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Holocene history on the northern part of the Kuršių Marios (Curonian) Lagoon

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The Holocene history of the Kuršių Marios (Curonian) Lagoon has been investigated using echosounding, high-resolution seismic and short gravity core data collected in 1998-1999. The objectives of the study was to compile a recent relief, to analyse a Holocene sequence according to stratigraphy based on seismounits and borehole cores, sedimentation conditions and depositional rate during Atlantic, Subboreal and Subatlantic climatic periods, and to reconstruct paleogeomorphology on the submarine coastal zone of the Baltic Sea during Litorina $_3$- Post-Litorina phases. The sedimentation conditions were compared to accumulational-erosional processes in the last century, based on the examination of the quantitative changes of the bottom topography, and to gamma dating of the short cores.
☐ *Holocene history, Curonian Lagoon, seismic units, sedimentation conditions, accumulation rate, paleogeomorphology.*

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INTRODUCTION

The Kuršių Marios (Curonian) estuary, as a 92.9 km long and less than half wide lagoon on the western coast of Lithuania, is an important basin, which evidenced the evolution of a south-east coastal zone of the Baltic Sea and the accumulation of sedimentary conditions (Fig. 1). These sediments are of polygenetic origin, mostly terrigenous clastic and biogenic. The cover of the Holocene deposits is very uneven and overlain by the Baltic Ice Laces and Ice Lakes deposits composed of clays to sand and gravel on the western part of the lagoon and till loam of the Late Weichselian (Upper Nemunas) on the eastern part towards the coastline plain. Thickness of Holocene ranges from 5 m in the SE part to 25 m in the NW part. Recent sedimentation is mostly influenced by wave action and drift transported to the sea from the Nemunas River. The modern mud and silt is patchily distributed and deposited in the western inlets, only.

Recent plain of the Kuršių Marios Lagoon bottom was formed under conditions of the Late Glacial and Holocene basin fluctuations. The lagoon was separated from the sea by a barrier island, named Kuršių Nerija (Curonian Spit), at Litorina-Post-Litorina stages. The topography shows that the study area in the northern part of the Curonian Lagoon (Lithuanian waters) is a shallow basin with 2-3 m depths prevailing. Maximum depths of 5.5 m have been found near the barrier island in the low of the southern part, and 8.0-m depths

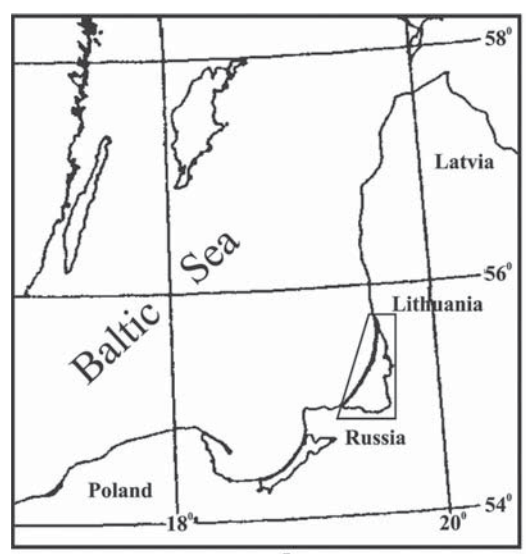

Fig. 1. Situation map of study area.

are in the waterway on the northern part. The bed forms oriented from north-west to south-east are most often in the morphological expression in this area.

MATERIAL AND METHODS

The Holocene sequence and paleogeography of the study area is described by Kabailienė (1967, 1996), Kunskas (1978, 1996) and Bitinas at al. (2001), and geomorphology has been dealt with by Gudelis (1959) and Červinskas (1955). The development of the Kuršių Marios by means of sedimentological data was analysed by Pustelnikovas (1998), Gulbinskas (1994-1995) and Galkus (1995).

This paper deals with a more detailed study on recent relief and depositional-erosional history based on the interpretation of echosounding, high-resolution seismic profiling, gamma dating and comparison with bore-hole stratigraphy. The material for this paper was collected in 1998-1999 during geophysical-geological survey of Kuršių Marios Lagoon done according to a joint Lithuanian-German project.

For this survey a vessel "Peilboot Ludwig"(7.8-m long and 2.5-m wide boat) owned by NAUTIK Nord GmbH, Germany; a Navstar 12 channel L1 GPS receiver, Digital VDO echosounder system (200 kHz) with a paper recording echosounder LOWRANCE X-16 200 kHz Model, a shallow seismic Boomer System (0.5-15 kHz), side scan sonar (100-325 kHz) and short gravity corer for sampling were used. On RV "Peilboot Ludwig" cruises, 230 km of echosounding, boomer and side scan profiles were collected, and 3 short sediment cores for radiometric measurements have been taken and analysed. Bathymetry data were collected using the basic sound velocity 1500 m/s in water. The exact sound velocity (1456 m/s) was calculated taking into account the transducer depth (0.5 m), temperature, salinity and relative water level fluctuation in the Curonian Lagoon (Kuršių Marios) during the survey. Penetration of the seismic profiler record has reached 60 ms, i.e., about 45 m beneath seabed, by using assumed velocity at 1450-1800 m/s in the uppermost sediments (Atzler 1997). Additional data, the depth measurements from 424 sampling sites collected by S.Gulbinskas et al. during geological mapping at a scale 1:50,000 in 1998-1999 are included in this study.

Data of 49 bore-holes drilled on the Kuršių Marios Lagoon and Kuršių Nerija Spit by S.Tamkutonis during geological mapping in 1960, V.Rimša in 1993 and J.Šimėnas in 1989 were used in the study (Fig. 2). Historical nautical charts at a scale of 1:25,000 - 1:150,000

