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3. RECENT ENVIRONMENT OF LAKE GOŚCIĄŻ AND CONNECTED LAKES

3.1. GEOLOGICAL STRUCTURE AND RELIEF IN THE SURROUNDINGS OF THE NA JAZACH LAKE SYSTEM

Bogumił Wicik

Quaternary substratum

The substratum of the Pleistocene deposits in the Płock Basin consists of Pliocene clays and, locally, of Miocene brown coals, sands, and carbonaceous clays as well as of calcareous sandstones and marls of the Cretaceous (Mapa Geologiczna Polski 1978). Discontinuities of the Tertiary sediments and their variable thickness result from erosional and glacitectonic processes (Skompski 1971, Madeyska, Chapter 2.2). In the area of lakes Na Jazach the topography at the top of the Tertiary deposits is fairly complicated. Between Lake Mielec and the western part of Lake Gościąż the top of the Tertiary deposits forms a meridional ridge at the height of 40 m a.s.l. East of the ridge the surface of the Pliocene clays forms an oval depression. The isoline closing this depression at the height of 30 m a.s.l. runs through the eastern part of Lake Gościąż and through lakes Mrokowo and Wierzchoń. In the bottom of this depression, occurring ca. 0.6 km to the east of Lake Gościąż, the Tertiary deposits are found below 20 m a.s.l. Small funnel-like depressions (with a diameter of ca. 300 m) at the top of the substratum have also been registered north of lakes Na Jazach. The surface of the Tertiary occurs there between 30 m and 20 m a.s.l. (Sołonowicz 1987, Tkaczyk 1987). The presence of weakly permeable deposits is documented by geoelectrical measurements (Churski & Marszelewski, Chapter 3.3). Ca. 0.6 km NE of Lake Wierzchoń the Miocene brown coals and thick fine-grained sands with coal dusts have been found directly under the fluvioglacial deposits at the depth of 27 m (ca. 40 m a.s.l.). At the northern shore of Lake Gościąż (ca. 200 m east of Tobyłka Bay) the Quaternary deposits reach thickness of 17 m. The Pliocene clays below occur to a depth of 30 m, and the underlying carboniferous series of the Miocene reach an elevation of ca. 27 m a.s.l. The top of this series is built of brown coals (2 m), while its lower parts consist of fine-grained sands with coal dust. Ca. 0.4 km south of Lake Gościąż the surface of the Pliocene clays occurs at the height of 31 m a.s.l., and the top of the Miocene coals at ca. 25 m a.s.l. The basin of Lake Gościąż intersects the Miocene deposits at an elevation of 26–24 m a.s.l.

The Pliocene clays contain siderite and pyrite concretions, and the Miocene marly clays contain crystals of gypsum and pyrite (Skompski 1971). The ash (67%) obtained after burning the sample of the Miocene coals of the surrounding of Lake Gościąż contained 0.23% Mg, 0.61% Fe, and ca. 0.32% SO_4.

The discontinuities in the isolating layer of the Pliocene clays play the role of hydrogeological windows (Churski & Marszelewski, Chapter 3.3). Mixing of the Tertiary (and older) waters with the Quaternary waters takes place. Direct seepage of the Miocene waters to the lake could have occurred in the initial period of the lake existence. Movement of waters within hydrological windows favours microbiological activation of the chemically active components of the Miocene coals such as carbon and sulphur. Their removal, especially in the gaseous form (CO_2, CH_4, H_2S), from the Miocene series results in a decrease in volume, which may cause the subsidence of the overlying geological layers. Such processes probably gave rise to the "karstic" character of the surfaces of the Tertiary deposits and also possibly to the funnel shape of the central deep in Lake Gościąż. Thus, it can be supposed that the development of the Late-Glacial meltwater morphology was modified by the local hydrogeological conditions (Wicik & Więckowski 1991).

