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Radosław PIKIES

New data about the Upper Cretaceous from eastern part of the Southern Baltic Sea

During preparing the sheets of the *Geological Map of the Baltic Sea Bottom*, scale 1:200 000, the current boundary of occurrence of the Upper Cretaceous deposits in eastern part of the Southern Baltic was located about 75 km northward from its previous position. The Upper Cretaceous was documented with micropalaeontological, mineralogical and seismic-acoustic data on area of sheet Gotland Basin and it lies with unconformity on the Upper Devonian and — probably — on Upper Silurian deposits. The meridional faults of older network, renewed in the Laramide Phase, had significant influence on such far northward extension of the described Cretaceous deposits, for example: Żarnowiec, Karwia and Kuźnica faults. Final position of limit of the Upper Cretaceous extent was determined by denudation processes, prevailed on this area during Tertiary (Paleocene – Lower Eocene, Neogene) as well as several times repeated ice-sheet exaration.

INTRODUCTION

Works on the *Geological Map of the Baltic Sea Bottom*, scale 1:200 000, sheets: Puck and Gotland Basin, supplied most of data for this article. Studied area is located on depositional cover of the East-European Platform. In south-eastern region of the Baltic Sea this cover consists of deposits of such structural stages: Vendian – Middle Cambrian, Middle Cambrian – Tremadoc, Arenig – Gedinnian, Variscian (Devonian – Carboniferous) and Alpine (W. Pożaryski, A. Witkowski, 1990). Deposits of stages: Arenig – Gedinnian (Upper Silurian), Variscian (Upper Devonian) and Alpine (Upper Cretaceous) formed the top of sub-Quaternary surface on area of Gotland Basin sheet. On area of Puck sheet the top of Quaternary basement was composed of deposits of Alpine Stage, included the Upper Cretaceous sediments as well as Paleogene ones in its landward part.

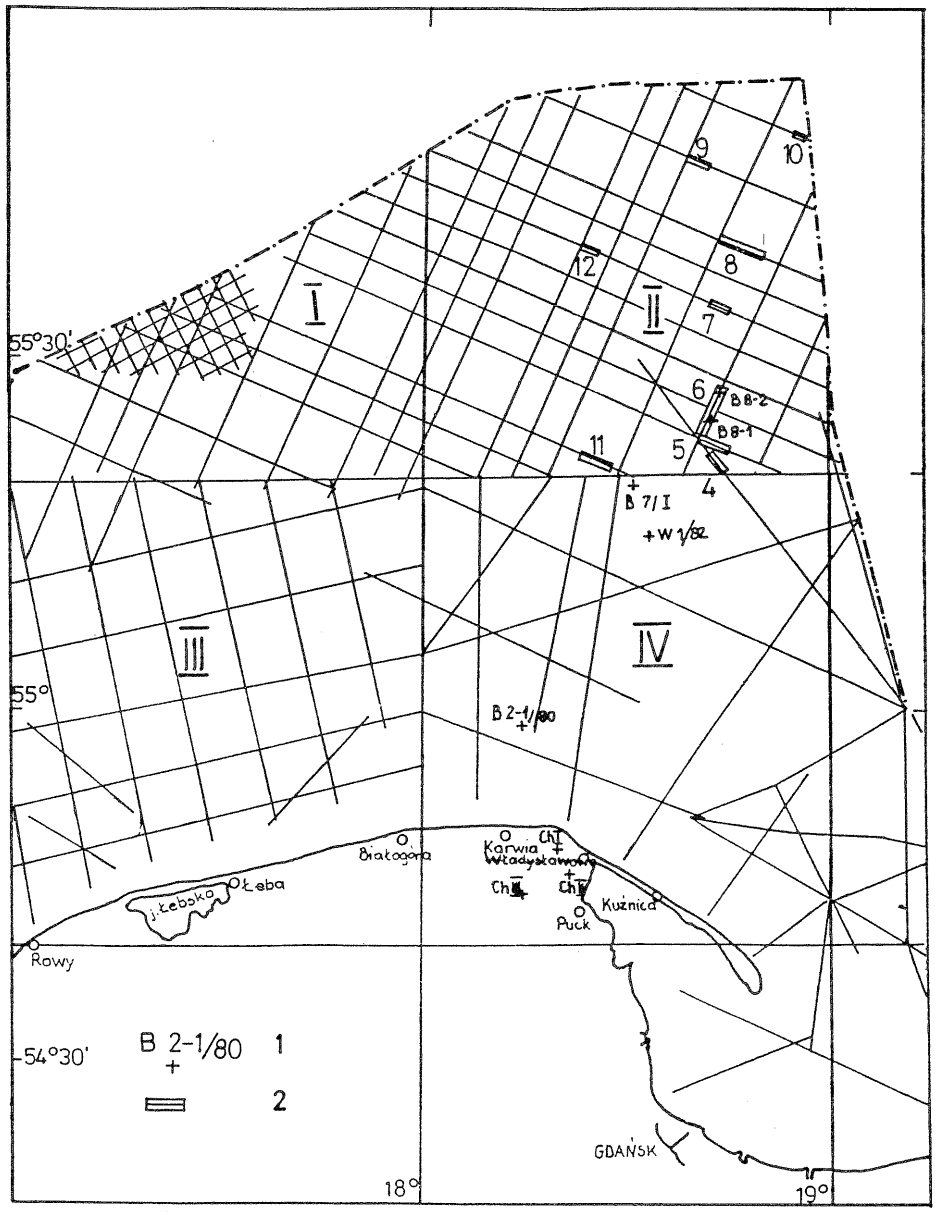


Fig. 1. Network of the seismo-acoustic profiles in eastern part of the Southern Baltic