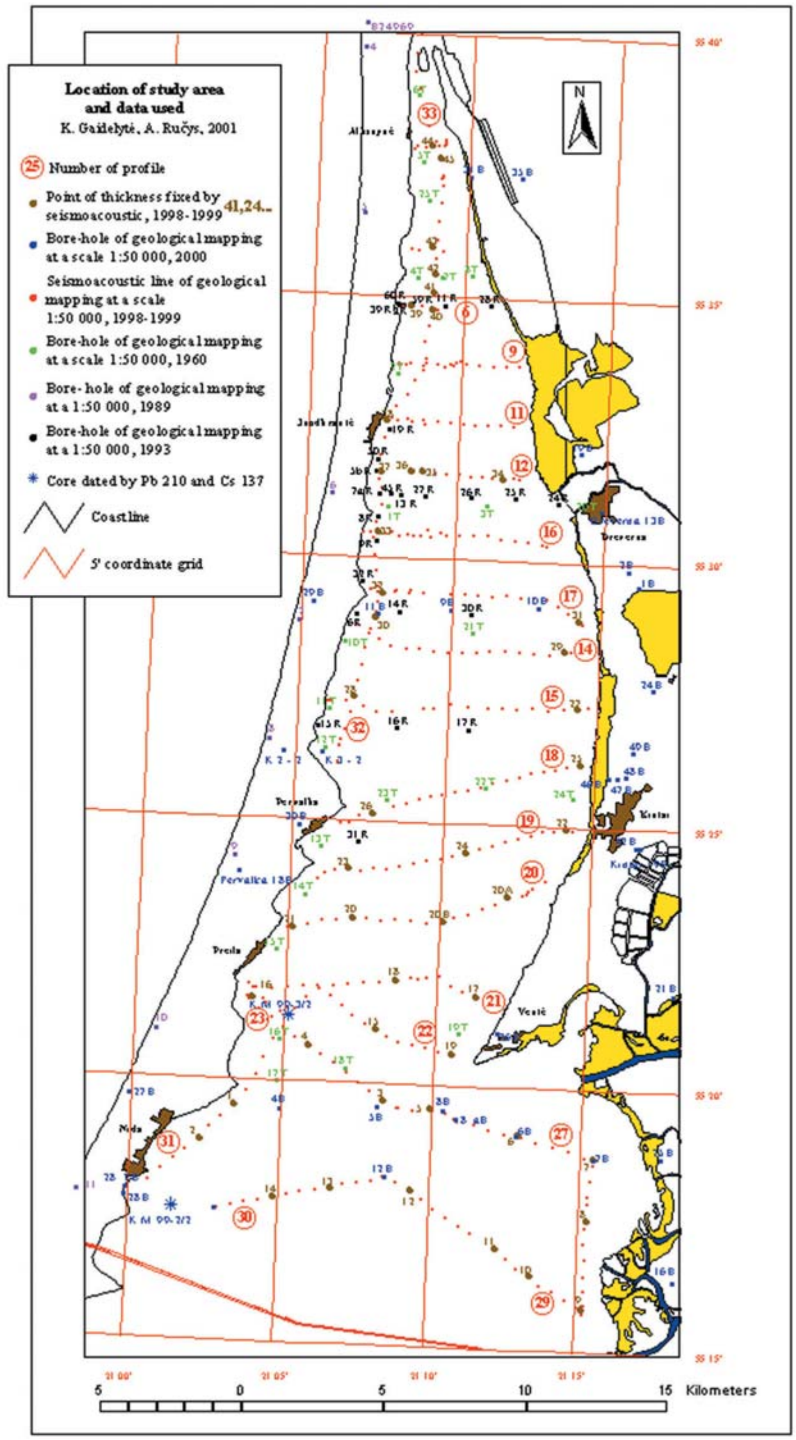

Fig. 2. Location of study area and data used. Compiled by K.Gaidelytė and A.Ručys, 2001.

(1915, 1943) were used for morphodynamic analysis during the last century (archive, German Hydrography Institute, Hamburg).

The paper presents the map of complete thickness of Holocene (10,300 ^{14}C yr BP-present, Lithuanian coast after Kabailienė and Rimantienė, 1996); the map of separate Post-Litorina (4000-3500-700-850 ^{14}C yr BP) sediments; the map of paleorelief of the Litorina $_3$ transgression phases (5200-4500 ^{14}C yr BP and diatoms data); the map of recent topography, and two maps of bathymetry depth differences evaluated from topography values obtained in 1915, 1943, and recently, 1999.

The GIS database has been formed using software packages EXCEL and ARC/View 3.0 version. The working scale for the handmade compilation of the maps was 1:50,000. Then drafts were scanned, digitised and cartographic images were prepared by Algimantas Ručys.

ANALYSES OF THE RELIEF MORPHOLOGY

The present bathymetric map (Fig. 3) with its 0.5-m depth contour intervals has expressed the changes in depths and size of submarine bed forms better than the previous maps (Červinskas 1955; Russian nautical charts on a scale 1:50,000, 1:25,000, 1984, 1993). Elongated and gently inclined from north to south bottom topography of the northern part Kuršių Marios Lagoon is shaped by small lows mutually separated by the elevations (Fig. 3). On the southern part A, the deepest Vidmarės Low (geographical names on the map are given after Gudelis, 1959) with a depth of 5.5 m is dissected by several banks: 1 - Kalvos, 2 - Akmenos, 3 - Ežios. Eastwards the Nemunas delta front forms are not clearly visible on our modern relief map, but from old times they have had geographical names Šilinė and Prūsinė. Northwards in the central part B, called Krantas, there are some large lows and elevations extended: 9 - Preilos Low with max depth of 4.5 m is distributed nearby the spit; 13-14 - Naglių-Kintų Rinos grooves with max depths of 2.5-3.0 m, and 6 - Bambalis Elevation with min depth of 0.5 m lie close together to the borderland. The lows spread on the western part of the Krantas are oriented from north to west, and elevations expressed on the eastern part are perpendicular to the latter. On the northern, narrowest part of the lagoon, morphological features prevail oriented north-south and realised with waterway.

Major features of the bottom topography reflect lagoon genesis and recent ongoing processes. The Akmenos and Kalvos banks divide the lagoonal depression into two parts, as obstacles of the moraine