Pleistocene sediments and forms

Lakes Na Jazach occur within the linear depression produced in fluvioglacial deposits (Madeyska 1991, 1993, Chapter 2.2). Within the Płock Basin these deposits form several terrace levels descending as indistinct steps towards the north. In that part of Płock Basin the flat surface of fluvioglacial sediments is dissected by the system of subglacial troughs and meltwater depressions (Fig. 3.1).

The fluvioglacial deposits of the terrace 67–70 m a.s.l. near lakes Na Jazach exhibit small differences in grain sizes. The patches of gravels and sands with boulders up to 15 cm in diameter occur only SE of Lake Wierzchoń

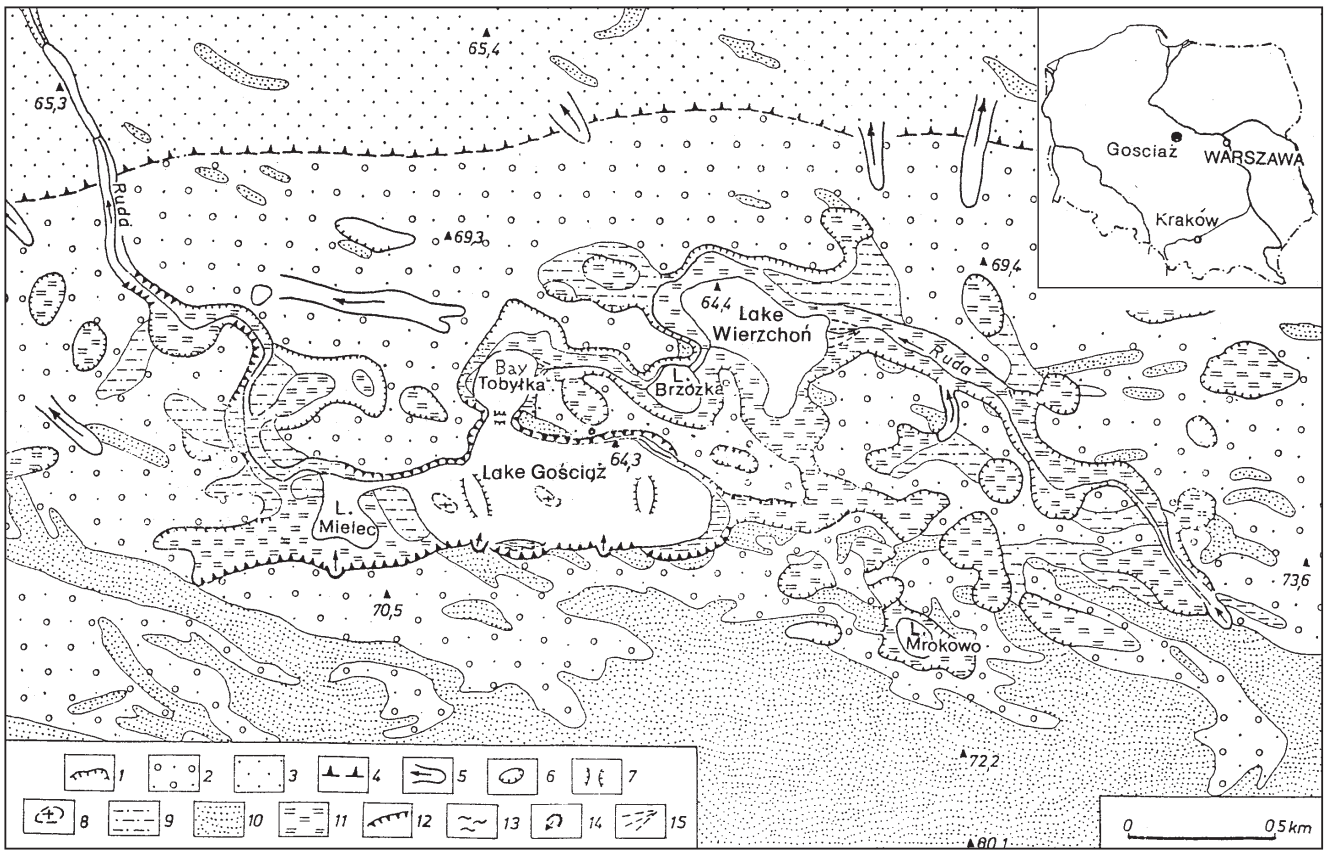

Fig. 3.1. Geomorphic map of the area of lakes Na Jazach. Pleistocene forms: 1 – subglacial channels, 2 – fluvioglacial terrace 70–67 m a.s.l., 3 – fluvioglacial terrace 64–60 m a.s.l., 4 – edges of terrace levels, 5 – erosional valleys, 6 – dead-ice depressions, 7 – deeps and steps in lake bottoms, 8 – meltwater depressions, 9 – plains of lacustrine deposition, 10 – dunes. Holocene forms: 11 – bog plains in dead-ice depressions and in the river valley floors, 12 – undercuts, 13 – landslide slopes, 14 – spring niches, 15 – alluvial fans.

(Skompski 1971). These deposits are to 1.1 m thick. Their grain-size composition is given in Table 3.1. Generally, in the near-surface zone of the surrounding of lakes Na Jazach, medium and fine sands with a few pebbles (Tab. 3.1) predominate. At the NE shore of Lake Gościąż, under these deposits at a depth of ca. 3 m is a layer of fine and medium sands with a few crumbs of carboneous substance in the basal part (61.5 m a.s.l.). At the northern shore of Lake Gościąż, under fine and varigrained sands at the elevation of 60 m a.s.l. are fine sands with chunks of coal, and below at the depth of 7 m are varigrained sands with gravels. At the southern shore of Lake Gościąż fine sands occur to the depth of 2–3 m above varigrained sands with gravels and then, from 8 m