

LGT Series of Marine Geological Maps No. 1  
SGU Series of Geological Maps Ba No. 54

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**Scale 1 : 500 000**  
**A short description**

*Leonora-Živilė Gelumauskaitė,  
Algimantas Grigelis,  
Ingemar Cato,  
Marijonas Repečka,  
Bernt Kjellin*



Vilnius - Uppsala 1999

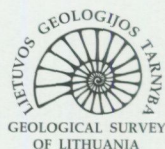
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L.-Ž. Gelumauskaitė<sup>1</sup>, A. Grigelis<sup>1</sup>, I. Cato<sup>2</sup>, M. Repečka<sup>1</sup>, B. Kjellin<sup>2</sup>. Centrinės Baltijos jūros batimetrinis ir dugno nuosėdų žemėlapis. M. 1:500,000. Trumpas aprašymas [Bottom topography and sediment maps of the Central Baltic Sea. Scale 1:500,000. A short description] // LGT SERIES OF MARINE GEOLOGICALS MAPS No.1 / SGU SERIES OF GEOLOGICAL MAPS Ba No. 54. Vilnius-Uppsala, 1999

L.-Ž. Gelumauskaitė<sup>1</sup>, A. Grigelis<sup>1</sup>, I. Cato<sup>2</sup>, M. Repečka<sup>1</sup>, B. Kjellin<sup>2</sup>. Kartor över centrala Östersjöns batymetri och sedimentfördelning. 1:500,000. En kort beskrivning [Bottom topography and sediment maps of the Central Baltic Sea. Scale 1:500,000. A short description] // LGT SERIES OF MARINE GEOLOGICALS MAPS No.1 / SGU SERIES OF GEOLOGICAL MAPS Ba No. 54. Vilnius-Uppsala, 1999

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## Abstract

Gelumbauskaitė, L.-Ž., Grigelis, A., Cato, I., Repečka, M., Kjellin, B. Bottom topography and sediment maps of the central Baltic Sea. Scale 1: 500,000. A short description // LGT Series of Marine Geological Maps No. 1 / SGU Series of Geological Maps Ba No. 54. Vilnius-Uppsala 1999. ISBN 9986-615-18-6 / ISSN 0373-2657

Within the framework of the GEOBALT project, one bathymetric and one bottom sediment map of the entire central Baltic Sea at a scale of 1:500,000 has been worked out and compiled from various relevant and new information collected by the states around the Baltic Sea. The work, managed by Lithuania and Sweden, has been undertaken as a cooperative project between the states. Supplementary to the hard prints, GIS data bases have been produced for the bathymetric and bottom sediments data. Both the maps and data bases are the most up-to-date and detailed regional compilations made for the central Baltic Sea. The GEOBALT maps and data bases are aimed at and directed to the scientific, commercial, and general public users of Baltic Sea information.

**Keywords:** Central Baltic Sea, geological map, bathymetry, bottom sediments, GIS data base.

## Introduction

The bottom topography and sedimentation of the Baltic Sea have been studied for more than one hundred years. Several maps at various scales have been compiled and published covering both the entire Baltic Sea and parts of it. Nevertheless, no regional compilation with isobath intervals better than 20 m for the central Baltic Sea has been made until now. Nor has an effort been previously made to bring the different sediment-classification systems used within the region into one map describing the bottom sediments in a comparable way.

Over several years, a large set of depth and sediment data has been gathered at the Lithuanian Institute of Geology (LIG), Department of Baltic Marine Geology. The attempts to compile maps, at a scale 1:200,000 and contour lines at 5-2 m, for the southeastern and central Baltic Sea were made by LIG in 1982-1991 (unpublished). In 1982, the Lithuanian Institute of Geology compiled a bathymetric map of the SE central Baltic Sea at a scale 1:200,000 with 2-m-depth contour intervals, using the bathymetric map data of the GUGK SSSR 1975-1977 (Gelumbauskaitė, 1982). In 1996, based on echo-sounding data collected by the Lithuanian Institute of Geology and Stockholm University during the joint Lithuanian-Swedish expeditions, a digital version of bathymetry of the central Baltic Sea with 5-m-depth contour intervals

was compiled (Gelumbauskaitė, Olea, 1996). Simultaneously, the Geological Survey of Sweden (SGU) compiled an outline bottom sediment map over the entire Baltic Sea at a scale 1:2,500,000 (Cato et al., 1992) and, in cooperation with the former Geological Survey of Denmark (DGU), now GEUS, a bottom sediment map over the southwestern Baltic Sea, Kattegat, and Skagerrak (Kuijpers et al., 1992). These works made up the background and impetus to initiate, in 1994, a joint Lithuanian-Swedish project, "GEOBALT", aiming at the compilation of regional bathymetric and bottom sediment maps covering the central Baltic Sea at a scale of 1:500,000.