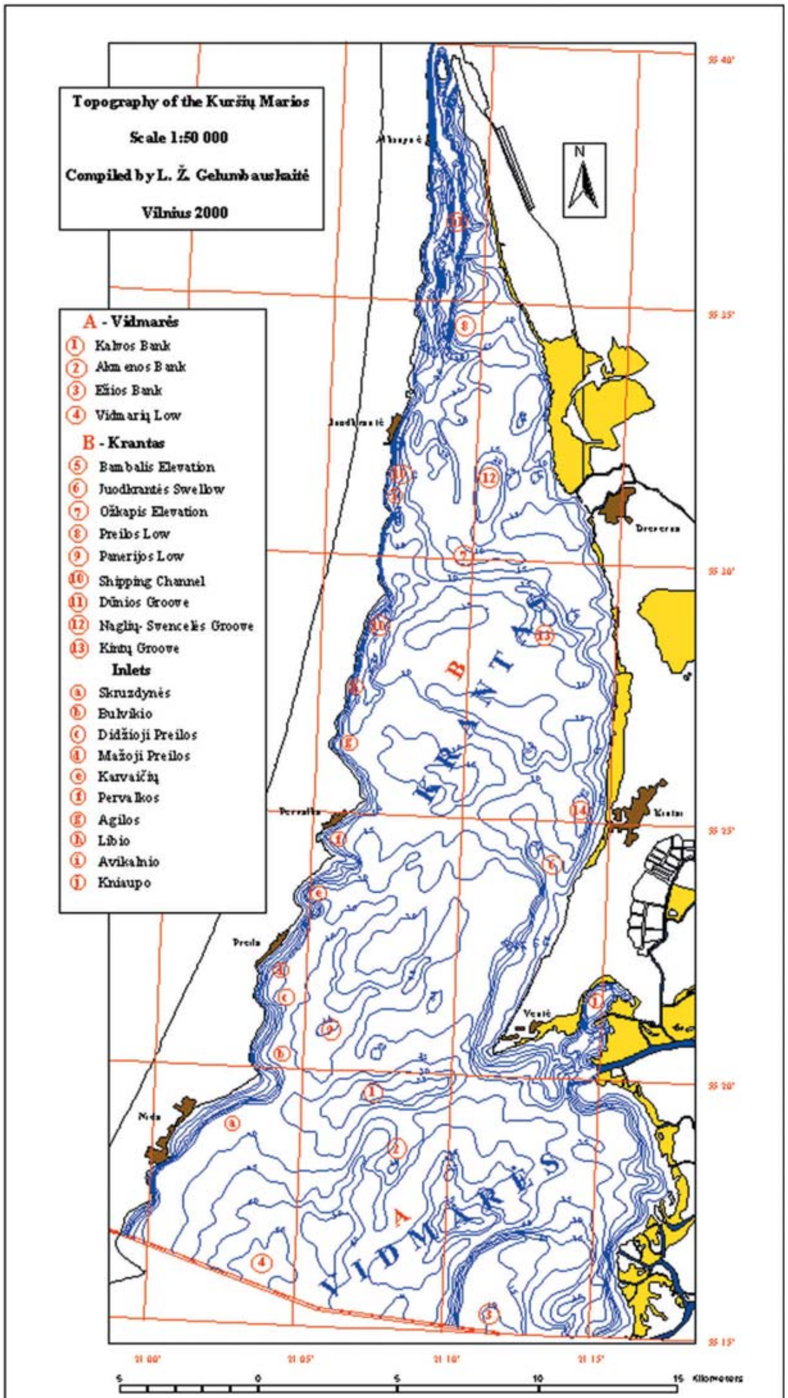

Fig. 3. Topography of the Kuršių Marios. Scale 1:50,000. Compiled by L.Ž.Gelumbauskaitė, 2000.

crop-out on the present bottom surface. These bed forms are well exposed on the echograms and seismic profiles, and its genesis is confirmed by bore-hole 8 and 8a lithostratigraphy. The Grooves 12 - Dūnios Molynė, 13 - Naglių-Svencelės Rina, 14 - Kintų Rina, the erosion forms of the along-shore transport paths were recognised on the echograms and scan sonar sonograms and depicted on the bottom topography.

New bottom topography has been compared to the bathymetry compiled in 1915 and 1943. These analogous map versions, presented in Mercator projection, were transformed on the recent topography into the TM projection, and quantitative changes of the bathymetric measurements were counted. Maps of the morphodynamic processes per 56 and 84 years, with 20-cm contour intervals have been drawn. The bathymetry differences showed that depositional-abrasional values in the last century reached 40-50 cm. More informative is the map of the topography value changes in 1943-1999, reflecting the various morpholitological regimes, ranging from abrasion-erosion to transit and accumulation (Fig. 4). The positive qualities of the accumulation processes +70- +60 cm are found on the flat of the southern Vidmarės, Preila lows, and lower values (+20, +30 cm) characterise the surface of the lows on the central and northern parts of the lagoon, respectively. The abrasion processes have been forming on the banks (for example on the Akmenos Bank negative qualities reaches –50 cm, on the Bambalis –30 cm, on the Ožkapis –20 cm) .The minus values -10, -20 cm displaced on the central and northern part of the lagoon mark long way drift from south-east to north-west, which was recognised on sonograms and echograms. Extreme values of the positive qualities +1.3, -+1.8, distributed close to the coasts, are mostly influenced by coastal processes. The migration of dunes towards the lagoon that make up promontories of the cape below water level and the deposition at the river mouths on the western borderland are principal factors forming fields with extreme values.

Five short cores of bottom sediments were taken at the Vidmarių and Preilos lows. Sedimentological analyses showed that aleuritic-pelitic mud predominates

