EXCURSION: MOSCOW—THE UPPER VOLGA*

INTRODUCTION

Intinerary: Moscow—Pereslavl Zalesskij—Rostov Yaroslavskij—Uglič—Moscow

The excursion was devoted to the field examination of paleogeography of the central part of the Russian Plain. The main attention was turned to the glacial history and periglacial phenomena as the itinerary crossed the area invaded by the Moscow ice-sheet and in which periglacial processes operated during the Valdai glaciation. These processes are evidenced by the occurrence of cover silts and lacustrine and fluvial sediments.

The sections prepared for demonstration during the Symposium excursion revealed glacial and interglacial deposits; and hence it was possible to examine successive phases of glacial and interglacial periods since the second half of the Pleistocene. Glacial marginal formations were also presented.

Among the periglacial phenomena there were mainly demonstrated loess-like deposits and fossil periglacial structures. These phenomena are indications of such a complex of processes that were characteristic of periglacial environment in the central part of the Russian Plain during the last, i. e. the Valdai glaciation.

MAIN FEATURES OF GEOLOGICAL STRUCTURE AND GEOMORPHOLOGY OF THE AREA

by S. L. Breslav

The route Moscow—Upper Volga runs across a large orographic region of the Russian Plain (fig. 1). From Moscow to Puškino it traverses the western margin of the large Meščera outwash plain formed by meltwaters of the Dnieper and Moscow ice-sheets. North of Puškino it rises the Klin—Dmitrov Ridge constituting the N—E border of the Smolensk—Moscow Upland. Farther, the way runs across

* The excursion was prepared and guided by: the Commission on Quaternary Research of Academy of Sciences of the USSR, the Institute of Cryopedology of Academy of Sciences of the USSR, Institute of Geography of the Soviet Academy of Sciences, the Faculty of Geography of the Moscow State University and the Geological Survey of the Central Regions of the Ministry of Geology and Protection of Mineral Deposits of the USSR.

the eastern part of the Volga—Šošin Lowland, the Borisoglebskij Upland, and the Rostov Basin which is a former lake basin. To Uglič the route follows along the northern slope of the Borisoglebskij Upland. The town of Uglič is situated in the SW part of the vast Upper Volga Lowland.

The landscape of this region is controlled by glacial and glaciofluvial accumulation which levelled the preglacial relief in various degree. The Meščera Lowland and Klin—Dmitrov Ridge correspond in general to the preglacial topography, whereas the lowlands of Volga—Šošin and of the Upper Volga as well as the Borisoglebskij and Uglič uplands are all spread on the buried Upper-Volga Plateau. The Borisoglebskij and Uglič elevations are built entirely of glacial deposits.

The compositions of so-called cover silts of the Moscow region and their correlation to the underlying glacial deposits are well known. The silts are rather unstratified and occur in two or three horizons showing some signs of soil-forming processes.

To the north of the Klin—Dmitrov Ridge the Upper Pleistocene deposits show another composition. Though in the Petrovskoe hilly area and in the Rostov Basin the cover silts occur, being similar to the silts of the Moscow region, but they do not contain the Mikulino fossil soil which separates the silts from the glacial till. The Mikulino peat near Rostov underlies the deposits which are regarded as morainal by some scientists or as deluvial—(colluvial)—solifluxion silts by other investigators. A close interrelation of moraine deposits and overlying covering silts may be examined in large number of sections near Rostov.

Westwards the composition of covering deposits is much different. In the eastern part of the Volga—Šošin lowland simple covering deposits are replaced by peculiar covering aleurites characterised by horizontal lamination which evidences their water sedimentation. Their structure does not depend on topographic situation: the aleurites are laminated and of the same grain-size gradation both on the lowlands and on the elevated surfaces (Krasnokholm, Sandovsk Uplands, etc.). Within the lowland of the Upper Volga these fine, clayey sands and/or covering aleurites are usually separated from the moraine deposits by lacustrine sediments containing peat horizons, the age of which dated for 40,000—49,000 Radiocarbon years B. P.

MOSCOW—ROSTOV YAROSLAVSKIJ

by. S. L. Breslav

INTRODUCTION

The area between Moscow and the Upper Volga may be divided into two distinct relief regions. The southern region covers the Meščera Lowland (Moscow is situated on its eastern border) and the Klin—Dmitrov Ridge. It was invaded only by lower- and mid-Pleistocene ice-sheets. Northwards lies the second region: the Upper-Volga Lowland, the Borisoglebskij Upland, and the Rostov Basin. The age of the surface moraine of the northern region is until now disputable. MIRČINK, ŠANCER, MOSKVITIN and other scientists believe that the Upper Pleistocene glaciers covered all or a part of this region of the Russian Plain whereas KRASNOV, MARKOV, ČEBOTAREVA and ŠIK suggest that the late-Pleistocene ice-sheets did not reach this area. All the investigators, however, distinguish within the region the Oka (Würmian), the Dneper (Rissian) and the Moscow (Warta stage) moraines separated by the Likhvin and the Odincovo interglacial sediments.

The structure of late-Pleistocene deposits differs, however, in both regions. North of the Klin—Dmitrov Ridge it is more complex. The deposits overlying the Mikulino (Mgin, Eemian) peats are variously interpreted. Some investigators regard them as periglacial deposits of deluvial—(colluvial)—solifluxion origin (ČEBOTAREVA) and other authors (MOSKVITIN) consider these to be moraine sediments.

RIVER VORYA

by A. I. SPIRIDONOV

Topic: Marginal Formations of the Moscow Glaciation

The road Moscow—Zagorsk—Pereslavl Zalesskij crosses the marginal zone of morainal hills and kames and adjacent outwash plain within the area of the Moscow glaciation. Low, slightly undulated relief of the outwash plain, 160—170 m above sea level is typical of the interfluves of the rivers Moscow—Klazma, Klazma—Uča, and of the left side of the river Uča, to the village Bratovščina. In the sections along both sides of the road yellow and gray sands were examined 3 m and more thick, which overlie the Moscow moraine. This part of the outwash plain crossed by the excursion route is only a small segment of a vast plain of the Meščera Lowland extending eastwards and SE-wards covering the interfluve of the lower Moskva and Oka in the south and the upper and middle Klazma rivers in the north.

Between Bratovščina and the Talica the hilly and low-relief area, 180—210 m above sea level, is built of red-brownish boulder clay. It was examined in the section exposed along the road. The Talica—Vorya interfluve lying 175—185 m above sea level is an outwash plain which extends along the Vorya far to the North-West dissecting the Klin—Dmitrov Upland. Meltwaters during the Moscow glaciation flowed southwards, along the Vorya and other rivers to the Meščera Lowland. West of the road where it crosses the valleys of the Vorya and Pazha there occur sections revealing glacifluvial sands. In the sandpit situated on the left side of the Pazha there are:

— silt with sand and brownish fine clayey sand, showing vertical jointing, thickness — up to 1 m,

— fine and medium-grained sands, brown and brownish-yellow, diagonally stratified, interbedded with horizontally laminated sands containing scarcely distributed gravels and pebbles, thickness — up to 5 m,

— coarse, medium and fine sand, gray and yellow in colour, diagonally stratified, at the top — of deltaic type, thickness — up to 4 m.

At the base, variously grained sands with gravels and pebbles overlie yellow-brownish aleurite sands, diagonally stratified with interlayers of clayey sands.

From the Pazha to Pereslavl Zalesskij the road passes the Klin—Dmitrov Ridge, 250—300 m above sea level. The Ridge was formed before Pleistocene time. The main bulk of the Ridge, 200—250 m in altitude, was formed at the end of Jurrassic and Cretaceous time. The Ridge was an obstacle for advancing ice-sheet of the Moscow glaciation and therefore the marginal hilly-ridge-like land-forms were accumulated; the thickness of glacial deposits is 50 m and more. The road runs across the alternatively occurring moraine and kame hills, elevated moraine plains, glacial meltwater valleys and erosional depressions. Many of the highest hills are built of boulder clay and stratified sands containing boulders, pebbles, and gravels.

PERESLAVL ZALESSKIJ

by S. L. Breslav

Topic: The development of Lake Pleščeevo

The picturesque, rather steep slopes of the Klin—Dmitrov Ridge near Pereslavl Zalesskij decline into the flat lowland of the Upper Volga. Due to erosional dissection the slope-foot forms bay-like outline in plan. The basin of the Lake Pleščeevo, oriented NE—SW, 9,5 km long and 7 km wide, occupies one of such laterally intruded depressions.

The lake is interpreted as being of karst or of erosional origin. The latter hypothesis is much more probable as evidenced by further description.

Figure 1 presents the burried sub-Pleistocene relief. The present lake basin is situated almost exactly in the place of a burried depression which developed as a result of the junction of two parallel erosional trenches. The bottom of this erosional trenches is in some places —48 m (below sea level), i. e. 5—6 km NE of Pereslavl. The origin of such erosional trenches is not known well enough. Probably they were valleys originally occupied by glacier and deepened by subglacial water erosion. Similar elongated depressions could be formed also during the later glaciations.

The present landscape is typical of the ice-lobe terminal land-forms with characteristic trench-like glacial lakes (e. g. Lake Seliger) in the outward margins.

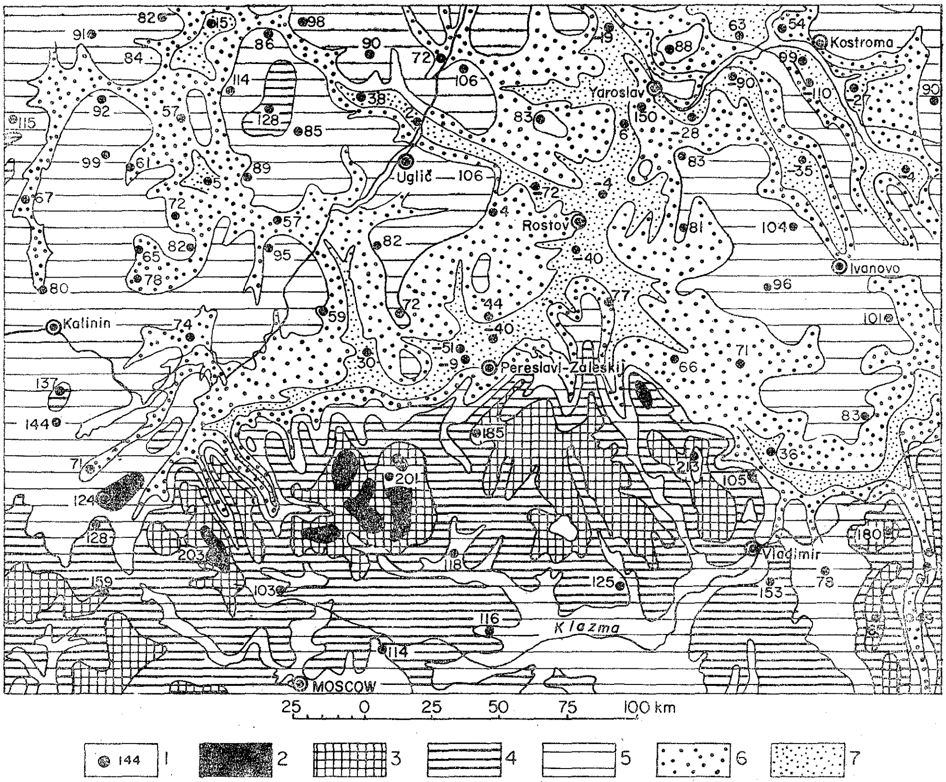


Fig. 1. Sub-Pleistocene relief of the middle part of Moscow syneclize (by S. L. BRESLAV)

1. boring holes and altitudes of substratum of the Quaternary sediments (contour intervals every 40 m); 2. above 240 m; 3. 240-200 m; 4. 200-160 m; 5. 160-120 m; 6. 120-80 m; 7. 80-40 m

The geological examinations and borings made in this area have revealed one system of trench-like hollows running along the main axes of the lakes Pleščeevo and Somino which have recently become separated (fig. 2). The age of formation of this elongated depression occupied by present-day lakes is not known yet as the borings penetrated only the upper part of the deposits.

A section in fig. 3 shows that the preglacial depression is filled with deposits belonging probably to four glaciations. The lowest moraine is related to the Dneper glaciation, the two higher horizons are regarded as deposits of two advances of the Moscow glaciation, and the upper moraine, which occurs also on the slopes of the Borisoglebskij Upland, represents the maximum extent of the Late Pleistocene ice-sheet.

Stratigraphy of lake deposits filling the trench has been examined in detail in the Somino Lake. The boring, 40 m deep, penetrates the gyttja, and underlying 5 m thick sands containing plant remains. Pollen analysis of gyttja and radiocarbon

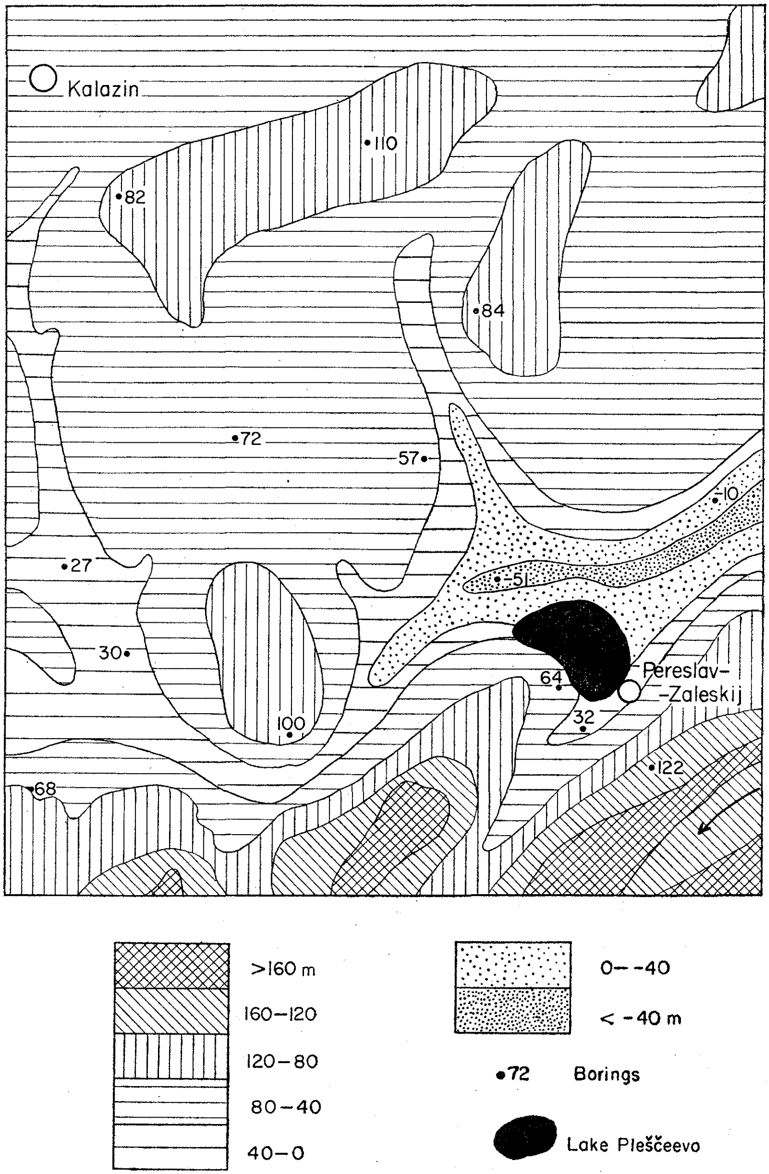


Fig. 2. Sub-Pleistocene relief in the region of Pereslavl Zalesskij (by S. L. Breslav)

determinations date the infilling deposits as Holocene (according to M. I. Nejštadt, N. A. Khotinskij, A. L. Devirc).

In the same section, near the mouth of the river Veksa to Lake Pleščeevo, there can be seen the transition of Holocene sediments into the late Pleistocene deposits at the depth of 17 m (N. A. Khotinskij). The increasing content of the pollen of

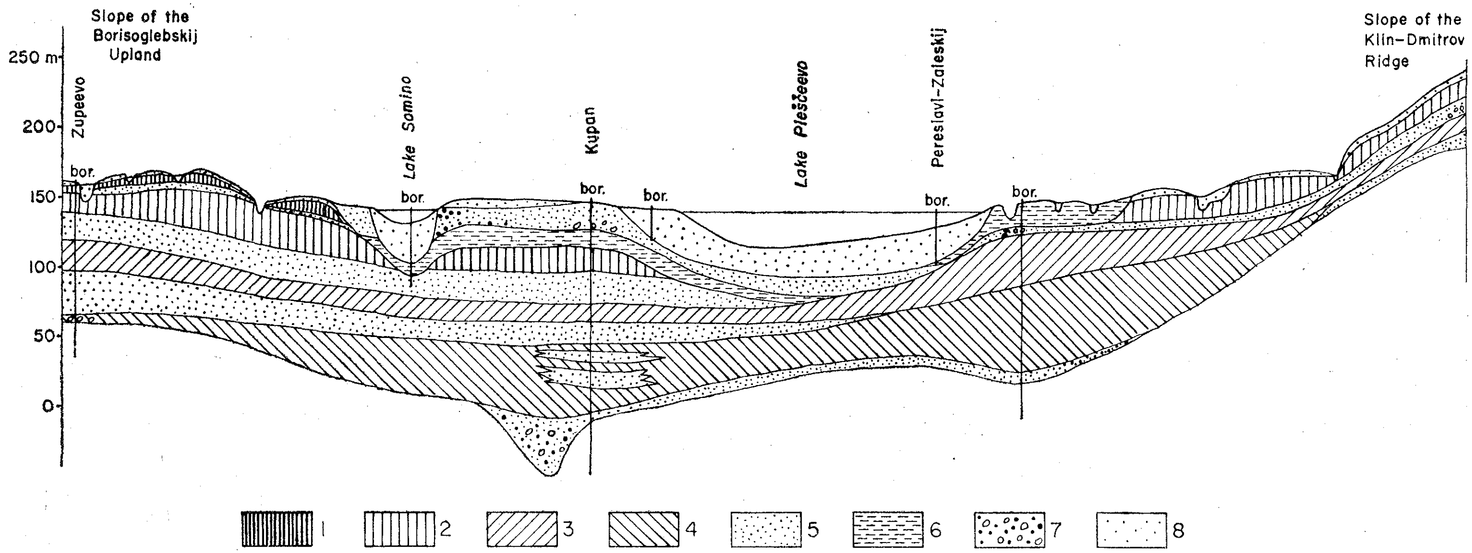


Fig. 3. Schematic geological cross-section

1. moraine of Kalinin glaciation; 2. and 3. moraines of Moscow glaciation; 4. moraine of Dneper glaciation; 5. sand; 6 till; 7. gravel and pebbles; 8. Holocene deposits

Betula nana indicates more severe climatic conditions. The absolute age is 10,535± ±33, i. e. the deposits belong to the Younger Dryas.

Near to this area, in the Polovecko-Kupanskoe Bogs the deposits containing flora are underlain by sediments with warm-indicating plants determined as Mikulino (Eemian) interglacial or Mologo-Šeksna (Early Würm) in age.

The above presented data indicate that the trench-like system of depressions began to form in late-Pleistocene time.

VICINITY OF ROSTOV YAROSLAVSKIJ

by

N. S. Čebotareva, A. K. Agadzhanyan, R. N. Gorlova
N. N. Paramonova, N. S. Sokolova, N. G. Sudakova, A. M. Cukurova

INTRODUCTION

Rostov Yaroslavskij, the old Russian town, is located at Lake Nero, in the lowest lying part of the Rostov Basin. The Basin is a depression formed due to the activity of ice-sheet of the Moscow glaciation[1].