It was decided that the outline of the new bathymetric and bottom sediment maps has to cover the central Baltic Sea area belonging to Estonia, Latvia, Lithuania, Poland, Russia, and Sweden between latitudes 54° and 59° N (see Fig. 1). Cartographically, the maps were prepared on the WGS-84 ellipsoid in a Transverse Mercator projection with central meridian 20° E, Geodetic Reference System GRS-80 and 1' coordinate grid. The coast line and land information used in the two maps are taken from ESRI Inc. DCW (Digital Chart of the World™ 1:1 M). The final map preparation was made by the Department of Baltic Marine Geology, Lithuanian Institute of

## BOTTOM TOPOGRAPHY AND SEDIMENT MAPS

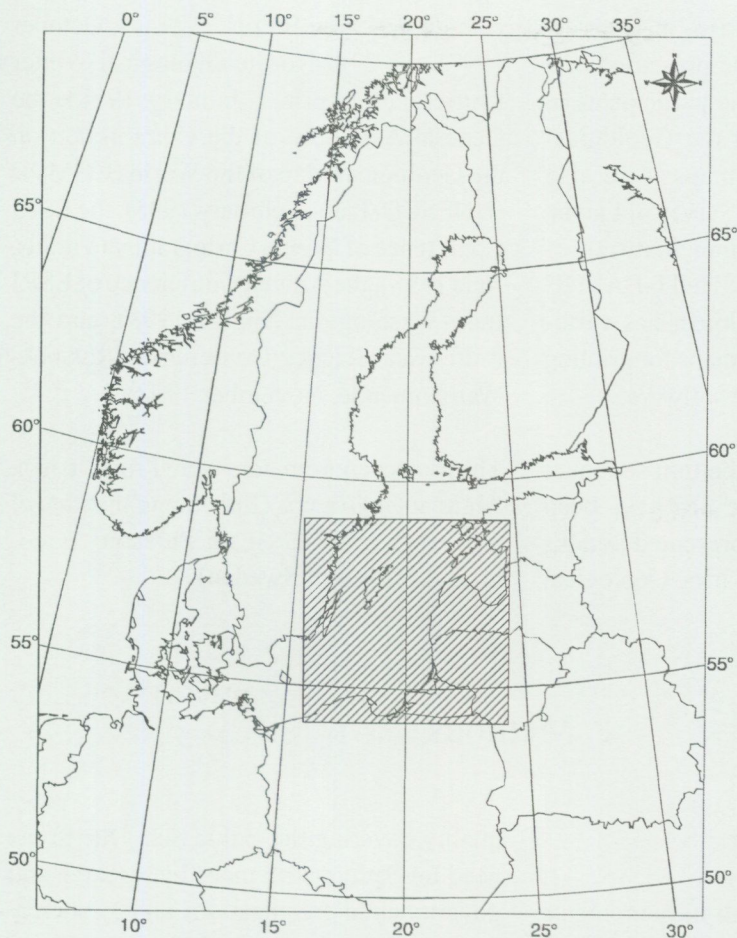


Fig. 1. Situation map of the central Baltic Sea area.

Sweden (SGU) and Swedish Maritime Administration (SMA) joined the GEOBALT Project in December 1997. Map publication expenses were covered on an equal basis by the Geological Surveys of Lithuania and Sweden, and partially supported by the Lithuanian Science and Studies Foundation through the Lithuanian Institute of Geology.

The concept for the map compilation and preparation issues were discussed in September 1995 at the Workshop held in the Lithuanian Institute of Geology, Vilnius. Map

Geology in 1995-1997; the maps are compiled in ARC/INFO™ GIS format by using digital data bases (formed by HNIT-BALTIC GEOINFOSERVISAS Ltd, Vilnius). The indexes of authors and factual material used are presented on the maps.

The GEOBALT Project was initially financed by the Geological Survey of Lithuania, and partly supported by the Lithuanian Institute of Geology. The Geological Survey of

legends and the technical conditions of preparation for printing were also coordinated. Representatives of the Geological Surveys of Lithuania, Latvia, Estonia, and Sweden; the Institute of Geology, Lithuania; and the Polish Geological Institute took part in the Workshop.

The issues that appeared during the work on map compilation were also discussed in November 1995 and September 1996 at the

Geological Survey of Sweden, in Uppsala. The completed maps were presented and accepted for printing by the participants in April 1998 in Uppsala at the Geological Survey of Sweden. The maps were also evaluated at the Geological Survey of Latvia, Riga, and at the Lithuanian Institute of Geology, Vilnius, in 1998. HNIT-BALTIC GEOINFOSERVISAS Ltd., Vilnius, has cartographically prepared these maps for printing by means of ARC/INFO™ software.