1 — boreholes; 2 — figure position (4–12) on seismo-acoustic profile; I–IV — areas of map sheets: I — Southern Middle Bank, II — Gotland Basin, III — Łeba, IV — Puck

Siatka profili sejsmoakustycznych we wschodniej części Bałtyku południowego

1 — otwory wiertnicze; 2 — lokalizacja figur (4–12) na profilu sejsmoakustycznym; I–IV — obszary objęte arkuszami: I — Południowa Ławica Środkowa, II — Basen Gotlandzki, III — Łeba, IV — Puck

According hither to obtained data it was known that the Upper Cretaceous deposits had their maximum evolution in axial part of the Baltic Syneclise, in vicinity of Gdańsk Bay and Sambia Peninsula (W. Pożaryski et al., 1978; W. K. Gudelis, J. M. Jemielianow, 1982; W. Pożaryski, A. Witkowski, 1990). The extent of Upper Cretaceous deposits, proposed by mentioned authors, was rather minimal. These boundaries resulted from data interpolation, coming from studies on land, and authors could not exclude possibility of occurrence of sheets or thin cover of the Upper Cretaceous deposits outside the zone of known exposures (W. Pożaryski et. al., 1978).

Studies of adjoined land area indicated overpassing arrangement of these deposits. The Łeba Elevation could be an example, where the Cretaceous lies on the Triassic in its western part but in eastern — on the Jurassic (S. Cieśliński, M. Jaskowiak, 1973; W. Pożaryski et al., 1978).

Results of own author studies documented overpassing position of Upper Cretaceous on Upper Devonian but not excluded — on Upper Silurian deposits.

The Mesozoic deposits older than Upper Cretaceous was not found but they could occur in form of isolated and residual slices, particularly in north-western part of area of Puck sheet. In south-eastern part of it such deposits had probably more complete development under Upper Cretaceous cover.

METHODOLOGY

Analysis of seismo-acoustic profiles correlated with borehole profiles (Fig. 1), allowed to characterize the Upper Cretaceous deposits from south-eastern part of the Baltic Sea. On area of both sheets were done 1640 km of continuous seismo-acoustic profiling: on the Puck sheet area — 559 km, on the Gotland Basin area — 1081 km, using apparature of boomer type. Frequency of emited beam was from 0.7 up to 2.0 kH_Z. This apparature allowed — depending on the bottom depth and kind of bottom sediment — to penetrate and interpretate in geological way the depths up to 40–60 m under the bottom level.

The borehole W1/82, located in marine part of the Puck sheet, with the depth 22.1 m, was logged and were studied archival materials from *Petrobaltic*, referred to the B 2-1/80 borehole (depth 118.6 m, up to bottom of the Upper Cretaceous) and the B 7/I borehole (depth 15.8 m).

The Upper Cretaceous on area of the Gotland Basin sheet was found in the B 8-1 borehole, at the depth 12.6 m. In nearby borehole B 8-2, at the depth 8.5 m, the Upper Devonian deposits occurred in Quaternary basement (Figs 2, 3). Cores of these two boreholes were offered by *Petrobaltic* to the Sea Geology Branch of State Geological Institute in Sopot, where they were detaily studied.

Results of studies of Upper Cretaceous deposits in boreholes from marine area have been compared with data, obtained during researches for amber-bearing deposits in vicinity of Chłapowo (M. Piwocki et al., 1985; B. Kosmowska-Ceranowicz, 1987; M. Piwocki, I. Olkowicz-Paprocka, 1987; I. Grabowska, 1987).

