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SELECTION AND CHARACTERIZATION OF NET SEDIMENTATION STATIONS FOR REFERENCE USE - FIRST RESULTS OF THE 1993 BALTIC SEA SEDIMENT BASELINE STUDY

Matti Perttilä and Lauri Niemistö

Finnish Institute of Marine Research
PO Box 33, SF-00931 Helsinki Finland

Abstract

The sampling field work of the first Helcom - ICES Sediment Baseline Study was carried out 13.6 - 9.7.1993 onboard the Finnish R/V ARANDA. The principal aims of the study were to serve as a reliable reference for future trend analyses and give a description of the distribution of chemical substances in the Baltic Sea sediments. To fulfill these aims, the first requirement was then to select suitable sedimentation stations for future reference use.

About 25 important net sedimentation areas were covered. In most areas, one primary sediment station was selected, surrounded by several secondary stations. The selection of the primary station was done on the basis of echo-sound mapping of the sedimentation area.

The paper describes the characteristics of the sediments in the studied sites, report the coordinates of the selected primary stations which we recommend to be used in future sediment work, and give a rough estimate for the rate of sedimentation in these stations, based on preliminary age determination by using a ^{137}Cs field equipment.

Introduction

Marine sediments provide a possibility to assess in a consistent manner the changes in the environment. Not only the present-day distribution of contaminants can be exposed, but also at the same time the history of the sampling site, providing certain hydrochemical and biological conditions are met. The use of biota as a pollution indicator in the Baltic Sea suffers from the drawback that only very few, if any, species are represented in all the subareas in sufficiently large quantities.

In order to assess the use of sediments as environmental indicator medium, the pollutant studies in the Baltic Sea sediments were reviewed recently (Perttilä and Brügmann, 1992). One of the conclusions was that while a large amount of work has been invested in the sediment studies, both sampling and analysis methods, as well as the positions of the sampling sites, have been selected using varying criteria. For these reasons the reported concentrations are seldom comparable. A suggestion was made to carry out a baseline study covering all the important net sedimentation areas of the Baltic Sea.

The Sediment Baseline Study was planned and organized within the ICES Working Group on Baltic Marine Environment. In this contribution, we report the general conduct of the study, give a list of the selected sedimentation sites, together with a preliminary characterization of the sites and approximate sedimentation rates.

General of the sedimentation in the Baltic Sea

In the bathymetric map of the Baltic Sea (Winterhalter 1981), several large basins are clearly discerned. In the bathymetric large scale map, however, the isobaths are drawn with 20 m intervals which makes it impossible to evaluate the small scale variations within a large basin. The small scale variations are either a result of differences in the basic topography, rocks, ridges etc. or some of them may be a result of the differences in the sedimentation.

The prevailing opinion has been that in the Baltic Sea there are basins in which the sediments form a final sink for many elements and substances. When benthic fauna is absent, the sediments in these basins are often laminated and seasonal changes layer by layer can be recognized. Many of the best examples of such sediments are found in the nearshore basins where shallow ridges and islands effectively shelter the local basin from any disturbances and erosion (eg. Morris &al. 1988).

Recently laminated sediments ranging from a few to some 30 - 35 laminae on the top of homogenous looking, older sediments have been found in the open Baltic Proper (Jonsson & al. 1990). An explanation for this change of facies has been assumed to be the long lasting stagnation and thereby the increased area of anoxic conditions with no bioturbation caused by benthic macrofauna. Former dynamic bottom areas populated with benthic animals have been changed to tranquil sedimentation bottom areas where seasonally influenced laminae are formed. In the Baltic proper the dominatingly important sink for material is the Gotland Deep.

In the Gulf of Finland, the recent changes development has been the opposite. The halocline so characteristic at the depth of some 50 m in the western Gulf and at 30 m in the East has been missing during the last 3 - 4 years (Perttilä & al. 1993). Several seasonal turnowers of the whole water body have obviously taken place resulting in oxidizing conditions at the sediments surfaces down to 80 - 85m depth. The benthic fauna has recolonized these areas (Andersin & Sandler 1991). The topmost laminae of the sediments have disappeared probably as a result of bioturbation. The sedimentation basins in the Gulf of Finland are numerous and a mosaik of small basins is characteristic of the Finnish side where the crystalline Pre Cambrian bedrock dominates with rugged forms. On the Estonian side the Cambrian and Ordovician basement has smoothened the ruggy forms and some larger sedimentation basins are found.

In the Gulf of Bothnia the dominant feature is the almost constant erosion of the older sediments in the less than 60 - 70 m deep coastal areas as a result of land upheaval which continuously rises former sedimentation bottoms up to the hydrodynamically active zone. The eroded material is transported towards the deeps. The present sedimentation contains a mixture of material of very old and present autochtonous origin.

General conduct of the study

The expedition was carried out on board the R/V Aranda in June-July 1993, covering the whole Baltic Sea (Fig.1). Differential GPS was used for the positioning, with an accuracy of +/-50m or better. At each pre-selected site, a grid was run in order to facilitate the selection of the exact position for sampling. 10 KHz and 110 KHz echo sounding equipment was used for the inspection of the layer structure of the bottom sediments (Fig.6). Depth measurements from the echo sounding during the grid were combined with the ship's navigation data, and at each station, a three dimensional picture of the bottom was made (Fig.7). A side scan sonar was also applied at most stations. The final selection of the sampling position was done by means of an inspection of these three sources of information.

The sediment surface was recorded with a video camera system. In order to study the inner structure of the sediments, a penetrating sediment camera system was also applied, which photographed the vertical structure. For this purpose, one core was also taken for X-ray analysis. The detailed results of these characterizations will be published later.

For samples intended for chemical analyses, a new type of gravity corer was used throughout the study (Fig. 2). This corer consists of a double core system, producing two identical cores at a time. The functioning of this corer type was found to be very reliable, and the sampler proved to hit the sediment surface at upright position nearly always, contrary to the conventional single-tube gravity corers. The sediment cores were cut to 1cm thick slices (0.8cm for redox measurements), and deep-frozen. Redox and preliminary Cs-137 measurements were carried out on board.