The new bathymetric and bottom sediment maps of the central Baltic Sea have been displayed on posters and presented at talks given at the Fifth Baltic Marine Geological

Conference "The Baltic" (Vilnius, October 1997), the 23rd Nordic Geological Winter Conference (Aarhus, January 1998), the General Assembly of the Commission on the Geological Map of the World (CGMW) (UNESCO, Paris, February 1998), the ESRI Conference of Digital Cartography (Vilnius, June 1998), the Annual Conference of ESRI Inc. (Washington, August 1998), and the Baltic Sea Science Conference (Rostock-Warnemuende, November 1998).

The project coordinators were Prof. Dr. hab. Algimantas Grigelis (Lithuanian Institute of Geology) and Dr. Gösta Persson (Geological Survey of Sweden).

## 1. Methods

### 1.1. Bottom Topography

Although methodical depth measurements in the Baltic Sea were begun during the 19<sup>th</sup> century, no detailed bathymetric maps covering the entire sea have been produced until now. Systematic echo soundings in their territorial waters, as well as partly in their economic zones, have been performed by the hydrographic services of the various states surrounding the Baltic Sea. For military reasons this material is mainly considered secret. This circumstance explains the impossibility of producing, and thus the lack of, bathymetric maps of high

quality covering the Baltic Sea. Due to the need for bathymetric maps by research and governmental organizations and by society in general, some maps based on open depth data had previously been produced covering the Baltic Sea. Of these, the following are the most important:

- ◆ a map covering "The Baltic Sea Area" compiled by B. Winterhalter (1981) at a scale of 1:1,700,000 with 20-m isobaths;
- ◆ a hydrographic relief map covering the waters surrounding Sweden at a scale of

1:1,700,000 with 25-m isobaths (Svenska Reproduktions AB, 1970);

- ◆ a Swedish navy map "Djupskiktskarta" at a scale 1:1,000,000 with 25-m isobaths (Generalstabens Litografisk Anstalt, Stockholm, 1971);
- ◆ a Swedish aeronautical map at a scale 1:1,000,000 with 25-m isobaths down to 100 m, 50-m isobaths down to 200 m, and 100-m isobaths for greater depths (LiberKartor Stockholm, 1977);
- ◆ a Baltic Sea bathymetric map at a scale of 1:500,000 with 10-m isobaths compiled by L.-Ž.Gelumbauskaitė and V.Litvin (1986, unpublished). The last map contained material from hydrographic, geological, and geophysical studies performed by the USSR Institute of Oceanology (IOAN), GUGK USSR, and other Baltic geological institutions;
- ◆ a central Baltic proper bathymetric map at a scale 1:500,000 with 5-m isobaths compiled by L.-Ž.Gelumbauskaitė;
- ◆ various Swedish and Russian (USSR) marine nautical charts at a scale 1:200,000, 1:500,000, and 1:1,000,000 with different depth contour intervals.

The present GEOBALT bathymetric map is far more detailed than the other maps mentioned here. With its 5-m-depth contour intervals in its southern and central part and

with 10-m-depth contour intervals in the northern part, it shows the changes in depths and the size of submarine land forms better than the previous maps. Major features of the proper relief reflect the seabed genesis and recent ongoing processes. The morphology of the central Baltic Sea varies considerably and is closely related to the bedrock morphostructure. The southern part is notable for latitudinal extension, the middle part for longitudinal extension, and the northern part for submeridional (SSW-NNE) direction of the bottom relief macroforms.

For the preparation of the draft bathymetric map (compiled and edited by Dr. Leonora Živilė Gelumbauskaitė, LIG), numerous hydrographic measurements during the period 1972-1995, as well as other bathymetric information from, for example, geological mapping, have been used. The most important contributions are taken from the following sets:

- ◆ bathymetric maps at a scale 1:200,000 and 1:500,000 from the central Baltic Sea;
- ◆ bathymetric maps at a scale 1:200,000 of the Polish and Estonian waters and of the Gulf of Riga area;
- ◆ a bathymetric map at a scale 1:500,000 of the Russian waters;
- ◆ bathymetric charts at a scale 1:25,000 and 1:50,000 of the southeastern Baltic Sea;

- ◆ hydrographic data from the sea charts at a scale 1:200,000 of the Swedish EEZ;
- ◆ Swedish marine nautical charts;
- ◆ Russian (USSR) marine nautical charts.

All the initial data were presented in analogous formats, the southeastern and the central Baltic Sea in Gauss-Krüger projection and west of Gotland in Mercator projection.

The working scale for the compilation of the bathymetric map was 1:200,000. The central Baltic Sea area (Gotland depression; Gdansk depression; Estonian and Latvian sectors) was manually prepared. Later, data from the Polish and the Russian sectors were inserted. This analogous map version was scanned, digitized, transformed into a TM projection, and formed into a GIS data base.