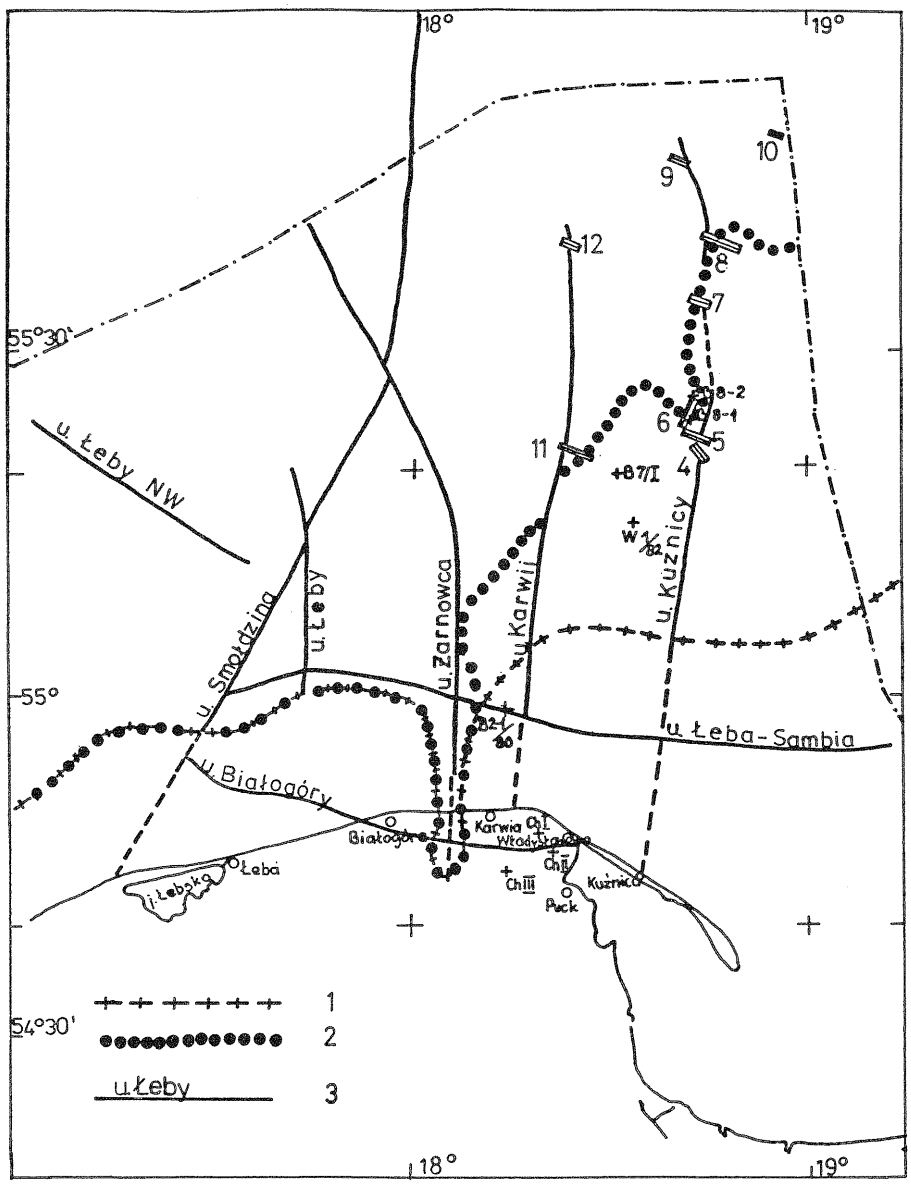


Fig. 2. Extent of the Upper Cretaceous deposits in eastern part of the Southern Baltic and more important dislocation zones

1, 2 — limits of extent of the Upper Cretaceous deposits after: 1 — W. Pożaryski and A. Witkowski (1990), 2 — author; 3 — more important dislocation zones

Zasięg granicy osadów górnej kredy we wschodniej części Bałtyku południowego oraz ważniejsze strefy dyslokacyjne

1, 2 — granice zasięgu osadów górnej kredy według: 1 — W. Pożaryskiego i A. Witkowskiego (1990), 2 — autora; 3 — ważniejsze strefy dyslokacyjne

LITHOLOGY AND STRATIGRAPHY OF THE UPPER CRETACEOUS IN BOREHOLES FROM EASTERN PART OF THE SOUTHERN BALTIC

The Upper Cretaceous deposits were documented in the W1/82 borehole (water depth — 80.5 m), located in northern part of the Puck sheet (Figs 1, 2). They consist of silty sands, dark-grey and green in colour, with glauconite admixture, calcareous, more or less flamed with grey-black silty material. Occasionally occurs there detritus of badly preserved *Inoceramus* shells. Exception of this is section from depth 102.3–102.4 m consists mainly of crushed, very badly preserved such fragments, parallel oriented. At borehole bottom (depth 102.4–102.6 m b.s.l.) dominates the silty sand with lenses of coarse quartz sand and single fine pebbles and dispersed bivalvia detritus (Fig. 3).

Mineral studies (grain size: 0.25–0.125 mm) indicated that main constituent of these sands, except quartz, was glauconite. Among transparent heavy minerals, beside significant content of biotite and chlorite (about 33%), were found epidote (18.8%), zircon (11.9%) and disthene (9% — see: Tab. 1). Quantitative thermal analysis documented calcite content from 3.6 up to 3.9% but organic matter content — from 1.8 up to 2.2%.

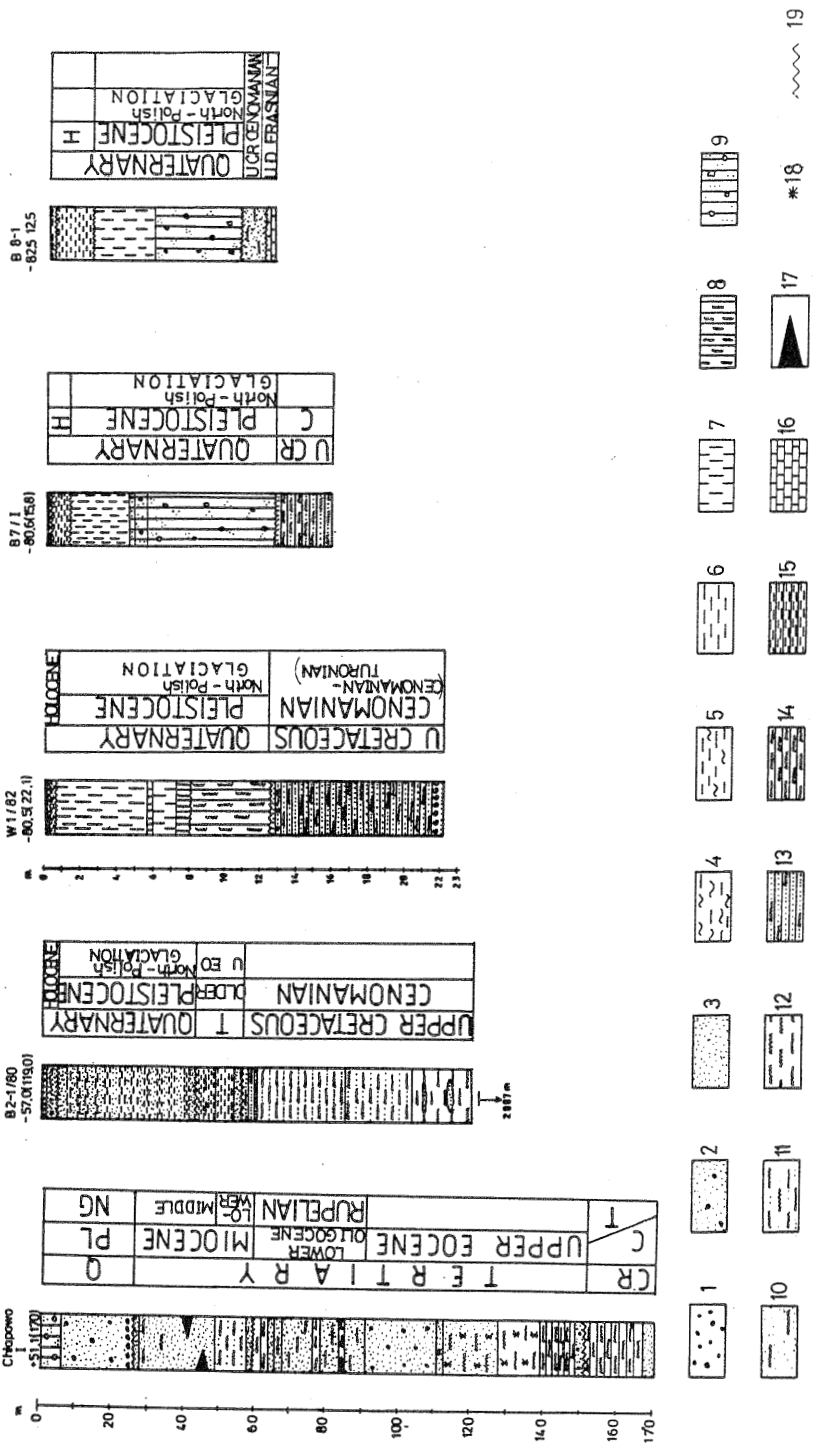
Micropaleontological studies dated the deposits from mentioned borehole as Upper Cretaceous in age. Coincident occurrence of species *Arenobulimina presli* (Reuss) and specimens of genus *Gavelinella* (after E. Gawor-Biedowa) documented it. Also were found there: *Marginulina* sp., *Lenticulina* sp., *Ostracoda* sp., fibres of *Inoceramus* and fish teeth.