The Cs-137 measurement gives an energy dispersion pattern, in which the Cs band is easily recognizable (Fig. 3). We assume that a major part of this element originates from the Chernobyl accident in 1986. The Cs-137 activity can be followed down in the sediment core. At most of the stations, the topmost sediment layers showed high activity, with a peak at the depth of 3-10 cm (Figs. 4a and b). In sediment layers below the peak, the Cs-137 activity decreased rapidly to background values. We assume that the sediment layer with the activity peak corresponds to the immediate Chernobyl fallout, giving thus a rough estimate of the net sedimentation rate. Fig. 5 shows the depth of the maximum activity layer in the observation stations of the Sediment Baseline Study.

Preliminary results

- Characterization of the sedimentation basins

The descriptions of the sampling sites are presented in Annex 1. The preliminary measurements of gamma emitting nuclides at least indicate, that the sediments chosen are sedimentation basins. This is confirmed at least partly by the depth to which the Chernobyl fallout of 137 Cs now seems to be buried. The clear echo sounding records of dune like formations and in some cases the direct video images of the sediment surface indicate that in some areas our understanding of the sedimentation process has to be reconsidered.

In the Gulf of Finland on two stations (F50 and XV-1) we could watch how a relatively strong (ca 15 - 20 cm/s) near bottom current detached particles and aggregates from the sediment surface. Particles were then transported along the sediment surface. Some times the sediment surface seemed to be rolled off by the current like miniature carpets. On some other samplig stations the macroscopic benthic animals were seen to dig into the sediment surface, and even very faint water movement was transporting clouds of material away. All this must influence the depth of the Chernobyl maximun fall out of 137 Cs and any other property of the sediments.

It appears that in most of the shallower basins with depths around 60 m or less, independent of the area of the Baltic Sea (Arkona and Mecklenburg basin in the South, the Gulf of Finland and the Gulf of Bothnia in the North), sediment particles were not descended on their final places. The above described visually observed reworking of the sediment surface makes the vertical timescales uncertain and uncontinuous. This kind of sediments are probably less suitable for even low frequency monitoring.

The deeper basins often show massive sedimentary packages of soft sediments of recent character, as observed by echo soundings. In these basins, stagnant dead bottom periods alternate with nonstagnant periods characterized by a recolonisation of benthic fauna and thus a return of water movement. This alternation may govern the vertical sedimentary record, rendering age determination meaningless. Only the deepest parts of the Baltic Sea seem to act as final sinks for particles to form continuous packages of layers.

The Gotland Deep, however, shows striking differences in the depth, thickness and structure of varves. The samples were of a totally different character than expected. On the top of the samples there was a 10 cm thick fluffy homogenous looking layer of very watery, loose grayish sediment. In 1992, a similar, but thinner layer had already been observed (Niemistö 1992).

No layers were visible, but the preliminary X-ray images this fluffy layer revealed three thick separate layers. Below these, the layers were drastically thinner, about 0.5 to 0.2 cm. Deeper down two white bands were found.

The gamma spectrometric analysis of 137 Cs showed a maximum at the depth of about 9 cm only. The Chernobyl accident having taken place in 1986 this layer is far too near the sediment surface if these layers were annual.

Here, thus, is a very controversial sediment package. On one hand, the topmost fluffy layers were undisturbed by any bioturbation or mechanical reworking caused by currents. On the other hand, the layers, referring to the x-ray analyses, were far too young to represent the proper depth layers revealed by radio nuclide analytical methods as used on several other sediment datings.

The origin of the fluffy layer is not known. It might be due to a very recent input caused by the January 1993 saltwater inflow by which the dynamic processes had detached sediments from areas where sediments had been resting only during the exceptionally tranquil stagnant Baltic Sea. On the other hand, they might have been moved by a strong current from areas where laminated sediments had been reported earlier, before the salty water inflow in January 1993.

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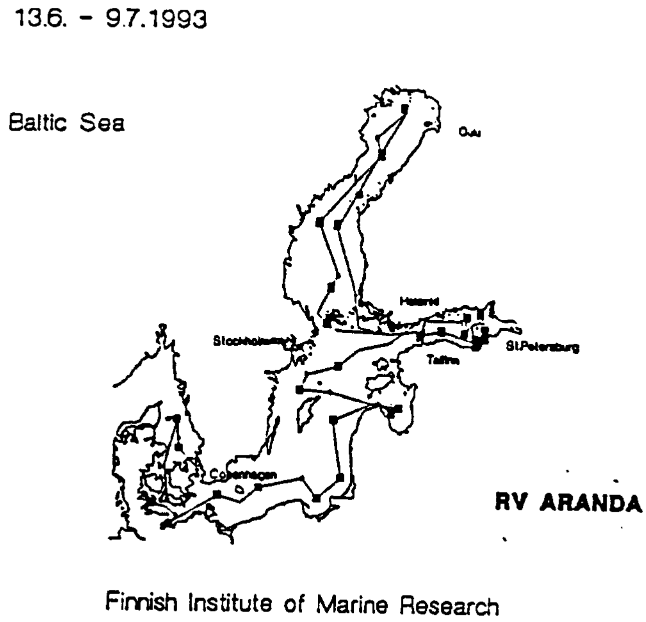
Fig. 1. Cruise itinerary of the 1993 ICES/Helcom Sediment Baseline Study