Hydrographic data for Swedish areas west of Gotland were scanned and transformed from a Mercator to a TM projection. The depth contours were drawn in this projection in an ARC/INFO environment. Then the digital version was corrected and edited. The gaps between isolated tracklines of the depth measurements were completed with depth data from the marine nautical charts from the Swedish and the USSR hydrographic services at scales 1:200,000, and 1:500,000. Having in mind, that data from marine charts sometime are incorrect, they were used as an auxilliary material. A

handmade bathymetric map from the Stockholm Archipelago area, based on marine navigational charts and digital data for 5-, 10-, and 15-m isobaths supplied by the Swedish Maritime Administration, was also included.

Taking into account the special features of bottom topography and factual density of depth soundings, a 5-m contour interval was chosen for the larger, southern and central part of the map. In the northern part from 17°00'–19°00' W and 57°20'–59°00' N, as well as 19°00'–21°30' E and 58°00'–59°00' N, depth contours were drawn at 10-m intervals. The greatest and smallest depths, in the depressions and shoals, respectively, are shown on the map as point information and reflect only main hydrographic data used.

After the final editing and approval of the entire map, the Bathymetric GIS Data Base, color legend and three-dimensional sea-bottom view were produced with ARC/INFO™ 7.1.2 software. Following the international praxis, physical, geographical and orographical names on the map are given in the national languages.

## 1.2. Bottom Sediments

In the draft bottom sediment map (compiled and edited by Dr. Marijonas Repečka, LIG, and Dr. Ingemar Cato, SGU), data from Lithuanian, Latvian, Estonian, Swedish, and Polish marine geological maps at scales

ranging from 1:50,000 to 1:200,000 (Fromm, 1943; Kjellin et al., 1987; Axberg et al., 1988; Elhammer et al., 1988; Tammik, 1990; Cato et al., 1992; SGU, 1999), as well as information from various expeditions in the Baltic, reports and publications, are included (among others Blazhchishin & Emelyanov, 1969; Blazhchishin et al., 1970; Emelyanov, 1988; Emelyanov & Kharin, 1988; Gripenberg, 1934; Martinsson, 1958, 1965, 1979; Mörner et al., 1977). It was found, when analyzing the grain-size distribution and lithology of the surficial sediments in the Baltic marine areas, that the most informative data base is obtained by applying a decimal-based classification of sediments. This also facilitated the integration of a large amount of previously published data sets.

The separate maps of bottom sediments, prepared by the different authors for their national waters, were integrated into one complete map in accordance with the requirements of the 1:500,000 scale. Sediment boundaries were drawn on the basis of sediment-distribution observations, taking into account the character of the seabottom topography in different areas.

The bottom sediment map shows the lithological type of sediments on the bottom surface (0-5 cm). The distribution of deposits of various composition (boulders, pebbles, gravel, sand, silt, and clay) reflects the various depositional regimes, ranging from erosion to transit to sedimentation conditions. Moreover, the map shows

geological features of different ages, ranging from pre-Quaternary rocks to areas of Pleistocene glacial deposits to Holocene, recent, sediments.

Due to the different classification systems used on the western and eastern sides of the Baltic Sea, the legend to the sediment map contains one column of explanatory boxes referring to the western part and one column of boxes referring to the eastern part of the central Baltic Sea. The legend for the western part is in accordance with the Swedish Standard (SGF 1981; Karlsson & Hansbo, 1982) grain-size classification system, whereas the eastern part is in the system commonly used in the Baltic countries. To facilitate the comparison between the two slightly different systems of sediment classification, a correlation table is included in the map. Furthermore, each sediment color is marked with its own figure, which may be found both in the map and the legend.

The depth contours on the sediment map are drawn at 20-m intervals down to a depth of 100 m, and at 50-m intervals for depths deeper than 100 meters. The isolines are identical to those showed on the bathymetric map. Physical, geographical, and orographical names are the same in both map types.

The fully completed, manually prepared version of the bottom sediment map was, in the same way as the bathymetric map, scanned, digitized, transformed into a TM projection, and stored as a GIS data base.

## 2. Bottom Topography of the Central Baltic Sea

The central Baltic Sea extends eastward from the Bornholm Island to the North Baltic Basin in the north. The bottom topography of this area presages a complicated relief of polygenetic origin. Its northern regions show topographical forms of denuded peneplain type, dissected by the Ordovician and Silurian cliff. For the most part, it is covered by glacial deposits. On the lower parts of the slopes and on the bottom of the depression, these deposits are covered by marine plains.

The gently inclined submarine plateau to the west and east of Gotland Island, as well as the depression slopes, possess a topography that is due to glacial erosion and deposition. At greater depths, these conditions are gradually replaced by even surfaces of soft sediment. The southern and southeastern parts of the Baltic Sea are characterized by a glacial topography flattened by marine abrasion and/or accumulation processes.

