fish and sea mussels, the sampling plans were coordinated with Fiskeridirektoratet and Oceanor who run their own environmental programs that focus on biota.

Sampling in Rogaland (Karmsundet/Skudenesfjorden and the southwestern part of Boknafjorden) was undertaken to obtain cores for dating of slide activity. Several slide scars have previously been mapped in Karmsundet/Skudenesfjorden and in SW Boknafjorden with the aid of swath bathymetry and relatively low resolution shallow seismic data, but the age of these mass movements has so far been unknown.

A modified Niemistø corer was used as the sampling device throughout the cruise. Altogether 157 sediment cores were obtained. Typical penetration depths (core length) ranged between 0.4 and 0.6 m, but in areas with fluffy, unconsolidated sediments penetration depths up to 1.1 m were reached.

Keywords: Marine geology	Cruise report	Sampling
Topas	Mass movement	Coring
Suspended matter	Geochemistry	Marine sediments

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1. INTRODUCTION

The geochemical mapping of marine and overbank sediments, undertaken by NGU over the last decade (Longva and Thorsnes, 1997; Ottesen et al, 2000) has indicated variable loads of environmentally significant heavy metals into marine areas from both natural and anthropogenic pollution sources. High natural loads of heavy metals in certain areas can be attributed to high heavy metal availability and supply from the local bedrock, whereas the pollution loads reflect discharges from industries. The consequences of those different loadings are equally important, determining healthiness, habitability and environmental state of the seabed and the marine basin in general.

2. CRUISE PLANNING

2.1 Geochemical sampling in fjords of western Norway

A sampling cruise to selected fjords in western Norway was undertaken in June-July, 2002. The objective of this cruise was to obtain sample material to study the fate of heavy metals and to gain understanding of their transport mechanisms, carrier phases, bioavailability, budgeting and provenances. The selection of the target fjords was made based on existing marine and terrestrial geochemical data. It was aimed to sample fjords occurring both in areas with relatively high and low natural heavy-metal background. It was also attempted to obtain sample material from polluted fjords. To facilitate the environmental assessment of heavy-metal pollution in fjords affected by industrial discharges, fjords within the immediate impact zone as well as beyond the zone, but still within similar geologic context, were sampled.

Our sampling plans were coordinated with Fiskeridirektoratet and Oceanor (Karl Tangen) i.e. with organisations that have been carrying out environmental studies in various fjords. Algae monitoring data of Oceanor provide interesting geographic and time-series information of algae blooms. Such blooms and related environmental effects result from complex changes in the ecosystem in which inorganic chemistry and supply rates of various reactants play major arole. Cooperation between NGU and Oceanor, combining data and expertise on sediment chemistry and algae blooms is expected to move us closer to an understanding of the chemistry control upon algae blooms. Fiskeridirektoratet has been running the environmental program which includes the determination of heavy-metal concentrations in fish and sea mussels, collected from numerous fish farms along the Norwegian coast (Julshamn and Duinker, 2001). In order to study the existence of a link between inorganic sediment geochemistry and metal abundances in fish and sea mussels, some of our sampling stations were placed in the neighbourhood of fish farms included in the Fiskeridirektoratet's program, particularly those showing relatively high heavy-metal values.

2.2 Sampling for mass movement studies in Karmsundet/Skudenesfjorden and SW Boknafjorden

The objective of the sampling in Karmsundet/Skudenesfjorden and the southwestern part of Boknafjorden was to obtain cores for dating of slide activity. Three major slide scars have previously been mapped in Karmsundet (Bøe et al. 2000). These slide scars were recognised with the aid of swath bathymetry and relatively low-resolution shallow seismic data acquired by sleevegun. In SW Boknafjorden, slide scars have been observed in swath bathymetry and boomer data acquired by Lyse Energi (Sverre Lund, pers. comm. 2002) in connection with the planning of a gas pipe line from Karstø to Stavanger Energy Park at Sola.

3. RESEARCH VESSEL AND CREW

The sampling cruise was undertaken using the 55-foot research vessel "Seisma" that belongs to NGU. Technical details of this vessel as well as the specification of onboard scientific instrumentation are given in Appendix 1.

The cruise was run during two time intervals, 03.06.2002-15.06.2002 and 18.06.2002-03.07.2002, and the crew consisted of the following personnel:

03.06.2002-15.06.2002		18.06.2002-03.07.2002	
Aivo Lepland	Scientist	Aivo Lepand	Scientist
Eilif Danielsen	Captain	Eilif Danielsen	Captain
John Anders Dahl	Engineer, technician	Oddbjørn Totland	Engineer, technician

4. METHODS

The exact positions for the geochemical sampling stations were determined using seismic data; parts of the basins with the highest interpreted sediment accumulation rates were most preferred localities. Seismic data from NGU's archives were used to position about half of the stations, while new seismic data obtained during the cruise helped to find sampling positions in fjords where no previous seismic data were available. A high-resolution Topas system was exploited to collect seismic data in fjords with water depth < 550 m; a Boomer was used in the deeper (> 550 m) basins. Seismic data and core positions were digitally logged in datum WGS 84 and UTM zone 32, and stored in the NGU database (SEGY-format).

Seismic data (Topas) in Karmsundet/Skudenesfjorden and Boknafjorden were acquired across 8 slide scars (Fig. 9) to map post-slide sediment thicknesses. This enabled sampling at optimal locations, i.e. where the up to 1-m-long Niemistöcorer had a chance to reach the lower boundary of the post-slide sediments. Due to poor weather conditions, the seismic data were not of the best quality, but still usable for locating coring stations. Coring was performed within slide scars as well as above mass-movement deposits, outside the slide scars.

A modified Niemistø corer was used as the sampling device. Corer loadings were kept unchanged throughout the cruise. Typical penetration depths ranged between 0.4 and 0.6 m, but in areas with fluffy unconsolidated sediments penetration depths up to 1.1 m were

reached. The length of the sampling tube (7 cm inner diameter) always exceeded the sediment penetration depth. Seawater that occurred above the sediment surface was kept in the sampling tube to limit disturbances at the sediment water interface. Retrieved cores were capped using rubber caps, and were handled and stored in upright position. Up to three parallel cores were collected from some selected stations (multi core stations), but from the majority of stations only a single core was obtained. All 156 cores were given unique identification numbers (P00206001 through P0206158).

Sampling of the suspended matter was carried out in the nose of the vessel simultaneously with the coring. Seawater was pumped up from about 8 m water depth using a submersible centrifugal pump (Eijkelkamp Agrisearch Equipment, Art no:12.12) and the suspended matter was collected by filtering about 2-5 litre of seawater through 0.45 μm Millipore filters. The filters with the suspended sediments were placed into Petri dishes and were immediately frozen. Numbering of the suspended samples generally overlaps with the core numbering. However, the suspended samples were collected over the periods of two or three corings at multi core stations and in those cases the identifications of the suspended samples indicate coring intervals they correspond to (for example P0206021-P0206023). Due to technical problems (e.g. pump malfunctioning, broken filter seals), sampling for suspended matter was impractical at some of the stations (Table 1).

5. RESULTS

Fig. 1 gives the general geographic locations of the fjords in Møre and Romsdal, Sogn and Fjordane and Rogaland that were profiled and sampled during the cruise. Positions of all 157 sampling stations and acquired seismic profiles are further detailed on Figs 2-9. Geographic coordinates of seismic lines and sampling stations are given in Tables 1-2. Water depths of sampling stations and lengths of obtained cores are shown in Table 2.

6. REFERENCES

Bøe, R., Hovland, M., Instanes, A., Rise, L. and Vasshus, S., 2000. Submarine slide scars and mass movements in Karmsundet and Skudenesfjorden, southwestern Norway: morphology and evolution. Marine Geology 167: 147-165.

Julshamn, K. and Duinker, A., 2001. Overvåkningsprogram for skjell 2000 – metaller i skjell. Fiskeridirektoratets Ernæringsinstitutt, Bergen.

Longva, O. and Thorsnes, T, (Eds.) 1997. Skagerrak in the past and at the present – an integrated study of geology, chemistry, hydrography and microfossil ecology. Norges geologiske undersøkelse Special Publication 8: 100 pp.

Ottesen, T.T., Bogen, J., Bølviken, B., Volden, T. and Haugland, T., 2000. Geokjemisk atlas for Norge. Del 1: Kjemisk sammensetning av flomsedimenter. Norges geologiske undersøkelse,140 pp.

