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BOTTOM DEPOSITS OF LAKE MOSZNE IN THE POLESIE NATIONAL PARK – LITHOSTRATIGRAPHY AND PALAEOENVIRONMENTAL INTERPRETATION

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Summary. In this paper we report the results of investigations of deposits filling the palaeobasin of Lake Moszne in the Polesie National Park. Sedimentological and palynological analyses of limnic-telmatic deposits were made, and lithology of their mineral substratum was determined. A first attempt was also made at conducting a georadar survey. Lateral and vertical lithofacial diversity of deposits was determined, as well as relief of its mineral substratum. Development phases of the lake-mire geosystem were reconstructed.

Key words: lake-mire deposits, palaeoenvironmental reconstruction, Lake Moszne, Polesie National Park, Polesie region

AIM AND METHODS OF RESEARCH

Limnic and mire deposits are a valuable source of information about environmental state in the past and its evolution. Especially biogenic deposits can very well keep a record of events. They contain not only the record of local environmental conditions but also their changes at least in regional scale. Changes of deposit type and features correspond to changes of climate, water conditions, vegetation cover and human economic activities. Therefore, limnic deposits are the subject of many scientific researches, especially in the field of biology and Earth sciences [Tobolski 2000].

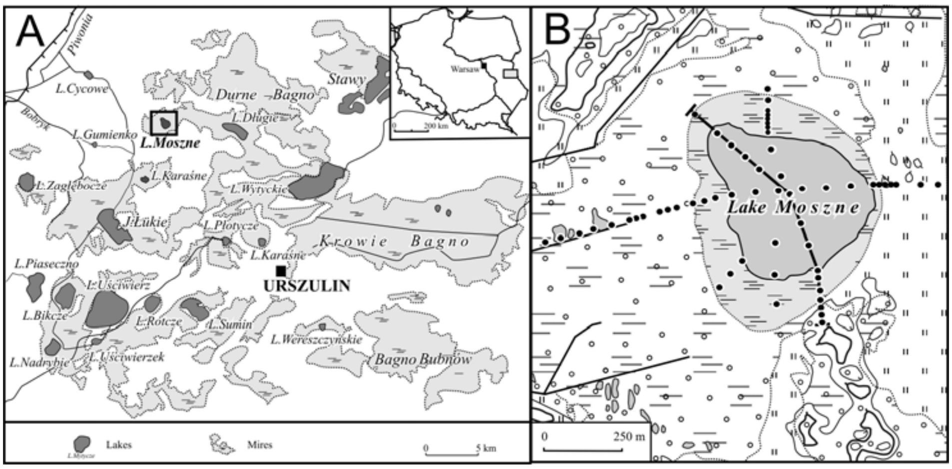

Fig. 1. Situation of Lake Moszne: A – in the system of lakes and mires of the Polesie National Park; B – in the lake-mire geosystem with location of borings; continuous line marks the section presented in Fig. 2

The Moszne lake-mire geosystem, situated in the Polesie National Park (Fig. 1), belongs to the best examined – in respect of geological and paleobotanical features – objects of this type in eastern Poland. Interdisciplinary researches (geological-palaeoecological) of the Moszne object have been conducted in stages since 1989 in connection with several scientific research projects. The results of these studies enable us to make corrections for the depth and morphology of the lake basin, and for the lithofacial type of bottom deposits [Bałaga *et al.* 1992, 1994, 2005, Bałaga 2002]. Deposit cores were taken for macroscopic examination, palynological analysis and C^{14} dating by means of Eijkelkamp hand corer with the Instorf sampler. In January 2009 an attempt was made at using the Zond-12e georadar with 100 MHz shielded bistatic antenna to obtain more detailed geological data. Georadar profiling along a section (see Fig. 1) was carried out on ice-covered lake. The recorded data were processed using version 2.3 of the Prism 2 software.

LAKE-MIRE GEOSYSTEM

The basin of Lake Moszne and adjacent mire is located on the north-western slope of the Wola Wereszczyńska chalk elevation. The slope passes into a fossil slope of latitudinal trough filled with fluvioglacial deposits of the Odra Glacial [Buraczyński and Wojtanowicz 1981]. They form a plain which borders the basin from the north. The Jamniki long sandy esker of the same period adjoins the basin from the west. A second, smaller esker stretches out to SSE from the south-eastern shore of the lake. From the east the basin is bordered by small elevations of the Cretaceous substratum, covered by the Odranian sands which rise up to 1 m above the mire surface (Fig. 1).