The deposits of Upper Cretaceous from the B 8-1 borehole (water depth — 82.5 m) had no stratigraphical dating. They were found at the depth 93.1–94.5 m b.s.l. Their small thickness suggested that it was zone of their pinching, that confirmed the seismo-acoustic profile GT 12 (Fig. 6), where such pinching of Upper Cretaceous deposits, laying on the Upper Devonian basement was visible. Also data from nearby B 8-2 borehole, where under 4.9 m thick Quaternary series occurred the Upper Devonian nodular limestones (Figs 2, 6), confirmed such opinion.

The Upper Cretaceous deposits in B 8-1 borehole consisted of silty sands, grey-greenisch in colour, calcareless, with glauconite and muscovite (Fig. 6). Studies of composition of transparent heavy minerals indicated high content of epidote (21.4–23.5%) and zircon (6.3–9.9%). Biotite and chlorite were also found in significant amount (22.1–33.0%, see — Tab. 1).

Similarities of heavy minerals spectra from boreholes B 8-1 and W 1/82, where deposits were micropalaeontologicaly dated, as well as seismo-acoustic continuity of discussed horizon indicated clearly that studied deposits were of Upper Cretaceous age.

The Devonian deposits occurred under the Upper Cretaceous ones. They formed a bed, 0.6 m thick, of hard, beige or locally cherry-red nodular limestones, with brachiopods detritus. There were found among others: *Productella subaculata* and numerous fragments of spiriferoids from group *Spirifer disjunctus* (after P. Filonowicz description). These deposits were referred to lowermost Frasnian after conodont data.


Chłopowo 1
-51.1(170)
CR
T E R T I A R Y
Q
C
UPPER EOCENE
LOWER OLIGOCENE
MIOCENE
PL
T
RUPELIAN
LO-WER
MIDDLE
NG
B2-1/80
-57.0(1190)
UPPER CRETACEOUS
CENOMANIAN
T
QUATERNARY
OLDER
PLEISTOCENE
U EO
North - Polish GLACIATION
W1/82
-80.5(122.1)
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CENOMANIAN
(CENOMANIAN-TURONIAN)
QUATERNARY
PLEISTOCENE
North - Polish GLACIATION
B7/1
-80.6(158)
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North - Polish GLACIATION
B 8-1
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In these limestones occurred relatively numerous conodonts of species *Polygnathus linguiformis linguiformis* Hinde and badly preserved conodonts of genus *Palmatolepis*. Analysis of time ranges of these two taxons indicated that mentioned limestones should be correlated with lowermost Frasnian — Manticoceras Stage, asymmetricus Zone — to Iα (after: M. Pajchlowa, M. Nehring-Lefeld).

The Upper Cretaceous deposits were also found in other two boreholes, drilled by *Petrobaltic*. In the borehole B 2-1/80 (Figs 4, 5) M. Jaskowiak-Schoeneichowa has distinguished there the lower and upper part (Fig. 6). The lower part (depth 142.5–176.0 m) consisted of dark-grey silty-sandy deposits, calcareous, with glauconite admixture and dispersed fine micas and phosphorite gravel. The upper part (depth 113.0–142.5 m) was composed of dark-green silty-sandy deposits, calcareous, with high content of glauconite and rare mica plates. The top section (depth 113.0–120.0 m) consisted of silty sandstone, grey-greenish, with clayey-calcareous matrix and nestform concentrations of glauconite. This sandstone contained the Eocene fauna *Inoceramus* shells that suggested its probable Eocene age and redeposition of included Upper Cretaceous fauna.