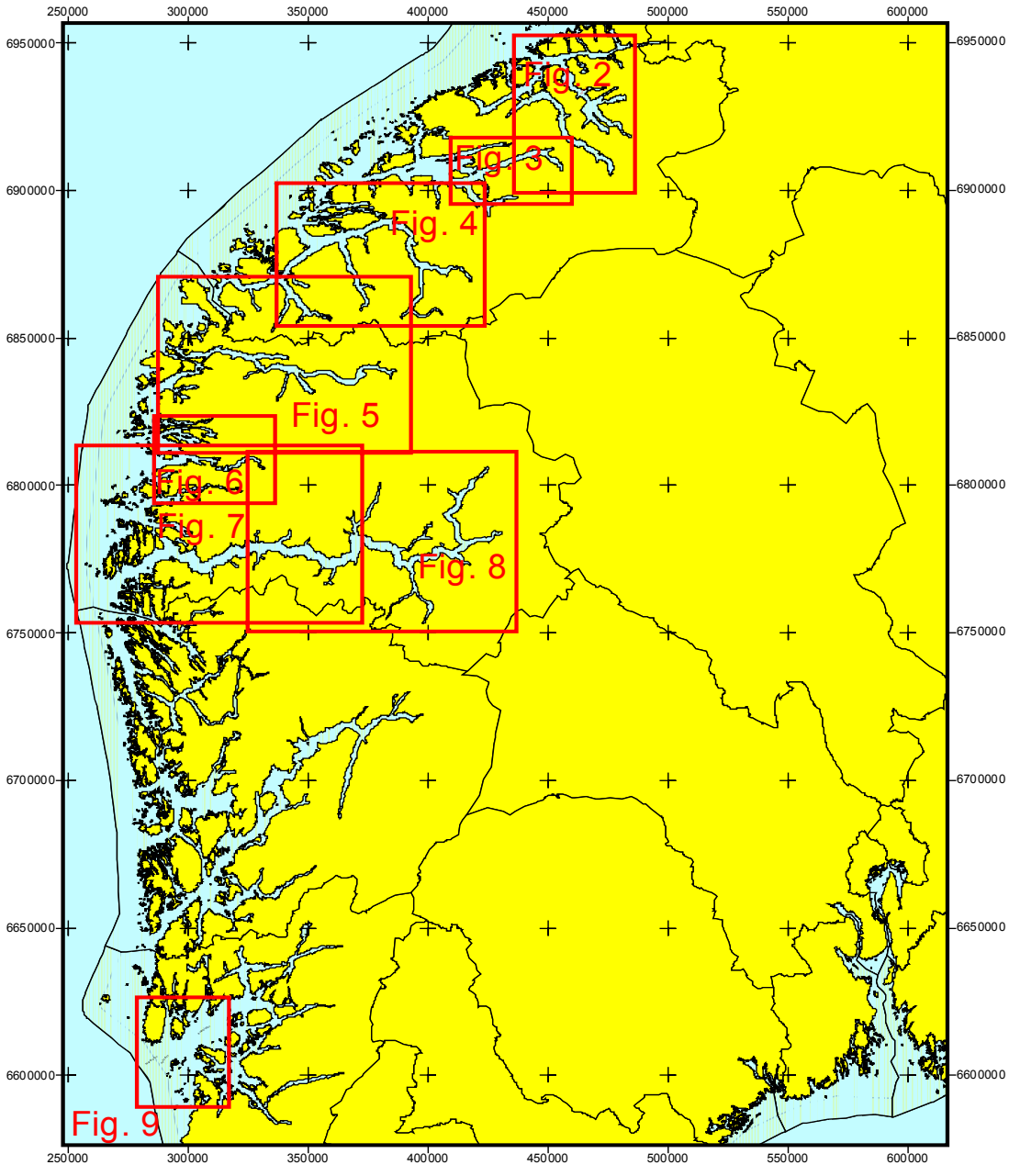

Fig. 1 Index map of investigated fjords.

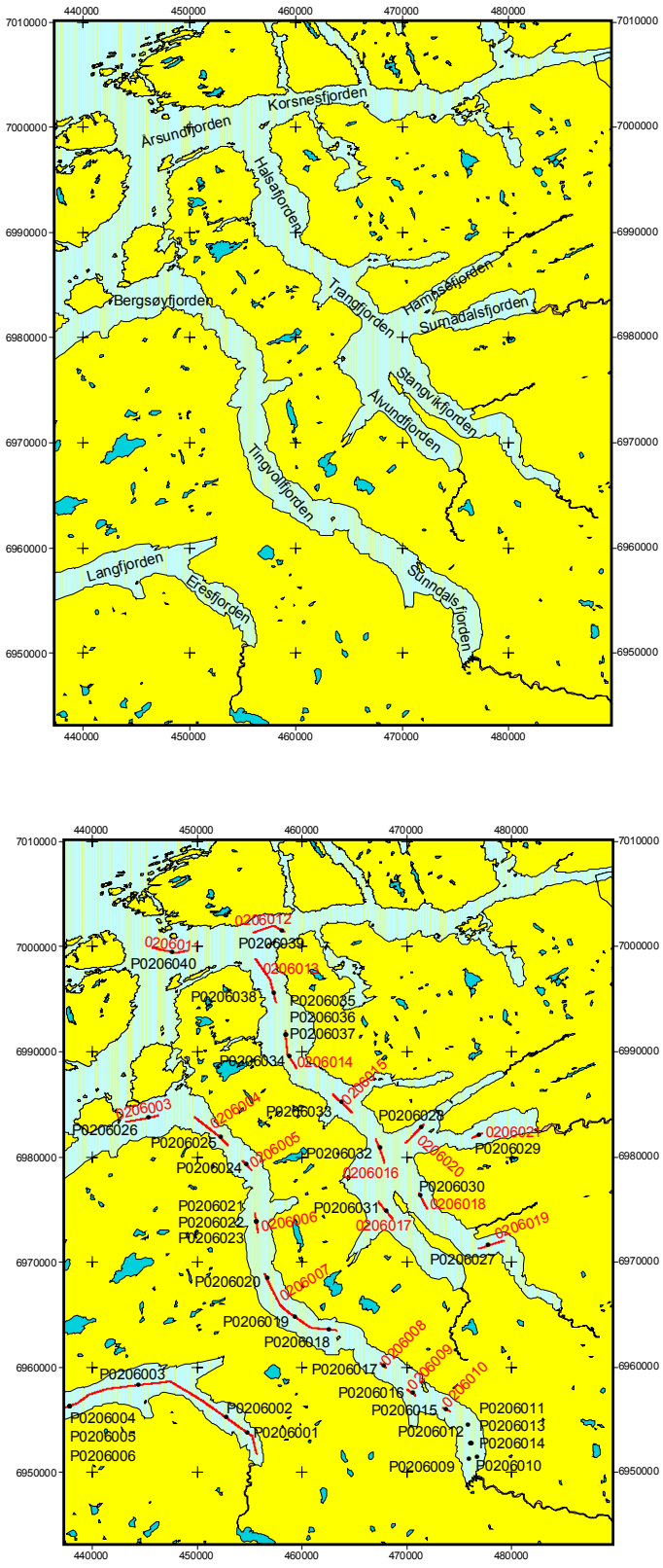

Fig. 2. Positions of sampling stations and seismic profiles in Tingvollfjorden-Halsafjorden area.

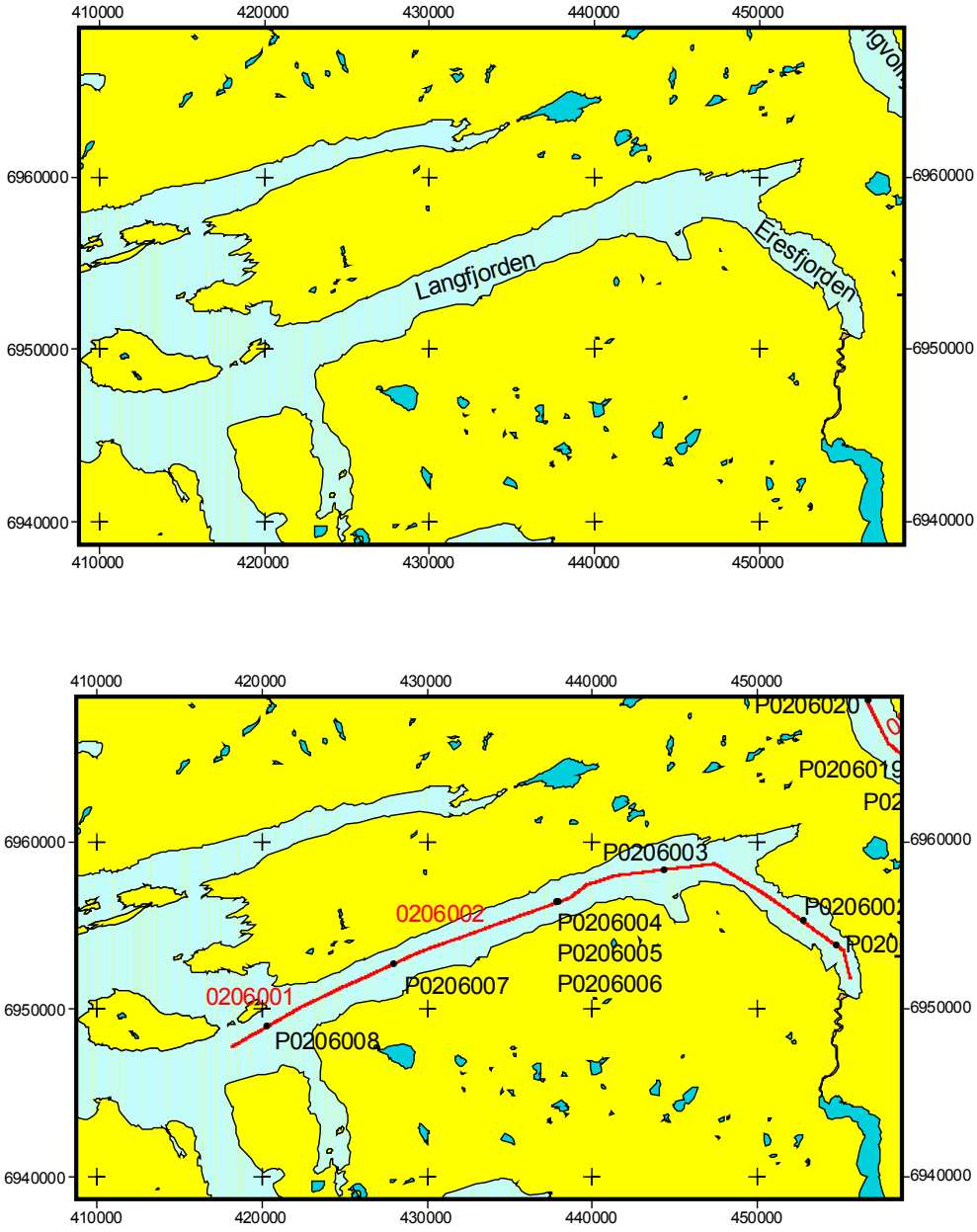

Fig. 3. Positions of sampling stations and seismic profiles in Langfjorden area.