The whole Moszne lake-mire geosystem is about 2 km^2 in area (Fig. 1). It includes the dystrophic lake with 17.5 ha in area and about 1 m in depth, and adjacent mires. The water surface is surrounded by a 30–150 m wide belt of floating bog (spleja). The spleja is composed of peatmosses and sedges, representing vegetation typical of transitional mires, with a *Sphagno-Caricetum rostratae* association covering the largest area. Aquatic vegetation is represented by four associations (*Elodetetum Canadensis, Nupharo-Nymphaetum, Nymphaetum candidae, Hydrochararitetum morsus-ranae*), and a community with *Chara delicatula*. The latter occurs on almost the whole lake surface, and plays an important role in the lake shallowing process. Rush vegetation develops at present both in the littoral zone (*Equisetum limosi*) and in the pelagial zone – several dozen metres from the lake shoreline (*Scirpetum lacustris*) [Sugier and Popiołek 1998]. Investigations of macrophyte structure changes indicate eutrophication of the lake in the last period [Sender 2008]. Alder carr of the *Alnetea glutinosa* class, *Tilio-Carpinetum* dry-ground forests, and patches of the *Vaccinio uliginosi-Pinetum* association occur in the forests surrounding the Lake Moszne complex.

DEPOSIT SEQUENCE – RESEARCH RESULTS

The geological work carried out to date enables us to reconstruct the substratum relief of the lake-mire geosystem. Borings along a latitudinal section indicate the occurrence of many fossil closed depressions in the western part of the geosystem (within the modern mire) and deep, vast lake basin in its eastern part [Bałaga *et al.* 1992, 1994, Bałaga 2002]. Detailed boring reconnaissance within the lake basin (Fig. 1) indicates the occurrence of two fossil basins: (1) southern – to 14 m in depth, and (2) north-western – over 16 m in depth (deposits were not drilled through because of technical limitations of equipment) [Bałaga *et al.* 2005]. The fossil basins are separated by a narrow elevation where the substratum occurs at a depth of 5–6 m (Fig. 2). This fact makes the Lake Moszne similar to other „double" lakes (Łukcze, Perespilno) of the Łęczna-Włodawa Lake District.

The GPR method is more and more often used in investigations of deposits of shallow water bodies and mires [Żurek and Ziętek 2004, Lamparski 2005, Karczewski and Ziętek 2009]. Georadar image indicates that bottom deposits of Lake Moszne have a considerable vertical and horizontal variability of dielectric properties, but their saturation with water causes muffling of electromagnetic impulses, reflection is weak, and the obtained results difficult to interpret. The boundary between water-saturated and consolidated deposits, and also relief of Cretaceous substratum to the depth of about 10 m, are clearly seen. However, the GPR profiling provided more detailed information about lateral diversity of previously examined deposit lithology (Fig. 2).

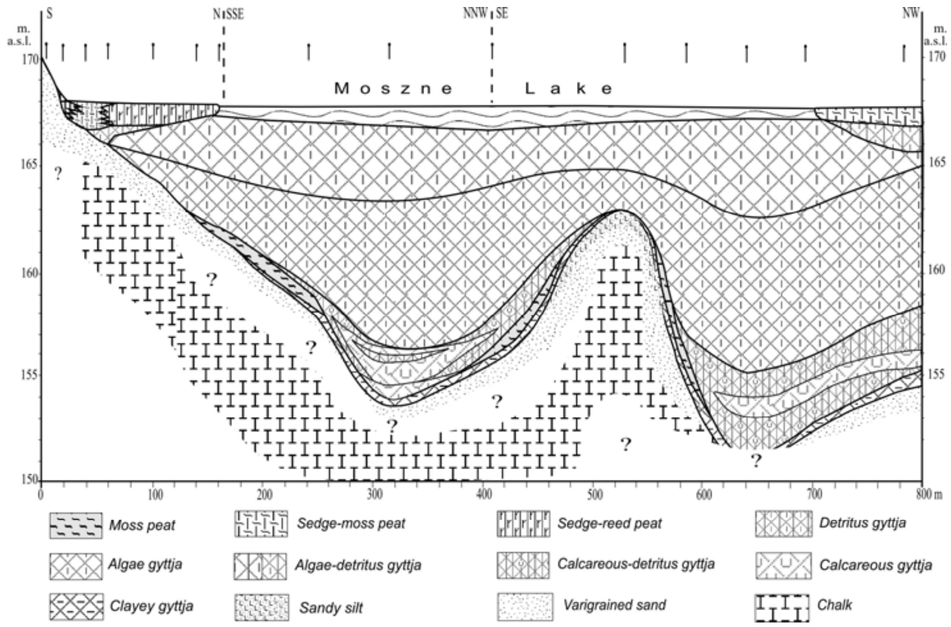

Fig. 2. Cross-section through the bottom deposits of Lake Moszne

The deposit sequence of the Moszne lake-mire geosystem is rather uniform laterally, and more differentiated vertically. Mineral substratum of organogenic deposits is composed of the Late Vistulian sandy silts and limnic sands with rather small thickness (< 0.5 m). They overlie weathered Cretaceous chalk and marls, and near the eskers – fluvioglacial deposits. The beginning of biogenic succession was palynologically determined and radiocarbon dated for Alleröd. Gyttja was accumulated in deeper basins, and moss peat in vast shallow depressions. A layer of weakly decomposed moss peat, up to 1 m thick, overlies the mineral bottom of lake basin, except for its western margin. This peat occurs also under gyttja in the mire part situated to the NE of the lake.