The topography of submarine plateaus in the central Baltic Sea, both adjacent to the shore or between the depressions, is due to separate banks and shallows of different sizes. Usually depths in those areas reach 15-20 m. The information used in the GEOBALT map gives new details of the morphology of all the banks and shallows in the central Baltic Sea, such as the South Middle Bank (minimum depth, 14 m; on marine nautical charts No. 21003

and No. 8, the depth is given as 8 and 9 m respectively) and North Middle Bank (9 m) situated south of Gotland. The bottom relief of the shallow areas in the Swedish waters west of Gotland also includes new information, for example, Hoburg Bank (10 m) as well as Knolls Shallow (9 m). Due to scarce depth data of the shallow area between the Landsort deep and the Norrköping depression this area can not be depicted in detail. Thus, the minimum depth fixed at the southern end of the Halls Bank is, according to the main data base, 60 m, and at the northern end, 64 m. However, on the nautical chart No. 401 these depths are given as 41 m and 35 m, respectively, and on the chart No. 7, as 41 and 36 m, respectively.

The bank "Nielsen Shallow" (minimum depth, 66 m) showed on the present bathymetric map does not correspond to the Nielsen Shallow (minimum depth, 15 m) given in the nautical charts No. 401 and No. 7. The latter shallow was found in 1963 (Thunberg, 1967) and is situated 7.5 km (lat. 58°17' N and long. 18° E) to the west of the "Nielsen Shallow" exposed on the present map. These two shallows are geographically not the same features. In order not to confuse in future the present authors suggest that the former bank with minimum depth 66 m from now on should be named as Nielsen Bank and not as in

the present map "Nielsen Shallow". The real Nielsen Shallow, found in 1963 and with minimum depth 15 m, does not yet exist in our main data-base and therefore has not been exposed on the present printed map. However, the shallow is included in the CD-ROM version.

Besides this, the GEOBALT map also gives new details of the morphology of the banks and shallows east of Gotland, for example, the relief of Klints Bank (25 m), the newly named South Klints Bank (105 m), and Klaipėda Bank (minimum depth is 47 m; but on the nautical charts No. 21003 and No. 8, the depth is given as 45 and 47 m, respectively) southeast of the eastern Gotland depression. On the eastern area of the Baltic proper the shallow zone off Ventspils in detail exposes features as Bezymjannaja (10 m) and Vinkova (8 m) Banks, Mihailova Shallow (6 m), and in the southern Baltic proper Slupsk Bank (8 m).

For the first time, a bathymetric map of this scale shows the rugged morphology of the near-shore bottom landscape in the archipelago south of the Stockholm region. Here the isobath contours have been drawn in 5-, 10-, 20-, and 30-m intervals.

Negative forms indicate plains formed by basin sedimentation as one morphogenetic type. However, the detailed bathymetry reveals a set of complicated forms which may be a result of some redeposition processes when soft sediments have slid

into the depressions. The map indicates an intricate topography of the western and the eastern Gotland depressions (maximum depths, 185 and 176 m, respectively) and of Gotland Deep (maximum depth, 249 m, but on the nautical charts No. 7 and No. 401 the depth is given as 243 m). During the map construction, new features were detected in the Fårö depression (maximum depth, 200 m, but on the nautical charts No. 401 and No. 7, the depth is given as 183 and 189 m, respectively), for example, that the depression extends much further to the south than previously known and that the depression is divided by a long narrow bank (minimum depth, 156 m).

The eastern Gotland depression depicts a southward continuation into the Gdańsk depression. The latter depression has a maximum depth of 101 m (on the nautical charts, 114 m) close to the eastern steep slope. Further to the north there exists a well formed channel due to the paleovalley of the Nemunas River (maximum depth, 76 m). Another channel that descends into the southward continuation of the eastern Gotland depression is the Slupsk Furrow located to the north of the Slupsk Bank. The maximum depth of the Slupsk Furrow varies between 94 and 95 m (according to the nautical charts Nos. 8 and 21003).

At the latitude of Ventspils, close to the shore, there is a newly depicted, complicated topography of the Piltene depression (maximum depth, 70.6 m).

The topography of the Landsort Deep and the Landsort and Norrköping depressions is by the present bathymetric map depicted in more detail. The Landsort Deep is especially notable for its complicated denuded topography. Here, also, is the deepest spot of the Baltic Sea (according to the main data base, 463 m). On the Swedish nautical chart, sheet No. 7, and on the Russian chart, sheet No. 401 the depth is given as 440 and 459 m, respectively. The Deep itself is divided into three parts by two thresholds (minimum

depths, 164 and 205 m). On the eastern side, it borders on the Landsort depression (maximum depth, 220 m), whereas on the western side a sill, made up by the Nielsen and Halls banks, separates it from the Norrköping depression (maximum depth, 203 m; on the nautical charts No. 401 and No. 7, 203 and 120 m, respectively). The Karlsö depression (maximum depth, 114 m; on the nautical charts No. 401 and No. 7, 115 and 120 m, respectively) between the islands of Öland and Gotland, is newly depicted.