As shown in figures 4 and 5 the glacial depression corresponds to an old, preglacial valley infilled with the Würmian (Oka) and Rissian (Dneper) glacifluvial deposits, the moraine and glacifluvial deposits accumulated during the retreat of the Dneper ice-sheet and during the advance of Moscow glaciation. The thickness of Moscow moraine is more than 15 m. After the retreat of the Moscow ice-sheet the depression was an ice marginal lake which existed later as interglacial lake in Mikulino time (in some places the Mikulino interglacial sediments are up to 40 m thick). The Rostov Basin is surrounded from West, South, and South-East by protruding spurs of the Borisoglebskij Upland. Within the Basin area some glaci-lacustrine and lacustrine terraces occur in form of dissected stripes.

The valleys of the Sara and Kotorosl have two terraces. The upper terrace, 12—14 m above the rivers, is erosional. Its base is built of Moscow moraine and/or glacifluvial sands. The lower, 6—9 m terrace, is mainly of accumulational origin. Both river terraces correspond to the upper and lower lake terraces. The plains

[1] The age of the glaciation is still disputable, in the most maps of this part of the USSR the area is presented as belonging to the late-Pleistocene glaciation. The present authors (except R. N. Gorlova) hold that the area was covered last time by the Moscow ice-sheet which extended into the Rostov Basin.

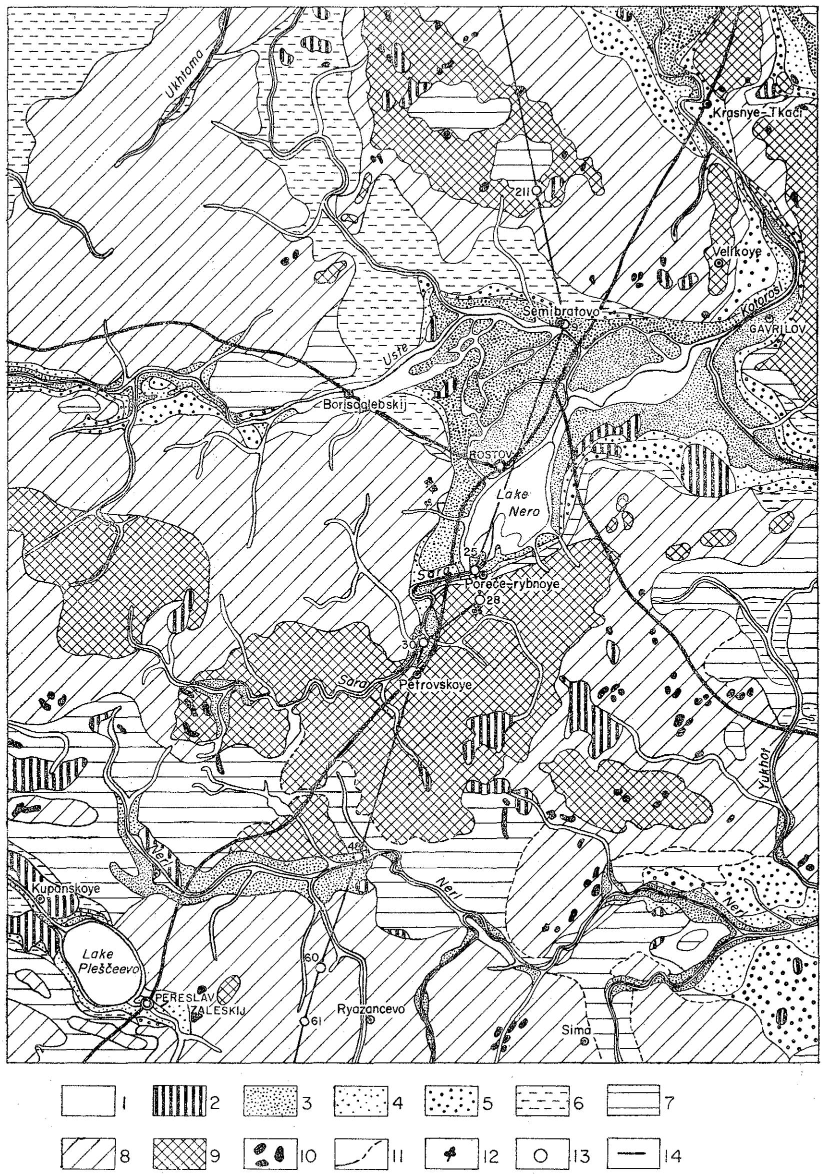


Fig. 4. Geomorphological sketch of the region of Rostov and Pereslavl Zalesskij (by A. M. CUKUROVA)

1. floodplain; 2. recent peat; 3. lake- and river 1st terraces; 4. lake- and river 2nd terraces; 5. lake- and river 3rd terraces; 6. glaci-lacustrine plain; 7. glacifluvial plain; 8. morainal plain; 9. terminal moraines; 10. kames and eskers; 11. geomorphological boundaries (established and supposed); 12. sites with interglacial flora; 13. boring holes; 14. line of geological cross-section A—B (see fig. 5)

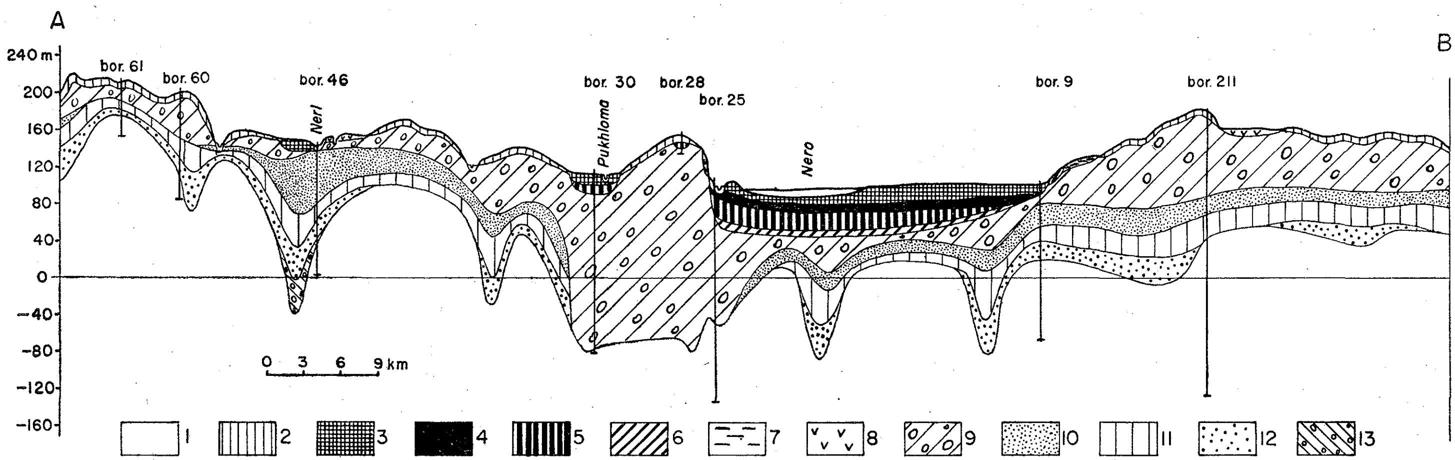


Fig. 5. Geological cross-section of Pleistocene sediments (see fig. 4; by A. M. CUKUROVA)

Recent sediments: 1. lacustrine and alluvial deposits. Upper Pleistocene: 2. covering and deluvial sediments, Valdai horizon; 3. lacustrine and alluvial sediments, first terrace; 4. lacustrine sediments, second terrace, Mikulino horizon; 5. lacustrine and bog sediments. Mid-Pleistocene — Moscow horizon: 6. lacustrine sediments, third terrace; 7. glacifluvial deposits of late stages of Moscow glacier retreating; 8. glacifluvial deposits of the early stages of Moscow glacier retreating; 9. glacial deposits (moraine): Dneper—Moscow horizons: 10. glacifluvial, fluvial, lacustrine and bog sediments. Dneper horizon: 11. glacial deposits (moraine). Middle and Lower Pleistocene — Oka—Dneper horizons: 12. glacifluvial, fluvial, lacustrine and bog sediments. Lower Pleistocene — Oka horizon: 13. glacial deposits (moraine) (upper and lower) occur in the river valleys as well as in the depression of Lake Nero.

Pleistocene deposits in the area in question are of complex character including glacial, glacifluvial, alluvial, and lacustrine-bog sediments. Their thickness varies from 20 to 100 m on interfluves and up to 200 m within the burried valleys. According to the opinions of many scientists (including the present writers) the Rostov area was invaded by ice-sheet of the Oka, Dneper, and Moscow glaciations.

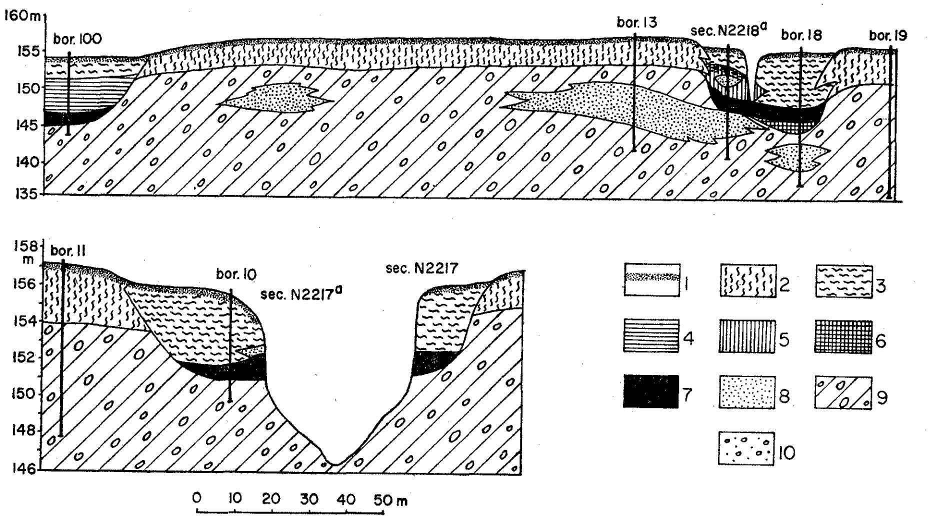


Fig. 6. Geological cross-section of Mikulino lacustrine and bog deposits near Čeremošnik (by A. M. CUKUROVA)

1. soil; 2. covering silts; 3. silts; 4. clays; 5. silty sands; 6. gyttja; 7. peat; 8. sands; 9. boulder clay; 10. pebbles and boulders

The Mikulino interglacial sediments are well known in many places near Rostov (fig. 6). They are exposed in various geomorphological situations: in ancient lake--basin recently occupied by Lake Nero (fig. 7), and at the foot of fluvial terraces and in gullies (figs. 8—11).

The age of lacustrine and bog sediments occurring in gullies near Šurskol and Čeremošnik as well as the origin of the overlying deposits have been discussed for the last 20 years because the covering deposits in some sections are boulderless silts, while in other sections they represent silty-loam containing a lot of rock fragments. Solution of the problem is very important for the determination of the limit of the post-Mikulino glaciation and whether the Rostov Basin was glaciated during the Valdai glaciation or the ice-sheet front was more NW-wards.

Some authors (I.P. GERASIMOV, V.P. GRIČUK, K.K. MARKOV, N.S. ČEBOTAREVA, and others) consider the lacustrine-bog sediments to be of Mikulino interglacial age, and the overlying silts of the Valdai glaciation but the ice-sheet did not reach

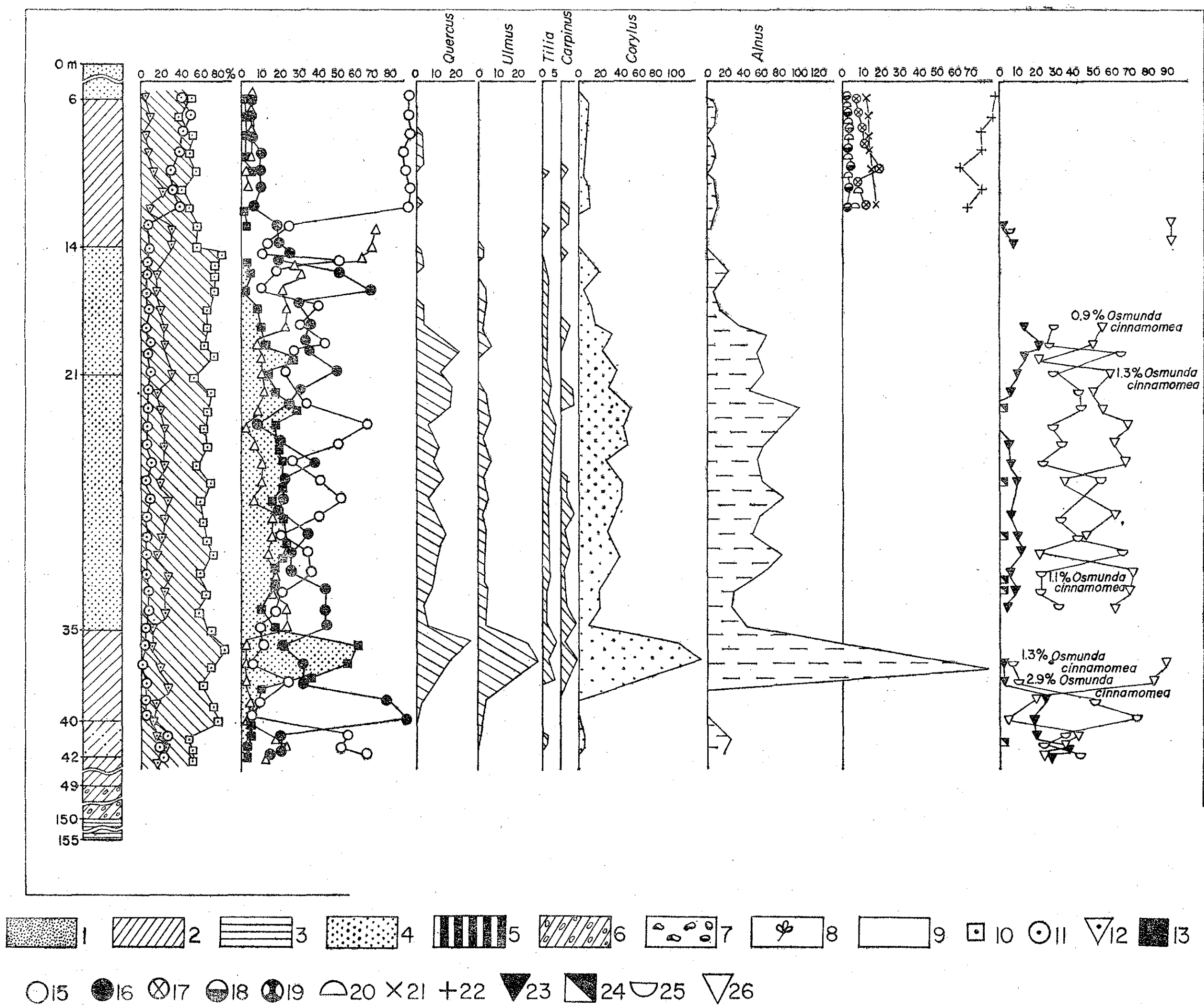


Fig. 7. Spore and pollen diagram of deposits near Poreče village, boring hole 25 (by M. N. VALUEVA, after A. M. CUKUROVA)

1. soil; 2. silt; 3. clay; 4. sand; 5. peat; 6. till; 7. pebbles and boulders; 8. plant remains; 9. gyttja; 10. tree pollen; 11. grass pollen; 12. spores; 13. total of pollen of latifolious trees (*Quercus, Ulmus, Tilia, Carpinus*); 14. *Picea*; 15. *Betula*; 16. *Pinus*; 17. *Ericaceae*; 18. *Gramineae*; 19. *Compositae*; 20. *Carex*; 21. *Chenopodiacae*; 22. *Artemisia*; 23. *Sphagnaceae*; 24. *Lycopodium*; 25. *Dryopteris*; 26. *Bryales*

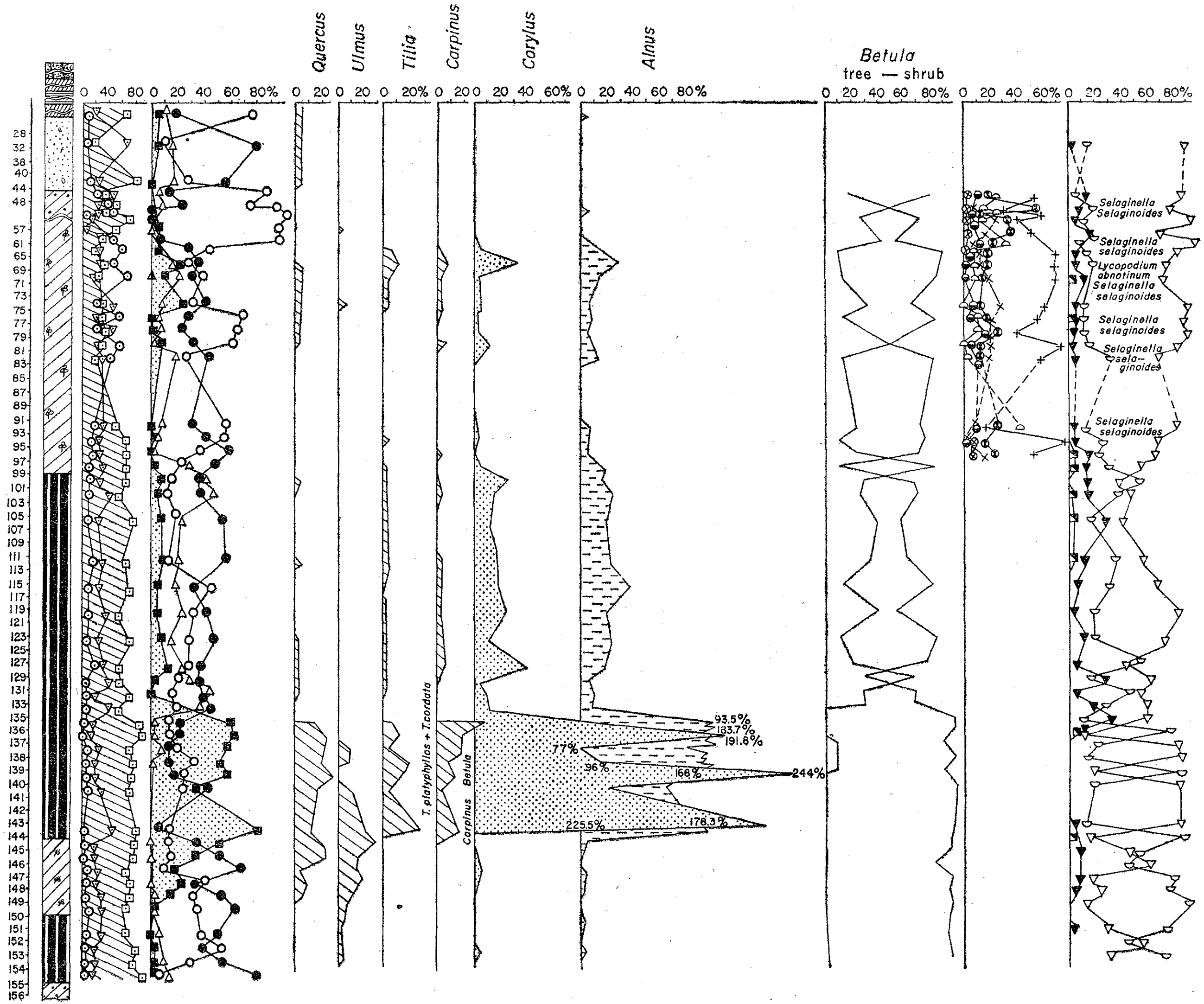


Fig. 8. Spore and pollen diagram of deposits near Klimatino, boring hole 28 (analyses made by M. N. VALUEVA, A. A. GUZMAN, A. N. GULIDOVA on the base of materials collected by A. M. CUKUROVA)

Explanations: see fig. 7

the Rostov Basin. Boulders and pebbles contained in silts are the result of deluvial (colluvial) and solifluxion transportation from the higher-lying adjacent plain of Moscow age dissected by gullies and small valleys.