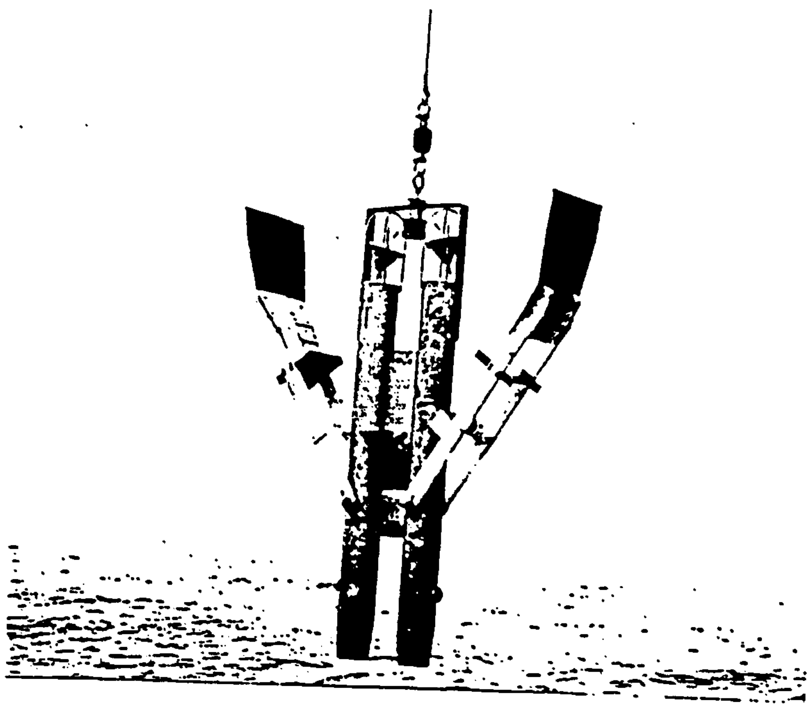


Fig. 2 . GEMINI double sediment sampler ready to descend

Fig. 3. Example of energy spectrum from a sediment sample taken in the Gulf of Finland during The Sediment Baseline Study. In a 25 min counting the 137 Cs and traces of 134 Cs give clear peaks.

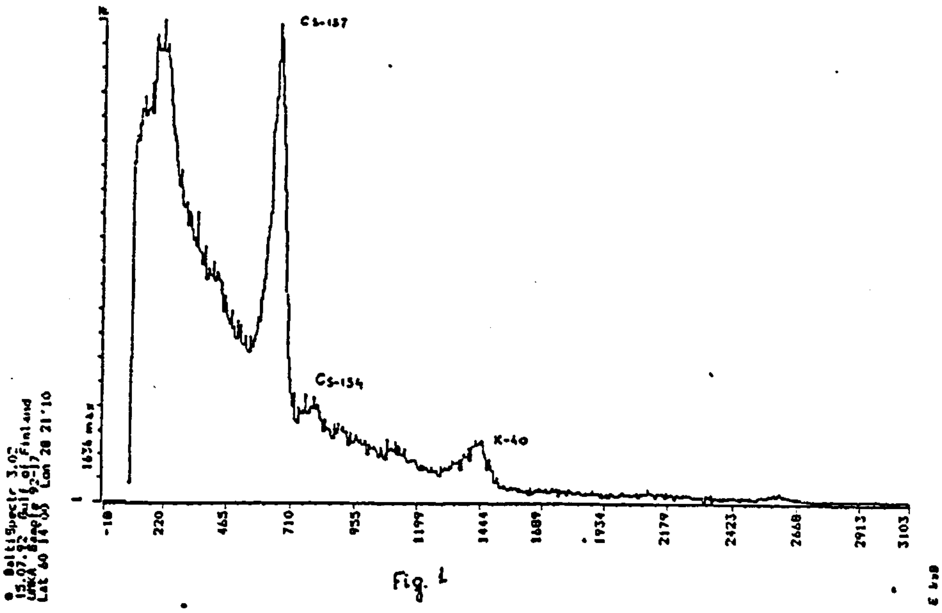


Fig. 1

Fig. 4 A. The "bulk density" (g/cm^3) by X-ray photography of the whole core and 137 Cs (DPM) by Gamma radiation from a core splitted to 1 cm slices. Both measurements were made onboard emmidiately after sampling.

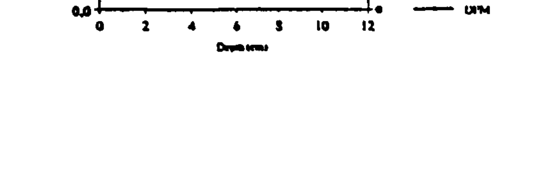


Fig. 4 B. The results of the 137 Cs (DPM) measurements corrected with the bulk density. The correction chances somewhat the topmost watery sediment slices, but still the Chernobyl peak is clearly discerned.