### 3. Bottom Sediments of the Central Baltic Sea

In order to compile the Baltic Sea sediment map, available material on sediment composition and distribution in various parts of the Baltic were collected and evaluated. The surficial sediments of the eastern part of the Baltic Sea were depicted according to the surveys and mapping data of Polish, Lithuanian, Latvian and Estonian authors, whereas the southern, western, and northern parts were based mainly on maps and unpublished data from the Geological Surveys of Poland and Sweden, respectively.

Due to differences in sediment-classification standards, the legend of the map is given separately for the western and the eastern parts. Sediments in the eastern part are

grouped according to the traditional decimal system (Bezrukov & Lisitsin, 1960), and in the western part according to the Swedish classification (Swedish Standard; SGF 1981) (Karlsson & Hansbo, 1982). The supplied correlation table facilitates comparison between the two systems.

In the eastern part of the Baltic Sea the following bottom types are distinguished:

- ◆ Pre-Quaternary rocks, uncovered,
- ◆ Pleistocene glacial deposits (tills),
- ◆ Baltic Ice Lake clay,
- ◆ Gravel (100-10 mm),

- ◆ Pebble (10-1 mm),
- ◆ Sand, coarse (1-0.5 mm), medium (0.5 - 0.25 mm), and fine (0.25-0.1 mm),
- ◆ Coarse aleurite (0.1-0.05 mm),
- ◆ Silt, fine-aleuritic (0.05-0.01 mm); mud, aleuritic-pelitic (<0.01 mm, 50-70%) and pelitic (<0.01 mm, > 70%).
- ◆ Clays of the Baltic Ice Lake, Yoldia Sea, and Ancylus Lake ("glacial clays"),
- ◆ Sand, coarse and medium (2-0.2 mm), and fine (0.2-0.06 mm),
- ◆ Silt (~ coarse aleurite) (0.06-0.02 mm) and gyttja clay—clay gyttja (clay with increasing organic content).

In addition there are also some minor, sandy areas of mixed grain-size composition, but these are too small to be separately distinguished on a map of this scale.

The Pleistocene morainic loam and Baltic Ice Lake clay are, in some areas, covered with unsorted sand. This 2- to 3-cm sand layer may have been deposited during the entire Holocene period, or more probably it is the residual material left after abrasion. Under normal sedimentary conditions, the sediments gradually pass from coarser to finer fractions with increasing water depth. Abrasion residuals, as well as sand and aleurite, in the zero sedimentation (transit) zone may, in places, be covered with pelitic sediments in recent sedimentary environments.

In the western part of the Baltic Sea, the following bottom types are distinguished:

- ◆ Crystalline and sedimentary rock outcrops,
- ◆ Glacial deposits (tills),

Gravel and pebble deposits are not distinguished in the shallow zone of the western part of the central Baltic Sea.

Basic regularities in sediment distribution in the central Baltic Sea depend on coastal and vertical zonation due to the hydrodynamic intensity of the sedimentary environment. In the shallow zone, which is most hydrodynamically active, coarse sand and gravel deposits prevail, but are seawards and, with increasing depth, are gradually replaced by finer aleuritic and pelitic fractions.

On the banks and shallows, even at great distance from the shore, due to more intense hydrodynamic conditions, coarser deposits are found. In the great depressions of the Baltic Sea, a final differentiation and sedimentation of fine-grained particles take place.

Near the shore in the northwestern part of the central Baltic Sea, many areas show regressional sedimentation facies due to land up-heaval and the lowering of the

erosion base. Here, coarser material often covers finer sediments of recent origin.

Also, in some central parts of the Baltic Sea, sedimentary regions typical of deep and shallow zones, as well as those of abrasion

and zero sedimentation (transit zones), are distinguished. Physical-chemical conditions at the bottom of these regions vary significantly, thus causing different geochemical and physical patterns in the bottom sediments.

## 4. GIS Data Base

The Baltic Sea bathymetric and bottom sediment maps were compiled in accordance with technical requirements submitted by the Lithuanian Institute of Geology for a scale of 1:500,000. The GIS data base was formed according to specification prepared by HNIT-BALTIC GEOINFOSERVISAS Ltd, Vilnius. Digital and cartographic images were worked out by the project leader, Rimantas Kaulakys, and engineer, Sigitas Radavičius. ARC/INFO™ 7.1.2, ArcView v. 3.0, and GeoVectra (ESRI Inc. USA) software; and extensions ArcScan, for data vectorization; ArcTin, for 3D image formation; and ArcPress, for converting graphic images and for printing, have been used. The work was done on a SunUltra 2 Creator work station.