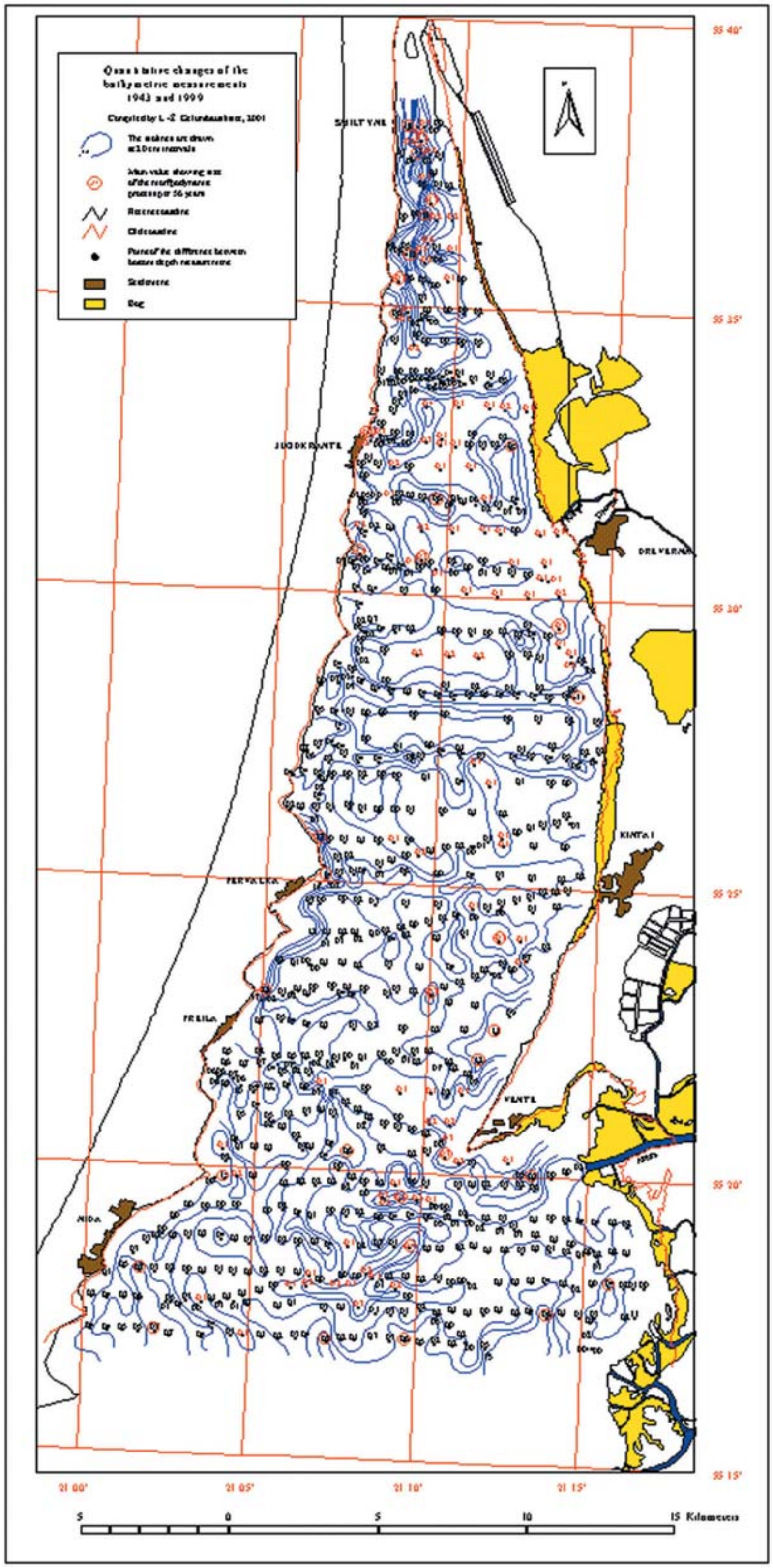

Fig. 4. Quantitative changes of the bathymetric measurements, 1943 and 1999. Compiled by L.Ž.Gelumbauskaitė, 2001.

in cored sediments. One core from Vidmarių Low KM 99-2/2 and one from Preilos Low KM 99-3/2 have been taken for radiometric Pb^{210} and Cs^{137} measurements to RISO National Laboratory (H.Kunzendorf, per. comm.). Analysing gamma dating, we can constitute very high sediment accumulation rate from 1 mm/yr in 1900 to 8 mm/yr in 1990. Analogous values have been got in 1996 estimated accumulation rate using Pb 210 profiles supplemented with the distribution of Chernobyl Cs 137 on the Vidmarių Low (K 1 from 2 mm/yr to 8 mm/yr) and on the south-eastern part of the Kuršių Marios Lagoon of the Russian EZ (V6 from 1 mm/yr to 6 mm/yr). Very high values might be connected to redeposition and bioturbation in the upper part of the cores (Larsen et al. 2000). However, comparing absolute accumulation rate value of the radiometric measurements with relative value of the accumulation processes, obtained from bathymetry differences, we found good correlation, but there was no correlation with radiometric dating to the other basins in the south-eastern Baltic. For example, average sedimentation rates amounting to 0.4-2.3 mm/year during the last 100-200 years were dominating in Greifswalder Bodden, Germany (Lampe 1998). Comparison of the gamma dating from estuaries to recent accumulation rate in the Gotland Deep and the North Central Basin, based on the Pb^{210} and Cs^{137} dating, suggests that sedimentation rate was lower and varied between 0.2-1.9 mm yr during the past 3000 years (Kunzendorf, Christiansen 1997).

GEOSEISMIC SECTION ANALYSES

The Boomer system profiles obtained during the survey allowed to distinguish seismic units and calibrate them with bore-hole and core stratigraphy. The deeper underground of the Kuršių Marios Lagoon, penetrated in the Late Glacial and Holocene sequence, can be subdivided into five different seismic units. The units can be interpreted as lithozones into shore facies of the postglacial freshwater and marine basins. As it is known, Baltic Ice Lake (BIL - Allerod - Younger Dryas) occurred between 12,300-10,300 cal yr BP, Yoldia Sea (Y – Preboreal) – 10,300-9300 cal yr BP, Ancylus Lake (A – Boreal) - 9300 - 8000 cal yr BP, Litorina Sea (L – Atlantic – Subboreal) - 8000-4000 cal yr BP and Post-Litorina Sea (PS - Subboreal – Subatlantic) from 4000 cal yr BP to 700-850 cal yr BP. According to bore-hole and core data, these deposits are composed of grey brownish clay with silt interlayering on the bottom of sections, as well as mostly sand and silt in the upper part of the sections. The marine deposits of the Yoldia Sea stage are completely absent in the supramarine coastal area (Kabailienė 1997).

The seismic records represent regular continuous boundary between units I-II (PS/L sea stage lithozones) and irregular continuous boundary between units II-III (L/A sea-lake stage lithozones). Partially truncated, difficult to be identified on the whole seismic lines in the southern and central parts, is the boundary between seismic units III-IV (A/BIL lake stages). The internal stratification is more or less similar for the seismic units I, II, III and has most homogenous transparent structure. Unit IV (BIL + IL lithozone) frequently shows weak bedded structure. The upper part of seismic unit V, which we can recognise on the bottom record bands but only on separate segments, clearly expressed erosional character with acoustic stratification, different from other units and similar to till. For example, in the area of the location 2 (southern part of Vidmarės, line 31) seismic unit I is observed between 0-2.8 ms, unit II between 2.8-11.5 ms, unit III between 11.5-25.5 ms, unit IV between 25.5-40.0 ms. The composed thickness reaches 2.5 m, 6.37 m, 10.5 m, 10.87 m as the seismic units I, II, III, IV in that order. Therefore, common thickness of the Holocene makes 19.37 m and Late Glacial – 10.87 m. The location 3 having three upper units, and the location 4 having two upper seismic units, as the L, L/A, A/BIL lithozones and top of till, have been identified.

HOLOCENE DEPOSITIONAL COMPLEX (10,300 ^{14}C YR BP-PRESENT)

A full set of Holocene depositional units is identified on the seismic records (locations 2, 3, 4, 13, 14) in the western part of Vidmarės. Otherwise, on the area of the Nemunas prodelta-delta (locations 6, 7, 8, 9, 10, 11) the Holocene sequence is incomplete. In the central part of Vidmarės area of banks, only two - upper I and lower V - seismic units were observed (locations 12, 5). The base of the Holocene succession in the western and eastern parts of Vidmarės has been recognised as a weakly draped-layered limit, but it is truncated and identified insufficiently. The Holocene base in the central part of the Vidmarės clearly demonstrates abrasional character of the till loam (Fig. 5).