on, fine sands again. The western section of the shore of Lake Gościąż to a depth of ca. 5 m is built of differentiated sands with gravels. Below, at the height of 59.5 m a.s.l., fine sands with chunks of lignite and lamellae of bogheads have been found. The eastern part of the southern shore of Lake Gościąż to a depth of ca. 4–5 m below the lake water level is built of sands and gravels with fine rounded pebbles, underlain by fine and medium sands. At 0.5–1 km to the north of the lakes, between 67–64 m a.s.l., the surface is folded (Fig. 3.1), with features of an erosional edge in places. Actually, this is the surface of the slope dipping to the north, with fragments of shallow valleys and fine dunes.

The lower fluvioglacial terrace, located at 64–60 m a.s.l., is built of varigrained sands with an admixture of gravels and fine pebbles. Within this terrace, NE of Lake Wierzchoń, in the near-surface layer, fine sands with gravels occur to the depths of 2.5–5 m, and fine sands to the depths of 11 m. Black and steel-grey clays (Miocene?) have been found there at 57 m a.s.l.

Meltwater depressions occupied at present by the lakes reach depths of 13–17 m (51–47 m a.s.l.). Greater depths (20–40 m) occur only in three hollows of Lake Gościąż (see Chapter 5.1). At the sites of the present peatlands the original depths of the depressions were 6–10 m. In the bottoms of meltwater depressions, fine sands usually occur under limnic sediments. The underwater sill separating Lake Gościąż from Tobyłka Bay at the water depth of ca. 4 m is built of differentiated sands with gravel and pebbles.

After accumulation of fluvioglacial deposits had been completed, the surface with buried dead ice was subjected to eolian processes. In the zone of meltwater depressions Na Jazach there was a border between the areas of deflation and accumulation. North of these depressions deflation was small and did not completely mask the ero-

Table 3.1. Grain-size composition of deposits in the area of the lakes Na Jazach.