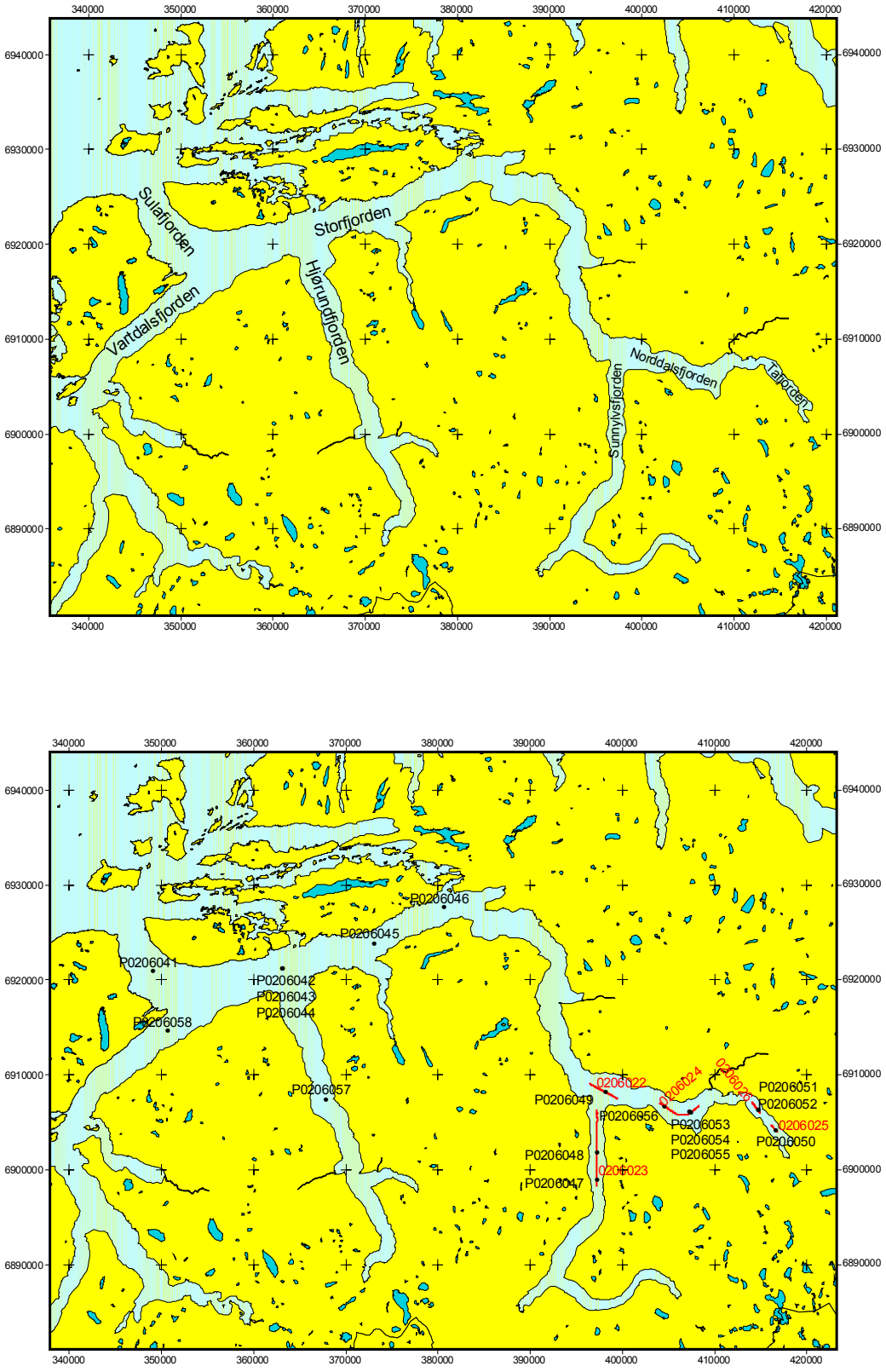

Fig. 4. Positions of sampling stations and seismic profiles in Storfjorden area.

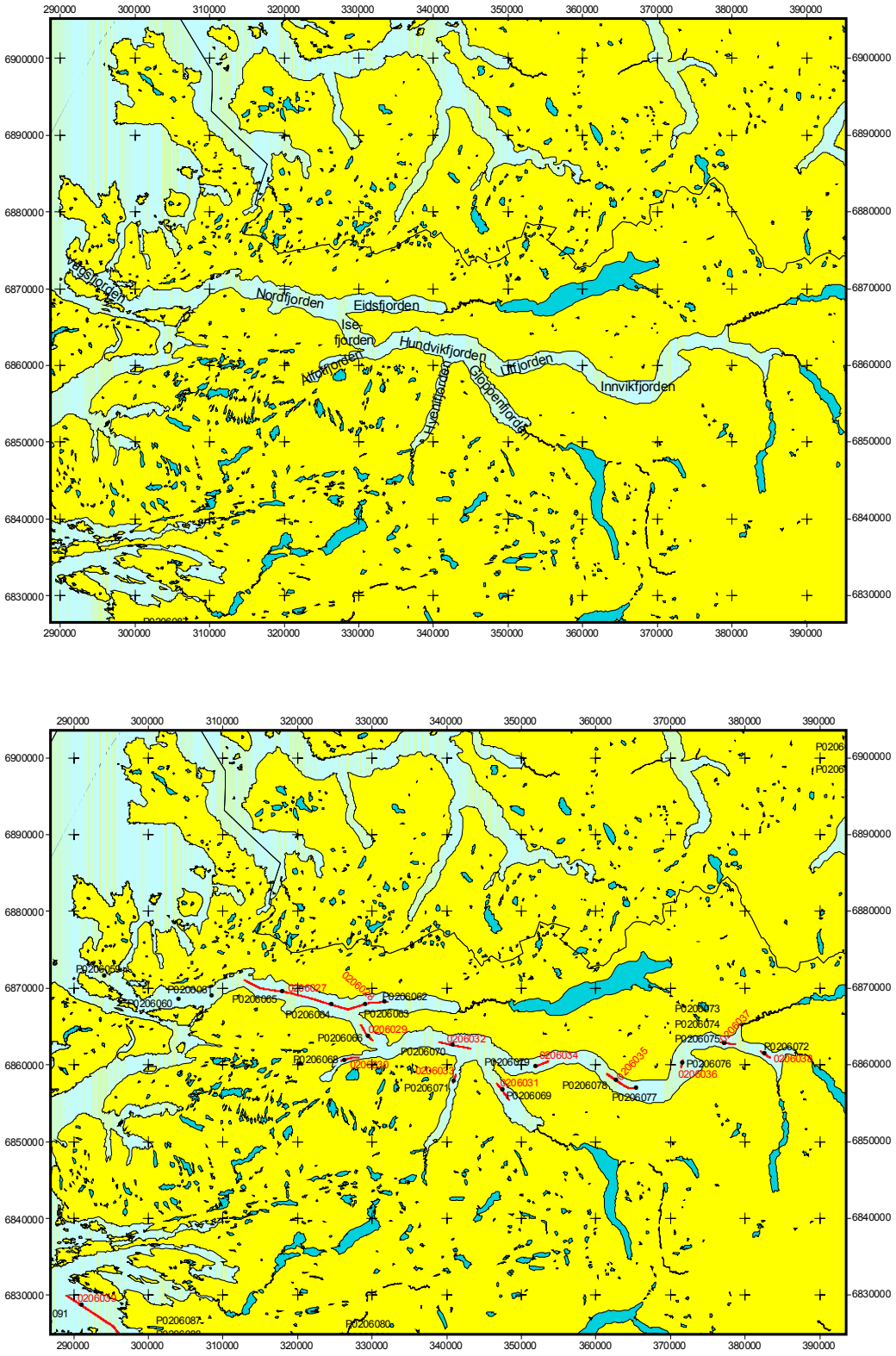

Fig. 5. Positions of sampling stations and seismic profiles in Nordfjorden area.

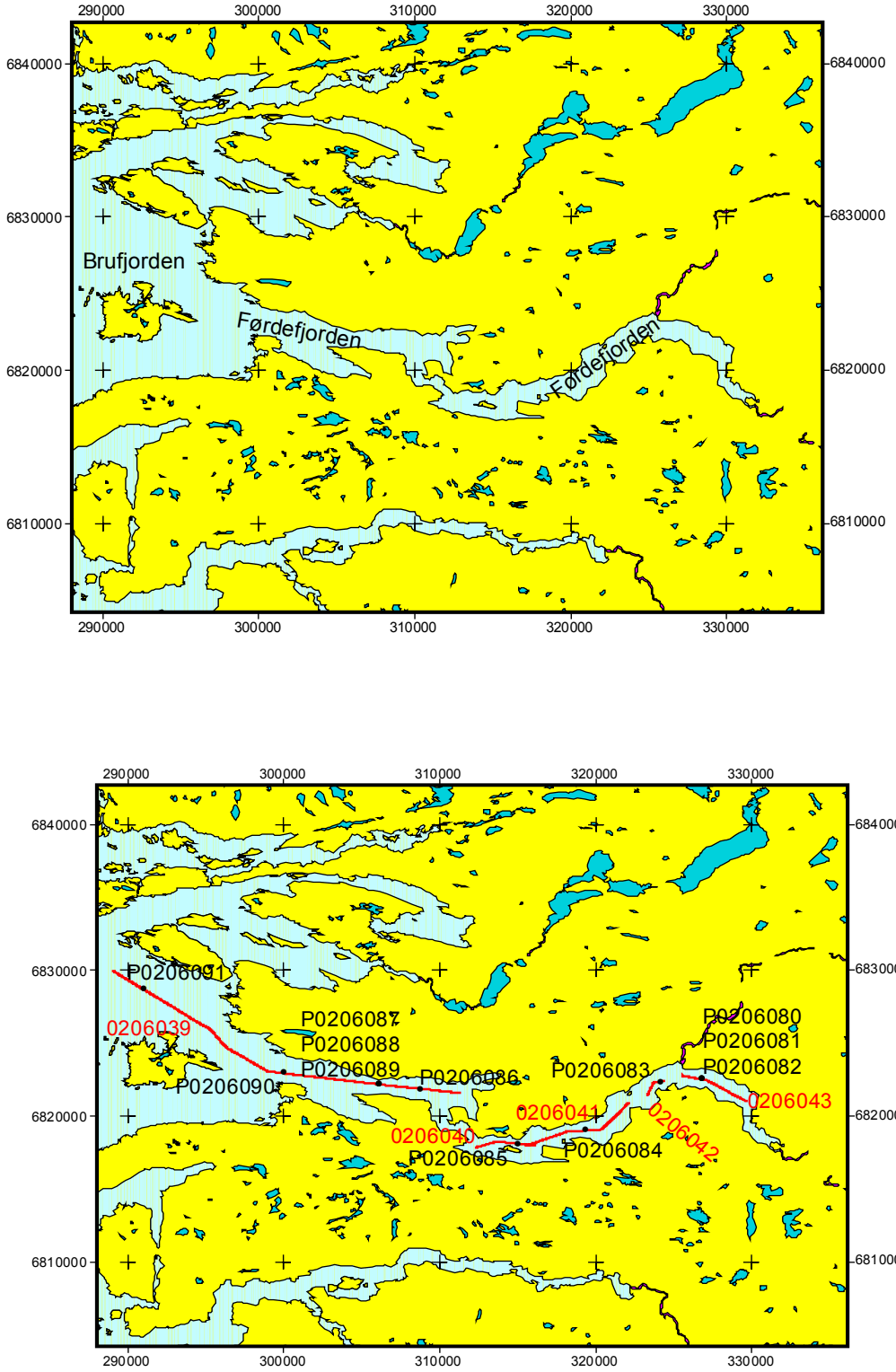

Fig. 6. Positions of sampling stations and seismic profiles in Førdefjorden and Brufjorden.

