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7. LAKE GOŚCIĄŻ: STRATIGRAPHY AND ENVIRONMENTAL HISTORY OF THE LATE-GLACIAL

7.1. FORMATION AND EVOLUTION OF THE NA JAZACH LAKES IN THE LATE VISTULIAN

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The examined cross-section of corings (see Starkel et al., Chapter 5.1, Fig. 5.1) indicates that the lakes were originally formed as separate depressions filled with water and later gradually joined into one branched lake system. Its filling by sediments and overgrowing were accompanied by water-level fluctuations. Finally the lake has been transformed into the system of isolated lakes drained by the Ruda stream (Fig. 7.1).

The fluctuations of the lake and groundwater level were determined on the basis of deposits in various zones, especially in the littoral sequences of forms and deposits in the coastal zone. Groundwater variations were also important in the small isolated dead-ice depressions filled mainly by peat (see Ralska-Jasiewiczowa & Starkel 1988, Więckowski 1993, Starkel et al. 1996).

In the deeper part of Lake Gościąż the variations of water level were recorded by changes in mineral matter, thickness of laminae, and appearance or disappearance of laminations, as well as by changes in plant and animal assemblages (e.g. Cladocera).

Processes of dead-ice melting and creation of lakes were reflected in organic deposits, later buried during

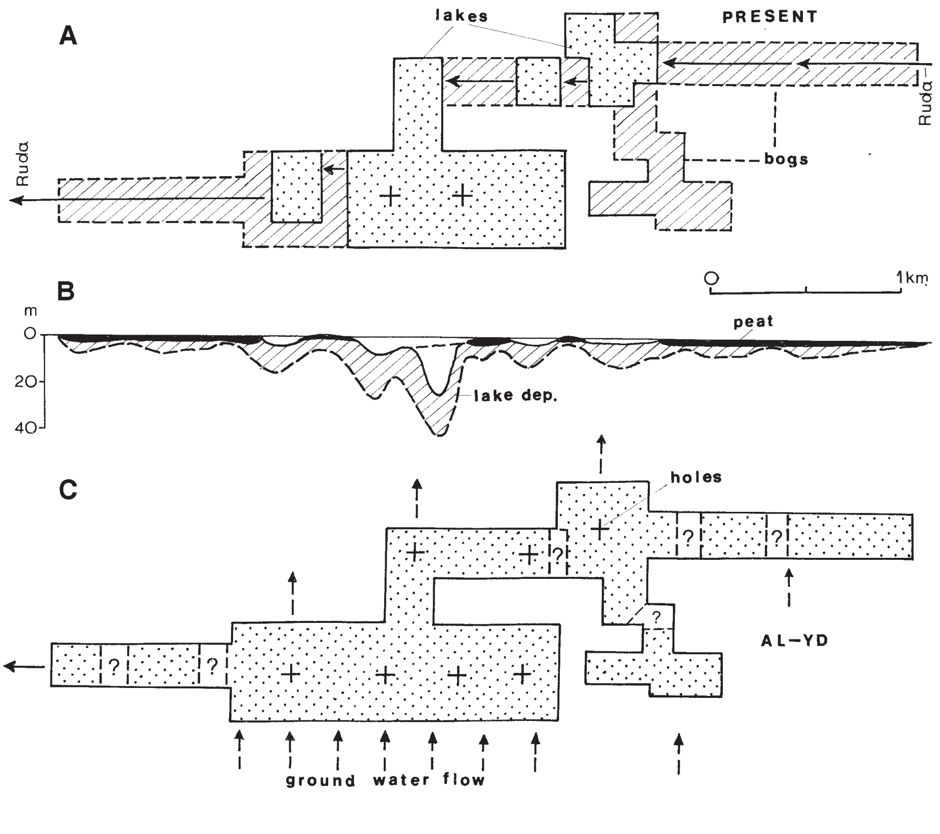

Fig. 7.1. Model of evolution of lake system Na Jazach: A – present, C – during late Vistulian. Dotted surface – lake surface, crosses – kettle holes, hachured – area of organic deposition (peatbogs and swamps). The simplified cross section in the middle (B) shows the filling of the previous large lake depression (after Starkel et al. 1996, completed).

lake transgression. Episodes of earth slumps and flows into or over the lake and formation of bog deposits indicate phases of transformation of the lake basins.

The beginning of dead-ice melting was metachronous and depended on the depth and size of the ice blocks. It may have started about 16–15 ka ^{14}C BP during warming before the Pomeranian phase, but only the retreat of permafrost after that phase (Kozarski 1991) created widespread conditions favourable for dead-ice melting. The oldest organic layers below the lacustrine sequences were dated at Lake Wierzchoń to 13,770±150 ^{14}C BP, and organic fraction from gyttja in core G1/87 at Lake Gościąż at 13,780±120 ^{14}C BP (Pazdur et al. 1994). Fragments of sandy plains up to 2 m above the present lake level, found between lakes Gościąż and Mielec or to NE of Lake Wierzchoń, could represent terraces of shallow melt-out lakes.