Comparison with bore-holes on the Kuršių Nerija Spit and Kuršių Marios Lagoon shows that the chaotic facies are occurring in this area from laminated clay to sand and gravel of the A/BIL lithozones, as the shoreface facies of the Ancylus Lake and Baltic Ice Lake transgressions. According to the 11Š, 10Š, 16T, 17T, 18T, 19T borehole litho-biostratigraphy (Kabailienė 1997) and correlations with seismounit data, the low in the western part of Vidmarės is filled by Holocene deposits until 20-25 m thick (Fig. 5). Another stratigraphic subdivision is obtained in this region by IR-OSL method (Bitinas et al. 2001). Using the OCL dating (bore-holes 27B, 29B, 18S, 19B, 165B), boundary between deposits of the Ancylus Lake stage and Baltic Ice Lake stage is pushed up, and the thickness of the Holocene sediments in the southern part of Vidmarės is considerably reduced. However, a good correlation of this subdivision with other litho-biostratigraphy, seismostratigraphy and paleogeomorphology data is missing.

The morainic obstacle occupying the central part of the Vidmarės constitutes another paleogeographic set of conditions in the Boreal -Atlantic – Sub-Atlantic time in this area. A thin Holocene cover, varying in thickness between 0 and 5 m, occurs on this elevation, and the second low (less deeper, Holocene thickness reaches 10 m) spreads on the Nemunas prodelta-delta region, only. Some bore-holes were drilled in this area. In the bore-hole 8B the top of the till achieves recent topography and in the bore-holes 8B-8aB Holocene thickness varies from 2.3 to 3.6 m. Going further to borderland, in the bore-holes 6B and 7B Holocene thickness reaches up to 5.5-6.8 m (Fig. 5).

Three upper seismic units of the Holocene sequence, penetrated between 0-30 ms that corresponds from 5-m thickness in its sediments near borderland to 25 m westwards to the spit, have been identified in the central part of the Krantas (B). On the seismic bands these units look like one massive sedimentary complex. The boundary of the Holocene base in the southern part of the Krantas is recognised on the whole seismic line No. 22. In the location No. 19 the base of the Holocene as boundary between units III/IV lays at 7.5 ms that equal 5.6 m. On this seismic line, going to the borderland, a coast of the Ancylus Lake transgression stages is very well exposed and there is a wedge-out of this unit III (A) recognised. This interpretation found correlation with stratigraphic subdivision in the bore-hole 19T (Kabailienė, 1997). Westwards, along the lines Nos. 22 and 21, traced Holocene base pushes down. Nearby the Kuršių Nerija Spit, in the Preila Low, at the location No. 16, there is acoustically transparent, in upper and lower parts weakly layered, massive seismic surface identified between 0-30 ms, that corresponds to 20 m sand with silt interlayer overlain by mud-peat lithofacies on the upper part of the section in the boreholes 15T and 16T.

Northwards, the Holocene depositional complex is distinguished between 0-25 ms that equals approximately 11.6 m at the location No. 25, 13.3 m at the location No. 29, and 19.6 m at the location No. 30, which is near to the Kuršių Nerija Spit. This seismic unit found correlation with boreholes 7Š, 6Š, 13T, 23T, 22T, 24T, 10T, 11B, 1T 12T, 9B, 10B, 11B lithozones and biostratigraphy. In this part of the Curonian Lagoon (Kuršių Marios) the paleo-river system (Minija and Dreverna) is recognised and exposed on the scheme of the Holocene

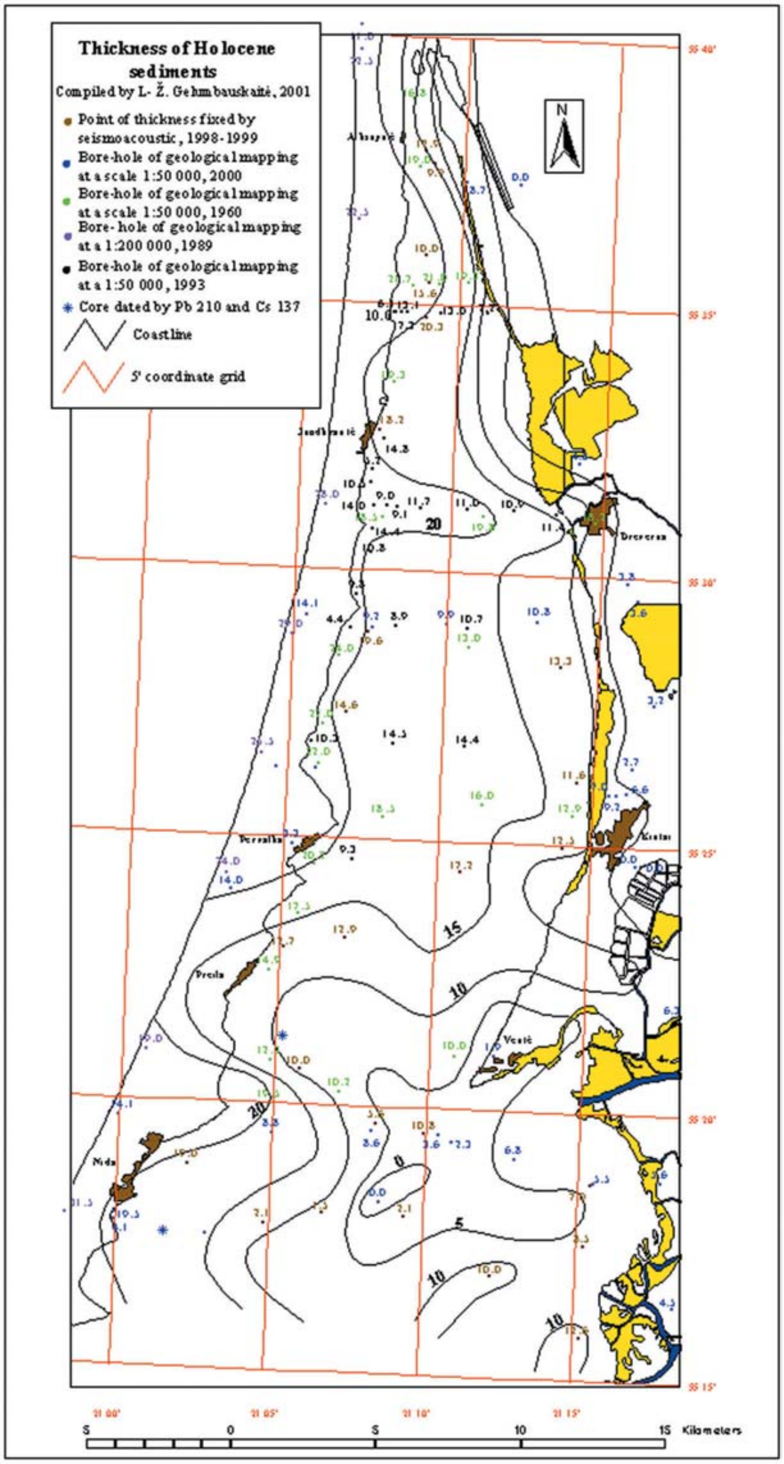

Fig. 5. Thickness of Holocene sediments. Compiled by L.Ž.Gelumbauskaitė, 2001.