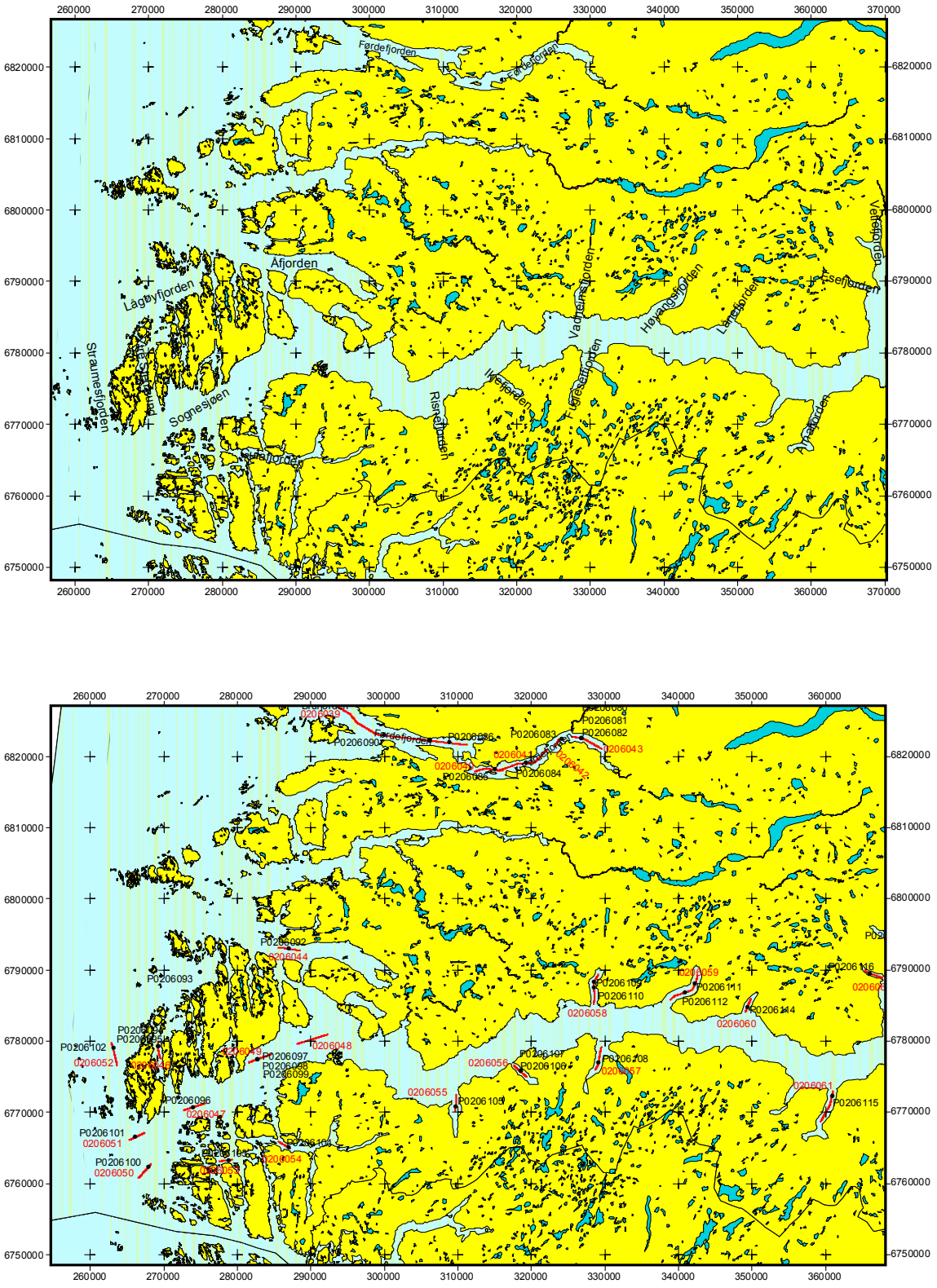

Fig. 7. Positions of sampling stations and seismic profiles in Sognesjøen and the outer Sognefjorden area.

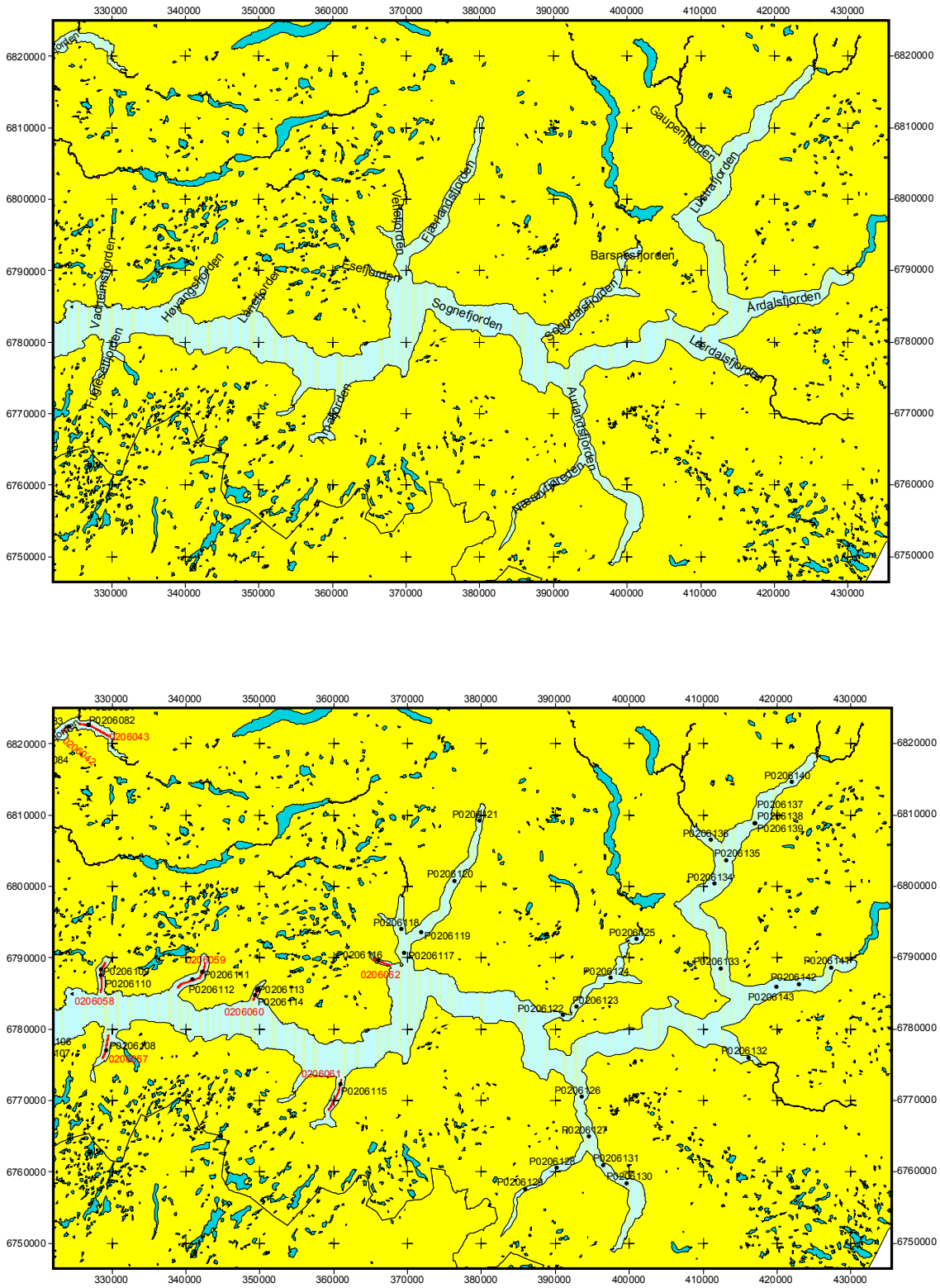

Fig. 8. Positions of sampling stations and seismic profiles in the inner Sognefjorden area.

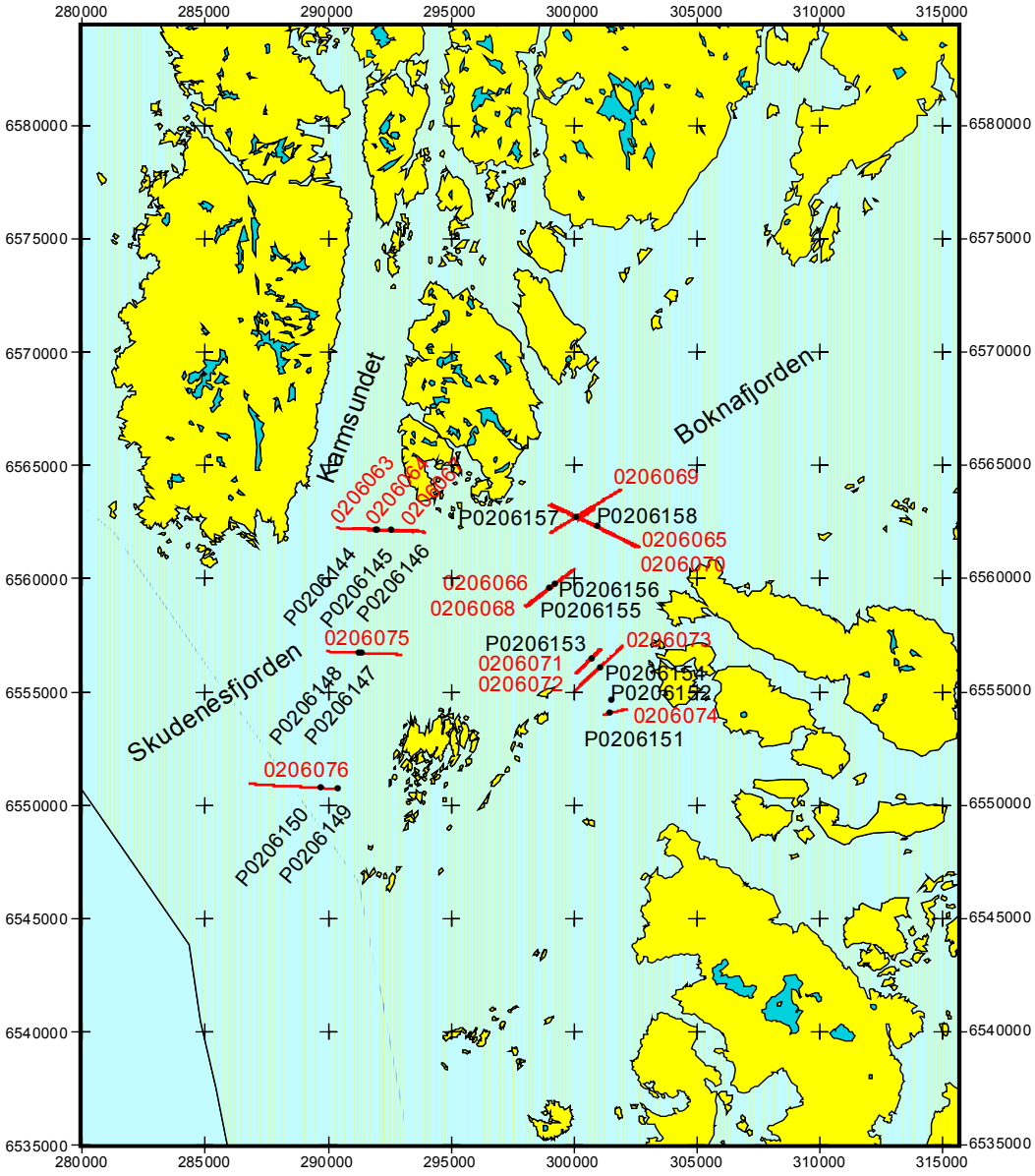

Fig. 9. Sampled fjords and positions of sampling stations and seismic profiles in Karmsundet, Skudenesfjorden and Boknafjorden.