The other investigators (A.I. Moskvitin, V.A. Novskij, and others) suggest that the lacustrine-bog sediments excavated in gullies near Šurskol and Čeremošnik are of different age. They relate the sediments which are covered by boulderless silts to the Mologo—Šeksna interglacial whereas the lacustrine sediments which are overlain by silts containing angular rock fragments — to the Mikulino interglacial, and the silts with boulders are regarded as a moraine till of the Kalinin glaciation.

The results of last investigations allow to conclude that the lacustrine-bog sediments in the Rostov area are of Mikulino age. This is evidenced by numerous and complete pollen and spore diagrams (figs. 7—13). The most complete diagrams showing characterisitic pattern of the Mikulino interglacial, including the climate optimum, are for the lacustrine sediments from the borings made near the village Klimatino, Tekhanovo, Čeremošnik and Poreče.

A large amount of pollen grains of latifolious trees (60%) and of *Corylus* and *Alnus* (separated from other trees) is very characteristic of the Mikulino climatic optimum. In the Rostov sediments it is very significant the occurrence of some exotic species typical of the Mikulino interglacial: *Aldrovanda vesiculosa* L., *Brasenia Schreberi* J. F. Gmel., *Caldesia parnassifolia* (Bassi) Parl., *Cladium mariscus*., *Carpinus betulus* L, *Najas flexilis* (Wild.) Rost. Schmidt., *N. marina* L, *N. minor* All., *N. tennussima* A. Br., *Potamogeton oxyphyllus* Miquel., *Salvinia natans* (L) All., *Stratiotes aloides* L, *Tilia platyphyllos* Scop., *Trapa natans* L.

However, the genesis of deposits overlying the Mikulino sediments is still disputable, especially of those occurring in gullies near Čeremošnik and Šurskol (fig. 14). Therefore the comparative examination of the structure and composition of different horizons of Pleistocene sediments is of great interest (figs. 15—21). The lithological and paleontological data are interpreted by the staff of the Department of Physical Geography and Paleogeography under the supervision of N.G. Sudakova. The analyses were made by A.G. Agadzhanyan, A.I. Vvedenskaja, E.S. Vlasova, N.I. Glušankova, N.G. Zaikina, S.S. Karpukhin, L.I. Maksimuškina, N.N. Paramonova, E.A. Petrovičeva, N. S. Sokolova, N.G. Sudakova, V.S. Khorev.

The Moscow moraine exposed in the gully near Čeremošnik comprises several facial varieties which are differentiated by: content of debris, its roundness index and orientation, and petrological and mineralogical composition (figs. 15, 16, 18: sections 202, 205—207). It is supposed that there are two horizons of Moscow moraine corresponding to different phases of ice-sheet advance.

As mentioned above, the Mikulino interglacial sediments are covered by loess--like silts and in some places by moraine-like deposits. The loess-like silts are of very common occurrence near Čeremošnik, Šurskol and Levina Gora. They

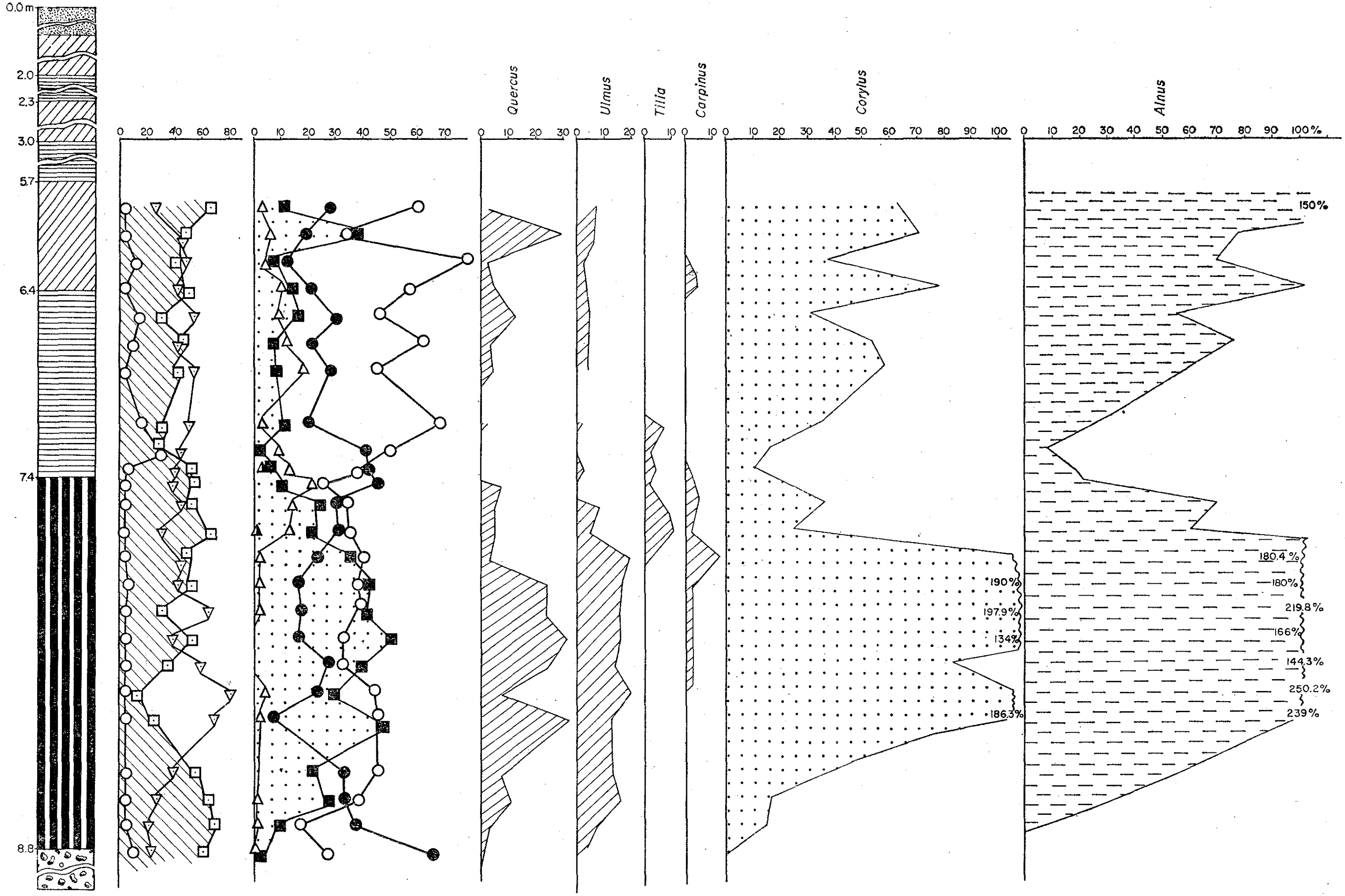


Fig. 9. Spore and pollen diagram of lacustrine and bog deposits of the Mikulino interglacial near Čeremošnik, boring hole 100 (analyses made by M. N. VALUEVA and G. N. ŠČERBO on the base of materials collected by A. M. CUKUROVA)

Explanations: see fig. 7

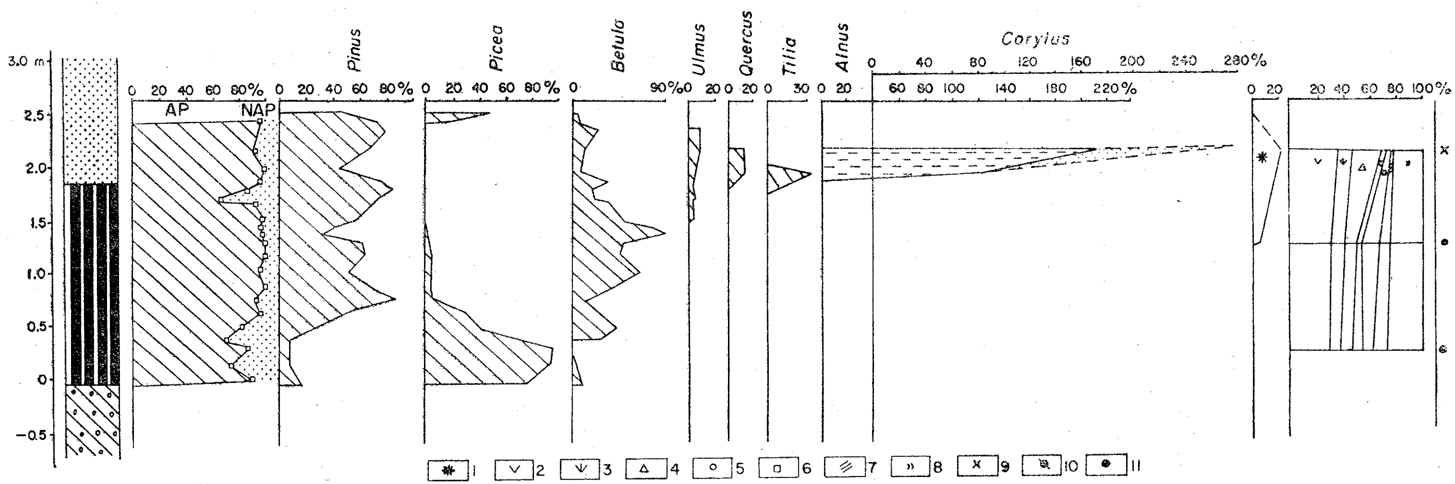


Fig. 10. Pollen and carpological diagrams of Mikulino deposits, Čeremošnik gully, exposure 2217 (by R. N. GORLOVA)

1. local exotics; 2. aqueous plants; 3. coastal aqueous plants; 4. marshy plants; 5. erosiophilous plants; 6. shrubs; 7. tress; 8. grasses; 9. individual; 10. few; 11. abundant

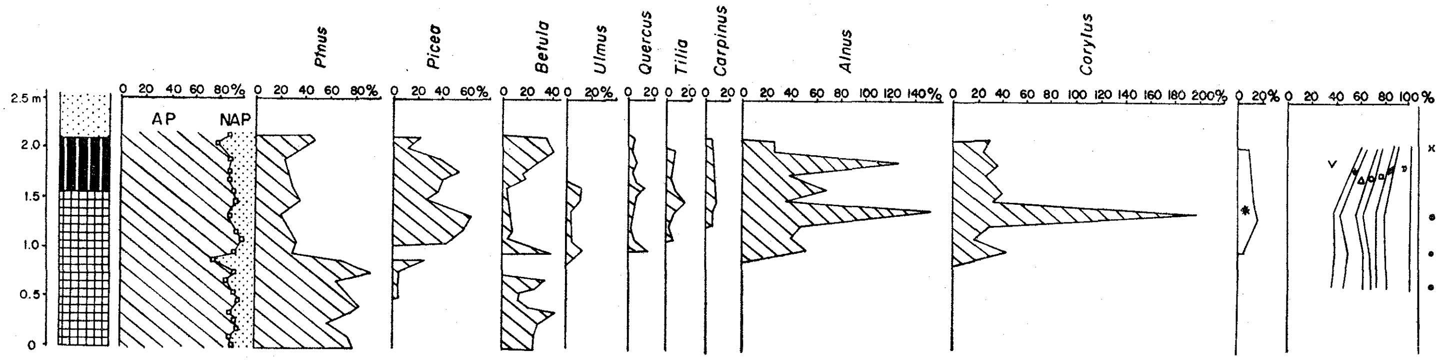


Fig. 11. Pollen and carpological diagram of Mikulino interglacial deposits, Čeremošnik gully, exposure 2218 (by R. N. GORLOVA)

Explanations as in fig. 10

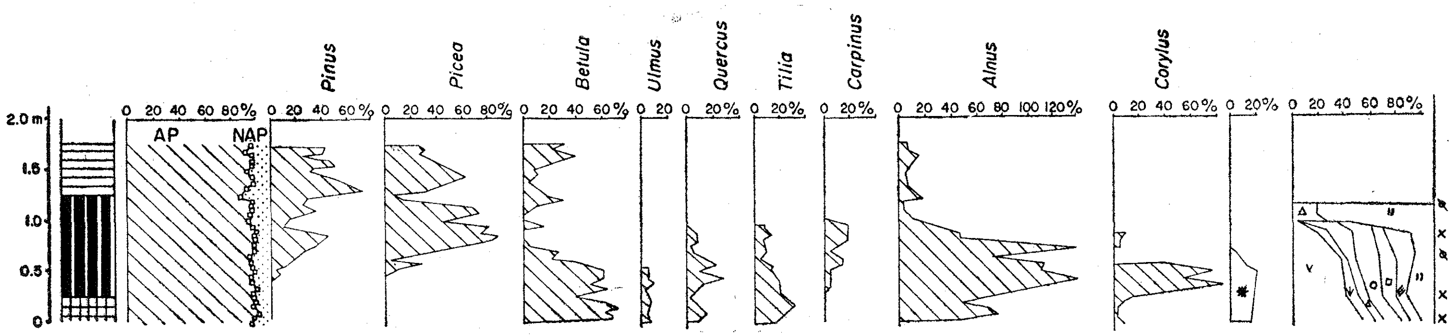


Fig. 12. Pollen and carpological diagram of Mikulino interglacial deposits, Levina Gora village (by R. N. GORLOVA)

Explanations as in fig. 10

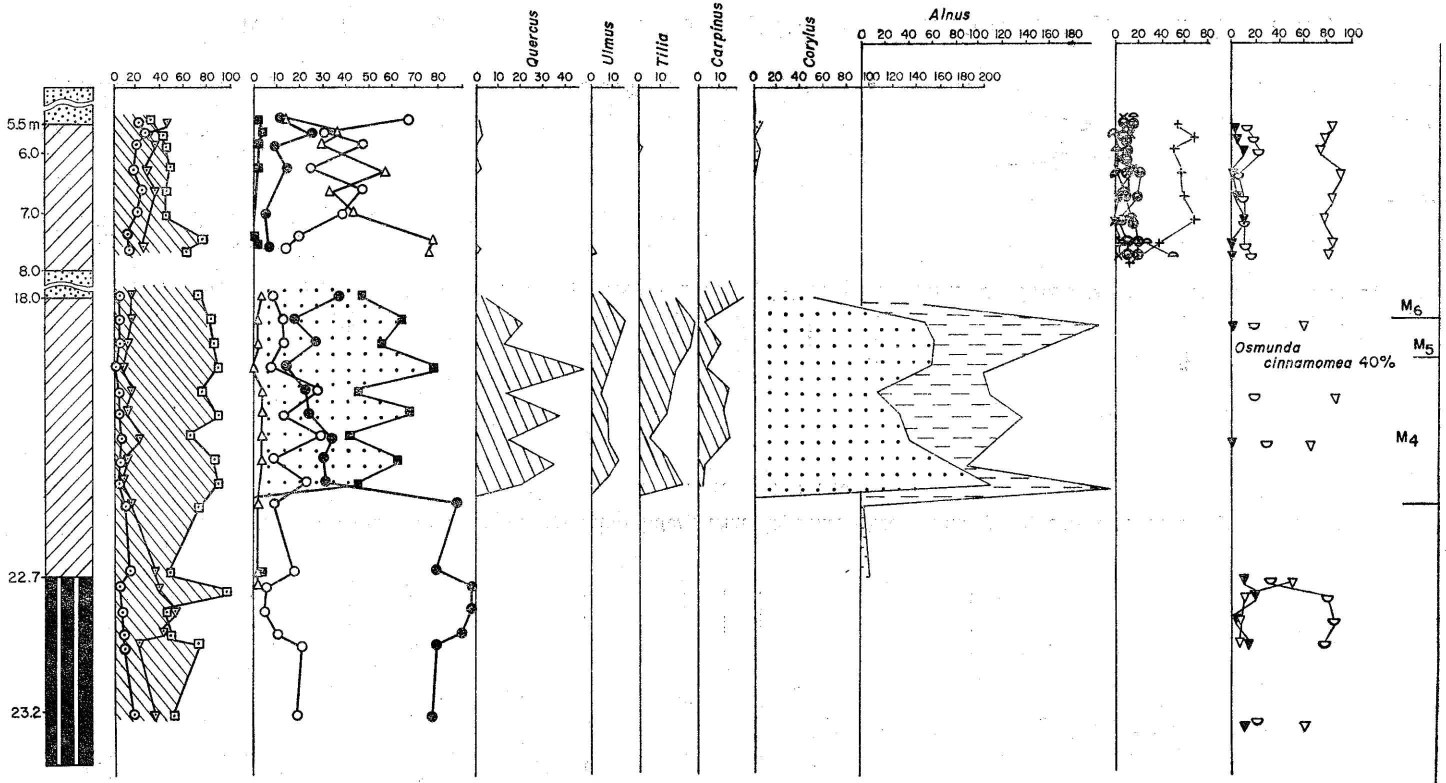


Fig. 13. Spore and pollen diagram of lacustrine deposits, Tekhanovo village (analyses made by N. M. VALUEVA and G. N. ŠČERBO on the base of materials collected by A. M. CUKUROVA)

Explanations as in fig. 7

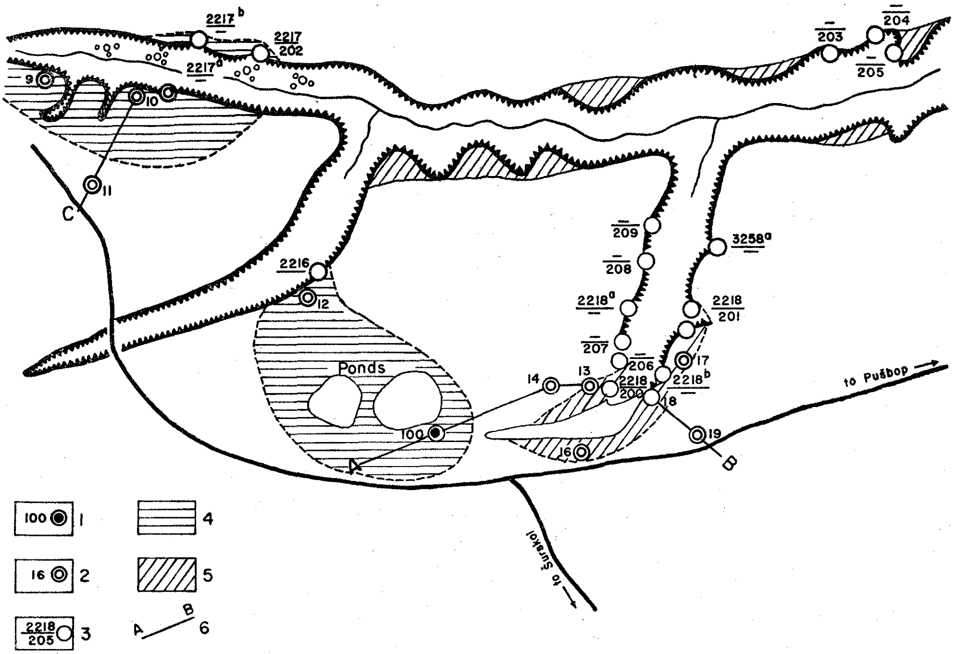


Fig. 14. Location of exposures and boring holes near Čeremošnik

1., 2. boring holes and their nos.; 3. nos. of sections investigated by GS — geological survey (numerator) and by MSU — Moscow State University (denominator); 4. ancient lake; 5. terraces; 6. lines of geological cross-sections

are present in various topographical situations. Because of this and of their structural pattern and composition they can be subdivided into the late-Moscow (figs. 17, 18: sections 203, 204, 206), and post-Mikulino silts of heterogeneous structure (figs. 13, 15: sections 201, 202).