Generally all Cretaceous series, found in the borehole B 2-1/80, had micropalaeontological dating and was referred to the Cenomanian (after data of E. Gawor-Biedowa). Such age was documented by occurrence of: *Gavelinella cenomanica* (Brotzen), *Orithostella formosa* (Brotzen), *Marginulina turgida* (Reuss), *Saracenoria spinosa* (Eichenberg), *Ostracoda* sp. Also *Inoceramus* shells, echinoderms spines and coprolithes were found.

In the borehole B 7/I (Figs 1, 2) were drilled deposits very similar to ones known from borehole W 1/82. They were silty sands, laminated with grey-black silt, calcareous, with abundant glauconite and muscovite. Fragments of *Inoceramus* shells were often there (Fig. 3). These deposits were referred according microfauna data to the

Fig. 3. Selected lithological-stratigraphical profiles of boreholes from eastern part of the Southern Baltic and vicinity of Chłapowo (Łeba Elevation). Profile descriptions after: M. Piwocki et al. (1985) — Chłapowo I; M. Jaskowiak-Schoeneich (for *Petrobaltic*) — B 2-1/80; R. Pikies, Z. Jurowska (1988) — W 1/82; R. Pikies (1990) — B 8-1; B. Uramowski (for *Petrobaltic*) — B 7/I

1 — gravels; 2 — sands with gravels; 3 — sands; 4 — clayey, jelly-like marine silts; 5 — silty, jelly-like marine clays; 6 — clays; 7 — clayey tills; 8 — silty tills; 9 — tills; 10 — silty sands of low terseness; 11 — sandy silts of low terseness; 12 — silts of low terseness; 13 — sandstones and siltstones; 14 — siltstones; 15 — claystones; 16 — nodular limestones; 17 — lignite interbed; 18 — amber; 19 — discordance, erosional gap; UD — Upper Devonian; CR — Cretaceous; UCR — Upper Cretaceous; C — Cenomanian; T — Turonian; Q — Quaternary; PL — Pleistocene; NG — North-polish Glaciation; UEO — Upper Eocene – Oligocene; H — Holocene

Wybrane profile litologiczno-stratygraficzne otworów ze wschodniej części Bałtyku południowego i okolic Chłapowa (wyniesienie Łeby). Opisy otworów według: M. Piwockiego i in. (1985) — Chłapowo I; M. Jaskowiak-Schoeneichowej (dla *Petrobalticu*) — B 2-1/80; R. Pikiesa, Z. Jurowskiej (1988) — W 1/82; R. Pikiesa (1990) — B 8-1; B. Uramowskiego (dla *Petrobalticu*) — B 7/I

1 — żwiry; 2 — piaski ze żwirami; 3 — piaski; 4 — ilaste muły morskie, galaretowate; 5 — muliste iły morskie, galaretowate; 6 — iły; 7 — gliny ilaste; 8 — gliny pylaste; 9 — gliny zwałowe; 10 — piaski muliste słabozwięzłe; 11 — mułki piaszczyste, słabozwięzłe; 12 — mułki słabozwięzłe; 13 — piaskowce i mułowce; 14 — mułowce; 15 — iłowce; 16 — wapienie gruzłowe; 17 — wkładka węgla brunatnego; 18 — bursztyn; 19 — niezgodność, luka erozyjna; UD — dewon górny; CR — kreda; UCR — kreda górna; UC — cenoman; T — turon; Q — czwartorzęd; PL — plejstocen; NG — zlodowacenie północno-polskie; U EO — eocen górny – oligocen; H — Holocen

Table 1

Composition of transparent heavy minerals in the Upper Cretaceous deposits (Upper Cenomanian – Lower Turonian) from eastern part of the Southern Baltic and Łeba Elevation

Boreholes (ordinate)	Studied fraction mm	Sample depth m	Zircon	TiO_2 group	Tourmaline	Disthene	Staurolite	Andalusite	Epidote	Garnet	Amphibole	Others	Author
Chłapowo I (+51.15 m)	0.5–0.06	151.5 151.7 165.5 169.3	26.8 47.9 49.8 34.1	8.9 10.0 5.7 8.2	17.9 9.5 6.2 4.8	3.5 0.5 0 12.0	1.8 0.5 0 0.5	6.0 4.0 0 0.5	25.6 17.0 27.1 30.8	9.5 11.0 32.8 9.1	0 0 0.4 0	0 0 0 0	M. Piwocki et al. (1985)
Chłapowo III (+57.46 m)	0.5–0.06	158.5	25.0	3.1	1.6	23.4	0	0	37.5	6.2	1.6	1.6	B. Kosmowska--Ceranowicz (1987)
W 1/82 (–93.1 m)	0.25–0.125	13.5	11.9	2.3	1.5	9.0	3.5	0.8	18.8	11.8	6.3	33	R. Pikies, Z. Jurowska (1988)
B 8–1 (–82.5 m)	0.25–0.125	9.4 10.6	8.6 6.3	7.4 0	1.2 5.1	9.9 6.3	3.7 2.5	0 1.3	23.5 21.4	24.8 16.5	6.2 7.6	22.1 33.0	R. Pikies (1990)

Cenomanian as indicated occurrence of: *Orithostella formosa* (Brotzen), *Gavelinella baltica* (Brotzen), *G. cenomanica* (Brotzen) and *Marginulina* sp.

THE UPPER CRETACEOUS FROM EASTERN PART OF THE ŁEBA ELEVATION

The Upper Cretaceous deposits on nearby land area were drilled in boreholes: Chłapowo I, II and III (M. Piwocki et al., 1985; M. Piwocki, I. Olkowicz-Paprocka, 1987; B. Kosmowska-Ceranowicz, 1987).