Table 1. Cruise log.

Date	Time (UTC)	X (UTM32)	Y (UTM32)	Locality	Core and suspension samples; seismic lines	Remarks
03.06.2002	6:00					Departure Molde
	07:29:19	418215	6947778	Langfjorden	SOL0206001	Topas
	08:20:23	425484	6951573		EOL0206001	
	08:23:29	425512	6951566	Langfjorden/ Eresfjorden	SOL0206002	Topas
	11:52:09	455672	6951820		EOL0206002	
	12:45	454776	6953788	Eresfjorden	P0206001	
	13:30	452751	6955263	Eresfjorden	P0206002	
	14:00	444365	6958322	Langfjorden	P0206003	
	14:40	437865	6956350	Langfjorden	P0206004	P0206004, P0206005, P0206006 – duplicates
	15:00	437862	6956340	Langfjorden	P0206005	P0206004, P0206005, P0206006 – duplicates
	15:20	437853	6956351	Langfjorden	P0206006	P0206004, P0206005, P020600 6 – duplicates
	16:10	427919	6952652	Langfjorden	P0206007	
	17:10	420305	6948962	Langfjorden	P0206008	
	18:05					Arrival Molde for overnight
04.06.2002	6:00					Departure Molde
	11:17:46	443207	6983332	Bergsøfjorden	SOL0206003	Topas
	11:35:56	446333	6983943		EOL0206003	
	11:49:15	449760	6983803	Tingvollfjorden	SOL0206004	Topas
	12:21:25	452955	6981097		EOL0206004	
	12:29:39	454360	6979640	Tingvollfjorden	SOL0206005	Topas
	12:39:39	455216	6978724		EOL0206005	
	12:56:47	455508	6974678	Tingvollfjorden	SOL0206006	Topas
	13:10:26	455824	6972823		EOL0206006	
	13:26:08	456429	6968923	Tingvollfjorden	SOL0206007	Topas
	14:36:17	463288	6963524		EOL0206007	
	14:55:29	467478	6960404	Sunndalsfjorden	SOL0206008	Topas
	15:00:39	468039	6959967		EOL0206008	
	15:11:19	469997	6957944	Sunndalsfjorden	SOL0206009	Topas
	15:18:38	470838	6957329		EOL0206009	
	15:28:52	473425	6956168	Sunndalsfjorden	SOL0206010	Topas
	15:34:12	474131	6955827		EOL0206010	
	16:00					Arrival Hydro wharf, Sunndalsøra – did not get permission to stay there
	17:30					Arrival to

						permitted wharf in Sunndalsøra
05.06.2002	6:50					Departure Sunndalsøra
	7:20	475853	6951285	Sunndalsfjorden	P0206009	No suspension sample
	7:40	476627	6951446	Sunndalsfjorden	P0206010	
	8:05	476091	6952729	Sunndalsfjorden	P0206011	P0206011, P0206013, P0206014 – duplicates
	8:25	475800	6954467	Sunndalsfjorden	P0206012	
	8:45	476080	6952739	Sunndalsfjorden	P0206013	P0206011, P0206013, P0206014 – duplicates; 1 suspension sample P0206013-P0206014
	8:55	476074	6952740	Sunndalsfjorden	P0206014	P0206011, P0206013, P0206014 – duplicates
	9:20	473718	6956010	Sunndalsfjorden	P0206015	
	9:45	470518	6957566	Sunndalsfjorden	P0206016	
	10:10	467745	6960197	Sunndalsfjorden	P0206017	
	11:10	462509	6963604	Tingvollfjorden	P0206018	
	11:30	459319	6964814	Tingvollfjorden	P0206019	
	12:10	456679	6968427	Tingvollfjorden	P0206020	
	12:45	455650	6973853	Tingvollfjorden	P0206021	P0206021, P0206022, P0206023 – duplicates
	13:00	455651	6973850	Tingvollfjorden	P0206022	P0206021, P0206022, P0206023 – duplicates
	13:15	455648	6973844	Tingvollfjorden	P0206023	P0206021, P0206022, P02060 23 – duplicates; 1 suspension sample P0206022-P0206023
	13:50	454707	6979265	Tingvollfjorden	P0206024	
	14:15	452207	6981846	Tingvollfjorden	P0206025	
	14:50	445371	6983728	Bergsøyfjorden	P0206026	
	18:00					Arrival Kristiansund for overnight
06.06.2002	6:50					Departure Kristiansund
	07:52:33	445768	6999913	Årsundfjorden	SOL0206011	Topas
	08:12:21	449086	6999616		EOL0206011	
	08:36:17	455393	7001328	Korsnesfjorden	SOL0206012	Topas
	08:55:26	458293	7001413		EOL0206012	
	09:13:15	455579	6998823	Halsafjorden	SOL0206013	Topas

	09:49:54	457513	6994696		EOL0206013	
	10:02:19	458375	6991993	Halsafjorden	SOL0206014	Topas
	10:31:39	459479	6988463		EOL0206014	
	10:52:57	462962	6985955	Trangfjorden	SOL0206015	Topas
	11:10:26	464772	6984242		EOL0206015	
	11:27:54	467031	6981698	Trangfjorden	SOL0206016	Topas
	11:44:34	467867	6979471		EOL0206016	
	11:59:50	467283	6975749	Ålvundfjorden	SOL0206017	Topas
	12:12:39	468631	6974149		EOL0206017	
	12:37:23	471134	6976557	Stangvikfjorden	SOL0206018	Topas
	12:47:43	471911	6975106		EOL0206018	
	13:11:14	476845	6971291	Stangvikfjorden	SOL0206019	Topas
	13:27:14	479230	6972064		EOL0206019	
	13:50	477722	6971565	Stangvikfjorden	P0206027	
	14:39:15	469882	6981323	Hamnsefjorden	SOL0206020	Topas
	14:54:05	471608	6983096		EOL0206020	
	15:10	471350	6982818	Hamnsefjorden	P0206028	
	15:30:24	476202	6981812	Surnadalsfjorden	SOL0206021	Topas
	15:37:04	477211	6982261		EOL0206021	
	16:00					Arrival Surnadalsøra
07.06.2002	7:00					Departure Surnadalsøra
	7:40	476809	6982083	Surnadalsfjorden	P0206029	
	8:30	471282	6976276	Stangvikfjorden	P0206030	
	9:00	467987	6974885	Ålvundfjorden	P0206031	
	9:40	467371	6980846	Trangfjorden	P0206032	
	10:30	463768	6985192	Trangfjorden	P0206033	
	11:30	458774	6989540	Halsafjorden	P0206034	
	12:05	458440	6991552	Halsafjorden	P0206035	P0206035, P0206036, P0206037 – duplicates
	12:30	458428	6991551	Halsafjorden	P0206036	P0206035, P0206036, P0206037 – duplicates
	12:50	458428	6991547	Halsafjorden	P0206037	P0206035, P0206036, P0206037 – duplicates; 1 suspension sample P0206036-P0206037
	13:45	457295	6995555	Halsafjorden	P0206038	
	14:10	458104	7001523	Korsnesfjorden	P0206039	No suspension sample
	14:55	447645	6999464	Årsundfjorden	P0206040	
	17:00					Arrival Kristiansund
08.06.2002	7:30					Departure Kristiansund
	12:50	349065	6920807	Sulafjorden	P0206041	
	13:40	363118	6921170	Storfjorden	P0206042	P0206042, P0206043, P0206044 – duplicates
	14:05	363124	6921168	Storfjorden	P0206043	P0206042, P0206043,

						P0206044 – duplicates
	14:35	363124	6921163	Storfjorden	P0206044	P0206042, P0206043, P0206044 – duplicates; 1 suspension sample P0206043-P0206044
	15:25	373047	6923762	Storfjorden	P0206045	
	16:15	380654	6927582	Storfjorden	P0206046	
	17:30					Arrival Strinda
09.06.2002	7:00					Departure Strinda
	07:41:22	396415	6909043	Norddalsfjorden	SOL0206022	Topas
	08:01:56	399447	6907474		EOL0206022	
	08:12:44	397249	6906216	Sunnylvsfjorden	SOL0206023	Topas
	09:00:23	397173	6898283		EOL0206023	
	9:20	397181	6898885	Sunnylvsfjorden	P0206047	
	9:50	397224	6901735	Sunnylvsfjorden	P0206048	
	10:30	398183	6908133	Norddalsfjorden	P0206049	
	11:21:13	404005	6906994	Norddalsfjorden	SOL0206024	Topas
	11:51:13	408265	6906679		EOL0206024	
	12:33:04	416758	6903975	Tafjorden	SOL0206025	Topas
	12:38:33	416138	6904662		EOL0206025	
	12:55	416610	6904120	Tafjorden	P0206050	
	13:04:21	414928	6905996	Tafjorden	SOL0206026	Topas
	13:12:51	414067	6907057		EOL0206026	
	13:35	414728	6906199	Tafjorden	P0206051	P0206051, P0206052 – duplicates
	13:50	414734	6906203	Tafjorden	P0206052	P0206051, P0206052 – duplicates; 1 suspension sample P0206051-P0206052
	14:30	407214	6906087	Norddalsfjorden	P0206053	P0206053, P0206054, P0206055 – duplicates
	15:50	407365	6905980	Norddalsfjorden	P0206054	P0206053, P0206054, P0206055 – duplicates; 1 suspension sample P0206053-P0206054
	15:05	407350	6905967	Norddalsfjorden	P0206055	P0206053, P0206054, P0206055 – duplicates
	15:35	404524	6906656	Norddalsfjorden	P0206056	
	18:30					Arrival Ålesund
10.06.2002	6:30					Departure Ålesund