thickness. The system drained this plain most likely in the Preboreal-Boreal time. On the latitude of Juodkrantė (profile No. 12), a paleovalley segment (probably an old Dreverna River) was recorded. This channel is distinguished in the internal reflectors on the boundary between units II/III that is identified as an erosional surface on top of unit III of the Ancylus regression stage.

Character and geometry of the Holocene seismic units in the northern edge of the study area is different to that of the central part Krantas. In the narrowest part of the Kuršių Marios Lagoon as seen on the seismic lines Nos. 33, 34 (location 41, 42, 43, 44), the horizontal weakly layered seismic facies of the units I - II change the homogenous seismic levels of the unit III and the laminated complex of the unit IV, that have a decline and deepening from east to west (Fig. 6). Comparison of seismic units with biostratigraphy and lithostratigraphy of bore-holes 25T, 6T, 5T 31B, 4Š, 24969B shows that seismic depositional complex corresponds to the nearshore zone of the Ancylus Lake and Baltic Ice Lake transgressions.

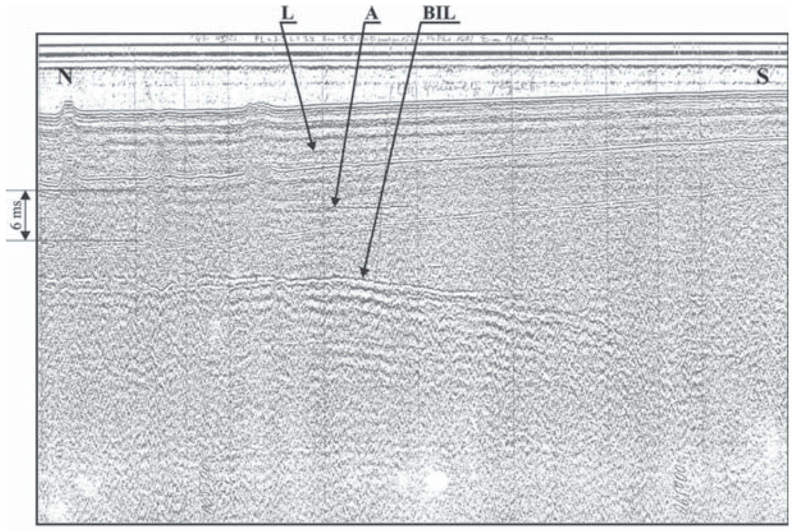

Fig. 6. Seismoacoustic profile Nr. 33. Location Nr. 42.

ANALYSES OF THE PALEORELIEF OF LITORINA$_3$ TRANSGRESSION PHASES (5200-4500 ^{14}C YR BP) AND POST-LITORINA SEDIMENTS (4000-3500–700-850 ^{14}C YR BP)

Seismic units II and unit I are well exposed on the upper part of the seismic records. The internal reflectors are similar in these units and have homogenous or weak bedded structure on the whole recorded bands. The boundary reflectors of the units II/I (L_3 -PS) are fixed on 75% of the profiles, and these levels are correlated to litho-zones of the Litorina $_3$ and Post-Litorina seas, composed mainly of mud and silt at the western lows and of sand and gravel in the gaps for passage of water between the open sea and the lagoon, at the Kuršių Nerija barrier island. Several shallows, drawn on the schemes in the eastern part of the Krantas, are not overlapped by unit I and II towards the borderland, and are mainly deposited by sand, according to bore-hole data. Therefore, a cover of Post-Litorina sediments is patchily distributed, and paleorelief of the Litorina $_3$ phases is greatly undulated (Figs.7, 8).

In the southern area, in the Vidmarių and Preilos lows, seismic unit I is found between 0-4.0 ms and the unit II between 4.0-12.0 ms at the locations 14, 2, 4, 16, 20, 21, 23, respectively. Their boundary is interpreted as the topography of the maximum Litorina Sea transgression. Hence, thickness of the upper units, for example at location 16, reaches PS-3, 6 m/L_3 top -6, 2 m. Correlation of seismic facies with bore-hole lithofacies allowed to draw an inlet on the scheme of the paleorelief L_3 (max depths 6.0 m in the lowest part of the infill), of the prograded Kuršių Nerija barrier spit, with a southern piece already formed. Eastwards, on the moraine elevation (interpretation of locations 3-12 and bore-holes 6B-8B, 12B, 19T), we show patchily spread cover of the Postlitorina sediments and vary in shape Litorina $_3$ relief (Figs. 7, 8). Following south-eastwards the separate spots are without cover of the Postlitorina sediments, and on the scheme of the paleorelief of the maximal Litorina Sea transgression there is a prolongated elevation going from Ventės Ragas to Akmenos Bank. This elevation separates Preilos and Vidmarių lows from the Nemunas Delta Low.

Seismic facies interpreted on the central part of the lagoon at the latitude Kintai—Preila (locations 20, 20A, B21-24) and correlation with bore-hole (19B, 18B, 30B, 8-9Š, 46-42B, 22-24T, 11-13T) data, allowed to reconstruct a large bay of the L_3 stage stretching to Juodkrantė settlement (correlation of seismic units I/II at the locations 28-33 with lithozones of the bore-holes 10-12T, 1T, 3T, 21T, 9-11B). Maximum depths reach -4.6- -4.8 m in the paleobay near the borderland. Going to the north-west and south-west the bay is connected with inlets, two gaps in the barrier-spit separate two small islands. The southern inlet is most likely a channel and the northern one - a large shaped bowel, where its depth ranges from 5.0 to 7.0 m. Post-Litorina depositional unit overlies the shaped in forms of paleorelief of the L_3 stage on the whole western part of the Kuršių Marios Lagoon entirely, and only the top of the detached islands of the barrier spit was prominent. The sediment thickness varies from 1.6 m in the eastern part of the bay to 6.0 m in the westerns inlets, composed mainly by sand and gravel (Fig. 8). According to the bore-holes (5-7Š) data on the Kuršių Marios Lagoon, coarse sand-gravel lithofacies infilled inlets, can be interpreted as water sorted facies of the channel flows.