The outlining of the GIS data base and the map preparation included the following steps:

- ◆ original raw cartographic material received from participating institutions

(at different scales and in different coordinate systems) was scanned;

- ◆ TIFF-formatted raster images were georeferenced by means of theoretical coordinates and ARC/INFO software;

- ◆ GIS data-base specifications for both maps were prepared – Geocode values correspond to those presented in the project of GIS standard, integrated in Lithuania;

- ◆ data for both maps were vectorized: depth contours, depth measurement points, depth values, placement for visualization symbols, sediment boundaries, and so on. ArcScan software was used for the vectorization. At the same time an attribute data base was formed with the main attributes of depth; bottom sediment classes;

- ◆ vectorized data were edited and corrected;

- ◆ data base was created in ARC/INFO™ format, according to the prepared specifications;
- ◆ proof-plots of the maps were made and supplied to the editors for editing;
- ◆ ARC/INFO software was used to prepare map insets: for the bathymetric map – a 3-D central Baltic Sea bathymetry image 1:2.5 M (by means of ArcTin software) and an Author Index of cartographic data; for the bottom sediment map – a correlation table of sediment-classification systems and an Author Index of sediment data;
- ◆ legends for the maps and symbols were created;
- ◆ ARC/INFO software was used for the map layout;
- ◆ new proofs were plotted and final version was edited;
- ◆ final maps and GIS database were delivered for latest approval.

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## Appendix 1: Technical Report

### I. Preparation of the digital Bathymetric and Bottom Sediment Maps 1:500,000 and GIS data base of the central Baltic Sea (by HNIT-BALTIC GEOINFOSERVISAS Ltd, Vilnius)

The digital bathymetric and bottom sediment maps at a scale 1:500,000 were prepared in 1996-1997 in accordance with technical requirements of Lithuanian Institute of Geology. The GIS data base of both maps has been prepared following the specifications.

Tasks carried out:

- ◆ scanning of the original research cartographic materials contributed by many of research institutions from Baltic region countries at different scales and in different coordinate systems;
- ◆ georeferencing of raster maps using theoretical coordinates by means of ARC/INFO software;
- ◆ vectorizing of the features of both maps: depth lines and points, placement of the visualization symbols, boundaries of different bottom sediments areas, and so on. ArcScan was used for the vectorization by zooming on screen. At the same time, the attribute data base was created. The main attributes are depth and bottom sediments class;
- ◆ preparation of correlation table of different classifications of bottom sediments and cartographic Author Index;
- ◆ creation of the map legend and symbols;
- ◆ design of the printed versions of both maps;
- ◆ printing of the final control digital maps by plotter;
- ◆ delivery of plots and GIS data base to the Lithuanian Institute of Geology.

The GIS data base is available in ARC/INFO format.

The digital data are in a Transverse Mercator, TM, coordinate system; Ellipsoid: World Geodetic System WGS 84; central meridian 20°; Zunits NO; Units METERS; Geodetic Reference System GRS 1980; Xshift 0; Yshift 0. Parameters: scale factor at central meridian 0.9996; longitude of central meridian 20 00 00; latitude of origin 00 00 00; false easting (meters) 500000; false northing (meters) 0.

The data-base size of the bathymetric map is 25 Mb. The data-base size of the bottom sediments map is 10 Mb.

**II. Specification of the GIS data base of Bathymetric and Bottom Sediment Maps 1:500,000 of the Central Baltic Sea**

1. Coverage: *SHORELINES*

*Shorelines data used in this coverage represents zero-line of the depth.*

<i>Feature attribute: GEOCODE</i>	<i>Feature</i>	<i>Attribute</i>	<i>Field</i>	<i>Attribute description</i>
hd13	<i>Shorelines</i>			

2. Coverage: *RIVERS (lines)*

<i>Feature attribute: GEOCODE</i>	<i>Feature</i>	<i>Attribute</i>	<i>Field</i>	<i>Attribute description</i>
hd06	<i>Rivers</i>	<i>NAME</i>	30, C	<i>River name</i>

3. Coverage: *LAKES (polygons)*

<i>Feature attribute: GEOCODE</i>	<i>Feature</i>	<i>Attribute</i>	<i>Field</i>	<i>Attribute description</i>
hd06	<i>Areas of lakes</i>	<i>NAME</i>	30, C	<i>Lake name</i>

4. Coverage: *BOUNDARIES (State boundaries, lines)*

<i>Feature attribute: GEOCODE</i>	<i>Feature</i>	<i>Attribute</i>	<i>Field</i>	<i>Attribute description</i>
as01	<i>State boundaries</i>			

## 5. Coverage: ISOBATHS (lines)

<i>Feature attribute: GEOCODE</i>	<i>Feature</i>	<i>Attribute</i>	<i>Field</i>	<i>Attribute description</i>
re19	<i>Isobaths</i>	DEPTH	7, N, 2	<i>Depth in meters</i>