	9:30	367827	6907405	Hjørundfjorden	P0206057	
	10:45	350629	6914551	Vartdalsfjorden	P0206058	
	14:25					Måløy – oil change
	16:00					Måløy- end of the day
11.06.2002	6:45					Departure Måløy
	7:25	294033	6871528	Vågsfjorden	P0206059	
	8:10	303976	6868479	Nordfjorden	P0206060	
	8:50	308495	6869054	Nordfjorden	P0206061	
	09:33:20	312913	6871005	Nordfjorden	SOL0206027	Boomer
	11:17:38	329199	6867921		EOL0206027	
	11:19:12	329460	6868002	Eidsfjorden	SOL0206028	Boomer
	11:34:42	332091	6868177		EOL0206028	
	12:50	331656	6868166	Eidsfjorden	P0206062	
	13:20	329011	6867863	Eidsfjorden	P0206063	
	14:05	324539	6867831	Nordfjorden	P0206064	
	14:55	317984	6869481	Nordfjorden	P0206065	
	15:54:40	328518	6865147	Isefjorden	SOL0206029	Topas
	16:08:30	330065	6863188		EOL0206029	
	16:35	329369	6863720	Isefjorden	P0206066	
	16:52:49	328214	6860912	Ålfotfjorden	SOL0206030	Topas
	17:06:19	325881	6860509		EOL0206030	
	17:15	326276	6860620	Ålfotfjorden	P0206068	NB sample P0206067 does not exist; No suspension sample P0206068
	19:00					Arrival Sandane
12.06.2002	6:30					Departure Sandane
	07:02:17	348338	6855453	Gloppenfjorden	SOL0206031	Topas
	07:17:20	346760	6857508		EOL0206031	
	7:45	347411	6856653	Gloppenfjorden	P0206069	No suspension sample
	08:16:34	343171	6862087	Hundvikfjorden	SOL0206032	Topas
	08:40:53	339051	6862928		EOL0206032	
	9:10	340759	6862570	Hundvikfjorden	P0206070	
	09:25:14	341236	6858714	Hyenifjorden	SOL0206033	Topas
	09:32:04	340864	6857666		EOL0206033	
	9:45	340921	6857827	Hyenifjorden	P0206071	No suspension sample
	10:28:45	351757	6859709	Utfjorden	SOL0206034	Topas
	10:40:05	353618	6860423		EOL0206034	
	11:08:09	361485	6858772	Innvikfjorden	SOL0206035	Topas
	11:35:28	365419	6856877		EOL0206035	
	12:00:14	371450	6859687	Innvikfjorden	SOL0206036	Topas
	12:05:44	371625	6860571		EOL0206036	
	12:25:42	376727	6862909	Innvikfjorden	SOL0206037	Topas
	12:38:22	378711	6862629		EOL0206037	
	12:50:27	382090	6861718	Innvikfjorden	SOL0206038	Topas
	13:00:17	383410	6860872		EOL0206038	
	13:25	382505	6861453	Innvikfjorden	P0206072	No suspension sample
	13:50	377163	6862849	Innvikfjorden	P0206073	P0206073, P0206074, P02060 75 -

						duplicates
	14:10	377171	6862849	Innvikfjorden	P0206074	P0206073, P0206074, P0206075 – duplicates
	14:25	377164	6862847	Innvikfjorden	P0206075	73, 74, 75 – duplicates; 1 suspension sample P0206073-P0206075
	15:00	371541	6860207	Innvikfjorden	P0206076	
	15:50	365312	6856895	Innvikfjorden	P0206077	
	16:25	362658	6858014	Innvikfjorden	P0206078	
	17:20	351853	6859746	Utfjorden	P0206079	
	18:10					Arrival Sandane
18.06.2002	6:00					Deprture Sandane
	12:10:02	289048	6829938	Brufjorden/ Førdefjorden	SOL0206039	
	14:39:50	311252	6821573		EOL0206039	
	15:00:02	312288	6817835	Førdefjorden	SOL0206040	
	15:22:51	316059	6817982		EOL0206040	
	16:00					Arrival Redalsvika
19.06.2002	6:00					Departure Redalsvika
	06:20:02	315528	6817955	Førdefjorden	SOL0206041	Topas
	07:02:59	322089	6820889		EOL0206041	
	07:10:05	323301	6821427	Førdefjorden	SOL0206042	Topas
	07:20:01	324349	6822382		EOL0206042	
	07:25:01	325514	6822750	Førdefjorden	SOL0206043	Topas
	07:53:40	329615	6821013		EOL0206043	
	10:15	326758	6822534	Førdefjorden	P0206080	P0206080, P0206081, P0206082 – duplicates
	10:40	326774	6822526	Førdefjorden	P0206081	P0206080, P0206081, P02060 82 – duplicates
	10:55	326768	6822531	Førdefjorden	P0206082	P0206080, P0206081, P0206082 – duplicates; 1 suspension sample P0206080-P0206082
	11:35	324096	6822353	Førdefjorden	P0206083	
	12:10	319286	6819018	Førdefjorden	P0206084	
	12:40	314971	681810	Førdefjorden	P0206085	
	13:20	308735	6821868	Førdefjorden	P0206086	
	13:45	306064	6822171	Førdefjorden	P0206087	P0206087, P0206088, P0206089 – duplicates
	14:05	306058	6822180	Førdefjorden	P0206088	P0206087, P0206088,

						P0206089 – duplicates
	14:25	306061	6822164	Førdefjorden	P0206089	P0206087, P0206088, P0206089 – duplicates; 1 suspension sample P0206087-P0206089
	15:00	299981	6822923	Førdefjorden	P0206090	
	16:15					Arrival Florø
20.06.2002	6:00					Departure Florø
	8:10	290961	6828699	Brufjorden	P0206091	No suspension sample
	10:07:29	285647	6793140	Åfjorden	SOL0206044	Topas
	10:24:38	288510	6792698		EOL0206044	
	10:45	286868	6792959	Åfjorden	P0206092	
	11:45:11	276619	6788993	Lågøyfjorden	SOL0206045	Topas
	11:58:51	274424	6789865		EOL0206045	
	12:20	274922	6789651	Lågøyfjorden	P0206093	
	13:06:22	269167	6779695	Ytre Steinsund	SOL0206046	Topas
	13:19:52	269515	6777577		EOL0206046	
	13:40	269208	6779247	Ytre Steinsund	P0206094	P0206094, P02060 95 – duplicates
	13:55	269202	6779241	Ytre Steinsund	P0206095	94, 95 – duplicates; 1 suspension sample P0206094-P0206095
	15:30					Arrival Solund
21.06.2002	6:00					Departure Solund
	06:35:58	275683	6771234	Sognesjøen	SOL0206047	Topas
	06:53:10	272774	6770288		EOL0206047	
	7:25	273921	6770663	Sognesjøen	P0206096	
	08:22:56	288093	6779571	Sognesjøen	SOL0206048	Topas
	08:50:36	292254	6780890		EOL0206048	
	09:19:29	284589	6778094	Sognesjøen	SOL0206049	Topas
	09:38:29	281544	6776966		EOL0206049	
	9:50	282641	6777368	Sognesjøen	P0206097	P0206097, P0206098, P0206099 – duplicates
	10:10	282651	6777365	Sognesjøen	P0206098	P0206097, P0206098, P0206099 – duplicates
	10:25	282647	6777375	Sognesjøen	P0206099	P0206097, P0206098, P0206099 – duplicates; 1 suspension sample P0206097-P0206099
	11:34:03	268283	6762719	Sognesjøen	SOL0206050	Topas

	11:51:03	266566	6760743		EOL0206050	
	12:20	267873	6762256	Sognesjøen	P0206100	
	12:37:17	265318	6766076	Sognesjøen	SOL0206051	Topas
	12:51:36	267339	6767070		EOL0206051	
	13:20	266073	67664555	Sognesjøen	P0206101	
	13:51:34	263648	6776586	Straumesfjorden	SOL0206052	Topas
	14:10:53	262867	6779766		EOL0206052	
	14:35	263068	6779023	Straumesfjorden	P0206102	
	18:00					Arrival Solund
22.06.2002	8:00					Departure Solund
	07:12:55	277568	6763103	Gulafjorden	SOL0206053	Topas
	07:23:25	279244	6763285		EOL0206053	
	7:35	278799	6763239	Gulafjorden	P0206103	
	08:10:32	285649	6765817	Gulafjorden	SOL0206054	Topas
	08:23:12	287140	6764938		EOL0206054	
	8:35	286941	6765052	Gulafjorden	P0206104	
	10:39:50	309732	6772409	Risnefjorden	SOL0206055	Topas
	10:53:59	309637	6770143		EOL0206055	
	11:30	309699	6770760	Risnefjorden	P0206105	
	12:21:44	317627	6776519	Ikjefjorden	SOL0206056	Topas
	12:36:34	319308	6774940		EOL0206056	
	12:45	318479	6775727	Ikjefjorden	P0206106	P0206106, P0206107 – duplicates
	13:00	318476	6775726	Ikjefjorden	P0206107	P0206106, P0206107 – duplicates; 1 suspension sample P0206106-P0206107
	14:05:46	329499	6779081	Fuglesetfjorden	SOL0206057	Topas
	14:24:26	328706	6775969		EOL0206057	
	14:45	329131	6776877	Fuglesetfjorden	P0206108	
	15:10:32	328494	6785204	Vadheimsfjorden	SOL0206058	Topas
	15:39:51	329123	6789313		EOL0206058	
	16:00					Arrival Vadheim
23.06.2002	6:00					Departure Vadheim
	6:30	328511	6788254	Vadheimsfjorden	P0206109	
	6:45	328468	6787505	Vadheimsfjorden	P0206110	1 suspension sample P0206109-P0206110
	07:39:02	338877	6785774	Høyangsfjorden	SOL0206059	Topas
	08:13:11	342592	6789169		EOL0206059	
	8:30	342243	6787940	Høyangsfjorden	P0206111	
	9:45	340906	6786803	Høyangsfjorden	P0206112	
	10:09:33	349105	6784068	Lånefjorden	SOL0206060	Topas
	10:21:03	349838	6785927		EOL0206060	
	10:30	349520	6785099	Lånefjorden	P0206113	
	10:45	349358	6784684	Lånefjorden	P0206114	
	11:48:14	361029	6772866	Arnafjorden	SOL0206061	Topas
	12:17:03	359331	6768646		EOL0206061	
	12:35	360861	6772158	Arnafjorden	P0206115	
	13:46:50	367725	6788887	Esefjorden	SOL0206062	Topas
	14:02:30	365366	6789895		EOL0206062	
	14:25	365967	6789494	Esefjorden	P0206116	