Reconstruction of post-Mikulino paleogeographical conditions under which the deposits were accumulated seems to be helpful in solving the question whether the Rostov area was invaded by the Valdai ice-sheet. Fossil remains of small mammals (figs. 15, 21: sections 202, 217) clearly suggest different conditions prevailing during the accumulation of Mikulino interglacial sediments (forest: *Clethrionomys* and bog: *Arvicola terrestris,* species typical of mild climate) and during the accumulation of fluvial sediments of the Valdai glaciation (species typical of tundra: *Dicrostonyx* and *Lemmus,* and of steppe environments: *Lagurus* sp. and *Citellus* sp.). Apart from the rodents there are found remnants of *Mammuthus primigenius* and *Coelodonta antiquitatis*.

The obtained results of investigations in the Rostov area permit to conclude: (1) the lacustrine—bog sediments are Mikulino interglacial in age, (2) during the Valdai glaciation the area was under the influence of cold climate and periglacial conditions favouring the activity of deluvial (colluvial) and solifluxion processes.

3. GULLY ČEREMOŠNIK. SECTION 202

Topic: Stratigraphy of glacial and interglacial deposits of the Mid- and Late Pleistocene

The gully Čeremošnik is cut in the rolling moraine plain which constitutes a proximal part of the Borisoglebskij Upland. In the landscape there are hollows filled with deposits of the Mikulino interglacial and Valdai glaciation. The most characteristic of these deposits are boring 100 (fig. 9), and section 202 (fig. 15). The section (202) reveals from the bottom upwards:
— moraine of the late stage of the Moscow glaciation, thickness: 5.5 m,
— Mikulino interglacial humus and peat, thickness: 2.5 m,
— greenish-grey sand and silt from Valdai time, thickness: 1.5 m,
— late-Valdai loess-like silts and sands, thickness: 2 m.

Moraine material represents the main facies: compact ($\gamma = 2.0$ g/cm^3), low degree of porosity ($\eta = 25\%$), calcareous (6.5%), rock fragments well rounded ($C_r = 20\%$) and weathered (30%), long axes of boulders and platty pebbles oriented SSE. The content of hornblende is higher than in the lower moraine horizons, which is characteristic of general tendency of increasing hornblende content towards the upper horizons of variously-aged moraines. The boulders contained in the moraine indicates that the alimented area was S and SE Karelia and the territory lying to the south of Lake Onega.

Washed organic deposits (humus) overlying the moraine have spore- and pollen spectra of the forest type. They contain small-mammals remains characteristic of forest- and bog species.

The greenish-grey sands overlie the foregoing deposits discordantly and contain the faunal remains of tundra and steppe species. The pollen grains are typical of a forestless landscape. The sands are calcareous (3%), their resistance coefficient of minerals is low in comparison with upper and lower horizons, the mineral grains show clay coatings (films). All the facts display evidence of severe climate prevailing during the sedimentation under periglacial conditions of the Valdai glaciation.

Late-Valdai loess-like silts deprived of boulders are characterized by a high percent of clay (55—59%), low content of $CaCO_3$ (0.2%), low degree of compactness $\gamma = 1.48$ g/cm^3), maximum porosity ($\eta = 42\%$), and high content of hornblende (showing regular changes in the section). These deposits may be subdivided into three horizons showing various composition.

4. GULLY ČEREMOŠNIK: SECTIONS 203, 204, 205

Topic: Facial varieties of boulder clay and loess-like silts

At the base of section 205 (fig. 16) the oldest moraine is exposed: it is dark-brown, calcareous (8%), clayey and friable, interbedded with sand, contains pebbles and cobbles of local rocks (38% of limestones). The long axes are oriented

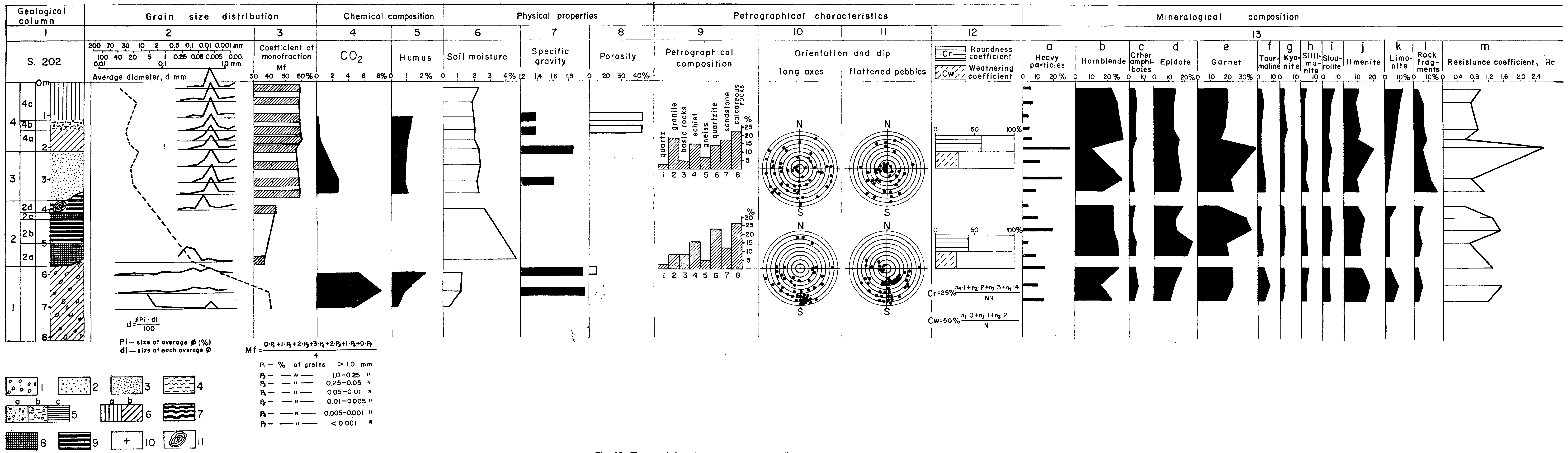


Fig. 15. Characteristics of Pleistocene deposits, Čeremošnik gully, section 202

1. pebbles; 2. gravel; 3. sand; 4. silty sand; 5a. boulders and sand, 5b. boulders and silty sand, 5c. stratified silt with boulders; 6a. unstratified silt, 6b. stratified silt; 7. boulder clay; 8. gyttja; 9. peat; 10. carbonate concretions; 11. wood remains

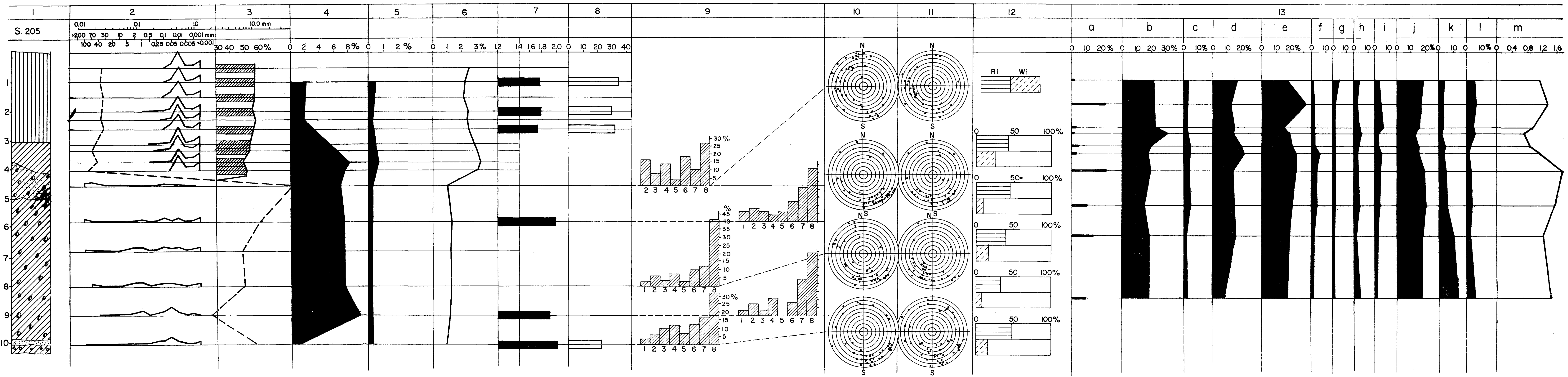


Fig. 16. **Characteristics of Pleistocene deposits, Čeremošnik gully, section 205** (by N. I. Glušankova, S. S. Karpukhin, L. I. Maksimuškina, N. N. Paramonova, E. A. Petroviceva, N. G. Sudakova)

Explanations as in fig. 15

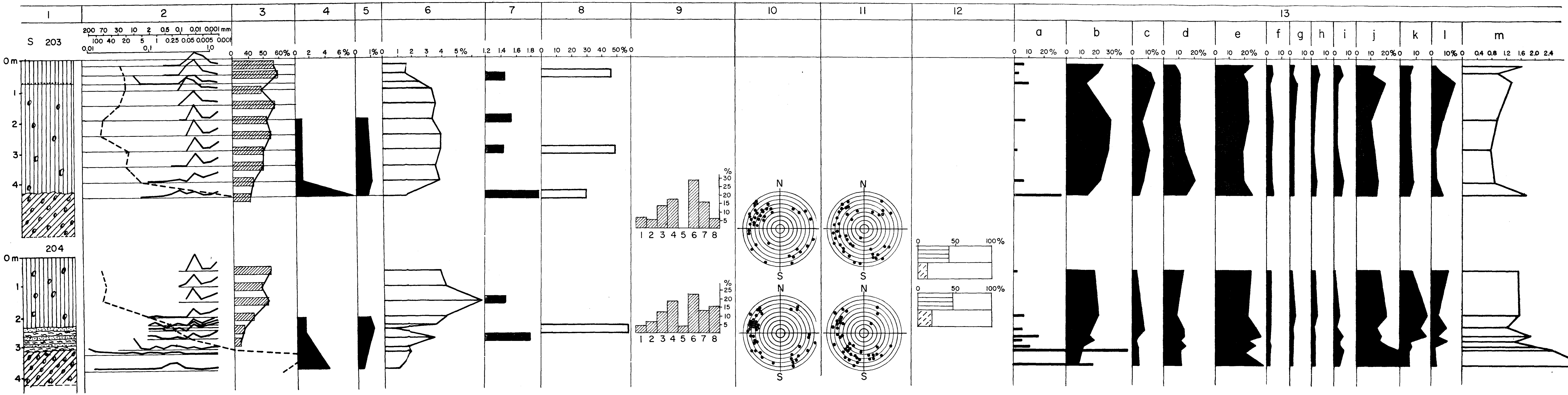


Fig. 17 Characteristics of Pleistocene deposits, Čeremošnik gully, sections 203, 204 (by S. S. Karpukhin, L. I. Maksimuškina, N. N. Paramonova, E. A. Petroviceva, N. G. Sudakova)

Explanations as in fig. 5

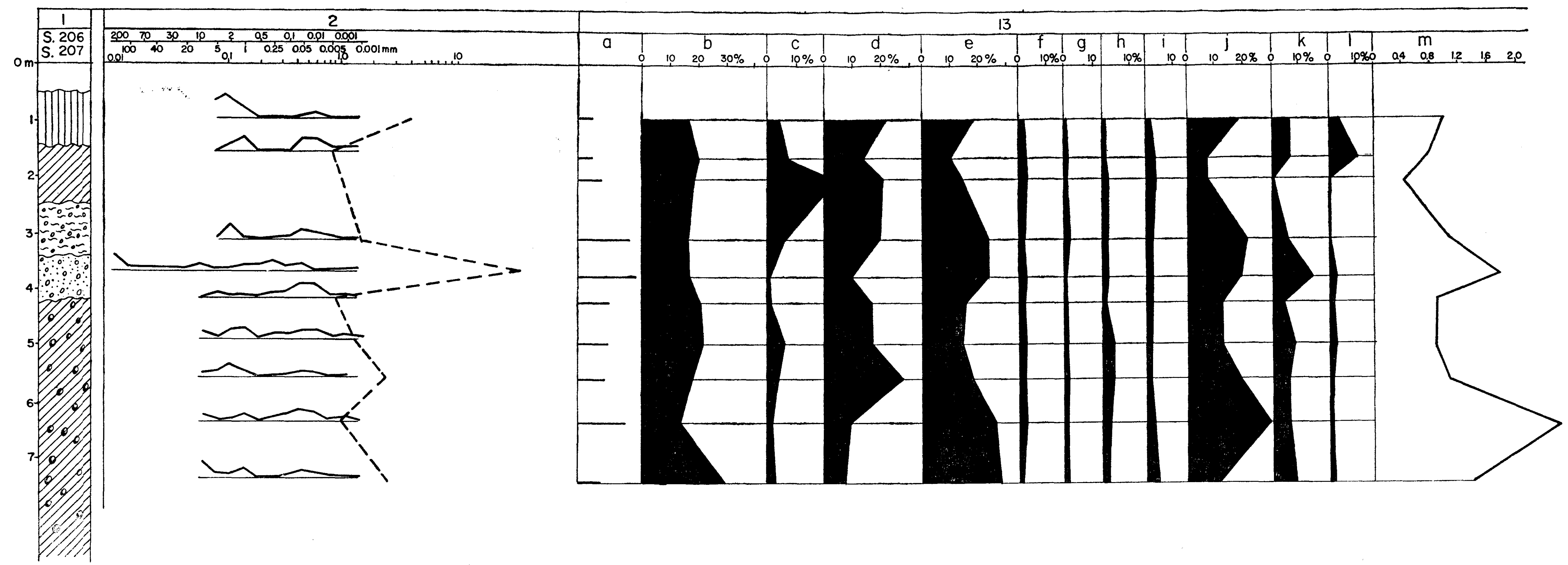


Fig. 18. Characteristics of Pleistocene deposits, Čeremošnik gully, sections 206, 207 (by L. I. Maksimuškina, E. A. Petroviceva, N. G. Sudakova)
Explanations as in fig. 15

SE and the slightly flattish pebbles dip at 10—20° to SSE or rest horizontally. Among the index minerals epidotes predominate over the hornblende. The secondary minerals are represented by sulphides and manganes which may indicate accumulation in stagnant water.

The above lying sandy ablational moraine (fig. 17, section 204) contains numerous rock fragments, including large quantities of heavy minerals (up to 60% of total rock fragments). The basic rocks and quartzites are prevailing amidst the resistant boulders and pebbles whose roundness is $C_r = 43\%$. The longer axes of pebbles are more inclined (30—40°) than in the lower horizon and are oriented to W and NW. These all characteristics testify more dynamic processes operating during the sedimentation and better sorting of the material depending on its specific gravity, grain size and resistance.

Loess-like silts and clays (fig. 17, section 204) overlying the moraine are rhythmically bedded at the base and unstratified upwards. They contain clayey-carbonate nodules (concretions) which are very typical of the post-Moscow horizon of silts. Chemical and mineralogical composition is more similar to the moraine deposits than to the younger silty horizons. The silts overlying the moraine are more calcareous and clayey, have lesser content of hornblende, and are much more differentiated in grain-size gradation than the silts of lake terraces of Mikulino age.

5. GULLY ČEREMOŠNIK: SECTION 200, 201, 206, 207

Topic: Stratigraphic situation of the Mikulino interglacial sediments

Mikulino interglacial sediments containing organic matter occur on the base of lake- and small valleys terraces (fig. 14). The deposits were examined in the gully Čeremošnik and in its branches: sections 200 and 201, situated in the head part of the main gully and in the right-side gully which is eroded in the moraine. The moraine is overlain by 2.5 m thick post-Moscow loess-like silts similar in composition to the previously described silts.

Lithological characteristics of the Moscow-age moraine were examined in sections 206 and 207 (fig. 18). It is the youngest moraine horizon. The moraine till in upper, 1 m thick, part is composed of alternating 1—20 cm layers of red, grey, and brown till. The differentiation in colour of this stratified morainic horizon is evidently of primary origin. The moraine differs from the previous sections because of higher content of hornblende.

6. VILLAGE LEVINA GORA: SECTIONS 214, 215, 217

Topic: Upper Pleistocene periglacial deposits

The river Sara issuing into the Lake Nero undercuts the second lake terrace which is built of the following deposits (fig. 20, 21), from the bottom:

— humus-rich clay, peat (Mikulino horizon), thickness: 1.5—2 m,

— horizontally stratified lacustrine sands, silts, clays with sporadically distributed pebbles, thickness: 5—7 m,

— horizontally stratified sands, with facial differentiation into sandy-stony horizon, thickness: 1.5—2.0 m,

— late-Valdai silts, deprived of boulders, thickness: 5 m.

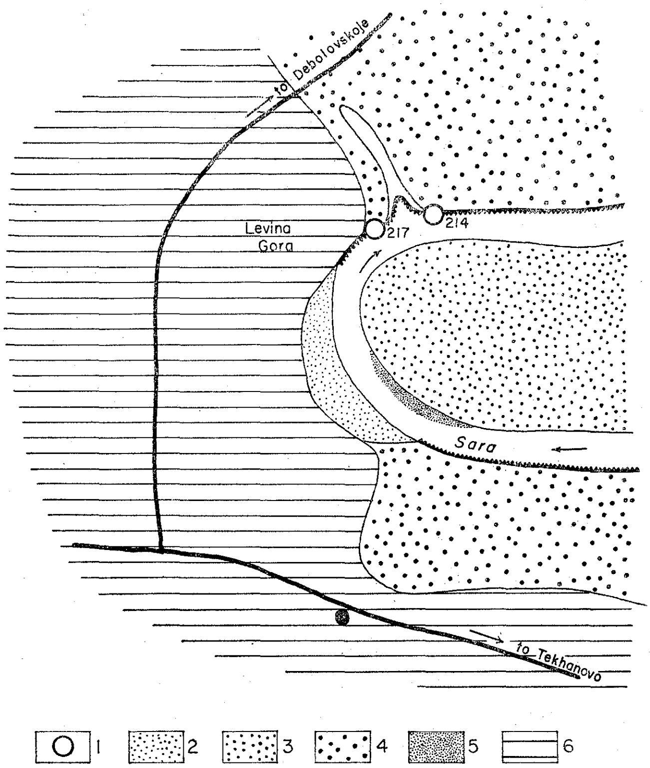


Fig. 19. Geomorphological sketch of the Sara valley near Levina Gora

1. sections; 2. flood plain; 3. first terrace; 4. second terrace; 5. beach; 6. morainal plain

Sands, overlying Mikulino interglacial sediments (fig. 10), contain lemming's teeth. This indicates the character of biocenoses of the tundra type occurring under severe periglacial climate which prevailed in the region during the accumulation of lacustrine sediments.

Presumably, the most severe conditions existed during the accumulation of the upper part of lacustrine sediments which locally contain rock debris. Further evidence of cold climate are: disturbation of horizontal stratification, ground wedges penetrating down the sediments (40 × 120 cm), high content of carbonates (1—5%).

The sediments cannot be regarded as moraine till because of their low density (1.48 g/cm^3), high porosity (44.9%), predominance of resistant rock fragments showing no constant orientation. Moreover, they pass into undisturbed, horizontally laminated lacustrine sediments.