Type of deposit	Grain sizes in %					
	above 2.5 mm	2.5–1.0 mm	1.0–0.5 mm	0.50–0.25 mm	0.25–0.10 mm	below 0.1 mm
Residual glacial deposits	24.0	12.1	37.0	23.8	2.3	0.8
Glacifluvial sands	0.2	2.7	38.2	41.4	9.9	0.6
Fluvial sands	0.4	0.9	12.3	48.5	19.7	12.2
Eolian sands	0.0	0.3	6.2	31.2	49.1	13.2

sional edge between the terraces. South of lakes Na Jazach the dune complexes are usually arcuate and reach to 12 m in height. At the southern and eastern margins of the meltwater depressions there are only singular small dune ridges stretching from NW to SE. Probably the dunes originally overlaid the dead ice, and because of that some of these dunes end abruptly at the edges of the lake basins. At the base of the dunes the layers of fossil soils and weathering zones are lacking. The dunes are built of fine sands (Tab. 3.1) containing locally fair amount of muscovite.

Melting of dead ice and formation of outwash took place after cessation of the eolian processes. Because of the lack of free surface runoff, marginal fragments of meltwater depressions played the role of reservoirs of limnic sedimentation. The plains related to this episode are covered with fine sands or silty sands with thin silty interbeddings (Fig. 3.1). These deposits exhibit an indistinct horizontal lamination (Kotarbiński & Urbaniak-Biernacka 1975).

Holocene deposits and forms

In the deeper meltwater depressions, limnic sedimentation started in the Bølling or Allerød and took place without major interruptions also at the beginning of the Holocene. However, in the eastern part of Lake Gościąż geomorphological and sedimentological changes occurred. In the borings located directly at the eastern shore, it was found that the limnic sediments accumulated around 11,800 ^{14}C BP became covered with a fine sand layer 4.4–6 m thick. The surface of the lake terrace there is adjacent to a landslide slope. Formation of the latter took place after deposition of the limnic sediments. The change in the shore morphology caused intensified sedimentation in the nearby part of the lake. The slopes and spring-niches at the southern shore of Lake Gościąż and at the springs of the Ruda stream are much younger. The 5–7 m steep scarp of the lake that incises the aquifer is subject to landslide processes. The beach is built of the sands transported towards the lake from numerous springs.

The Holocene limnic sediments of the present-day lakes Na Jazach consist of carbonate and carbonate-sulphide gyttjas. The latter are common in Lake Gościąż. The meltwater depressions occupied at present by the peatlands, are filled with carbonate gyttjas being up to 4 m thick. The peats overlying the gyttjas are 1.2–4 m thick. Swamp peats with *Phragmites* and wood peats predominate there. The peats of the transitional peatlands are 1.5–2 m thick and occur in the meltwater depressions located mainly on the northern side of the system of lakes Na Jazach. Lake Mrokowo is surrounded by moss peat.

When the activity of the Ruda stream began, the gyttjas became locally covered with deposits of the alluvial fans. These deposits consist of sands of various grain sizes and with plant detritus and chunks of charcoal.

3.2. BATHYMETRY AND MORPHOMETRY OF LAKE GOŚCIĄŻ

Zygmunt Churski

Lake Gościąż was sounded for the first time by Jaczynowski in 1925 (Lencewicz 1925). The depths were measured every 20 or 30 meters by means of a string with a weight. Distances between sounding points were marked on a rope extended on floats. Positions of transects were determined by geological compass. The water table of the lake during the measurements was at a level of 63.9 m a.s.l. As a result of this sounding the maximum depth was determined as 25.8 m, with the lake area as 46.9 ha. Moreover, Jaczynowski (1929) worked out the lake morphometry based on the established grid.

After initiation of the studies on the deposits of Lake Gościąż, which required precise determination of sounding coordinates, new measurements were undertaken in order to obtain an up-to-date and a very detailed grid of the lake and its surrounding. Toruń Military Unit No. 1440 under the supervision of Lt. J. Ciuba, M. E., performed bathymetric (echosounding) and topographic measurements, which allowed for working out a new plan (Fig. 3.2).

Application of echosounding and modern surveying techniques enables precise positioning of sites of sounding and levelling as well as for precise determination of depths from water table to the surface of the bottom deposits. When a weighted line (sounding line) is used, its submergence into the upper layer of lake deposits, even down to 0.5 m, has to be taken into consideration. Moreover, Jaczynowski's measurements of 1925 did not include large parts of the lake. Thus, a new plan was necessary.