Along the traced paleobay through the eastern part, the morphological region Krantas is occupied by several shallows with a depth of 2 m below MSL. These shallows are not covered by the Postlitorina sediments completely and look as a one continuous submarine plain. Towards the north, on the scheme of the paleorelief of the maximum Litorina Sea transgression, a paleochannel is exposed with three branches. One branch cuts the lagoon across at the latitude Dreverna-Juodkrantė. This erosional form, recognised by the internal acoustic stratification (seismic line No. 12) on the limit between units III/II and could be interpreted as a paleochannel of the Dreverna River, inserted into the surface of the Ancylus regression stage. In the seismic facies of the unit II (L_3), wich is interpreted as a second branch of the erosional form, with varying depths from 4.5 m to 6.0 below MSL, stretching from Dreverna to Alksnynė. This is the largest and deepest (7.0 m below MSL) channel (location Nos. 39-43; boreholes 2T, 4T, 7T, 8T, 31B, B24969) cut as a gap prograding barrier spit southwards of Alksnynė. The last branch occupies the northern narrowest part of the Kuršių Marios Lagoon. These erosion forms at the upper seismic levels, were most likely inserted as paleochannels in the Boreal time regarding their morphogenesis; in the Atlantic time they can be interpreted as channel flows in the inlets. Deposition of the Post-Litorina phases flatted and made a relief of the northern part of the study area smoother (Fig. 8).

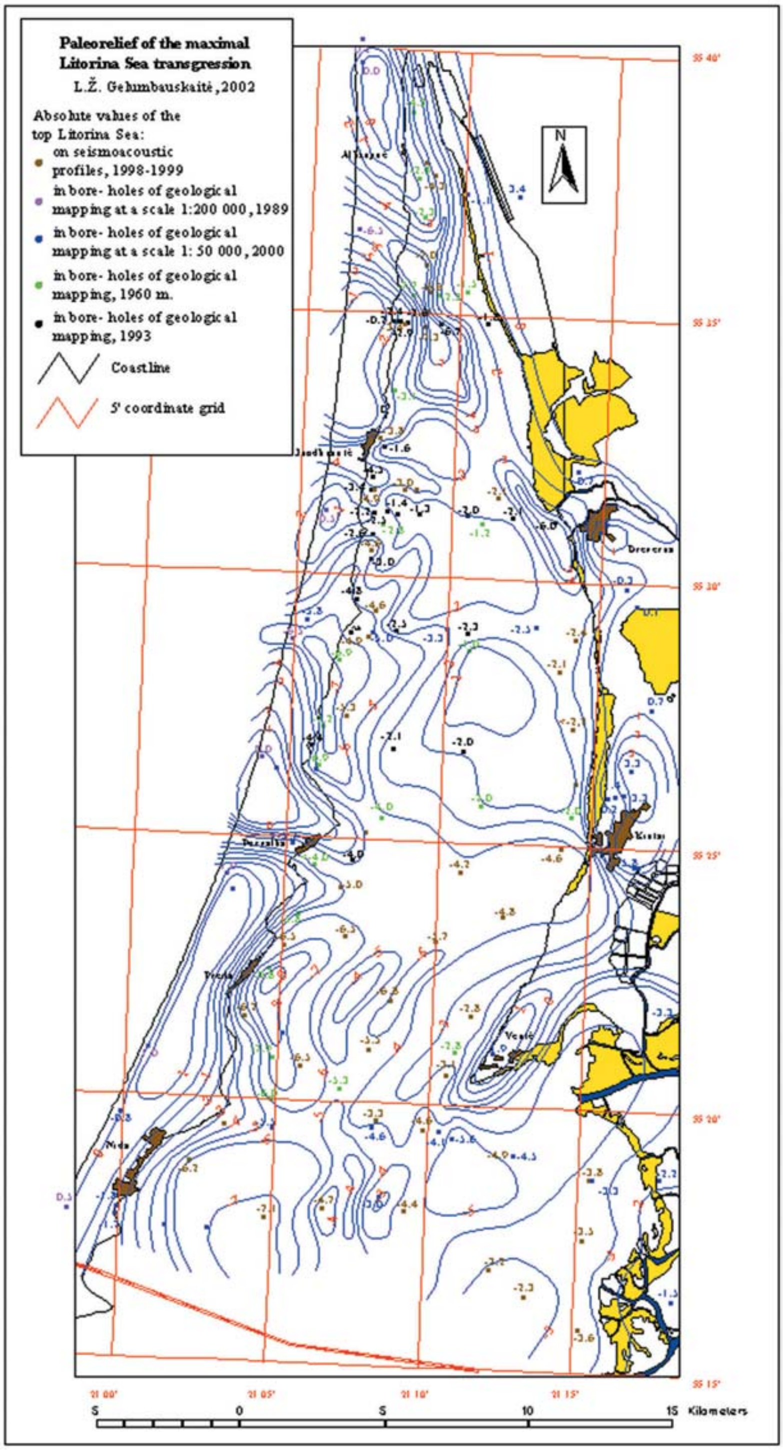

Fig. 7. Paleorelief of the maximal Litorina Sea transgression. Compiled by L.Ž.Gelumbauskaitė, 2002.

CONCLUSIONS

The complete reconstruction of the Holocene history (from 10,300 ^{14}C yr BP), and detailed analysis of the Litorina maximum transgression and Post-Litorina phases depositional history (5200-4500 ^{14}C yr BP and- 4000-3500 -700-850^{14}C yr BP) enables to conclude that recent morpho- and sediment dynamics in the last century in the study area could be interpreted as having been associated with different relations between hydrography, sedimentation and matter transport. The fluctuation of the Holocene fresh and marine basins and fluvial processes have formed this sedimentary complex. A very uneven Holocene cover shows the interdependence between Late Glacial surface deformations and Holocene depositional surfaces.