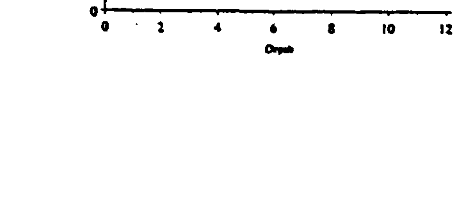
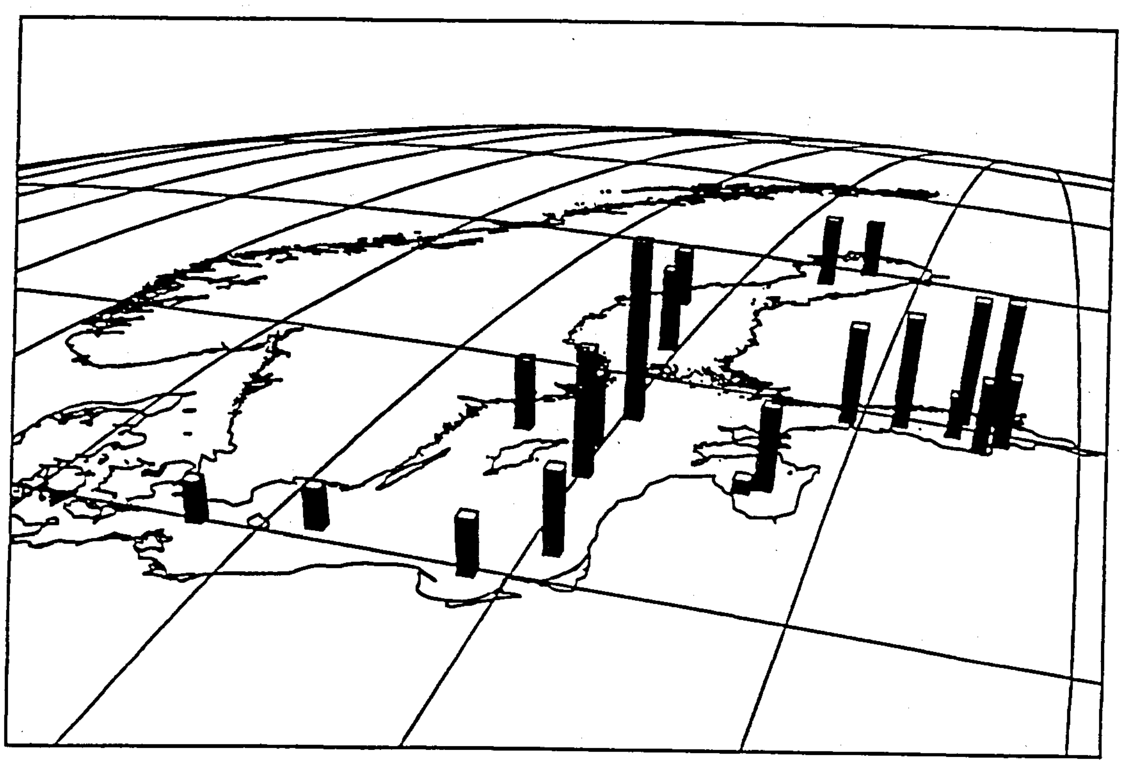
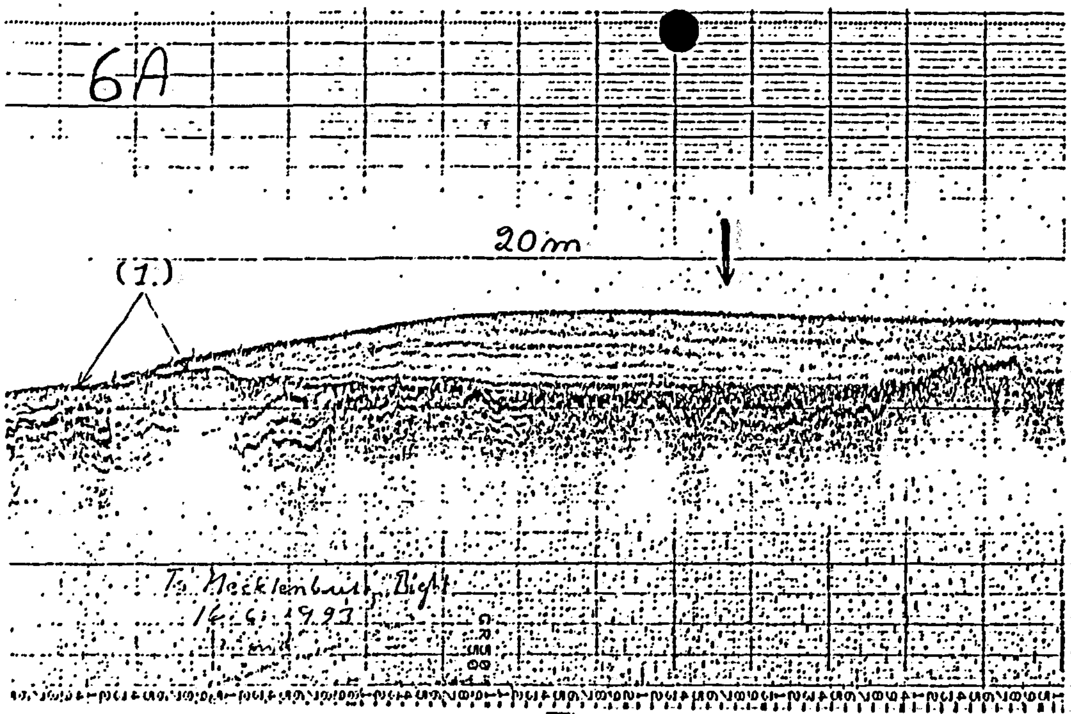
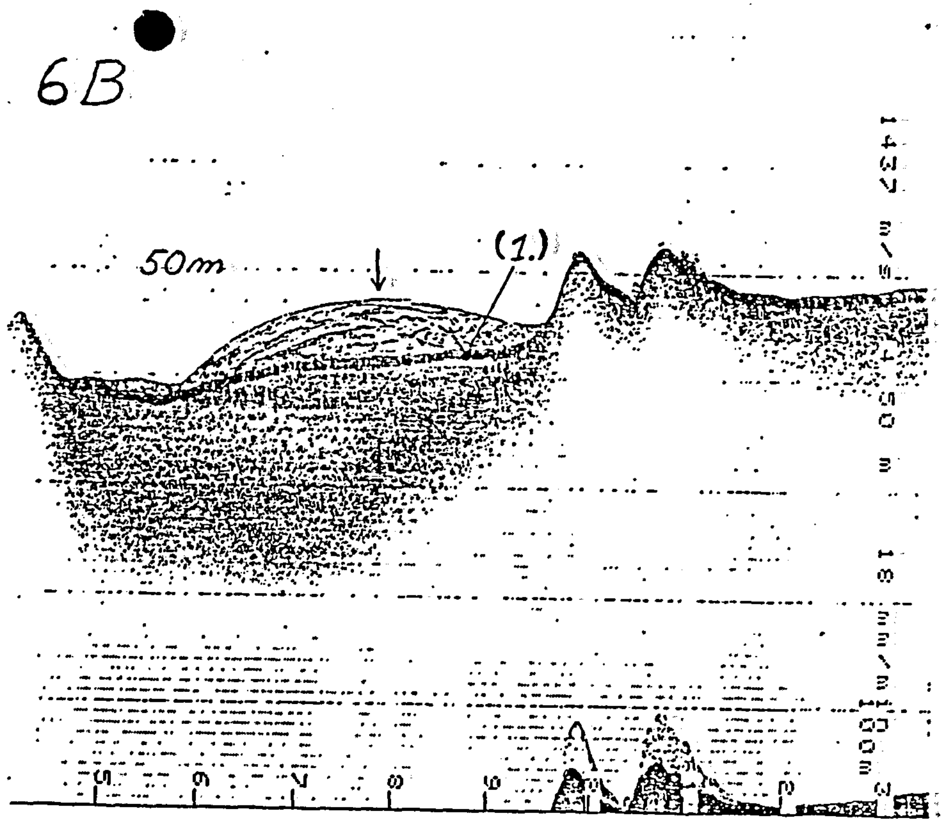