ROSTOV YAROSLAVSKIJ—UGLIČ

by. S. L. Breslav

INTRODUCTION

The Borisoglebskij Upland and its northern spur — the Uglič elevation — rise between the Rostov Basin and the Upper Volga. Unlike the Klin—Dmitrov Ridge which is mainly due to bedrock elevation, the Uglič and Borisoglebskij Uplands are entirely accumulational formations. Their bedrock base is flat and lies 80—100 m lower than that of the Klin—Dmitrov Ridge although the present surface relief of both these areas are almost of the same altitude. Stratigraphically, the Pleistocene sediments are also differentiated: two moraine horizons are characteristic of the Klin—Dmitrov Ridge, whereas within the Borisoglebskij Upland and its Uglič spur three horizons of moraine occur, the upper one of which is — as already mentioned not definitely dated. As the age of underlying peat is variously interpreted, the upper moraine is regarded by some scientists as Upper-Pleistocene, or as belonging to the Mid-Pleistocene glaciation by the others. The Borisoglebskij Upland and the Uglič spur form some arcs bent southwards where they are bordered by the river Nerl from the South, and by the rivers Žabnya and Ulejma from the West. The landscape shows very diversified relief between Borisoglebskij and Uglič.

It is conspicuous that in the highest part of the Borisoglebskij Upland, most ridges and hills are elongated SW—NE. The origin of some ridges and hills is disputable. Probably they were formed between the Rostov and Pereslavl ice lobes. The most distinct land-forms are kames and eskers consisting of gravels, pebbles and boulders.

In the Uglič region the most remarkable are: the valley of the Volga, moraine, covering deposits and relict permafrost phenomena.

7. UGLIČ

by V. V. DAŠEVSKIJ

Topic: *Geology and morphology of the Volga valley between Kalyazin—Uglič—Myškin*

Geological and morphological investigations of the valley of the Volga in this part are difficult because of raised water table in the river after construction of the dams at Uglič and Rybinsk[2].

[2] In the diagram (fig. 22) and the text, the elevations of terraces are referred to the original water table of the Volga lying at 92 m above sea level.

The Volga valley has the following characteristics: (1) three (above-flood plain) terraces, the second one of them being large, (2) the asymmetry of the valley — expressed in various inclination of valley-sides and in different geological structure. Lacustrine sediments, up to 10 m thick, occurring on the left side of the valley, are entirely absent on the opposite valley side. The different erosional dissection of both the valley slopes depends on differentiation of the deep tectonic structure of the left and the right valley sides; the tectonical boundary runs probably along the Volga due to which the river has a stright course between Kalyazin and Rybinsk.

The valley of the Volga is incised into moraine tills and glacifluvial sediments of the Dneper, Moscow, and Valdai glaciations (fig. 22). On the left side of the Volga, the glacial deposits are overlain by much younger lacustrine and covering sediments. Along the valley, the late Pleistocene (Valdai) glacifluvial deposits adjoin these younger sediments forming a distinct surface horizon, 125 m above sea level, i.e. 33 m above the river.

Sub-Pleistocene surface is very uneven. Near Uglič it lies below sea level, whereas 10 km to the North (near the village Vasilki) and 20 km to the South (village Priluki) the Volga valley cuts the pre-Pleistocene elevations built of sands with phosphorite interbeds, of upper Jurrassic and lower Cretaceous age. It is due to the occurrence of ancient valley net and deep incision diversified the sub-Pleistocene surface (the data obtained by borings and VES (vertical electric soundings).

The main characteristics of the valley of the Volga near Uglič are presented in table I.

Table I

Valley element	Absolute height above the Volga	Maximum thickness	Lithological composition	Remarks
Inundation terrace a IV	Up to 13 m	10 m	Fine sands, silts, in the lower part, medium-grained sands with gravel and pebbles at the base	Entirely flooded, except for the mouth of the Korožečna near the village Zolotoruča
Inundation terrace a IV	Up to 16 m	10 m	Fine and medium-grained sands, coarse sands at the base	Flooded upvalley of Uglič
Second terrace a (2t) III	Up to 20 m	5 m	Fine sands with silt lenses, coarse sands and gravels at the base	
Third terrace a (3t) III	Up to 25 m	2—3m	Fine sands	

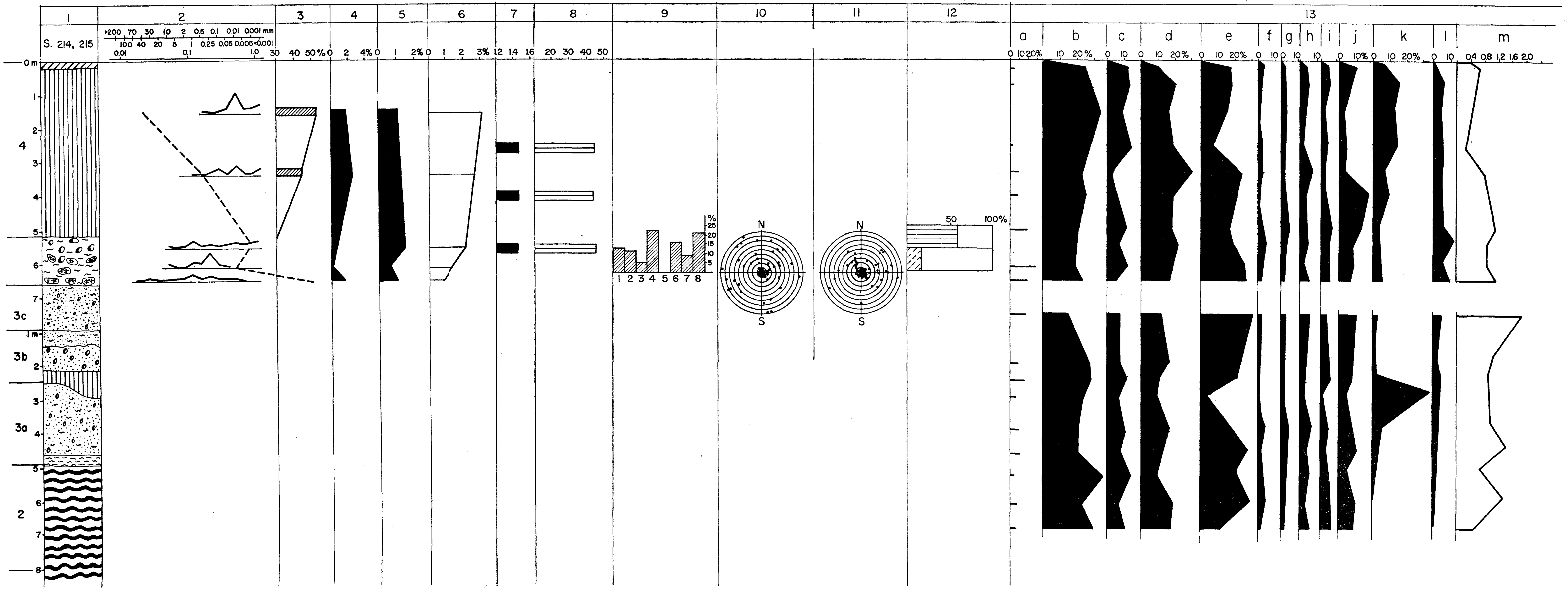


Fig. 20. Characteristics of Pleistocene deposits, Levina Gora, section 214, 215 (by A. I. Vvedenskaya, N. I. Glušankova, S. S. Karpukhin, N. N. Parmonova, N. G. Sudakova)

Explanations as in fig. 15

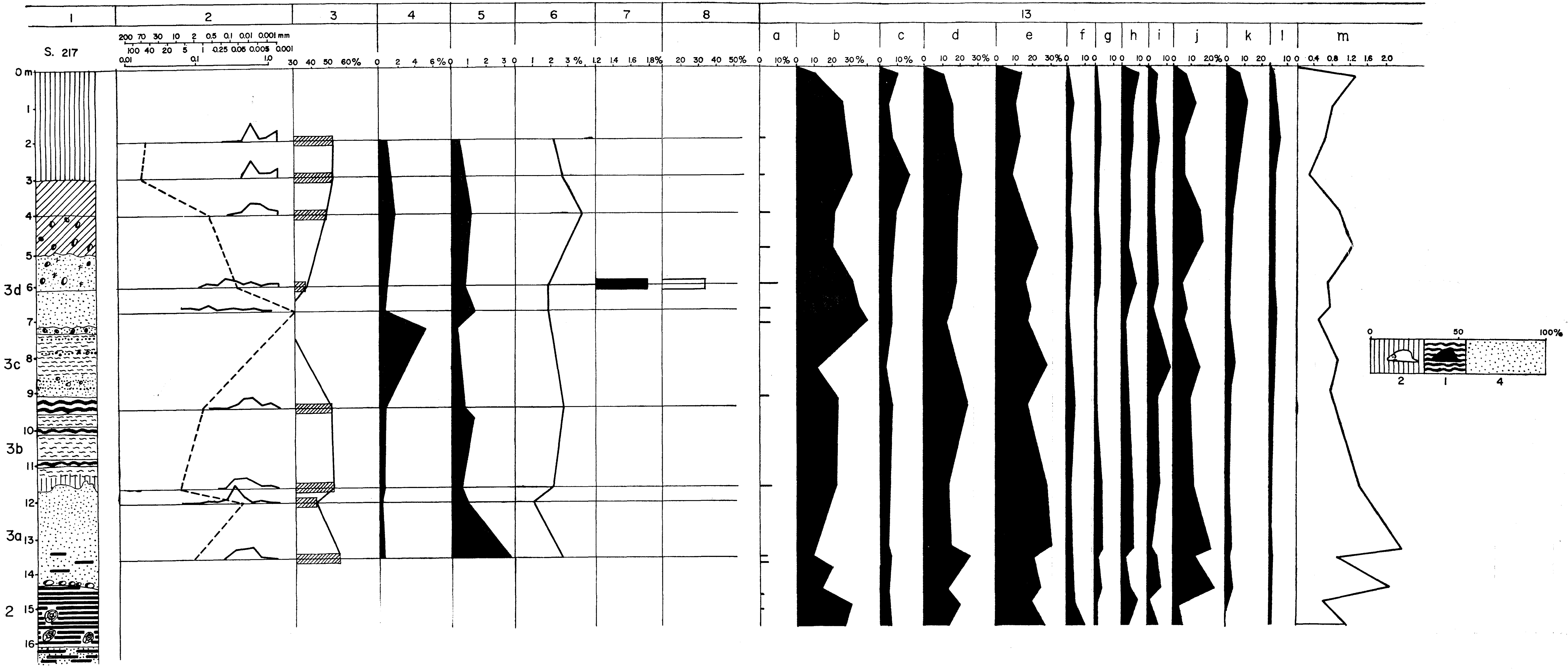


Fig. 21. Characteristics of Pleistocene deposits, Levina Gora, section 217 (by A. K. Agadzanyan, K. I. Glušankova, N. N. Paramonova, N. G. Sudakova)

Explanations as in fig. 15

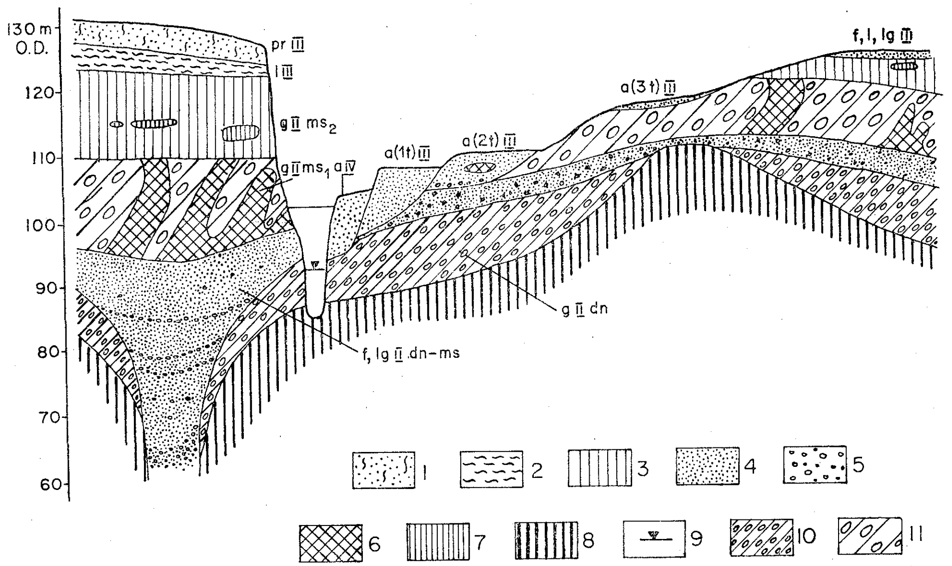


Fig. 22. Cross-section through the valley of the Volga near Uglič (by V. V. DAŠEVSKIJ)

1. silty and clayey sand; 2. silt and sand; 3. silt; 4. sand; 5. rock fragments (boulders, pebbles, gravels); 6. displaced masses of rock, disturbed; 7. displaced masses of rock, undisturbed; 8. undisplaced solid rocks; 9. water table of the Volga (before flooding); 10. and 11. boulder clays

8. THE VILLAGE ALTYNOVO

by A. A. VELIČKO, V. V. BERDNIKOV, V. V. DAŠEVSKIJ

Topic: Glacial dislocations, covering and periglacial deposits

Near Uglič the Volga separates two geomorphologically different landscapes: the upland on the left side of the river is a plain, 30—40 m high, whereas on the right side there is a slightly rolled surface which rises gradually eastwards.

The most complete section of Pleistocene deposits, on the left valley-side downward of Uglič, shows:

1. grey-brown covering silts, with admixture of sand at the base, thickness: 3 m
2. loose silts, grey with brownish tint, in the lower part dark- and light grey spots, thickness: 2 m
3. reddish-brown moraine till, thickness: 6 m
4. dark-grey moraine till, thickness: 8 m
5. greyish-brown moraine till, thickness: 10—12 m

Three moraine horizons consist the main part of the section and have been recognized by G. F. MIRČINK. They are widespread, and at Uglič they occur also on the right valley side consisting almost the whole profile. Most frequently the lower moraine descends below the river bed. In some places, however, mainly down the valley, Jurassic variously-grained sands and black clay are exposed (underlying the moraines). Sometimes, the lower moraine contains rock fragments which bear evidence of its local character.

Formerly (G. F. MIRČINK), each moraine horizon was correlated with individual glaciation: lower moraine — with the Mindel (Oka), middle — with the Riss (Dneper), and the upper moraine — with the Würm (Valdai) glaciations. According to present opinion (K. K. MARKOV) it is well stated that the Valdai glaciation extended as far southwards as 150—200 km NW of Uglič, and the area under discussion was invaded last time by the Moscow ice-sheet.

Great deformations of Jurassic sands and clays, and moraine clays, sometimes reaching 20—40 m in length and 8—10 m, and even 12—15 m in height, can be

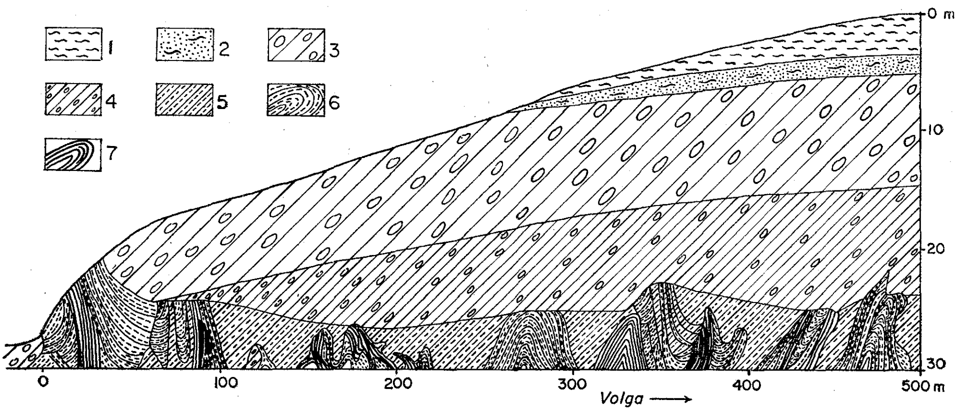


Fig. 23. Altynovo village on the Volga; glacial dislocations (by A. A. VELIČKO)

1. covering silt; 2. silt with humus, grey; 3. boulder clay, red-brown; 4. boulder clay, dark-grey; 5. boulder clay, grey-brown; 6. Jurassic sand; 7. Jurassic clay

examined in the section at Altynovo, on the left side of the Volga (fig. 23). These glacial deformations are similar in shape but smaller in size to the true tectonic forms (diapires, sinclines and anticlines, flexures, etc.).

The deformations occur in the lower moraine which is, therefore, disturbed and in some places even disrupted by the yellow or grey-yellow sands and black clay. The middle and upper moraine series are almost undisturbed. The bottom line of the middle moraine is usually waved and it truncates the tops of glacitectonic structures. Only some, very individual structures penetrate into the middle moraine. This suggests that glacial deformations are younger than the lower moraine, and were formed during or even after the accumulation of the middle moraine horizon. Anyway, the period of glacial disturbances separates the deposits of the middle and the upper moraines.

Petrological analysis of rock fragments contained in the moraines reveals that the lower horizon differs (granites) from both the middle and upper moraines. This probably is due to different direction of ice-sheet courses.

The section at Altynovo (fig. 24) shows the moraine overlain by loess-like silts. At the bottom the silts have a structural pattern which suggests the traces of pedogenic processes (the Mikulino soil?). The silts are gleyed having blue-grey colour in the lower part. Their origin is disputable, whether they are lacustrine or eolian deposit accumulated on periodically wet surface. Anyway, as suggested by palynological data they were accumulated under cold climatic conditions. The structure of these silts is like that of other sections occurring in the vicinity. Radiocarbon dating shows that the silts are of the Valdai period.

In this and near-by lying sections the silts show large — 3—5 m — pseudomorphoses of ice-veins appearing 0.5—1.0 m from the surface.

On the right, low side of the Volga the loess-like silts are absent. The moraine till with stone pavement on its top is overlain here by fine sand, 0.3—0.4 m in thickness. Probably, the thin sandy horizon is residuum layer: finest particles have been removed away.

PALYNOLOGICAL ANALYSIS OF ABOVE-MORAINE SILTS IN SECTION 6-68, NEAR THE VILLAGE ALTYNOVO

by Z. P. GUBONINA

The silts overlying the moraine are lithologically almost homogeneous, and only two horizons may be distinguished. The lower horizon, 3 m thick, lying immediately above the morainal deposits, is of lacustrine origin. In the bottom part it represents the greyish yellow heavy silts with slight humus admixture, and in upper part it contains fine grey silt considerably ferrugineous. The upper horizon, 2.3 m thick is composed of covering silts, light-brown, medium grained in the lower part, and light-yellow, medium-grained upwards.

12 samples from the whole section were analysed using the cavitation method according to which the samples were maximally enriched with pollen grains and spores. The results presented in the diagram (fig. 25) show that the samples from the lower horizon contain the highest quantity of pollen and spores whereas the covering silts reveal only single (sporadical) pollen grains. Pollen-spore spectrum of the lower silt horizon indicates the transition character from forest to forest-steppe conditions. Due to differentiation of composition of pollen and spores two series may be distinguished within this horizon: I — lower (4.25—5.5 m) and II — upper (2.5—4.25 m).