The borehole Chłapowo I (depth 170.0 m), after passing Quaternary and Tertiary series, was finished in the Upper Cretaceous deposits (drilled part — 18.4 m thick). Just under the Tertiary occurred the bed of silty, calcareous, quartz-glauconitic sand, 0.3 m thick. Main part of drilled Upper Cretaceous series consisted of dark-grey siltstones, intercalated with grey-greenish quartz-glauconitic sands (Fig. 3). These deposits contained phosphorites, single foraminifers, bone fragments and fish teeth. Microfaunal data indicated their Lower Turonian age (after E. Gawor-Biedowa report, in: W. Piwocki et al., 1985). Later I. Grabowska (1987) referred — basing on microplankton data — the Upper Cretaceous deposits from boreholes Chłapowo I and III to age interval: Upper Cenomanian – Lower Turonian.

Analysis of heavy minerals content (M. Piwocki et al., 1985; B. Kosmowska-Ceranowicz, 1987) facilitated correlation of Upper Cretaceous deposits from land part of the Puck sheet with similar ones found in marine wells. These studies documented significant content of epidote (30.8–37.5%), zircon (25.0–34.1%) and disthene (12.0–23.4%, see — Tab. 1).

Similar concentrations, found in Upper Cretaceous deposits from boreholes W 1/82 and B 8-1, allowed to reckon them into age interval: Upper Cenomanian – Lower Turonian.

THE UPPER CRETACEOUS EXTENT

Observed limit of occurrence of the Upper Cretaceous is a superposition of primary basin extent and activity of later tectonics and erosion. This part of the Baltic Sea was dominated by orthogonal fault network, with N–S and W–E orientations (Fig. 5; R. Dadlez, 1989; A. Witkowski, 1990). Meridional faults, framing or crossing the Łeba Elevation, were known as Łeba, Żarnowiec and Karwia faults. Eastward from the last one was marked the Kuźnica Fault. Białogóra and Łeba — Sambia faults were latitudinal forms (names of dislocations — after R. Dadlez, 1989; A. Witkowski, 1990).

According A. Witkowski (1990) the latitudinal faults have shifted the meridional ones that suggested their younger age but more eastward, on the Lithuania and Latvia areas, these relations were reversed and meridional faults have been shifted by latitudinal ones (A. Witkowski, 1989, 1990). Author observations from the Gotland Basin sheet have not confirmed such opinions.

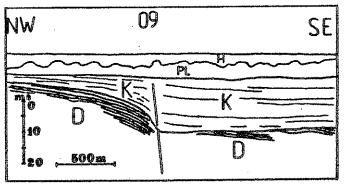

Fig. 4

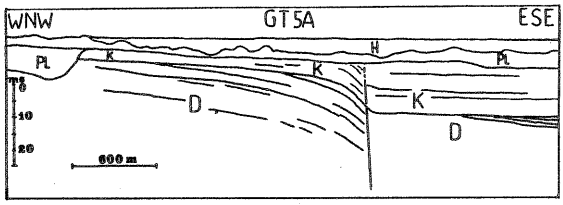

Fig. 5

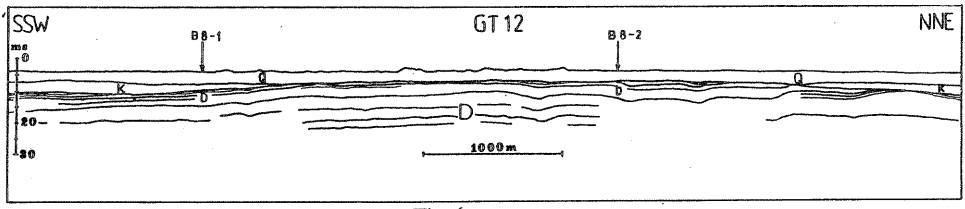

Fig. 6

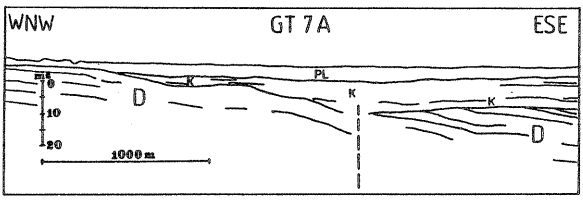

Fig. 7

Fig. 4. The Kuźnica Fault, fragment of seismo-acoustic profile 09
D — Devonian; K — Cretaceous; PL — Pleistocene; H — Holocene
Uskok Kuźnicy, fragment profilu sejsmoakustycznego 09
D — dewon; K — kreda; PL — plejstocen; H — holocen

Fig. 5. The Kuźnica Fault, fragment of seismo-acoustic profile GT 5A
Explanations as in Fig. 4
Uskok Kuźnicy, fragment profilu sejsmoakustycznego GT 5A
Objaśnienia jak na fig. 4

Fig. 6. Fragment of seismo-acoustic profile GT 12. In its middle part, under Quaternary deposits, occur Upper Devonian rocks (borehole B 8-2), in northern and southern parts — Upper Cretaceous deposits (borehole B 8-1)
Q — Quaternary; other symbols as in Fig. 4
Fragment profilu sejsmoakustycznego GT 12. W środkowej części profilu, pod osadami czwartorzędu, wychodnie utworów górnego dewonu (otwór B 8-2), w części północnej i południowej — utwory górnej kredy (otwór B 8-1)
Q — czwartorzęd; pozostałe objaśnienia jak na fig. 4