Fig. 5. Depth (cm) of of the maximum 137 Cs activity (DPM, wet sediment) in the sediment cores taken during the Sediment Baseline Study sampling.







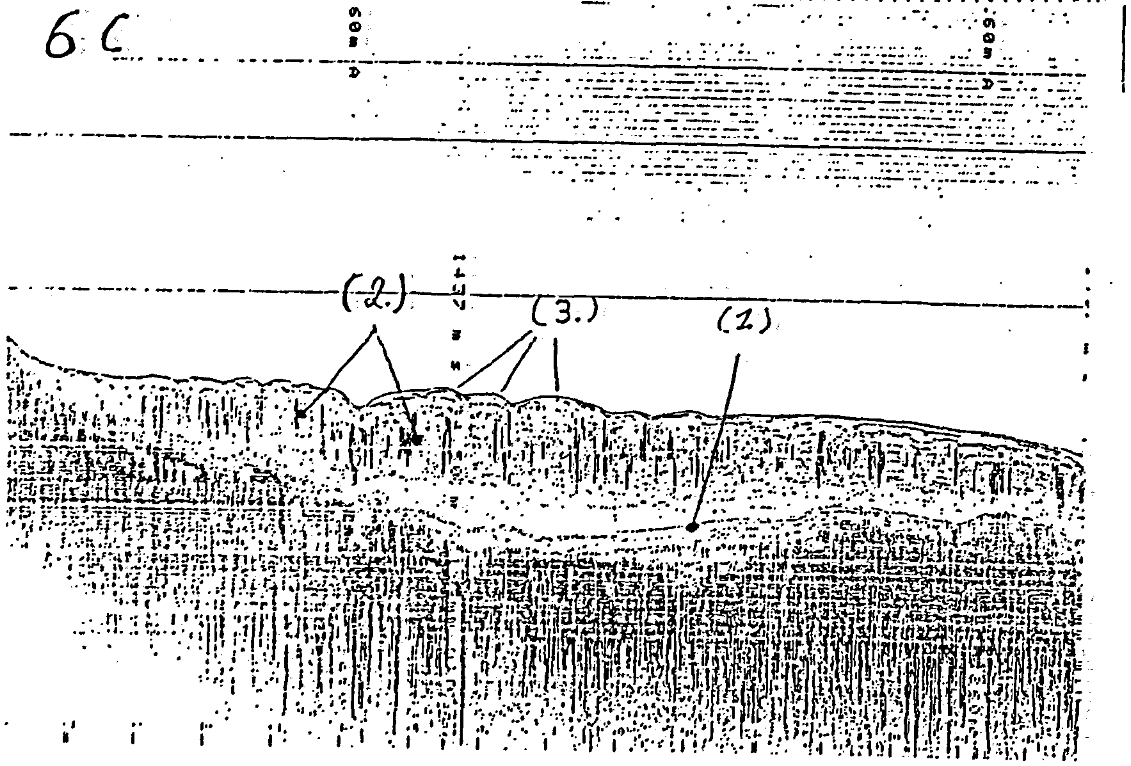


Fig. 6 A. Echogram of the Mecklenburg Bigt . The samples were taken from this 24 m deep basin from the ca. 5 m thick resent package of resent soft sediments (the final place marked with an arrow). The package is owerlying an old erosion horizon (1) clearly seen under even the thickest part of the acoustically very transparent sediment formation.