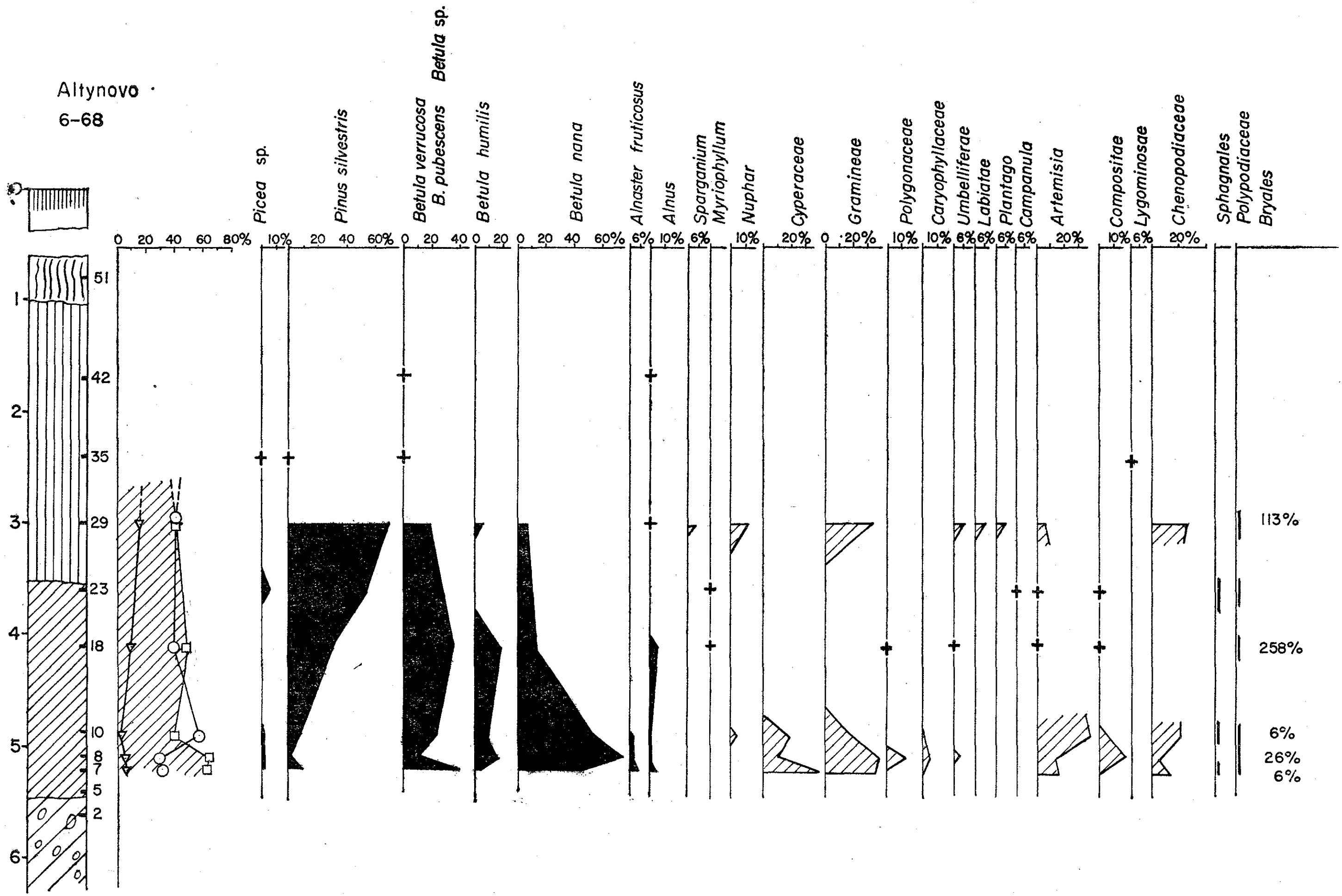


Fig. 24. Spore and pollen diagram of Pleistocene deposits, Altynovo

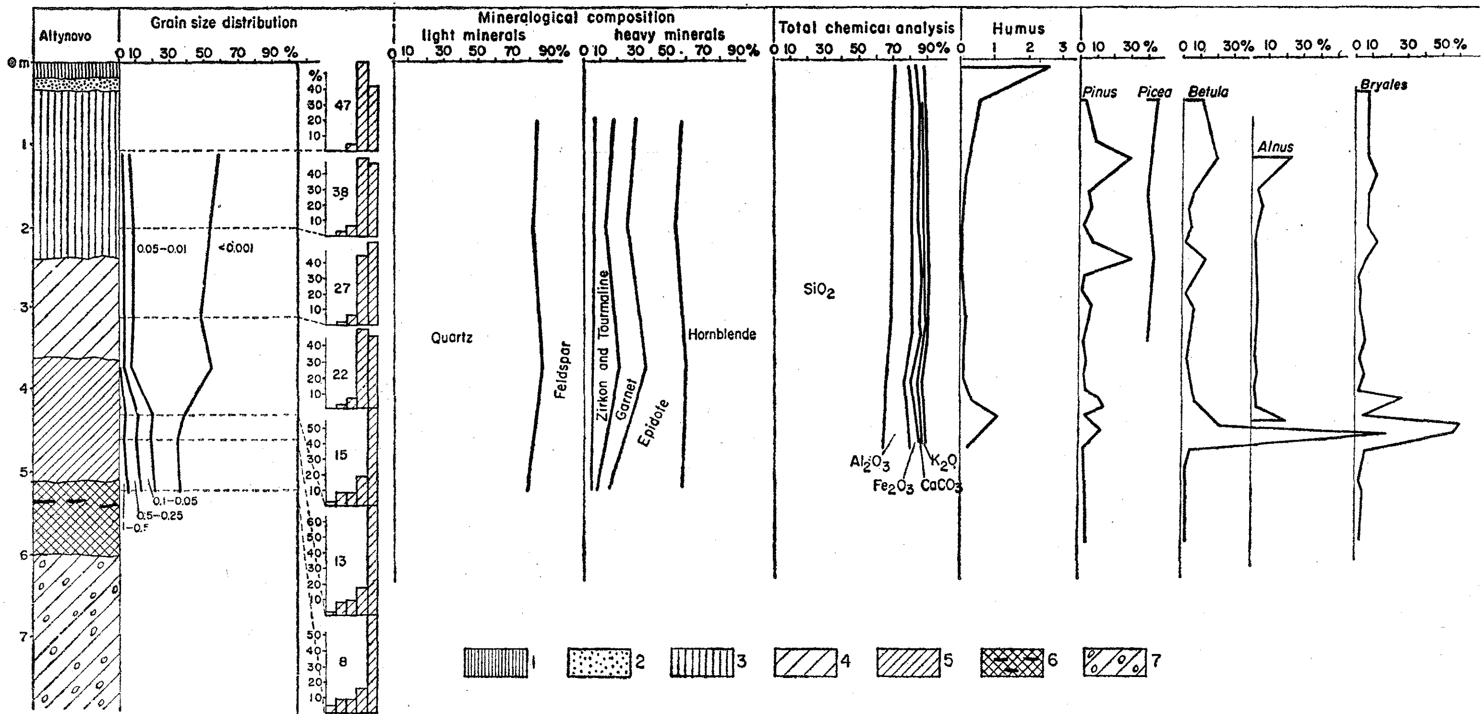


Fig. 25. Composition of Pleistocene deposits, Altynovo (by A. A. Veličko, V. V. Berdnikov, V. V. Daševskij)

1. sandy silt with humus; 2. sandy silt, light grey in colour; 3. silt, brownish; 4. greyish brown silt; 5. blue grey silt; 6. blue grey silt with humus and red stains; 7. boulder clay, reddish brown

Apart from pollen analysis the species of plants were defined. Their identification were made comparing with keys in published papers on morphology of plants (MONOŠON, 1952; ERDTMAN, BERGLAND and PRAGLOVSKIJ, 1961), atlases and unpublished materials (Institute of Geography). Each individual pollen grains from the samples has been compared to key-plant pollen and to present-day plant pollen and spores.

As a result 16 species have been distinguished (tab. II). Though the number of species is small, the data of pollen analysis and a list of identified species permit to define more exactly the climatic conditions prevailing during the accumulation of the silts.

As illustrated in fig. 25 and table II, the pollen-spore spectrum of the lower I series comprises abundant pollen grains of trees and shrubs belonging to *Betula* genus, with predominance of *Betula sect. Nanae.* The presence of pollen-grains of cold-resistant birch coincides rightly with the presence of *Alnaster fructicosus* and the absence of pollen of latifolious trees. Pollen of dwarf birch appear also in II, upper series but there they are reduced in number. It is characteristic that

Table II

Species	Types of biocenosis					
	Coniferous and mixed wet forests	Wet, dry and salt meadows	Grass-steppes	Sands	Bare lands	Water and bogs
1. *Picea* sp.	+	—	—	—	—	—
2. *Pinus silvestris* L.	—	—	—	+	—	—
3. *Betula sect. Nanae*	—	+	—	—	—	+
4. *Betula humilis* Schrank.	—	+	—	—	—	+
5. *B. verrucosa* Ehrh.	+	—	—	—	—	—
6. *B. pubescens* Ehrh.	+	—	—	—	—	—
7. *Alnaster fruticosus* L. db.	+	—	—	—	—	+
8. *Alnus* sp.	+	—	—	—	—	+
9. *Polygonum* cf. *viviparum* L.	—	+	—	—	—	—
10. *Erosia ceratoides* (L) CAM.	—	—	+	—	+	—
11. *Salsola* sp.	—	—	+[1]	—	+[1]	—
12. *Petrosimonia* cf. *crassifolia* (Pall) Bge.	—	—	—	—	+[2]	—
13. *Nuphar luteum* (L) Sm	—	—	—	—	—	+[2]
14. *N.* cf. *pumilum* (Hoffm.) D. C	—	—	—	—	—	+[1]
15. *Myriophyllum spicatum* L.	—	—	—	—	—	+[2]
16. *Plantago* cf. *lanceolata* L.	—	+[2]	—	—	—	—

\+ — species from I and II horizons
+[1] — species contained only in horizon I
+[2] — species contained only in horizon II

forest-tundra elements (*Betula nana, Betula humilis*) appear together with typical xerophytes and halophytes (*Eurotia ceratoides, Petrosimonia* cf. *crassifolia, Salsola* sp.). Pollen of grasses appear in both series; 12 species are defined, among which are: *Carex, Compositeae, Chenopodiaceae*. It is characteristic that pollen spectrum of both series (horizons) comprises species belonging to aquatic plants (*Nuphar luteum, Nuphar* cf. *pumilum, Myriophyllum spicatum*). Both the ecological characteristics of present-time vegetation and analyses of pollen occurring in the geological section at Altynovo indicate the character of the elements of Altynovo flora. It is very diversified in its ecological components: typical forest- and aquatic plants are associated with „pioneer" species and halophytes.

All data of palynological analyses show that the silts are water-laid sediments. During their accumulation the vegetation was represented by cold-indicated plants. The area was poorly forested at the beginning phase, birch trees dominated (later — — pines appeared) but dwarf birches were of wide extension. Grass species were also abundantly represented. Elevated surfaces, unforested, were overgrown by xerophytes (*Artemisia, Chenopodiaceae*) and halophytes, low-lying places were covered by mosses. The presence of psychrophytes, xerophytes, halophytes and abundance of spores are the proofs of the existence of permafrost at that time, whereas *Alnaster fruticosus* found in the lower part of the silts directly indicates permafrost conditions. The change of climatic conditions is evidenced by the presence of psychrophytes and xerophytes in the lower series and of halophytes in the upper series of silts.

Therefore, it may be supposed that the silts were deposited in the transition phase between the humid (cryohydrothermic) and arid (cryoxerothermic) stages of the glacial period.

9. THE VILLAGE NOVOSELKI

by V. V. BERDNIKOV

Topic: *Relict polygonal land-forms of the moraine surface and their geological composition*

The section near Novoselki, 3 km to the south of Uglič, is situated on the high, right side of the Volga. The top of the abrupt face lies ca. 130 m above sea level.

Aerial photographs of the area adjacent to the abrupt valley side reveal a net of white bands, 25—30 cm in diameter. In the section of the face running almost strictly N—S, there is sandy soil, 0.25—0.35 cm thick underlain by yellow fine sand mostly ferrugineous, 0.25 cm in thickness. Its lower line is uneven, penetrating with individual "wedges" down the underlying silts. These silts have peculiar structure, are compact and contain separate intrusions of gravels. From the very top they are thin-laminated and of net-like texture, and at the depth of 0.8 m downwards they change into a thick-bedded and coarser net-like textured deposit. At 1.4 m depth this pattern disappears. Reddish-brown clays — the moraine — lie below (fig. 26).

After cleaning the exposure face, a structure form was discovered. It corresponds in plan with one of white stripes seen on the aerial photograph. The structure is two-storied in vertical profile. A narrow vein reaching 5.2 m depth is filled with sands containing lumps of morainal clays. Tiny, ferruginous vertical lamination within the structure indicates differentiated process of infilling. Lower, vein-like part of the structure runs at ca. 30° to the upper funnel-like part (fig. 26). Detailed picture of the structure shown in fig. 27 displays its asymmetrical outline: left border is slightly inclined whereas the right one almost vertical. The pattern of infilling material also changes. In the left part, the moraine clay prevails being underlain by yellow and brown sands, highly ferruginous and slightly disturbed; in the right side and in middle parts the sands are strongly contorted. Vein-like structure is lacking in the bottom part. Thereby the structure is like so-called "veneering frost structures".

It is worthy to note the intrusions of dark-grey organic material in the central part of the wedge-structure at 1 m depth. Most probably it is not derived from recent soil but is supposed to be remains of a fossil soil.

All described characteristics indicate that a system of frost-fissure polygons exists in the area adjoining the abrupt valley-side. It is suggested that they are pseudomorphoses of ice-fissure polygons.

10. THE VILLAGE KIRYANOVO

by A. A. VELIČKO, V. V. BERDNIKOV, V. A. KOTYUKOV

Topic: Relict polygonal topography; geomorphological, geological and geophysical investigations

The site is situated 24 km to the NNE of Uglič, and 0.4 km NE-wards of Kiryanovo, on a slightly sloping surface, 116—117 m above sea level. Aerial photographs display a field 400 × 500 m large which exhibits a net pattern of light-coloured narrow bands forming tetragonal polygons, 15—20 m in size.

Though the polygonal micro-topography is poorly visible on the surface, ca. 60 m long profile of levelling shows flat blocks 15—20 m long and intervening 3—4 m depressions. Figure 28 presents the geological cross-section.

Central parts of the blocks having undisturbed original stratification show three horizons: 0.3—0.4 m thick layer of fine sands containing ferruginous intrusions, 1.2 m thick horizon of brown silts with scarce gravel concentrations, and the reddish moraine till begins at 1.5 m from the surface. According to some opinions (V. A.

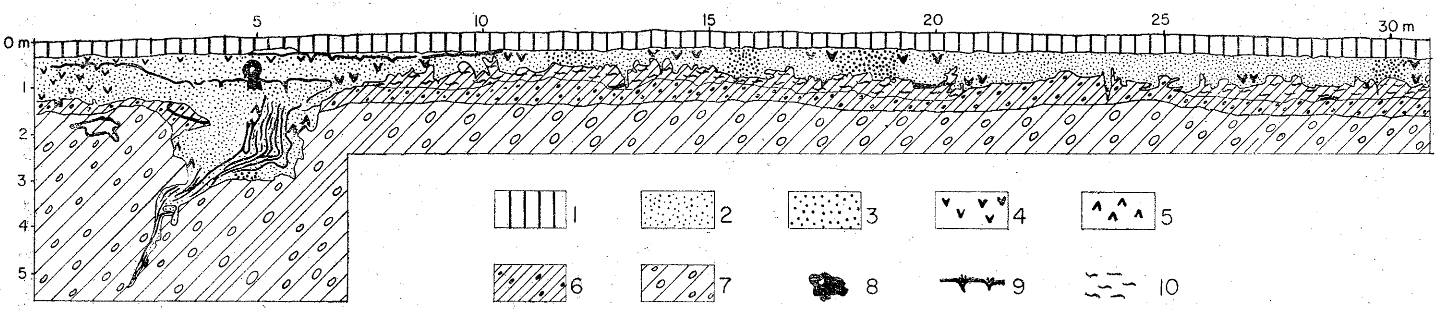


Fig. 26. Exposure near Novoselki village (by V. V. BERDNIKOV)

1. sandy silt, grey — arable horizon; 2. medium- and fine grained sand; 3. coarse sand; 4. ferruginous inclusions; 5. gley; 6. brown silt with sporadic gravels; 7. red-brown silt with gravels and pebbles; 8. sandy silt, dark brown, with humus; 9. podzol horizon boundary; 10. stratified structure

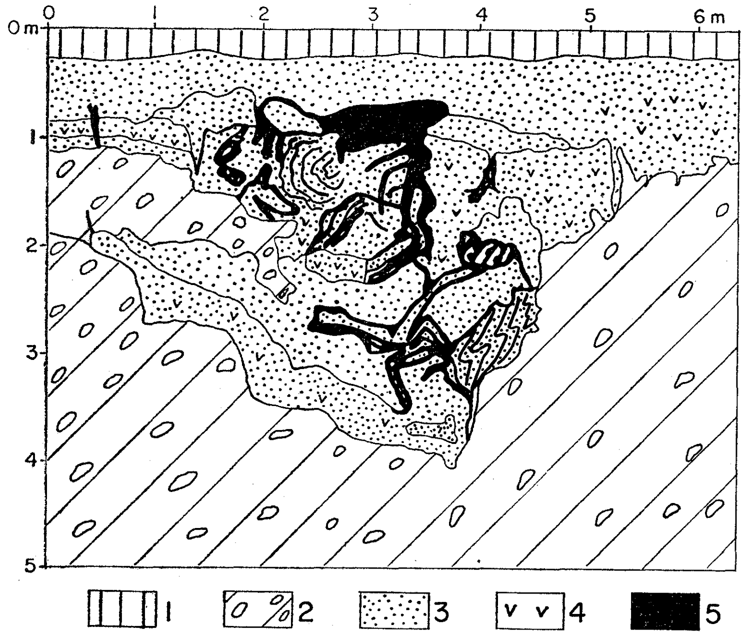


Fig. 27. Section near Novoselki village, wedge-like structure (by V. V. BERDNIKOV)

1. sandy silt, grey; 2. red-brown silt with gravels and pebbles; 3. sand; 4. ferruginous intrusions; 5. sandy silt dark brown, with humus

NOVSKIJ and N. S. ČEBOTAREVA) the moraine till is of Moscow age whereas other scientists (G. F. MIRČINK, A. I. MOSKVITIN) believe that it is of the Valdai glaciation. Anyway, the two upper horizons — silts and sands — date from the Valdai period and originated most probably under periglacial conditions.

The upper sandy horizon contains fine sands and coarse aleurites and, unlike the underlying series, it comprises relatively high content of 0.5—0.25 mm sand grains. The lower-lying silts are composed of clay and fine aleurite (silt) particles. Grain-size gradation of the moraine till is very differentiated. In the mineralogical composition light minerals prevail; they are mainly quartz and feldspars. Heavy minerals are represented by considerable percentage of epidote, and hornblende which testifies to slight weathering of rock fragments.

Pollen grains are scanty in all analysed samples taken from the whole profile. In the silts filling and closely adjacent to the wedge structures *Betula* predominates among the trees. Single pollen grains of grasses (*Chenopodiaceae*, *Artemisia*) have been found in covering silts (fig. 29).

Two polygonal blocks were cut across. The first exposed in the border part showed two wedges at 9 m distance. The wedge-structures in the second block cut its centre were 20 m apart.