Fig. 7. The Kuźnica Fault, fragment of profile GT 7A. Tectonic deformations zone marked with local lack of data. Discordant position of the Upper Cretaceous on the Devonian rocks
Explanations as in Fig. 4
Uskok Kuźnicy, fragment profilu GT 7A. Strefa tektonicznego zaangażowania zaznacza się miejscowym brakiem czytelności zapisu. Wyraźnie niezgodne ułożenie kredy na dewonie
Objaśnienia jak na fig. 4

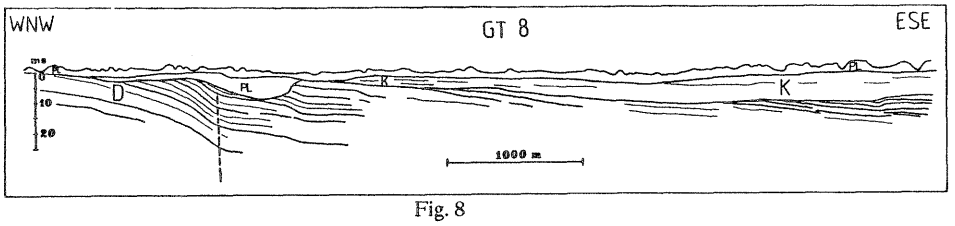

Fig. 8

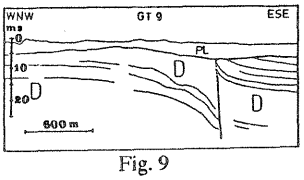

Fig. 9

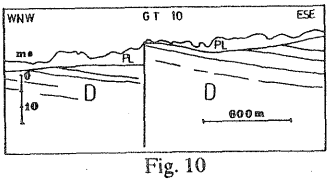

Fig. 10

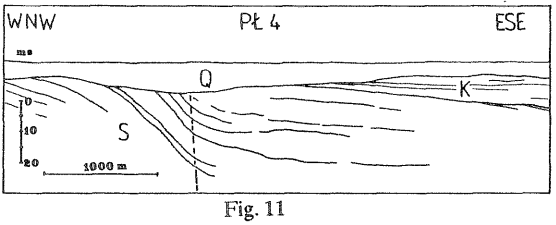

Fig. 11

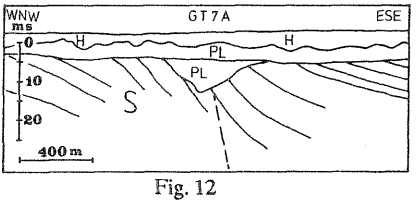

Fig. 12

Fig. 8. The Kuźnica Fault, fragment of profile GT 8. Dislocation of flexural type within Devonian deposits. Rocks in near-fault zone have often weakened resistance and are easy to remove. Local depressions in the Quaternary basement infilled with young glacial deposits

Explanations as in Fig. 4.

Uskok Kuźnicy, fragment profilu GT 8. Dyslokacja o charakterze łagodnej fleksury w obrębie utworów dewonu. Skały w strefie przyuskokowej wykazują często osłabioną odporność, są łatwo usuwane. Lokalne obniżenie w podłożu czwartorzędu wypełnione młodymi osadami glacjalnymi

Objaśnienia jak na fig. 4

Fig. 9. The Kuźnica Fault, fragment of profile GT 9. Flexure within Devonian deposits

Explanations as in Fig. 4

Uskok Kuźnicy, fragment profilu GT 9. Fleksura w obrębie utworów dewonu

Objaśnienia jak na fig. 4

Fig. 10. Fragment of profile GT 10. Neotectonic phenomena — young Quaternary fault origined due to loading of Earth crust. Thickness increase of Pleistocene deposits on its downthrown side

Explanations as in Fig. 4

Fragment profilu GT 10. Przejaw neotektoniki — młody uskok czwartorzędowy powstały w wyniku obciążenia skorupy ziemskiej. Wzrost miąższości osadów plejstocenu w skrzydle zrzuconym

Objaśnienia jak na fig. 4

Fig. 11. The Karwia Fault, fragment of profile PŁ 4. Dislocation of flexural type

S — Silurian, K — Cretaceous, Q — Quaternary

Uskok Karwi, fragment profilu PŁ 4. Fleksuralny charakter dyslokacji

S — sylur, K — kreda, Q — czwartorzęd

Fig. 12. The Karwia Fault, fragment of profile GT 7A. Flexural bed dip increase — in tectonic zone local depression in the Quaternary basement infilled with young glacial deposits

S — Silurian; other explanations as in Fig. 4

Uskok Karwii, fragment profilu GT 7A. Fleksuralne zestromienie upadów warstw — w strefie tektonicznej lokalne obniżenie w podłożu czwartorzędu wypełniają młode osady glacjalne

S — sylur; pozostałe objaśnienia jak na fig. 4

Tectonic studies of Southern Baltic Sea, on Precambrian Platform area, indicated that mentioned faults were variaged, several times renewed (R. Dadlez, 1989). Part of them have their basis in Old-Paleozoic structural complex. Their considerable part resulted from synorogenic Hercynian movements. After Carboniferous intensive sub-Hercynian uplifting movements have acted on the Łeba Elevation (R. Dadlez, 1989).

Authors studies proved that position of the Upper Cretaceous extent depended on next phase of tectonic movements, which maximum took place on the turn of Cretaceous and Tertiary. These movements acted after deposition of the Upper Cretaceous cover. The Laramide faults with NW–SE strike were noted from marginal part of the Precambrian Platform, especially they were frequent nearby Bornholm and involved formation of the Christianso and Bornholm horsts.