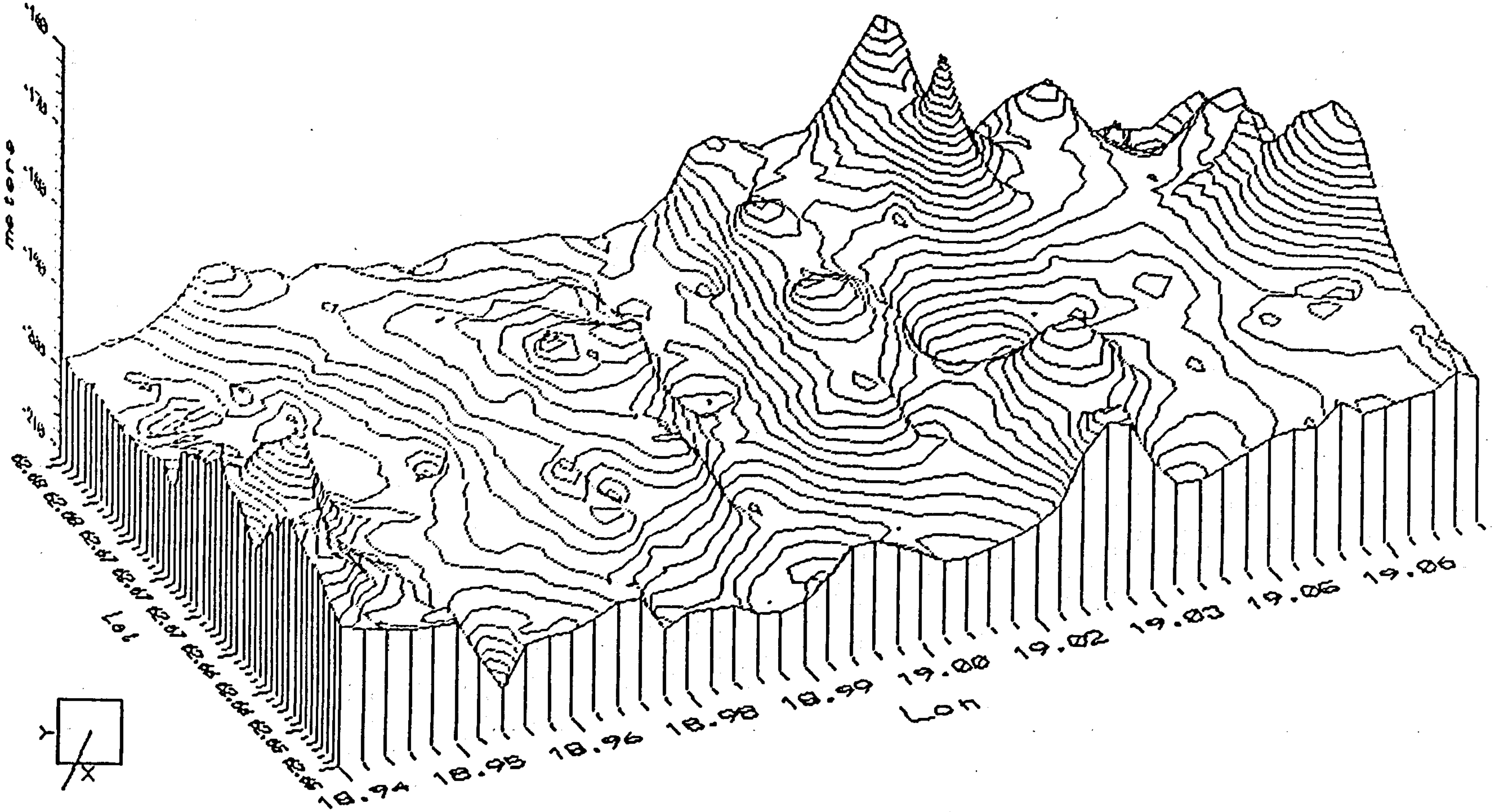
Fig 6 B. Echogram of a sediment pillow in the Gulf of Finland (GF-6). The samples were taken from the top of this 52 m deep formation. A hard bottom horizon (1) is clerly discerned at the deplh of some 5 m below the surface.

Fig. 6 C. Echogram from the Åland Sea at the depth of about 160 m. A strong reflector (1), probably glacial clay, is buried under a sediment package, some 30 - 40 m thick and acoustically transparent. The black spots inside the recent part (2) are assumed to be reflections of gas containing "pockets". The undulating surface may be reflactions of "dunelike" formations, which indicates water movement and uneven transport, may be even erosion over this surface.

Fig. 7

The SURFER plot is based on echo-soundings made by r/v ARANDA along parallel profiles. Contour line interval is 1 meter.

Site - Hernosend Deep



ANNEX 1. Description of the sediment sampling stations.

Katt1 (155)

The basin represents the outer part of the Great Belt channel, and it is mainly influenced by the Sound area. Depth below the thermocline and halocline (at 20max). Reflector layer at 4 meters from the surface of the sediment (4 meters of postglacial, underneath glacial clay). Characterized by very small topographic variations. Silty, somewhat sandy, oxidized sediment.

Katt2 (156)

The basin represents the NE Kattegatt, being a prolongation of the western slope of the deep channel in Kattegatt, with an irregular topography. The sedimentation area is situated on a terrasse. There is at least 10m thick layer of postglacial soft sediment, but gas-containing mud prevents precise estimation. The sediment surface is oxidized, but redox turns negative already at 4cm depth.

Kiel Bight (157)

Reflector at 7m visible now and then; gas containing lower layer does not allow acoustic penetration; very flat topography. The selected site is in the western part of the sedimentation basin of the Little Belt area. The area has hydrographically strongly varying conditions, with a strong halocline. Redox positive down to ca. 5 cm, after which depth also an indication of H_2S can be detected. Trawling tracks detected by side scan sonar, which may weaken the usefulness of the station as a monitoring station. Because of surrounding land, probably affected by agricultural discharges.

KB2 (158)

In the echogram, a well-known channel (possibly eroded) can be seen. Gas containing sediment bed, with some structure reflecting at about 4m. Some patchiness in the surface structure. Strong erosion conditions prevent its use as a monitoring station.

Mecklenburg (159)

A 5m thick package of recent marine sediment lying on top of a very flat reflector, which possibly marks the dry-land era. Very weak reflectors are also visible in the upper sediment package. Probably representative of outflow water from the Great Belt area.

Lübeck Bay (160-161)

Package of sediments where gas prevents the acoustic penetrations. The visible bed is 2m thick, probably deeper (hard rock surface not seen). The sediment surface is oxidized, with redox turning negative from 5 cm on. There are gas reflectors in the sediment bed. Land pollution is significant (agriculture, industry, tourism).

Arkona basin (162-166)

The study area is in the central part of the flat basin. Secondary stations and primary station differed somewhat in thickness of the mud layer. The sediment bed has a thickness of around 2.5 - 7m, with ca 3m. of clay beneath. This basin is the first real representant of the Baltic Sea (southern part). Some patchiness in the thin organic surface, indicated by the video document. The sediment surface is oxidized, redox is positive down to 7 cm. Cs137 analysis shows a maximum activity at the depth of 2-3 cm. No animals detected. Small (1-2cm) aggregates (clumps) visible, possibly a consequence of trawling. Some trawling tracks were indicated by echo and sonar.

Bornholm basin (167)

As the bottom water layer and sediment surface area is usually reducing, sediment laminae were expected, but not found, neither by visual inspection nor x-ray. The selected station is situated at the far eastern end, close to the Slupsk channel, representing the outlet of the Bornholm basin. Probably the site is not very representative of the basin. Flat bottom, mud layer thickness (down to the reflecting surface) ca 2m. The site appears to be unsuitable for reference use.