The structures bordering the polygonal blocks display some characteristics:

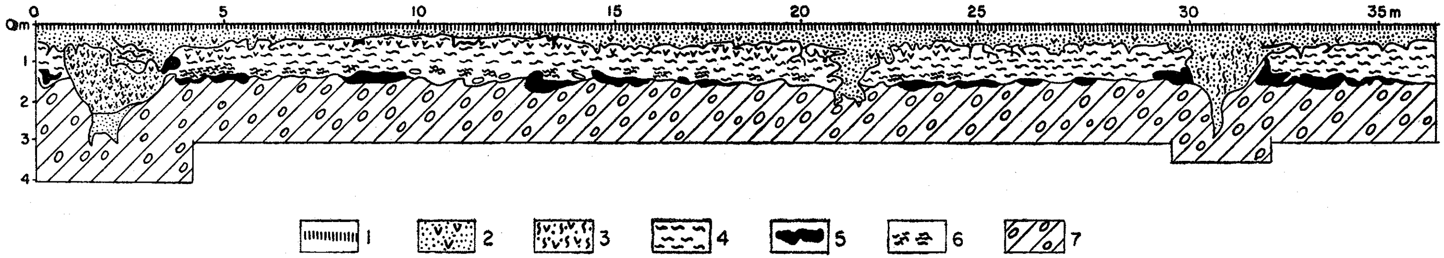


Fig. 28. Section at Kiryanowo (by V. V. BERDNIKOV)

1. sandy silt, grey — arable horizon; 2. medium- and fine sand with ferruginous spots and striae; 3. gleyed sand; 4. brown silt; 5. dark- brown silt with humus; 6. brown and blue-grey silt; 7. red boulder clay

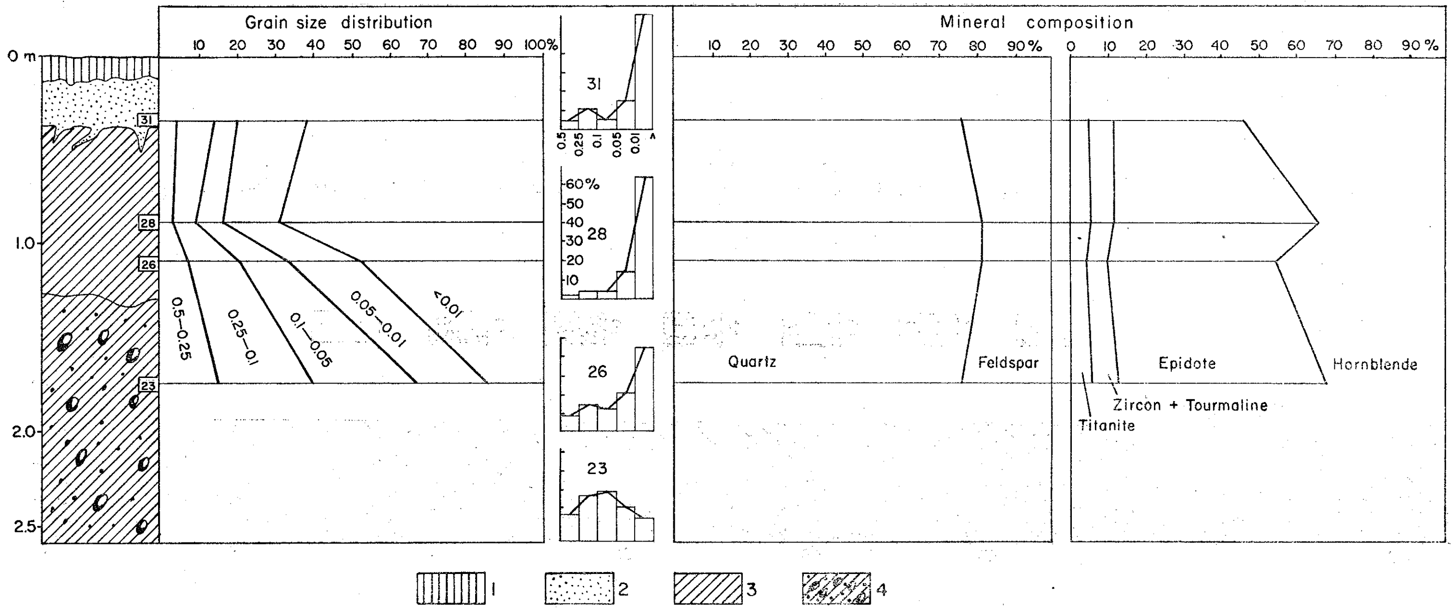


Fig. 29. Structure and composition of Pleistocene deposits, Kiryanovo (by A. A. Veličko and V. V. Berdnikov)

1. grey sandy silt — present-day soil; 2. medium grained sand; 3. brown silt; 4. red boulder clay

(1) they are wedge-shaped: the best example is the structure 3.1 m deep and 2 m wide;

(2) all the structures are two-storied: upper part is wide (down to 1.5—1.7 m) and the lower one is distinctly narrow;

(3) borders of the structures are uneven, there occur border protrudings; some structures are asymmetrical.

The above described features testify that these were fissure-ice polygons, filled after melting of ice, and at present occurring as pseudomorphoses.

The furrows oriented W—E are asymmetrical in cross-profile (V. V. BERDNIKOV): at the 1 m depth the borders of fissure 1 are 0.5—0.6 m and 1—1.2 m from the structure axis (fig. 20). This asymmetry is due to the different sun exposure during the melting of ice as south-facing "micro-slopes" of the fissure were strongly degraded. Better insolation of south-facing "micro-slopes" of fissures resulted in step-like borders, well visible in fissure 3 and in other sites. This testifies to the regularities in development and common occurrence of such asymmetrical forms.

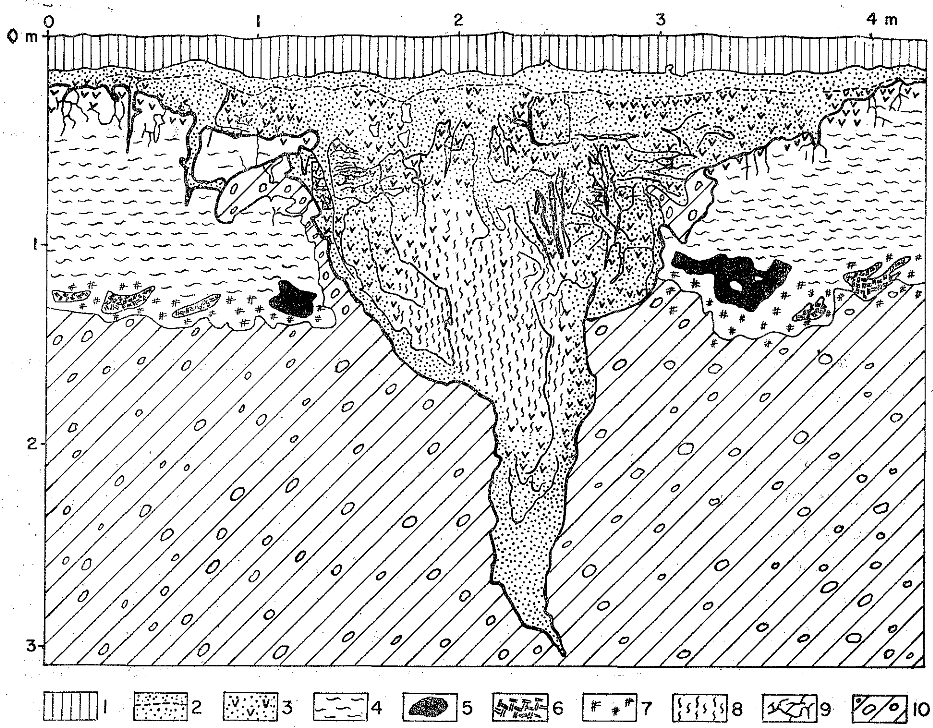


Fig. 30. Wedge-like structure in the section near Kiryanovo (by V. V. BERDNIKOV)

1. present-day soil; 2. podzol-horizon boundary; 3. medium and fine sand with ferruginous spots and striae; 4. light-brown silt; 5. dark-brown silt with humus; 6. gleyed grey-blue silt; 7. brown and orange silt, ferruginous; 8. sandy silt, light-brown, with manganese spots; 9. thin red-brown (iron) interbeds; 10. red-brown silt with gravel — moraine

Geophysical research of the deposits in which the fissures originated (moraine) and that filling the structures (sand, silt) has revealed that they differ in specific resistance: 35Ω in the moraine and 65—85Ω — in the infilling sand and silt. Therefore, further investigations were possible to find the stripes of ground exhibiting a high resistance. In order to make the geoelectric profile there were employed the following methods: of symmetrical profiling, of medium gradient, and of dipole profiling. All the three methods have given good results but the method of medium gradient is accepted as the simplest and most effective.

The geophysical observations were made in the experimental site 50×150 m. Obtained results of potential difference (Δ V) are shown in fig. 31. The main, parallel profiles revealed the majority of axes of anomalies. Additional tests were made along the perpendicular lines, in places of intersections of fissures.

As the adaptation of perpendicular profiles in geophysical measurements facilitates finding the lines of anomalies it should be accepted as a prime method in that task. Axes of anomalies — long broken lines in fig. 31 — crossing at angles ca. 90° form a dense rectangular net. The individual cells of the net are of similar size in the most parts of the area, and almost twice as large as the "elementar" cells of some elongated square-like shapes, 10×16 m in size.

Comparison of the net of axes of anomalies with the polygonal system displays the similarity of general characteristics. It should, however, be said that the characteristics of the polygonal pattern obtained by geophysical methods are the most adequate.

11. THE VILLAGE OKHOTINO

by A. A. VELIČKO, V. V. BERDNIKOV, V. A. KOTYUKOV

Topic: Polygonal pattern obliterated in land-relief and related thermokarst forms in the moraine landscape

Okhotino sections are situated 30 km NNE from Uglič and 7 km from Kiryanovo. One of the section examined, 20 m long, is in an arable field. Under the present-day soil, thin sand horizon overlies the moraine till. The wedge-like structure dissecting the moraine material down the 3.2 m depth (fig. 32) is asymmetrical and has distinctly step-like borders (fig. 33), analogically to the forms in Novoselki. Probably, the step-like limits of the wedge resulted from insignificant lowering of permafrost table at the time of its degradation and proceeding infilling of the void by sand. The present writers regard this structure as pseudomorphosis of fissure ice.

The second section is situated in boggy, slightly depressed area of an elliptical outline, 43×27 m in size. In general, it is similar to previous section but the sandy horizon is thicker (0.5—0.6 m) and contains intrusions of humus in the middle

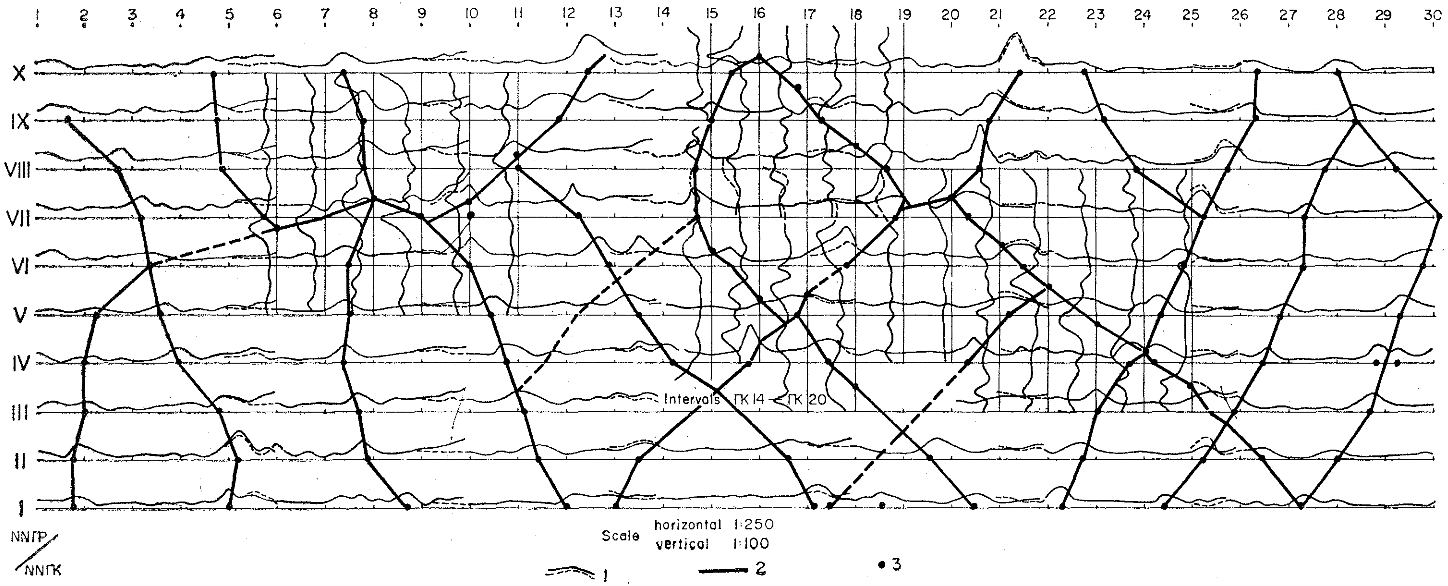


Fig. 31. Location of graphs Δ V, medial gradient and anomaly axes at a site near Kiryanovo (V. A. Kotyukov)

1. graphs ΔV; 2. anomaly axes; 3. points with ΔV_{max}.

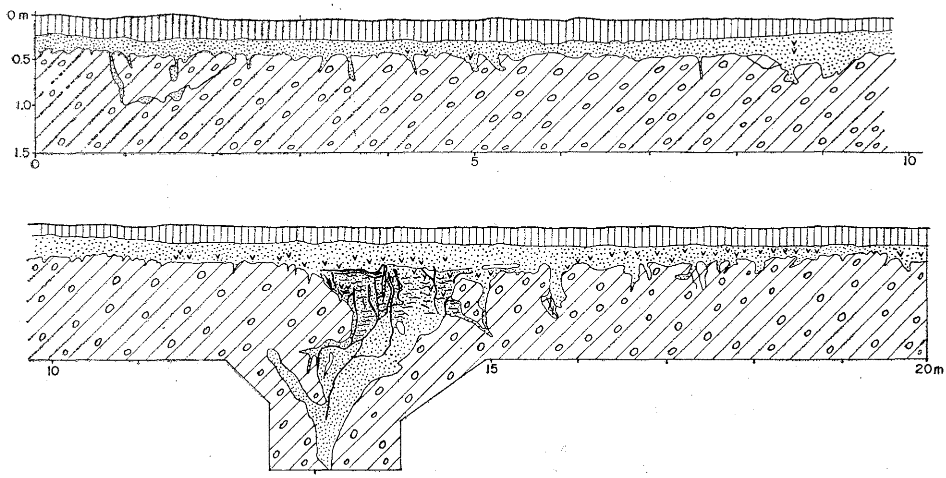


Fig. 32. Cross-section of deposits near Okhotino (by V. V. BERDNIKOV)

Explanations as in fig. 26

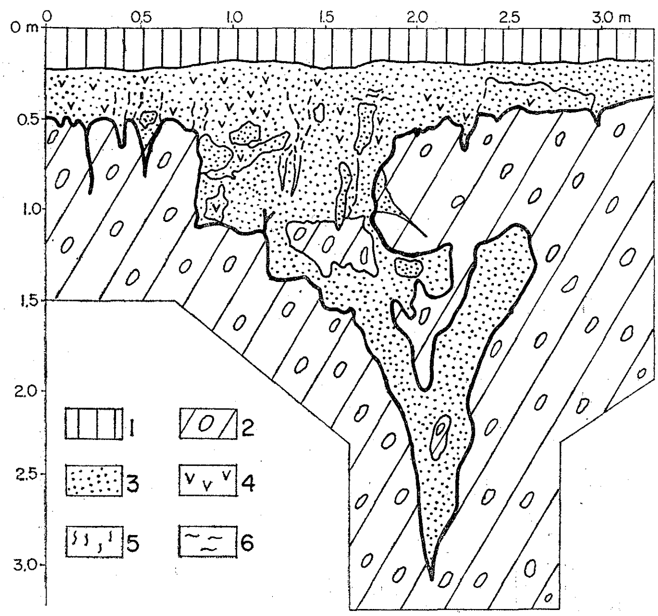


Fig. 33. Section near Okhotino, showing wedge-shaped structure (by V. V. BERDNIKOV)

1. present-day soil; 2. red-brown silt with gravels and pebbles; 3. sand; 4. ferruginous inclusions; 5. gleyed material; 6. paquets of stratified material

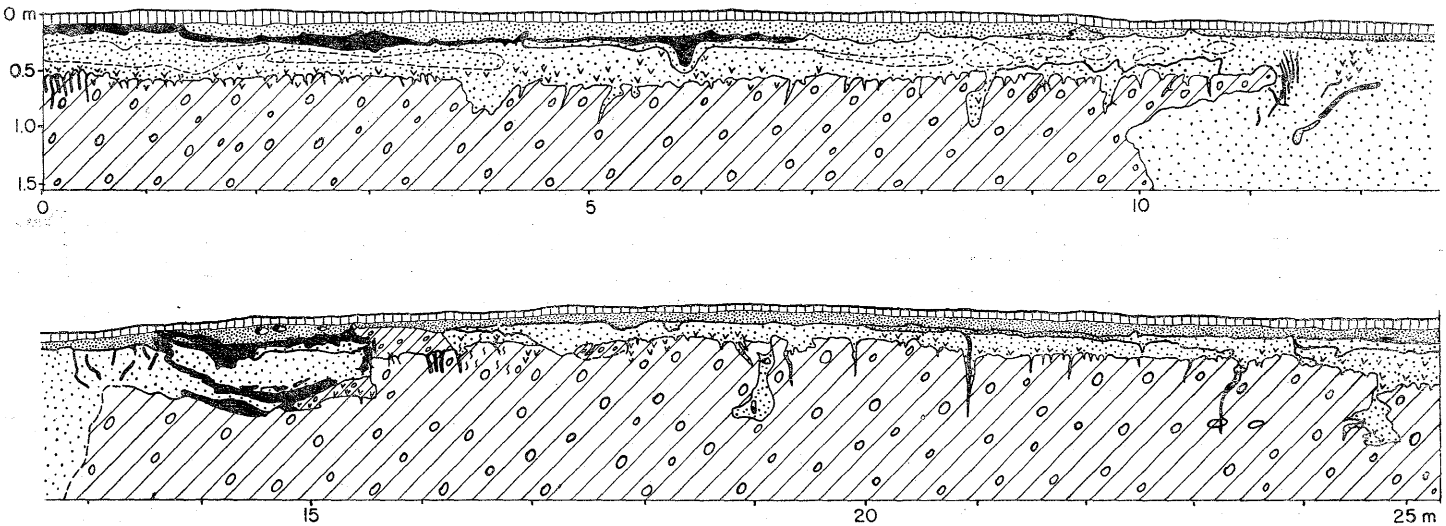


Fig. 34. Cross-section of deposits near Okhotino (by V. V. Berdnikov)

Explanations as in fig. 26

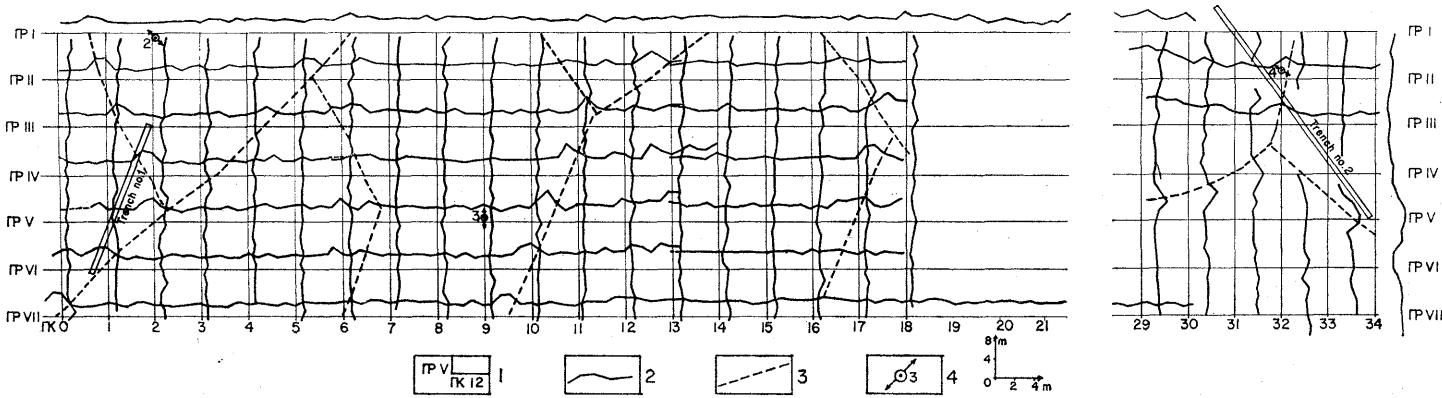


Fig. 35. Location of graphs ΔV, medial gradient and anomaly axes at a site near Kiryanovo (by V. A. Kotyukov)

1. nos. of profile lines and points; 2. graphs ΔV; 3. anomaly axes; 4. points of soundings

and left-side parts (fig. 34). In the middle of the section there is 3 m wide wedge-structure which was cleaned only to a depth of 1.5 m. The characteristics of the wedge itself and of its borders may suggest that it is a fragment of a polygon fissure.