	15:15	369510	6790664	Fjærlandsfjorden	P0206117	
	15:35	369099	6793834	Vetlefjorden	P0206118	
	16:00					Arrival Balestrand
24.06.2002	6:00					Departure Balestrand
	6:45	371792	6793530	Fjærlandsfjorden	P0206119	
	7:25	376346	6800638	Fjærlandsfjorden	P0206120	
	8:00	379727	6809040	Fjærlandsfjorden	P0206121	
	9:55	391057	6781856	Songdalsfjorden	P0206122	No suspension sample
	10:15	392877	6783052	Songdalsfjorden	P0206123	
	10:40	397437	6787057	Songdalsfjorden	P0206124	
	11:30	401029	6792546	Barsnesfjorden	P0206125	
	13:20	393586	6770479	Aurlandsfjorden	P0206126	
	14:00	394542	6764854	Aurlandsfjorden	P0206127	
	14:40	390210	6760495	Nærøyfjorden	P0206128	
	15:05	385872	6757507	Nærøyfjorden	P0206129	
	18:50					Arrival Flåm
25.06.2002	5:45					Departure Flåm
	7:00	399602	6758349	Aurlandsfjorden	P0206130	
	7:30	396454	6760843	Aurlandsfjorden	P0206131	
	9:20	416140	6775948	Lærdalsfjorden	P0206132	
	10:30	412447	6788396	Lustrafjorden	P0206133	
	11:15	411569	6800298	Lustrafjorden	P0206134	
	12:10	413074	6803567	Lustrafjorden	P0206135	
	12:30	410996	6806375	Gaupenfjorden	P0206136	
	13:05	416998	6808741	Lustrafjorden	P0206137	P0206137, P0206138, P0206139 – duplicates
	13:45	416995	6808737	Lustrafjorden	P0206138	P0206137, P0206138, P0206139 – duplicates
	14:10	417000	6808744	Lustrafjorden	P0206139	P0206137, P0206138, P0206139 – duplicates; 1 suspension sample P0206137-P0206139
	14:45	421961	6814505	Lustrafjorden	P0206140	
	17:00					Arrival Årdalstangen
26.06.2002	6:00					Departure Årdalstangen
	6:30	427326	6788507	Årdalsfjorden	P0206141	
	7:30	422906	6786227	Årdalsfjorden	P0206142	
	8:10	419936	6785893	Årdalsfjorden	P0206143	
	17:00					Arrival Bergen
27.06.2002	6:00					Departure Bergen
	13:33:37	290368	6562223	Karmsundet	SOL0206063	Topas
	13:57:47	293923	6562038		EOL0206063	
	14:14:13	293603	6562102	Karmsundet	SOL0206064	Topas
	14:29:43	291010	6562192		EOL0206064	
	15:22:24	302476	6561406	Boknafjorden	SOL0206065	Topas
	15:47:33	298947	6563246		EOL0206065	

	16:00:07	300007	6560408	Boknafjorden	SOL0206066	Topas
	16:16:27	298029	6558727		EOL0206066	
	17: 20					Arrival Skudenes
28.06.2002	6:45					Departure Skudenes
	07:31:32	290981	6562177	Karmsundet	SOL0206067	Topas
	07:44:52	292788	6562102		EOL0206067	
	8:10	292521	6562111	Karmsundet	P0206144	No suspension sample
	8:30	291924	6562144	Karmsundet	P0206145	No suspension sample
	8:50	291922	6562138	Karmsundet	P0206146	No suspension sample
	9:30					Arrival Skudenes – bad weather
29.06.2002	7:30					Departure Skudenes
	08:32:10	297991	6558772	Boknafjorden	SOL0206068	Topas
	08:55:49	299722	6560177		EOL0206068	
	09:18:05	299006	6562012	Boknafjorden	SOL0206069	Topas
	09:55:54	301875	6563922		EOL0206069	
	10:24:10	302600	6561394	Boknafjorden	SOL0206070	Topas
	10:49:59	299068	6563268		EOL0206070	
	11:19:02	301021	6556859	Boknafjorden	SOL0206071	Topas
	11:27:21	300114	6555891		EOL0206071	
	11:29:47	300071	6555826	Boknafjorden	SOL0206072	Topas
	11:39:37	301054	6556860		EOL0206072	
	11:48:17	301954	6557010	Boknafjorden	SOL0206073	Topas
	12:15:06	299974	6554994		EOL0206073	
	12:26:00	301168	6553978	Boknafjorden	SOL0206074	Topas
	12:36:20	302114	6554218		EOL0206074	
	13:17:11	292941	6556632	Skudenesfjorden	SOL0206075	Topas
	13:34:41	289925	6556767		EOL0206075	
	13:55	291313	6556699	Skudenesfjorden	P0206147	No suspension sample
	14:15	291215	6556701	Skudenesfjorden	P0206148	No suspension sample
	14:58:22	286777	6550922	Skudenesfjorden	SOL0206074	Topas
	15:26:41	290349	6550718		EOL0206074	
	15:50	290317	6550716	Skudenesfjorden	P0206149	No suspension sample
	16:15	289649	6550764	Skudenesfjorden	P0206150	No suspension sample
	16:45					Arrival Kvitsøy
30.06.2002	6:00					Departure Kvitsøy
	7:10	301402	6554034	Boknafjorden	P0206151	No suspension sample
	7:40	301485	6554610	Boknafjorden	P0206152	No suspension sample
	8:00	301027	6556069	Boknafjorden	P0206153	No suspension sample
	8:20	300665	6556468	Boknafjorden	P0206154	No suspension sample
	9:35	298938	6559523	Boknafjorden	P0206155	No suspension sample
	10:20	299195	6559741	Boknafjorden	P0206156	No suspension sample

	11:00	300882	6562288	Boknafjorden	P0206157	No suspension sample
	11:40	300035	6562695	Boknafjorden	P0206158	No suspension sample
	14:00					Arrival Haugesund
01.07. – 03.07.2002						Transport to Trondheim
03.07.2002	16:00					Arrival Trondheim

Table 2. Core inventory

Core ID	Longitude (WGS84)	Latitude (WGS84)	X (UTM32)	Y (UTM32)	Water depth (m)	Core length (cm)
P0206001	8°6.951'	62°42.706'	454776	6953788	88	35
P0206002	8°4.551'	62°43.485'	452751	6955263	99	52
P0206003	7°54.652'	62°45.062'	444366	6958323	339	52
P0206004	7°47.062'	62°43.938'	437865	6956350	358	55
P0206005	7°47.059'	62°43.932'	437862	6956341	358	55
P0206006	7°47.048'	62°43.938'	437853	6956352	358	46
P0206007	7°35.486'	62°41.838'	427920	6952652	365	41
P0206008	7°26.667'	62°39.757'	420305	6948962	197	60
P0206009	8°31.695'	62°41.478'	475854	6951286	112	16
P0206010	8°32.601'	62°41.567'	476627	6951446	116	22
P0206011	8°31.962'	62°42.257'	476092	6952730	140	35
P0206012	8°31.605'	62°43.191'	475800	6954467	165	20
P0206013	8°31.949'	62°42.261'	476080	6952739	140	28
P0206014	8°31.942'	62°42.262'	476075	6952740	140	24
P0206015	8°29.149'	62°44.014'	473719	6956011	199	26
P0206016	8°25.376'	62°44.837'	470518	6957567	238	49
P0206017	8°22.090'	62°46.240'	467746	6960197	275	26
P0206018	8°15.890'	62°48.045'	462509	6963605	314	32
P0206019	8°12.120'	62°48.676'	459320	6964815	324	36
P0206020	8°8.957'	62°50.603'	456679	6968427	330	0
P0206021	8°7.658'	62°53.517'	455651	6973853	333	48
P0206022	8°7.659'	62°53.516'	455651	6973851	333	43
P0206023	8°7.656'	62°53.512'	455649	6973844	332	54
P0206024	8°6.456'	62°56.424'	454707	6979265	311	54
P0206025	8°3.457'	62°57.795'	452208	6981847	337	46
P0206026	7°55.334'	62°58.750'	445372	6983728	302	32
P0206027	8°33.725'	62°52.406'	477723	6971566	230	46
P0206028	8°26.093'	62°58.439'	471351	6982818	257	36
P0206029	8°32.560'	62°58.067'	476810	6982084	110	45
P0206030	8°26.081'	62°54.916'	471283	6976277	410	50
P0206031	8°22.205'	62°54.151'	467987	6974886	294	41
P0206032	8°21.408'	62°57.357'	467372	6980846	521	41
P0206033	8°17.089'	62°59.677'	463769	6985193	533	34
P0206034	8°11.110'	63°1.986'	458775	6989540	498	49
P0206035	8°10.684'	63°3.067'	458441	6991552	487	45
P0206036	8°10.669'	63°3.066'	458429	6991552	487	38
P0206037	8°10.669'	63°3.064'	458429	6991547	487	43
P0206038	8°9.262'	63°5.215'	457295	6995556	500	17
P0206039	8°10.132'	63°8.434'	458105	7001523	192	46
P0206040	7°57.724'	63°7.243'	447645	6999465	307	34
P0206041	6°4.824'	62°23.275'	349065	6920807	449	50
P0206042	6°21.095'	62°23.797'	363118	6921170	435	23
P0206043	6°21.102'	62°23.796'	363124	6921168	435	26
P0206044	6°21.103'	62°23.793'	363124	6921164	435	30
P0206045	6°32.495'	62°25.403'	373048	6923763	404	29