In the lake, on the bottom moss peat, many metres thick series of gyttja occurs. The bottom part consists of calcareous-detritus gyttja interlayered with calcareous gyttja and algae-detritus gyttja. Algae and algae-detritus gyttja form the main deposit mass which is poorly consolidated in its upper 3.5 m thick layer. Within the mire, on a limnic series with diversified thickness (0–5 m), 2–3 m thick peat series occurs that consists of sedge-moss peat (bottom part) and *Sphagnum* peat (upper part). The thickness of peat decreases toward the lake where the mire encroaches on limnic deposits as spleja (Fig. 2).

PALAEOENVIRONMENTAL INTERPRETATION

Late Glacial

The bottom silt deposits, dated at the end of the Older Dryas, evidence the formation of many small water bodies [Bałaga 2002]. Lithofacial diversity of deposits from the Alleröd phase (calcareous-detritus gyttja and moss peat) evidences a mosaic nature of the past landscape and indicates that small lakes and mire patches coexisted already at the end of the Pleniglacial. At the end of the Alleröd, as a result of substratum subsidence (effect of karst or/and thermokarst processes), the main lake was formed [Bałaga 2002, Dobrowolski 2006]. The Younger Dryas deposits are represented by calcareous-detritus gyttja in the profiles from the mire and from the central part of the lake. They mark the maximum extent of the lake. The high water level, similar to the present level, is shown by the shallow occurrence (at the depth of 1 m) of peat with gyttja in the marginal part of the mire. Based on the mean rate of sedimentation, it can be assumed that about 60 cm thick layer of gyttja was accumulated on the Alleröd peat during the Younger Dryas.

Holocene

At the beginning of the Holocene, in the Preboreal, algae-detritus gyttja was accumulated in the vast at that time water body. Species with higher thermal requirements such as *Typha latifolia* and *Nymphea alba* appeared in the lake and occupied the littoral zone. Algae-detritus gyttja was accumulated in the Boreal, and calcareous-detritus gyttja – at the end of that phase. The depth of the lake in its central part was about 8 m. Its shallowing to about 5.5 m occurred in the younger part of the Atlantic phase. In the mire profile, calcareous-detritus gyttja is covered by non-carbonate coarse-detritus gyttja. In the Subboreal phase (since about 4300 ± 120 years BP) the mire formed in the zone surrounding the lake: first the transition mire, and since 2890 ± 140 years BP – the peat bog. Lowering of water level resulted in the enlargement of littoral zone with rush vegetation. The lake depth at that time is estimated at about 3 m. In the Subatlantic phase the lake shallowing proceeded, and spleja encroached on the water-saturated deposits.

The modern lake occupies only the eastern part of the original lake basin. Asymmetric development of the geosystem is reflected by the different width of the modern spleja belt (Fig. 1). The predominant westerly winds, through wave action, made it difficult for the eastern shore to become overgrown, and compensatory near-bottom current transported deposits to the west. Such a directed asymmetry of lake development is found also in other lakes of the Łęczna-Włodawa Lake District [Okruszko *et al.* 1971], and the process of deposit transport occurs in our times in the Zemborzyce Reservoir near Lublin [Rodzik *et al.* 2009].

FINAL REMARKS

Interdisciplinary research on biogenic bottom deposits of modern and fossil lakes enable detailed reconstruction of palaeoenvironmental conditions. However, it is possible to the full only in the case of detailed examination of lithological and palaeobotanical (including palynological) vertical diversity of representative deposit profiles, the age of which is determined by absolute dating methods. It seems that examination of deposit lateral diversity is equally important as it enables us to determine the extent and mechanism of sedimentation. In order to reduce the number of borings, non-invasive methods of deposit structure examination are recommended, including georadar profiling.

The gathered data enable us to (1) examine in detail the original relief of mineral substratum of the lake-mire geosystem, (2) describe biogenic deposit succession and its lateral diversity, (3) reconstruct the development of the geosystem during the last ca. 13 ka BP.

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OSADY DENNE JEZIORA MOSZNE W POLESKIM PARKU NARODOWYM – STAN ROZPOZNANIA I INTERPRETACJA PALEOŚRODOWISKOWA

Streszczenie. W pracy przedstawiono wyniki badań osadów wypełniających kopalny zbiornik Jeziora Moszne w Poleskim Parku Narodowym. Przeprowadzono rozpoznanie sedymentologiczne i palinologiczne osadów limniczno-telmatycznych oraz litologiczne mineralnego podłoża. Podjęto także pierwszą próbę rozpoznania georadarowego. Określono lateralne zróżnicowanie i wertykalną zmienność litofacjalną osadów oraz konfigurację ich mineralnego podłoża. Odtworzono fazy rozwojowe geosystemu jeziorno-torfowiskowego.

Słowa kluczowe: osady jeziorne, rekonstrukcja paleośrodowiskowa, Jezioro Moszne, Poleski Park Narodowy, Polesie