The melting continued during different lengths of time, but it seems to have proceeded relatively fast, because the basal organic (peaty?) layer is no more than 5–20 cm thick and it is covered by deep lake deposits. Most of the depressions were formed between 13,300 and 12,000 ^{14}C BP, i.e. in Bølling (Fig. 7.2). The larger or deeper buried ice blocks (Lake Brzózka) continued to melt during the early part of the Allerød. This seems to correspond to the sands layers which buried the lacustrine deposits dated between 11,840 and 11,700 ^{14}C BP in the eastern corner of Lake Gościąż.

At the beginning of the Allerød, the area presented several isolated lake basins (Fig. 7.3), and their level was rising due to the melting ice and the increasing supply of groundwaters from the south. In the younger part of the Allerød (ca. 11,500–11,200 ^{14}C BP) the water table of Lake Gościąż and surrounding basins reached a level similar to the present one. In the isolated small depressions the water level probably exceeded the level of Lake Gościąż, as documented by the expansion of lacustrine deposits (Chapter 5.1, borings GTO3/89, and G1/92).

The onset of deposition of sulphur-calcareous laminated gyttja in the late Allerød indicates that a kettle 40 m deep was finally formed. The presence of calcareous gyttja in the non-lacustrine segments of the present Ruda valley floor indicates that in the Late Vistulian existed one long and sinuous lake, composed of several kettles with shallowings and narrowings in-between. One cannot exclude that some of these narrowings were formed as gaps by the overflow during the lake-level rise from Bølling until mid-Allerød.

The area and volume of that reconstructed late-Allerød lake up to 5 km long was much greater than the present one (Fig. 7.1. see also Chapter 8.5, Tab. 8.6). The present lakes of the group Na Jazach complex cover area

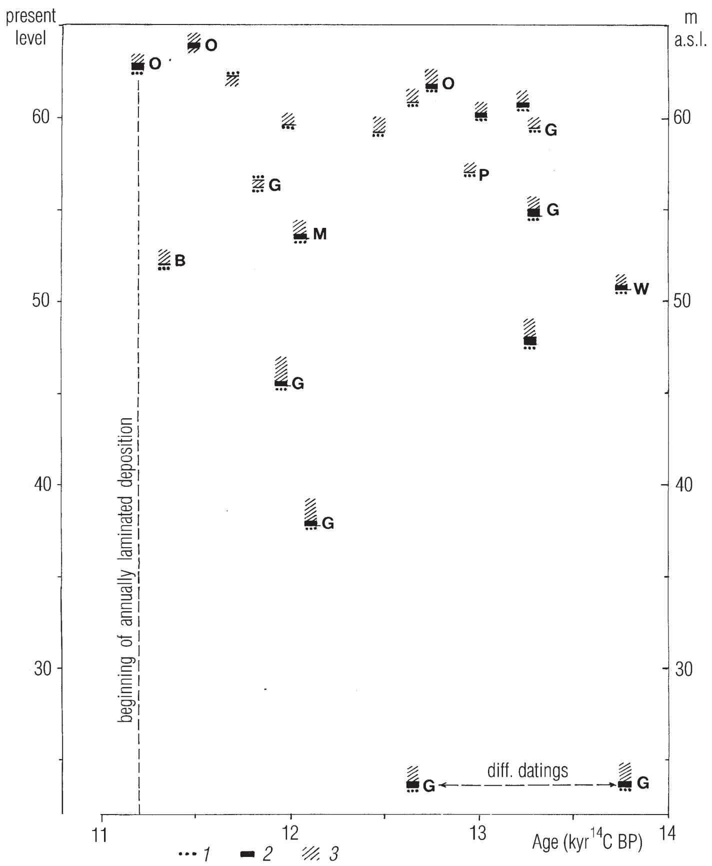

Fig. 7.2. Age of the bottom samples from Lake Gościąż and its surrounding indicating phases of the dead-ice melting and stabilization at the end of Allerød. 1 – sand, 2 – organic layer, 3 – lake deposits. G – samples from Lake Gościąż, W – Lake Wierzchoń, B – Lake Brzózka, M – Lake Mielec, O – depressions outside the Ruda valley system. Without letter – other localities in the surroundings.