P0206046	6°41.165'	62°27.609'	380654	6927582	588	23
P0206047	7°1.396'	62°12.459'	397182	6898885	314	27
P0206048	7°1.345'	62°13.994'	397224	6901736	346	36
P0206049	7°2.228'	62°17.454'	398183	6908134	522	29
P0206050	7°23.646'	62°15.568'	416610	6904121	199	18
P0206051	7°21.412'	62°16.661'	414729	6906199	208	36
P0206052	7°21.419'	62°16.663'	414734	6906204	208	33
P0206053	7°12.733'	62°16.493'	407215	6906087	354	54
P0206054	7°12.911'	62°16.438'	407365	6905981	354	48
P0206055	7°12.894'	62°16.431'	407350	6905968	354	40
P0206056	7°9.606'	62°16.759'	404524	6906656	388	35
P0206057	6°27.184'	62°16.493'	367827	6907405	435	36
P0206058	6°6.961'	62°19.948'	350630	6914551	298	38
P0206059	5°4.570'	61°55.217'	294033	6871528	326	27
P0206060	5°16.105'	61°53.894'	303976	6868480	487	6
P0206061	5°21.218'	61°54.341'	308496	6869054	487	35
P0206062	5°47.676'	61°54.522'	331657	6868167	366	49
P0206063	5°44.677'	61°54.288'	329012	6867863	509	20
P0206064	5°39.581'	61°54.148'	324540	6867831	579	25
P0206065	5°32.008'	61°54.851'	317984	6869481	587	30
P0206066	5°45.320'	61°52.070'	329369	6863721	478	45
P0206068	5°41.978'	61°50.319'	326276	6860621	92	56
P0206069	6°6.232'	61°48.728'	347412	6856654	249	33
P0206070	5°58.355'	61°51.747'	340760	6862570	356	30
P0206071	5°58.791'	61°49.200'	340922	6857827	190	42
P0206072	6°45.968'	61°52.056'	382506	6861453	193	57
P0206073	6°39.822'	61°52.706'	377163	6862849	348	50
P0206074	6°39.832'	61°52.706'	377172	6862849	348	49
P0206075	6°39.824'	61°52.706'	377165	6862848	348	41
P0206076	6°33.526'	61°51.174'	371541	6860208	380	36
P0206077	6°26.581'	61°49.262'	365313	6856895	443	57
P0206078	6°23.510'	61°49.807'	362658	6858014	446	72
P0206079	6°11.131'	61°50.497'	351854	6859746	354	34
P0206080	5°44.696'	61°29.852'	326759	6822534	247	42
P0206081	5°44.715'	61°29.848'	326775	6822526	247	45
P0206082	5°44.707'	61°29.851'	326768	6822531	247	44
P0206083	5°41.711'	61°29.682'	324096	6822353	273	33
P0206084	5°36.496'	61°27.756'	319287	6819019	387	43
P0206085	5°31.701'	61°27.140'	314971	6818100	416	26
P0206086	5°24.464'	61°28.984'	308735	6821868	333	28
P0206087	5°21.442'	61°29.067'	306064	6822171	347	28
P0206088	5°21.435'	61°29.072'	306058	6822181	347	30
P0206089	5°21.439'	61°29.064'	306062	6822165	347	32
P0206090	5°14.556'	61°29.286'	299982	6822923	383	32
P0206091	5°4.024'	61°32.104'	290962	6828700	354	35
P0206092	5°1.867'	61°12.764'	286869	6792959	387	45
P0206093	4°48.797'	61°10.586'	274923	6789651	398	42
P0206094	4°43.198'	61°4.798'	269208	6779247	157	55
P0206095	4°43.193'	61°4.795'	269203	6779242	157	57
P0206096	4°49.036'	61°0.351'	273922	6770663	487	25
P0206097	4°58.229'	61°4.248'	282641	6777369	294	30

P0206098	4°58.240'	61°4.247'	282652	6777366	294	35
P0206099	4°58.236'	61°4.252'	282648	6777375	294	42
P0206100	4°42.952'	60°55.624'	267873	6762256	293	48
P0206101	4°40.660'	60°57.817'	266074	6766456	387	26
P0206102	4°36.407'	61°4.459'	263069	6779024	278	15
P0206103	4°54.947'	60°56.528'	278799	6763240	215	47
P0206104	5°3.821'	60°57.770'	286941	6765052	193	47
P0206105	5°28.649'	61°1.536'	309700	6770761	138	5
P0206106	5°38.097'	61°4.455'	318480	6775727	123	55
P0206107	5°38.093'	61°4.455'	318476	6775726	123	56
P0206108	5°49.861'	61°5.360'	329132	6776878	147	20
P0206109	5°48.556'	61°11.462'	328512	6788254	234	32
P0206110	5°48.549'	61°11.058'	328469	6787505	265	33
P0206111	6°3.877'	61°11.640'	342244	6787941	220	75
P0206112	6°2.444'	61°10.996'	340907	6786804	264	37
P0206113	6°12.138'	61°10.579'	349521	6785099	80	7
P0206114	6°11.964'	61°10.056'	349358	6784684	103	9
P0206115	6°25.329'	61°3.571'	360861	6772158	192	33
P0206116	6°30.264'	61°13.007'	365968	6789494	15	30
P0206117	6°34.169'	61°13.708'	369510	6790664	302	34
P0206118	6°33.579'	61°15.406'	369100	6793835	214	49
P0206119	6°36.600'	61°15.296'	371792	6793531	245	40
P0206120	6°41.407'	61°19.210'	376346	6800638	213	56
P0206121	6°44.869'	61°23.796'	379728	6809041	119	47
P0206122	6°58.534'	61°9.363'	391057	6781856	42	4
P0206123	7°0.521'	61°10.037'	392877	6783053	134	70
P0206124	7°5.474'	61°12.266'	397438	6787057	264	64
P0206125	7°9.309'	61°15.276'	401029	6792547	67	107
P0206126	7°1.735'	61°3.280'	393587	6770480	432	57
P0206127	7°2.982'	61°0.266'	394542	6764854	504	30
P0206128	6°58.329'	60°57.849'	390211	6760496	290	51
P0206129	6°53.631'	60°56.167'	385872	6757508	66	51
P0206130	7°8.797'	60°56.844'	399603	6758350	416	55
P0206131	7°5.232'	60°58.138'	396454	6760843	440	45
P0206132	7°26.643'	61°6.552'	416141	6775949	57	32
P0206133	7°22.188'	61°13.205'	412447	6788396	632	50
P0206134	7°20.872'	61°19.602'	411569	6800299	374	87
P0206135	7°22.467'	61°21.382'	413074	6803568	376	17
P0206136	7°20.056'	61°22.866'	410996	6806376	273	23
P0206137	7°26.730'	61°24.220'	416999	6808742	347	95
P0206138	7°26.727'	61°24.217'	416996	6808737	347	95
P0206139	7°26.732'	61°24.222'	417000	6808744	347	90
P0206140	7°32.160'	61°27.385'	421962	6814506	133	67
P0206141	7°38.802'	61°13.448'	427326	6788508	162	61
P0206142	7°33.922'	61°12.170'	422907	6786227	293	48
P0206143	7°30.616'	61°11.954'	419937	6785893	346	72
P0206144	5°22.320'	59°8.845'	292521	6562111	312	64
P0206145	5°21.694'	59°8.845'	291924	6562144	308	69
P0206146	5°21.692'	59°8.842'	291922	6562138	308	71
P0206147	5°21.366'	59°5.900'	291313	6556699	360	40
P0206148	5°21.264'	59°5.898'	291216	6556701	360	45

P0206149	5°20.668'	59°2.653'	290318	6550716	327	97
P0206150	5°19.968'	59°2.659'	289650	6550765	294	82
P0206151	5°32.057'	59°4.755'	301402	6554035	220	32
P0206152	5°32.112'	59°5.067'	301485	6554610	251	111
P0206153	5°31.554'	59°5.839'	301027	6556070	355	90
P0206154	5°31.154'	59°6.044'	300665	6556468	365	87
P0206155	5°29.181'	59°7.638'	298938	6559524	488	69
P0206156	5°29.438'	59°7.763'	299196	6559742	502	80
P0206157	5°31.064'	59°9.180'	300883	6562288	562	71
P0206158	5°30.155'	59°9.375'	300036	6562695	523	68

NGUs RESEARCH VESSEL R/V "SEISMA"

R/V "Seisma" within the slide-scar of the 1996 Finneidfjord slide. The TOPAS transducer/reciever system is strapped to the bow of the vessel when surveying.

Main specifications:

Built:	1985
Shipyard:	West Products A/S, 6718 Deknepollen, Norway
Construction:	Sandwich/Divinycell
Length oa.:	16,8 m (55 feet)
Draft:	Ca. 1,5 m
Tonnage:	34 g. tons
Speed:	Ca. 16 knots

General arrangements:

Bridge:	Navigation and seismic survey instrumentation
Workroom:	Behind bridge, ca. 8 m^2.
Cabins:	3 cabins á 1 person, mess, pantry, WC, shower .
Aft deck:	Ca. 24 m^2.

ENGINES, POWER SUPPLIES ETC.:

2 Scania DSI 11 á 350 HP/2100 RPM, with hydraulic pitch propellers.
Stamford Isuzu diesel generators 18 kw 3-phase, 220 V/AC
Transformer for 380 V, 3-phase
Frequency modifier for variable rpm for el. motors (380 V, 3-phase)
35 amp. generator, 24 V/DC (start)
35 amp. generator, 24 V/DC (usage)

Hydraulic driven systems:
Bauer high pressure compressor 600 l/min. 200 bar (airgun)
Tallmek bow propeller, 30 HP
Effer marine crane 2.6 t/m with winch, 400 kg
Winch, 5 tons, 600 m wire
Anchor winch
Bunkers: Diesel 3 500 l
Fresh water supply: 1 000 l

NAVIGATION INSTRUMENTS

Simrad CP40 map plotter
Anschütz gyro compass
Robertson AP9 autopilot
Furuno FCR 1411colour radar
Furuno FR 240 radar
Furuno echosounder
Hoccom Famita Good VHF-radio with sel.call. no. 90144.
Ericson NMT. tel. no. 947 27052

SURVEY INSTRUMENTS

Positioning:
Ashtech GPS12
Trimble Navbeacon radio with standard RTCM external port.
Kongsberg Diffstar software
Simrad CP40 map plotter

Echosounding
Simrad EA 400, 2 channels; 200 kHz / 7°, 38 kHz / 13°
OLEX chart plotter which generates topographical maps from echo sounder and GPS.

APPENDIX 1

Magnetometer:
GSM-19M Overhauser proton magnetometer with 100 m cable

Seismics and sonar
"Boomer"-source "GeoPulse-High Resolution Sound Source", model 5813 B, 280 Joule
TOPAS (Topographic Parametric Sonar)
Sleevegun, 15-40 cubic inches
Benthos hydrophone streamers, 7.5 m
4-channel hydrophone streamer, Fjord Instruments, 24 m
Analogue filtering system
SUN Sparc 20 workstation for operation of TOPAS system and digital logging of seismic
DAT- tape station
EPC 3200, graphic plotter
EPC 9800, thermal plotter
IBM-compatible PC's for logging of positions, depth measurements, and magnetometer records
An interferometric sonar system will be evaluated in August 2003 and be in operation from 2004

Corers
Gravity corer, 63 mm, max. load 300 kg.
Modified Niemistöe sampler, 63 mm
HYBAV, vibrocorer, 110 mm
Box corer, 70 kg