## 6. Coverage: DEPTH (depth points)

<i>Feature attribute: GEOCODE</i>	<i>Feature</i>	<i>Attribute</i>	<i>Field</i>	<i>Attribute description</i>
re22	<i>Depth points</i>	DEPTH	7, N, 2	<i>Depth in meters</i>

## 7. Coverage: SEDIMENT (bottom sediments, polygons)

<i>Feature attribute: GEOCODE</i>	<i>Feature</i>	<i>Attribute</i>	<i>Field</i>	<i>Attribute description</i>
re23	<i>Areas of bottom sediments</i>	TYPE	3, N, 0	<i>Type of the bottom sediments</i>
		CLASS_ENG	70, C	<i>Name of the bottom sediments in English</i>
		CLASS_LT	70, C	<i>Name of the bottom sediments in Lithuanian</i>

## Appendix 2: Titles of the maps

### LITHUANIAN-SWEDISH PROGRAMME BATHYMETRY & SEDIMENTS OF THE BALTIC SEA (GEOBALT)

Programme Co-ordinators *Algimantas Grigelis and Gösta Persson*

#### BATHYMETRIC MAP OF THE CENTRAL BALTIC SEA

Scale 1:500,000

*Editor Leonora-Živilė Gelumauskaitė*

**Compiled by:** *Leonora-Živilė Gelumauskaitė*, Lithuanian Institute of Geology  
*Tomas Holmquist*, Swedish Maritime Administration  
*Vladimir Litvin*, Kaliningrad University, Russia  
*Boris Malkov*, Geological Survey of Estonia  
*Sergey Seredenko*, *Oskars Stiebriņš*, Geological Survey of Latvia  
*Szymon Uścińowicz*, State Geological Institute, Poland

#### Georeference Data:

Coordinate System: Transverse Mercator TM; central meridian 20° E; central scale factor 0.9996;  
ellipsoid World Geodetic System WGS 84; Geodetic Reference System GRS 80  
Coast line, map grid, and hydrography from The ESRI Digital Chart of the World 1:1 M data base  
Isobaths are drawn at 5-m intervals. In the NW area 19°-21° E and 58°-59° N, the map depicted  
bathymetric contours at 10 m

#### Digital Info:

Digitizing and cartographic design - *Rimas Kaulakys and Sigitas Radavičius*,  
HNIT-Baltic GEOINFOSERVISAS Ltd, Vilnius, Lithuania  
Software: ARC/INFO Version 7.1.1  
Hardware: SunUltra 2 Creator

**Project funded by grants from the Geological Survey of Lithuania (LGT)  
and the Swedish Maritime Administration (SMA)**

Recommended reference to this publication: Gelumauskaitė, L.-Ž. (Ed.), 1998. Bathymetric Map of  
the Central Baltic Sea, scale 1:500,000. *LGT Series of Marine Geological Maps No. 1 / SGU  
Series Ba No. 54*. Vilnius-Uppsala. [Gelumauskaitė, L.-Ž., Holmquist, T., Litvin, V., Malkov, B.,  
Seredenko, S., Stiebriņš, O., Uścińowicz, Sz.]

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the SWEDISH MARITIME ADMINISTRATION

Vilnius - Uppsala 1998

**LITHUANIAN-SWEDISH PROGRAMME  
BATHYMETRY & SEDIMENTS OF THE BALTIC SEA (GEOBALT)**

Programme Co-ordinators *Algimantas Grigelis and Gösta Persson*

**BOTTOM SEDIMENT MAP OF THE CENTRAL BALTIC SEA**

Scale 1:500,000

*Editors Marijonas Repečka and Ingemar Cato*

**Compiled by:** *Marijonas Repečka*, Lithuanian Institute of Geology  
*Ingemar Cato, Bernt Kjellin*, Geological Survey of Sweden  
*Oskars Stiebrīņš, Francis Kovalenko*, Geological Survey of Latvia  
*Jan Lutt*, Institute of Geology, Estonia  
*Priit Tammik*, Geological Survey of Estonia  
*Szymon Uścińowicz*, State Geological Institute, Poland

**Georeference Data:**

Coordinate System: Transverse Mercator TM; central meridian 20° E; central scale factor 0.9996;  
ellipsoid World Geodetic System WGS 84; Geodetic Reference System GRS 80  
Coast line, map grid, and hydrography from The ESRI Digital Chart of the World 1:1 M data base  
Isobaths are drawn at 20-m intervals for depths <100 m and at 50-m intervals for depths >100 m

**Digital Info:**

Digitizing and cartographic design - *Rimas Kaulakys and Sigitas Radavičius*,  
HNIT-Baltic GEOINFOSERVISAS Ltd, Vilnius, Lithuania  
Software: ARC/INFO Version 7.1.1  
Hardware: SunUltra 2 Creator

**Project funded by grants from the Geological Survey of Lithuania (LGT)  
and the Swedish Maritime Administration (SMA)**

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