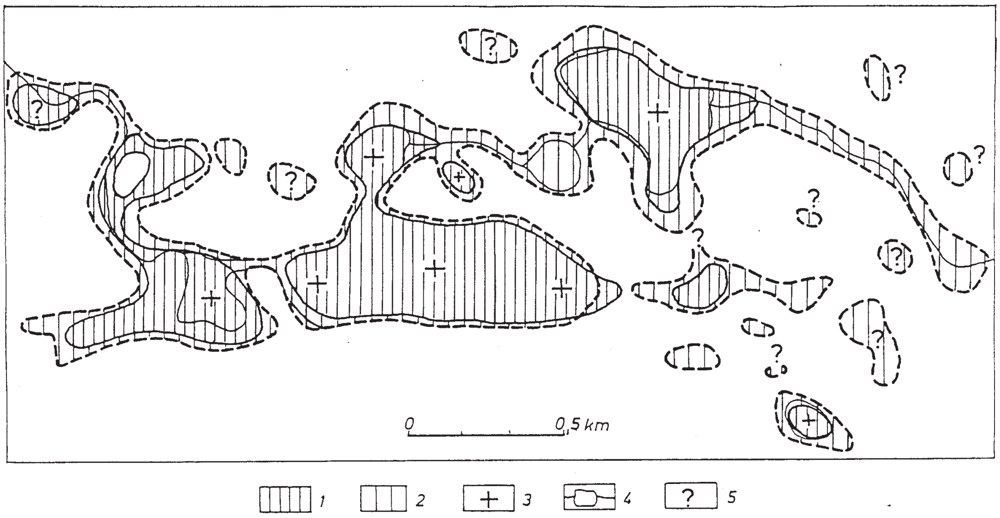

Fig. 7.3. Extent of lakes during various phases of the Late Vistulian. 1 – lakes at the beginning of Allerød, 2 – lake transgression during the late Allerød, 3 – deep dead ice hollows, 4 – present Ruda stream and lakes, 5 – lack of radiocarbon dating of lake formation – the reconstruction is based only on the extent of existing peatbogs.

of ca. 62 ha. The Allerød lake was at least 60% larger. The calculated volume of the present lakes does not exceed 2300 thousands m^3, and reconstructed volume of the late-Allerød lake was close to 8500 thousands m^3. The existence of such a great water volume was possible due to the direct contact of lake water with the ground waters moving freely from the south before the sealing of the lake bottom by the sediments, as well as due to lack of the surficial drainage. During the Younger Dryas the lake level was high but probably unstable and slightly lowering, as may be proved by the change from gyttja to peat in small separated depressions (borings GTO6, GTO3 – see Chapter 5.1). Simultaneously the activity of slope processes increased, facilitated by the seasonal freezing and fluctuations of lake level. The Younger Dryas was a phase of distinct decline in the volume of lakes as a result of intensified slope processes. In the central deep these are documented by a thick sand layer reflecting two subwater laminar flows differing in granulometry (see Chapter 5.1., Fig. 5.3). These flows were facilitated by steep slopes, which still have gradients of 17–27% (9–13^o).

7.2. LATE-GLACIAL SEDIMENTS OF LAKE GOŚCIĄŻ – CHRONOLOGICAL BACKGROUND

*Tomasz Goslar**

Basic varve structures

In a temperate zone the variance in the annual cycle is large enough to affect the growth of organisms as well as the chemical and physical processes that occur around and within the lake. Because of this the composition of matter accumulating at the lake bottom changes seasonally. If no disturbance occurs on the surface of depositing sediment (i.e. through water movements, gas bubbling or bioturbation), the seasonal cycle of accumulation should be reflected in the form of the laminations. The succession of single layers in laminated sediment corresponds then to the succession of processes within and around the lake and therefore should reveal an annual cyclicity. The high diversity of circumstances in which annual laminations may be formed causes the successional seasonal patterns of laminae to differ from lake to lake, and it also may change over time in a single lake. The review made by O'Sullivan (1983), however, led to a conclusion that four groups of basic patterns of annual lamination may be distinguished, and one might expect that any annually laminated lacustrine sediment reveals the cyclicity similar to one of four basic structures.

The sediments of Lake Gościąż reveal quite typical calcareous lamination. In the Allerød section, the varve structure is simple (Fig. 7.4), since it consists only of a calcite-rich light (white, light-yellow) layer and a darker (dark-yellow, light-brown) one with higher content of organic matter. Diatoms are quite rarely visible and occur below the calcite layer.

The most complex laminations occur in the Younger Dryas section of sediment. The main varve components (Fig. 7.5 left) are the layers of fine-grained, carbonate-free mineral matter, carbonate grains, and organic matter. In the layer of mineral matter, usually some frustules of centric diatoms (more or less dissolved) are visible. The chrysophycean cysts occur more rarely, and the large quartz grains (Fig. 7.5 right) are rare, too. The calcite (or Ca-rhodochrosite, see Łącka et al., Chapter 7.3) crystals

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