According to our investigations a shallow marine and lacustrine deposition has been predominant during the

Holocene only in the Vidmarių-Preilos lows and the central part of the Krantas. The complete central part of Vidmarių Low, in its present morphology is exposed as an elevation of the Akmenos and Ežios banks and interpreted as prolongation of the moraine ridges from Ventės Ragas, most probably it existed in Younger Dryas—Boreal time as an island and occurred under the water level from Atlantic time. Going to the borderland, on the Nemunas delta region, we cannot recognise an incision of the Pra-Nemunas River in the internal reflectors of the III/IV seismic units, and these data correspond to geological mapping data (Bitinas, 2000). The boundary between units III/IV (A/BIL) as the Holocene base is not erosional in its character, mostly truncated and identified not sufficiently. In the bore-holes on the study area we could not detect lithofacies associated with gravel deposits that can be interpreted as a break in the basin sedimentation. Consequently, sediments of the lower Holocene complex can be interpreted as lacustrine in this area of the Kuršių Marios Lagoon and similar in the local basin BIL-A.

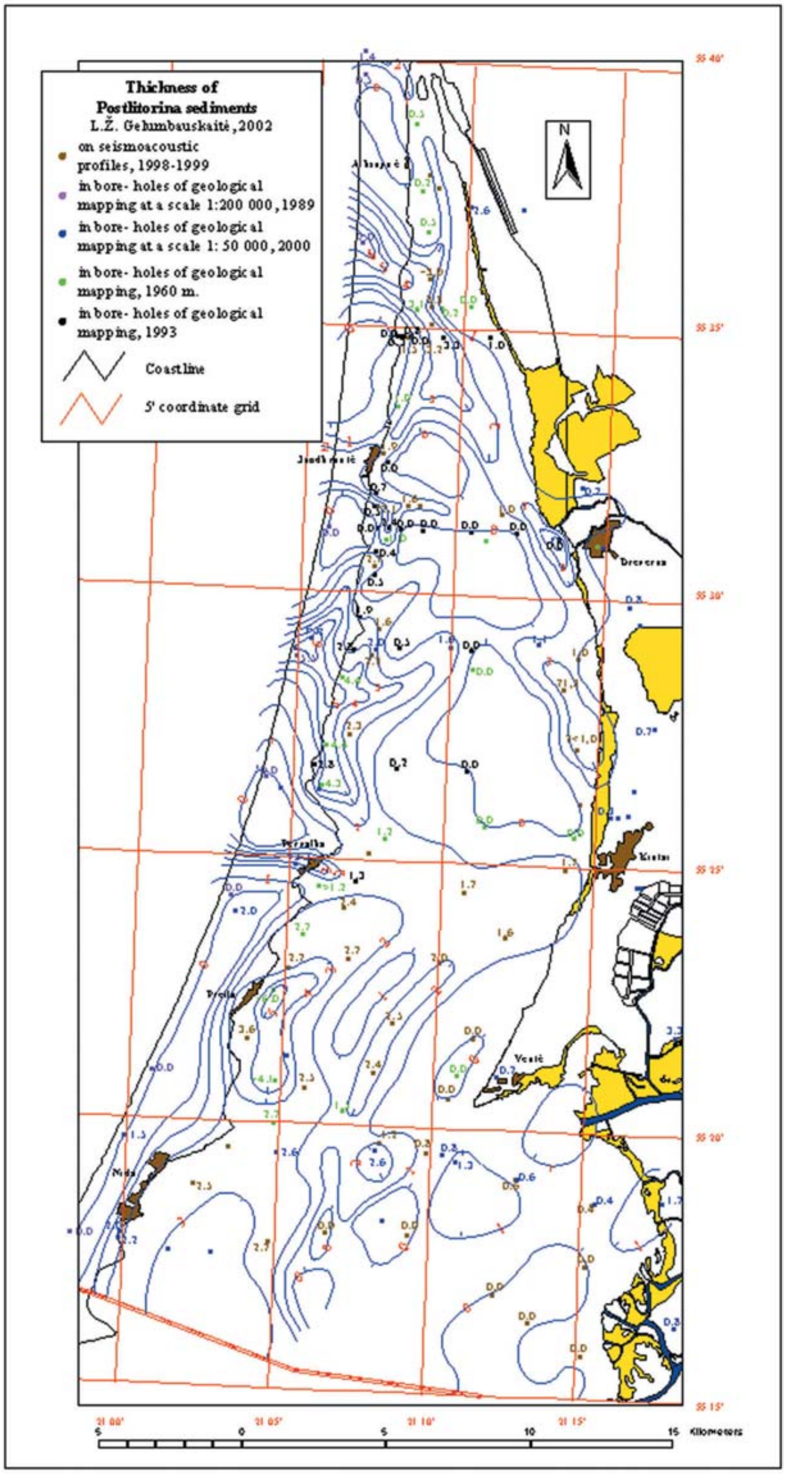

Fig. 8. Thickness of Post-Litorina sediments. Compiled by L.Ž.Gelumbauskaitė, 2002.

The character of the infilling of the Holocene depositional complexes is more variable in the northern part of the study area. In this part of the Kuršių Marios Lagoon the seismic facies of the fluvial deposition have been recognised, and the segments of channels (probably Minija–Dreverna) of the Ancylus regression stage are inserted in this surface.

Correlation of seismic data in the lagoon with data in the offshore and inter-calibration with bore-hole cores stratigraphy allows to maintain Ancylus Lake transgression-regression phases very significant in history of the central part of the Baltic, including the south-eastern part as well (E.Andrén 1999, Gelumbauskaitė 1996, 2000). The analyses of the long sediment cores from the Bornholm and Gotland Basins showed that Ancylus Lake stages were reflected in the sediments on the Gotland Basin more longer than in the Bornholm Basin and marked 9400-7400 ^{14}C yr BP.

Analysis of well exposed seismic units II/I and correlation with litho-biostratigraphy allowed to reconstruct the paleorelief of the Litorina$_3$ transgression phases and thickness of the Post-Litorina sediments. Paleorelief of the Litorina$_3$ stages varies in shape, and Post-Litorina sediments are patchily distributed. The scheme of the paleorelief showed that Kuršių Nerija barrier island did not finish its formation during this phase, ca. 6700-5700 years (after Kabailienė 1996).

A widespread shallow lagoon from Nida to Juodkrantė (with absolute depths of –6, –7 m) was separated from the sea by a barrier island dissected by three gaps as a passage for water between the open sea and the lagoon. Second branched channel was extended to the north from Juodkrantė. Several shallows not overlain by Post-Litorina sediments, existed on the eastern part of the lagoon.

The depth differences counted between topography in 1915, in 1943 and in 1999 reflect the relative values in the various morpholithological regimes. Analysing these data and absolute data obtained according to Pb 210 and Cs 137 dating in the short cores (1-6 -8 mm/yr) we could constitute, that accumulation rate is very high over the past ca. 100 years, with abrasion processes in the northern part of the Kuršių Marios Lagoon. The accumulation rate in another estuaries is lower, but it is higher than that in the offshore depression.

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