BCSIII-10 (168)

The site is situated at the southern entrance to the eastern Gotland basin. The bottom is flat, with 2-3m to the reflecting surface. Several reflecting surfaces above the main acoustic barrier due to gas, probably the clay layer. Mud thickness appears to increase towards the north in the area. Erosion due to contact to halocline may affect the station's usefulness as a monitoring station. The site appears to be unsuitable for reference use.

Gdansk Bay (169)

Acoustically very transparent area, with several sharp reflectors. No traces of gas. Top of the sediment has been reduced. There is no regular current system to disturb sedimentation. The basin is probably highly affected by pollution from industry and agriculture. It is also the main accumulation area for pollutants from the Vistula river. Probably a suitable area for reference use, with respect to land-based discharges.

Lithuanian coast (170)

The selected area belongs to the north-eastern part of the Gdansk basin, which is separated from the eastern Gotland deep by a treshold (in southwest - northeaset direction). Represents pollution from Kaliningrad and Klaipeda. Possibly an erosion surface below the recent sediment layer. In the recent sediment layer there are two reflectors close to each other. Probably no gas in the reflecting clay.

Eastern Gotland deep (171)

This is the largest sedimentation basin in the Baltic Sea, with substantial parts deeper than 200m. The station is well-known, situated at the western part of the basin, close to the maximum depth of the basin. There seems to prevail regular sedimentation conditions, as the distance to land is large in each directions. The station has long history of sediment studies. The area has a multitude of small basins. According to the echogram, the selected site shows the largest bed of Litorina mud over the Ancylus layer. Ten topmost centimeters are formed by slurry material, not real sediment. This layer was detected already in 1992, though its thickness was only 1cm them. Earlier reports of such slurry do not exist. X-ray study reveals the slurry to be laminated, in spite of the apparent homogeneity. Cs137 results indicate that the Chernobyl activity is roughly evenly distributed from top of sediments down to eroded glacial clay. This sequence is typical of the Baltic Proper, but it can be seen very clearly from ths. The station has very stable sedimentation conditions, with practically no current.

Riga Bay (172-175)

Probably presently a net sedimentation area. After the narrow strait leading into the bay, a series of surfaces can be detected. The lowest represents probably glacial till, then follow upwards two weaker reflecting surfaces, the lower one probably of varved glacial clay and the next one glacial clay, and in two areas. The more recent sediment bed is on top of the clay. Elsewhere the surface consists of

Fårö Deep (176, 177)

Two positions were visited. In both, very exceptional sediment, on top 2 cm of slurry, but clearly laminated material, followed by a layer of very soft, grey, clayey sediment with obviously very high water content. The soft clay could be suspended glacial clay, redeposited under marine conditions (smell of H2S). Probably the station studied does not represent the Fårö basin, while otherwise the area might be very interesting from the point of view of research on transportation processes. The studied sites are unsuitable for a reference use.

West Gotland Deep (178)

The re is a clearly distinguishable layer of 2m, beneath at least two reflecting layers. Uneven topography. Cristalline baserock (earlier sedimentary base). Probably the studied station represents the basin; the general structure of the core resembles those reported earlier. On the surface, bacterial film. The upper layers brownish, laminated, 1-7.1cm brownish-blackish, reduced, 25-30 laminae (not very clear), successively changing between 7.1-11cm from grey-brownish to more firm and more clearly laminated (14 laminae, last one very black, 2.5cm). 11-24 cm, more firm, brown-green sediment with a few laminae. 25-44 firm, blue-greyish, sulphide-spotted, with a few visible laminae. According to x-ray studies, the topmost 3cm varved, then again at the depth of 35cm was a 5cm thick varved layer. Between these layers, no laminae was found.

Landsort basin (180)

Large depth variations. The samples were taken from a flat plateau. The studied position probably not good for our puposes. Sedimentation conditions seemingly very similar to those found at East Gotland Deep, Fårö Deep and at Western Gotland Deep. Large flat area south-east of the deep. The deep itself is very mixed due to unknown reasons, being thus not suitable for any monitoring purpose. Coastal conditions probably partly reflected, in combinaison with general Baltic Sea conditions, due to the overall circulation system of the waters. The area is probably affected by the outflow of Bothnian Sea waters.

LL19

On top of the sediment bed, there is a thick package of acoustically penetrable sediment. The thickness of this mud increases with water depth, which is an indication of recent sediment accumulation. The sediment samples are very gaseous, even though acoustic penetration is very good. Large depth variations.

GF - 1

The area is characterized by very variable small scale differences in the topography and the reflectors on the echo sounder indicating glacial sediments sometimes reach the sediment surface. The basin chosen for sampling shows several distinct reflectors in the echogram. These glacial clay layers are buried in the sampling station at the depth of about 15 m below the sediment surface. The recent package of soft sediments contains some gas.

GF - 2

The small basin chosen shows the same features as GF-1. Gas formation makes the deeper reflectors nonvisible.

GF-3

Large sedimentation area with abundant small scale variations. A clear reflector is visible in the very surface on large areas. This reflector might be a gas containing recent layer on the top of the sediment but allso a discontinuity layer caused by bioturbation. The final sampling was performed on a sediment area, where this reflector was at the depth of 5 - 6 m.

GF-4

The reflectors indicating glacial clay sediments was very variable, but distinctly buried below a package of recent sediments. The surface topography is very even on large areas, which indicates basin filling sedimentation over a longer period. At the sampling position the glacial reflectors were at a depth of some 15 m and an additional reflector was visible emmidiately above the gas containing bulk of the resent sediments. Gas in the sedimnet package decreased the penetration of echo sounding, and the varable reflector was not allways discerned.

GF-5

Large basin with abundant small scale variations in topography. Several small sedimentation basins filled with acustically transparent soft sediment between strongly reflecting peaks and ridges. At the sampling position gas in the recent sediment made the deeper reflectors invisible, but they were sited deeper than 4 - 5 m, probably 7 - 10 m.