During Laramide movements parts of faults were renewed in eastern regions of the Southern Baltic. Similar opinion could be regarded to the Żarnowiec Fault and — particularly — to the Karwia and Kuźnica ones. The Żarnowiec Fault, in its initial part meridional, transformed northward to NW–SE direction, similar to Laramide network. Supposed renewing of this fault during Laramide Phase, with constant uplifting of the Łeba — Żarnowiec Block and lowering tendency of western limb of the Baltic Syneclise, could explain such significant southward retreat of extent of Upper Cretaceous deposits on the Łeba Elevation area. It also could explain their considerable expansion northward on eastern, downthrown side of this dislocation zone.

The Żarnowiec Fault, due to diminishing of resistance of nearby rocks, activated exaration of ice-sheet and caused complete removing of Cretaceous and Jurassic rocks from its surroundings. Triassic deposits occurred there under thick Quaternary cover.

Author studies indicated undoubtful activity of meridional faults such as: Karwia (Figs 11–12) and Kuźnica (Figs 4, 5, 7, 8, 9) faults, also after deposition of the Upper Cretaceous. Effects of this activity were good visible on area of the Gotland Basin sheet. Both dislocations had flexural character, with lowered eastern sides (Figs 3, 4, 11). Thickness increase of the Upper Cretaceous and distinct shifting of its limit northward on eastern side of the Kuźnica Fault (Figs 4, 5) were clearly marked. Own author studies documented also change of orientations of Kuźnica and Karwia faults, from initially meridional to NW–SE in their northern parts (Fig. 5).

Sings of neotectonics were visible in northern part of the Gotland Basin sheet. Small active, also during Quaternary, faults were found there (Fig. 10), resulted probably due to isostatic relievering of Earth crust.

The prolonged processes of denudation have influenced on final position of limit the Upper Cretaceous deposits. They dominated on eastern area of the Southern Baltic during all Palaeocene, Lower Eocene and Neogene.

Recent extent of the Upper Cretaceous deposits was determined by ice-sheet exaration, which has grooved several times the bottom of the Baltic Depression.

Translated by Grzegorz Czapowski

Oddział Geologii Morza
Państwowego Instytutu Geologicznego
Sopot, ul. Polna 62
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Radosław PIKIES

NOWE DANE O GÓRNEJ KREDZIE WE WSCHODNIEJ CZĘŚCI BAŁTYKU POŁUDNIOWEGO

Streszczenie

W trakcie prac geologiczno-kartograficznych dla *Geologicznej mapy dna Bałtyku* w skali 1:200 000, wykonywanych we wschodniej części Bałtyku południowego, poszerzono znacznie stan znajomości budowy geologicznej podłoża czwartorzędu. Stało się to możliwe dzięki skorelowaniu płytkich badań sejsmoakustycznych (boomer) z profilami otworów wiertniczych. Ogółem, na obszarze dwóch arkuszy tej mapy (Puck i Basen Gotlandzki) wykonano 1640 km profili sejsmoakustycznych i wykorzystano materiał badawczy z pięciu otworów wiertniczych, o łącznej długości 178,0 m (fig. 1).

W granicach obszaru arkusza Basen Gotlandzki podłoże czwartorzędu tworzą osady górnego syluru (podlasie), górnej kredy (cenoman/turon), a także lokalnie górnego dewonu (fran).

W granicach obszaru arkusza Puck pod czwartorzędem występują głównie osady górnej kredy, a w części przylądowej i osady dolnego trzeciorzędu (górny eocen – dolny oligocen).

Rozprzestrzenienie osadów górnokredowych ku północy jest znacznie większe od dotychczas przyjmowanego (fig. 2). Występują one w południowo-zachodniej części obszaru arkusza Puck na głęb. 113–176 m p.p.m. (otwór B 2-1/80), w północnej części strop położony jest na głęb. 93 m p.p.m. (otwóry: W 1/82 i B7/I). W otworze B 8-1, zlokalizowanym w południowej części obszaru arkusza Basen Gotlandzki, utwory górnokredowe występują na głęb. 93,1–94,5 m p.p.m. i są podścielone przez wapienie franu.

Osady górnej kredy w otworach wiertniczych są reprezentowane przez ciemnozielone piaski muliste, wapniste, ze znaczną domieszką glaukonitu i rozproszonej drobnej miki (fig. 3). Często są wyraźnie smugowane materiałem mulistym o szaroczarnym zabarwieniu. Obficie spotyka się źle zachowany detrytus inocermów.

Analizy składu minerałów ciężkich wykazały obecność charakterystycznej asocjacji minerałów ciężkich, typowej dla osadów górnokredowych z rejonu Chłapowa (wschodnia część wyniesienia Łeby). W próbkach z otworów W 1/82 i B 8-1 występują podwyższone zawartości epidotu (18,8–23,5%), cyrkonu (6,3–11,9%) i dystenu (6,3–9,9%).

Badania sejsmoakustyczne z obszaru arkusza Basen Gotlandzki dowodzą, że szerokie rozprzestrzenienie ku północy osadów górnokredowych jest wynikiem ożywienia w fazie laramijskiej starych stref tektonicznych. Szczególnie dotyczy to trzech południkowych uskoków: Żarnowca, Karwi i Kuźnicy. Uskoki Karwi i Kuźnicy mają charakter fleksuralny, o obniżonych skrzydłach wschodnich. Szczególnie dobrze widoczny jest, po wschodniej stronie uskoku Kuźnicy, wzrost miąższości osadów górnokredowych, a także ich dalekie rozprzestrzenienie ku północy (Fig. 4–12).

Północną granicę występowania osadów górnokredowych określiły ostatecznie procesy długotrwałej denudacji (paleocen – dolny eocen, neogen) oraz lodowcowa egzaracja.