GF-6

Large basin in a depression characterized by bedrock and glacial moraines. The depression is filled with a pillow-like package of acustically very transparen recent sediments. A clear reflector, very much like the one found also on the sediment surface on GF-3, was here sited clearly below the surface the depth varying between a few meters to more than 10 meters. The samples were taken on the top of the large pillow-like sediment package, and the reflector described abowe was not visible, but still deeper than 10 m.

XV-1

Probably the largest basin in the area NE of the Gogland island. Has been sampled during several years before. The glacial reflectors are acoustically visible only in the fringes of the sedimentation basin and otherwise buried below a more than 15 m thick layer of recent sediments.

LL-7

Semilarge separate basin in the middle of the Gulf of Finland. Large areas 60 - 80 m deep and the deepest part 105 m is probably the deepest trench of the whole Gulf of Finland (area west of the Hanko peninsula). Acoustically transparent sediments with some gas in the middle parts.

Åland Deep

Large trench area between Sweden and Finland. The deepest part of the whole formation is about 300 m. Strong erosion is eroding the deepest parts, but along the W flank of the trench active sedimentattion is prevailing at the depth range between 250 to 150 m. The bedrock and glacial clay layers are clearly discerned acoustically in this sedimentation area. The sediments at the sampling position are characterized by besides the above general features also by dunelike smallscale rounded ridges and depressions a few meters in hight. These give the impression of dynamic sediment surfaces. The recent sediment package on the sampling site is some 20 m thick, and only very sligt gas formation was recorded as small pockets.

EB-1

The Eastern Basin (EB) is the largest formation in the Bothnian Sea. Large areas are deeper tha 100m and the basin is extended to the NW ending up in the deepest part on the Swedish side.
The sampling site is characterized by small scale variations of a few meters to several 10 meters. The average depth is some 120m. Recent, Post Glacial sediments are dominating, but erosion channels can be found in the area. At the sampling site the sediments are typically of a basin filling character. The clear acoustical reflector at the depth of 2-4 m below the sediment surface is probaly the border between Ancylus and Litorina stages in the Baltic sea evolution.

Härnösand Deep

The deepest area of the Eastern Basin in the Bothnian Sea exceeding 210 m depth. The sediments in this deep area are generally surprisingly thin, which might be an indication of currents and internal water movement. The Ancylus - Litorina reflector was not discerned clearly among several other reflectors.

BO-3

This deep area is the largest and deepest basin in the Bay of Bothnia. Large areas are deeper than 100 m. The sampling site Post glacial sediments are deposited on an acoustically visible moraine and till reflector the whole package beeing some 10 - 12 m thick.

F-9

The station is sited in the same basin as BO-3. It is in the deepest depression of the basin. Acoustically very transparent sediments cwerly the glacial till and moraine reflectors. On the sampling site the thickness of the Post Glacial sediments was some 10 - 12 m.

F-2x

In the Northernmost part of the Bay of Bothnia large areas are hard, sandy or moraine bottoms. The active sedimentation basins are small and often sited in the vicinity of erosion bottom areas or even erosion channels. The sampling site is in one of numerous small sedimentation areas. Acoustically transparent Post Glacial sediments, containing several reflectors, 5 -6 m thick is sedimented directly on the hard moraine.

US-5b

This small separate trench is the deepest basin in the Bothnian Sea. The acoustic reflectors in the transparent sediment package are several and not very regular. The Post Glacial sediment was on the sampling site some 10 - 14 m thick.

Table 1. Station list

Station		lat	long	d
155	KATT1	56 26.57	11 38.02	28
156	KATT2	57 17.57	11 28.59	75
157	KIELBIGHT	54 44.30	10 10.54	23
158	KIELBIGHT2	54 43.23	10 13.05	24
159	MECKLENBURG	54 19.03	11 32.57	27
160	LÜBECKBAY	54 04.59	11 10.00	22
161	LÜBECKBAY2	54 07.00	11 10.00	23
162	ARKONA-1	54 58.32	13 42.33	50
163	ARKONA-2	55 01.27	13 47.43	47
164	ARKONA-3	54 58.50	13 47.21	42
165	ARKONA-4	55 01.45	13 42.47	42
166	ARKONA(BY2)	54 59.97	13 45.01	45
167	BORNHOLM	55 15.29	15 57.56	90
168	BCSIII-10	55 32.53	18 23.48	89
169	GDANSKBAY	54 55.00	19 14.44	107
170	LITHUANCOAST	55 34.59	20 29.47	68
171	GOTLAND(F81)	57 18.28	20 03.33	240
172	RIGABAY-1	57 31.14	23 13.14	45
173	RIGABAY-2	57 30.20	23 14.07	44
174	RIGABAY-4	57 28.58	23 13.18	62
175	RIGABAY-1	57 40.50	23 36.06	54
176	FARODEEP	58 05.44	19 50.57	183
177	FARODEEP-2	58 06.01	19 47.07	155
178	NGOTDEEP	58 10.59	18 09.11	145
179	LANDSORTBAS	58 37.50	18 31.59	215
180	LL19	58 50.57	20 13.05	200
181	GF-1	59 42.29	24 41.12	84
182	GF-2	59 50.30	25 51.59	84
183	GF-4	59 32.57	27 46.09	35
184	GF-5	59 45.51	28 14.21	24
185	GF-6	60 20.29	28 00.29	44
186	GF-3	59 47.21	27 07.39	57
187	XV-1	60 14.16	27 15.29	61
188	LL-7	59 50.57	24 49.59	77
189	Åland Sea	60 01.18	19 32.48	214
190	EB-1	60 59.21	19 43.59	130
191	EB-2	61 18.51	20 07.36	130
192	Harnosand	62 39.02	18 59.56	200
193	BO-3	64 18.50	22 19.14	110
194	F-9	64 41.26	22 02.57	137
195	F-2X	64 58.29	23 23.20	100
196	US-5B	62 35.13	19 58.29	210