Analogically to Kiryanovo, geophysical investigations were made also in this area. As the geoelectric profile seemed to be similar to the one at Kiryanovo, the method of medium gradient was applied. Observations were performed in the elongated area, 170 m long and 30 m wide, situated partly on a arable surface and partly stretching onto the boggy depression. The results of geoelectrical soundings confirm the possibility of using the geophysical methods in field mapping of fissure polygons. It should be mentioned that arerial photographs made in this area did not show any polygonal pattern, unlike the geophysical methods which were found useful to trace the spatial occurrence of fissure forms (fig. 35).

In Okhotino the polygonal pattern, being similar to those at Kiryanovo, shows more complicated picture because of insignificant anomalies in specific resistance (fig. 35). The course of fissures within the boggy area permits to suppose that three fissures intersect in the lowest part of the depression (fig. 35). This indicates, probably, that the boggy depression is of thermokarst origin induced by fissure ice polygonal system.

The results obtained by application of geoelectrical soundings indicate that both the areas — on the arable surface and in the boggy depression — show similar specific resistance to the depth of 3—4 m, but they differ in deeper parts. Within the depression the deposits lying below 4 m have specific resistance of 32—34 Ω and are watersaturated or more fine-grained and clayey than those of the arable field where at the same depth the specific resistance is 70—90 Ω. The higher specific resistance may indicate that these are compact morainal deposits with small admixture of sand.

Translated by Ł. Dutkiewiczowa

DISCUSSION AND GENERAL REMARKS
(Excursion: Moscow—the Upper Volga)

A. G. Kostyaev: ADDITIONAL EXPLANATIONS TO THE SECTION AT LEVINA GORA

Polygonal structures of the upper part of the inundational terrace on the Sara left bank lying some 150—200 m higher than the exposures examined, were investigated in October 1968, that is in a relatively arid period, and in April 1969 during the spring thaw and flood (Pls. 1—3, fig. 1).

From the most general data such as the geomorphologic situation and geologic structure it comes out that the origin of the polygons has been most probably associated with the convection instability on the contact line between the layers I and II (Pl. 2), this instability was caused by subsiding of the ground at the polygon edges. The first results of analyses confirmed this opinion: (1) specific gravity in the pockets (layer I) was about 0.06—0.13 g/cm^3 bigger than in the surrounding material (layer II); (2) limit of the maximum relative fluidity amounted 1.25 g/cm^2 at the humidity of 20% (layer II).

This hypothesis to be completely endorsed required examination of the density and stability (fluidity) of the ground during snow melting and floods in spring. Particularly important were the observations made in low-relief area (fig. 1: a, b), which — unlike higher hillocks — can be still developing. From this point of view the most suitable seems to be the structure presented in figure 1 a; the geologic features of the structure in figure 1 b suggest that its development practically came to an end.

Density of the ground varies greatly, especially in the centres of the polygons. This differenciation caused by the character of primary sedimentation is also due to the fact that the upper parts were secondary intensively hollowed by the channels formed by plant roots and insects. But in the whole the inversion of the layers I and II prevails, and it proves that the opposite situation is improbable (moreover the differentiation of density of the ground layer cannot hamper the gravity convection).

Therefore, when estimating the possibilities of the occurrence of convection movements between layers I and II, $\Delta\gamma \cdot \Delta h \geqslant \tau_0 max.$ according to Artyuškov's criterion, where $\Delta\gamma$ is the difference of density of the ground, Δh — mean value of the oscillation of the border of section of layers at a distance equal to the diameter of polygons, $\tau_0 max.$ — relative limit of the fluidity of the less mobile material. The

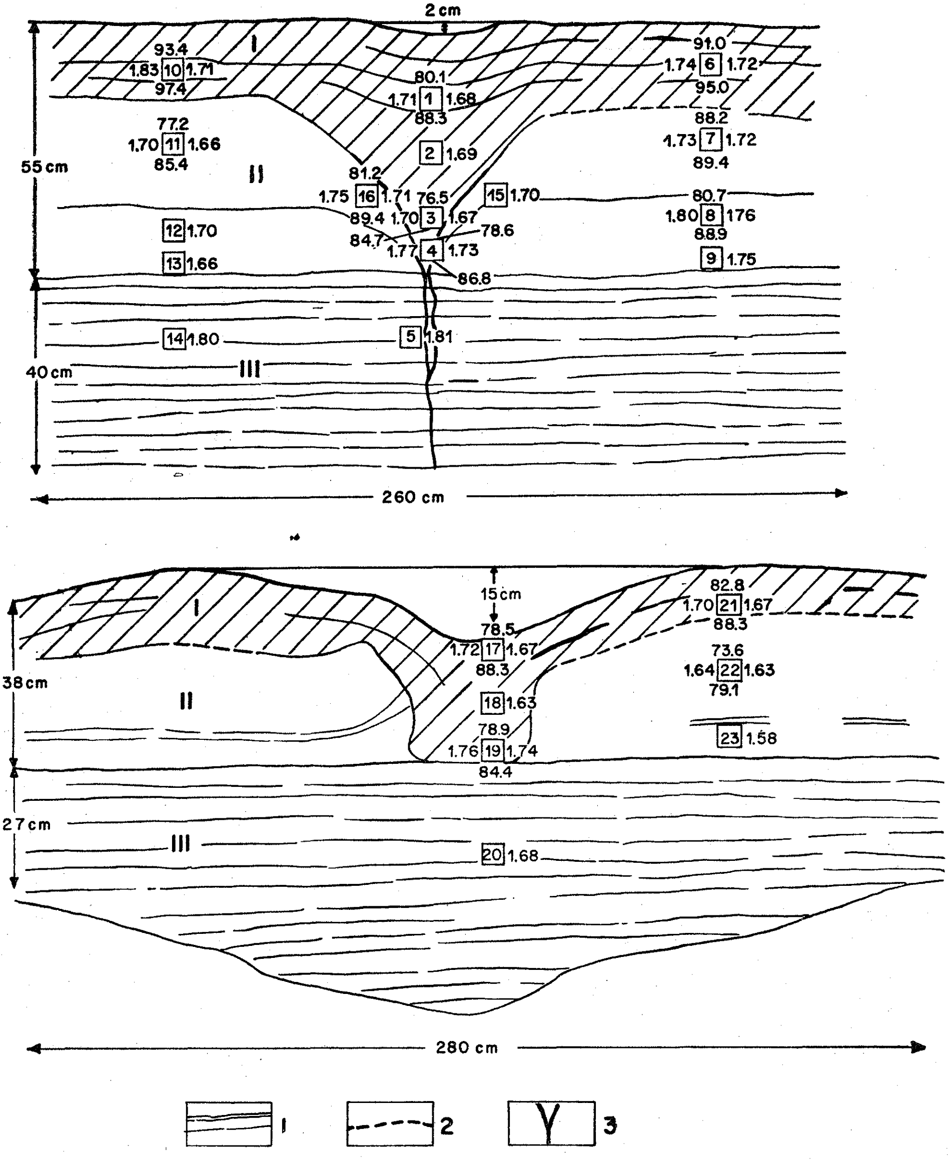
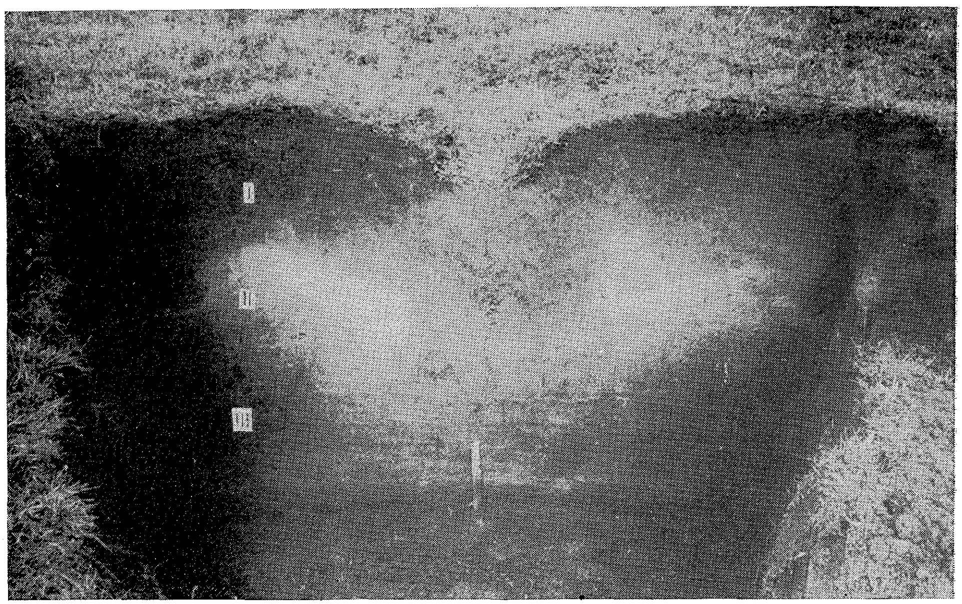


Fig. 1. Schematic sections through the polygons: a — with indistinctly visible polygonal furrow, b — with a good marked furrow

I, II, III — layers corresponding to those on Pl. 2; 1. limits between layers; 2. indistinct limits between layers; 3. thin (1-2 mm) winding ice-vein in still frozen deposit

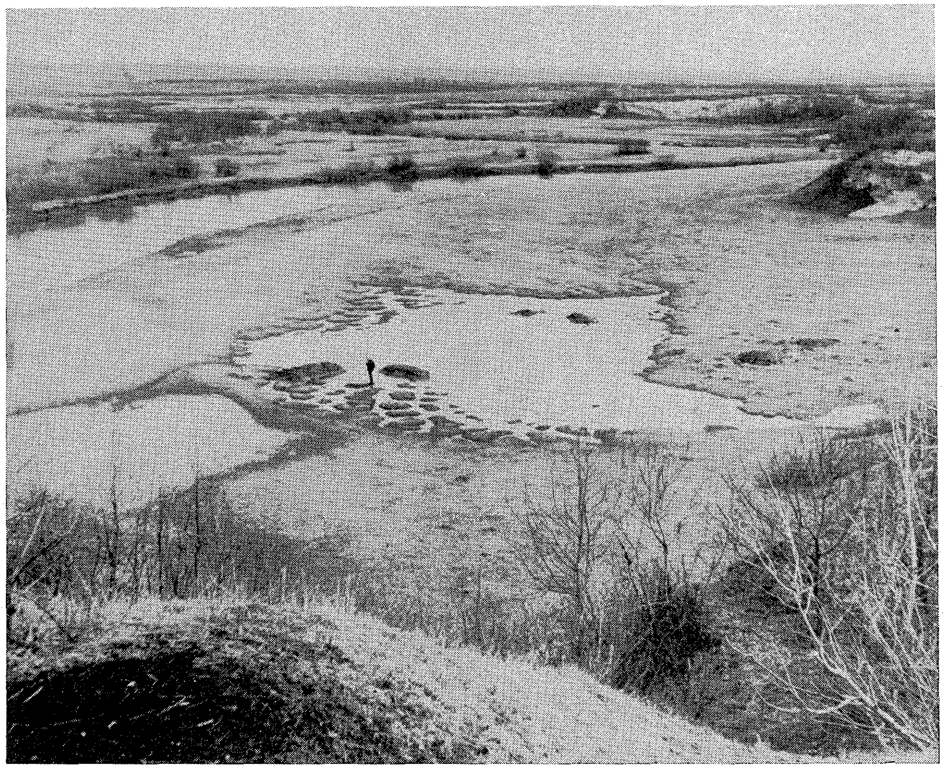
Figures on the right from the square with the numero of a sample show specific weight of the material on 20 April 1969; figures over the squares — real humidity in percentage in relation to the maximum humidity; figures under squares — humidity during the presumable flood in percentage in relation to the maximum humidity; figures on the left of the squares — specific gravity of the ground during the presumable flood

Pl. 1. The upper part of inundational terrace of the Sara with the best developed polygonal mounds (situated within the depression on the terrace surface)



Pl. 2. Section through two adjacent polygonal mounds and the depression

I — dark grey silt with an intermediate admixture of dust and humus; II — reddish-brown, light silt; III — horizontal stratified silt and fine-grained sand



Pl. 3. General view of a part of the inundational terrace with a polygonal relief (April); depression in the middle filled with meltwater

minimum and mean values of $\Delta\gamma$ and minimum value of Δh have been taken[1].

The results obtained are presented in Table I, which clearly shows that the convection movements are possible in each case except for 2a, because the process to be active on a flat surface requires higher moisture of the ground.

To estimate the humidity during the presumable inundation the initial point was humidity measured for the sample from the layer I, taken under the water in a lake.

It has been assumed that the samples 1, 17, and 21 have the same humidity. As to other samples (except for samples 6 and 10) their humidity for the period of presumable flood was calculated in relation to the above experimental value, assuming that it is proportional to the real humidity. For samples 6 and 10 the humidity has been assumed to be 4% higher than the real humidity.

Table I

Possibilities of development of polygons in the upper part of the inundational terrace of the Sara as a result of convection movements in ground

1. Possible formation of the present-day polygonal forms:	$\Delta\gamma \cdot \Delta h \geqslant \tau_0 max$	
a. Autumn (surface completely dry; upper horizons of the layer I soaked by rain fall)	0.06 g/cm³ · 30 cm > 1.25 g/cm² 1.80 > 1.25	possible
b. During the spring thaw (accumulation of water on the surface was not noticed)	0.02 g/cm³ · 30 cm > 0.025 g/cm² 0.6 > 0.025	possible
c. Under probable flood	0.02 g/cm³ · 30 cm > (<) 0.025 g/cm² 0.6 > (<) 0.025	possible
2. Possible initiation of the primary convection movements between the layers I and II:		
a. Autumn (completely dry surface; upper horizons of the layer I wet with rain fall)	0.06 g/cm³ · 1 cm < 1.25 g/cm² 0.06 < 1.25	impossible
b. During the spring thaw (accumulation of water on the surface not observed)	0.03 g/cm³ · 1 cm > 0.025 g/cm² 0.03 > 0.025	possible
c. Under probable flood	0.06 g/cm³ · 1 cm > (<) 0.025 g/cm² 0.06 > (<) 0.025	possible

A. P. Dedkov: ON SLOPE ACCUMULATION UNDER PLEISTOCENE PERIGLACIAL CONDITIONS

In the exposure of the Čeremošnik gully the Mikulinian muddy-lacustrine deposits are overlain with loess-like silts, including coarse debris material. The petrological composition of these sediments is correlated to the boulders and pebbles

[1] The data have been obtained through the examination of samples taken from the polygons, especially the samples soaked during 21—36 hours (the final humidity 28—31%). The fluidity of samples taken from the exposures 1 and 2 will be investigated lately. The primary use of the laboratory analyses is valid, because humidity of the ground was lower when examined than that of the ground during the spring thaw and flood (27—39%). Grain-size composition of the material taken for examination of fluidity was much the same as of the material in the polygonal blocks.

The author express his thanks to I. M. Gorkova and H. G. Grave for the analyses.

of the Moscow moraine which left the highest watershed in this region. It seems difficult to disagree with the opinion expressed by the majority of the participants of that excursion, who hold that the silts overlying the Mikulinian sediments are Valdai formations of a colluvial—(deluvial)—solifluxion origin rather than morainic deposits. At a superficial glance at the exposures, the thick stratification of the silts in some places seems to most convincingly to that effect. The layers are dipping from the edge to the center of the Mikulinian lacustrine depressions.

The exposures presented indicate that under periglacial conditions at the beginning of the Valdai stage, accumulation by water in the Mikulinian lake depressions was still in progress but got subsequently replaced by accumulation of deposits due to solifluxion. The latter occur most probably only on the margins of depressions, while they may be absent from their center. For instance, in the lake depression south of the village Čeremošnik borings have revealed the presence of a thin horizon of Holocene formations overlying the Mikulinian lacustrine muddy deposits.

An analogous change from subaqueous to slope accumulation is, it seems typical of vast areas of the Russian Plain. For example, in the river system of the Middle Volga, the „humid" alluvium of terrace III (the age of this terrace is thought to coincide with either the Odincovo or the Mikulino interglacial) passes gradually towards the upper part of the profile into colluvial—(deluvial)—solifluxion deposits which rise from the valley bottom onto the slopes. The interglacial „humid" Likhvinian alluvium, costituting the base of terrace IV is overlain with Dneper periglacial alluvium, which in the valley of the Volga includes even colluvial—solifluxion sediments. The lesser the width of a valley the more conspicuous is the process which, under periglacial conditions, inhibited accumulation by river in favour of slope formations.

The paleogeographic conditions of Pleistocene periglacial zones promoted the development of both colluvial and solifluxion processes. Well-defined colluvial—solifluxion formations often interbedded with fossil soil horizons or surfaces of denudation, afford convincing evidence of the existence of periglacial conditions. The number of periglacial periods can be inferred from the amount of colluvial—solifluxion deposits commonly occurring in any given area. The age of these formations, hence also the time of existence of periglacial conditions have been settled on the basis of their stratigraphic situation relative to the horizons of lacustrine, fluvial, marine and glacial sediments which are already dated.

R. Galon: CONTRIBUTIONS TO THE DISCUSSION

During the summary discussion and when discussing with Soviet colleagues I concluded that our opinion on the maximum extent of the last ice-sheet in the area visited during the excursion is still open. The Valdai stage is undoubtedly a second part of the Würm, like the Leszno stage in Poland and Brandenburgian stage in Germany. During the first part of the Würm the maximum limit of the Scandinavian ice-sheet extended to the south of Valdai moraines as regarded by some scientists, while others hold that it run farther to the north and was later mantled by the Valdai deposits. I would like to suggest that similar opinion is discussed in Poland where — according to HALICKI — there are end moraines older than the Leszno stage in the region of Białystok. HALICKI has regarded them as representatives of an individual glaciation. Probably, they may be landforms and deposits corresponding to the first part of the Würm. These formations have their continuation in the area of the USSR. Elucidation of this disputable problem, i. e. the maximum extent of the last ice-sheet, requires more co-operation of Polish and Soviet research workers.

V. A. ZUBAKOV: CONTRIBUTIONS TO THE DISCUSSION

When did the maximum expansion of the Würmian glaciers take place — in the Early or Late Würm? The question is discussed with the same fervor in Siberia as in North America or in West Europe. Most of scientists hold that the maximum ice-sheet expansion in England, Alaska, British Columbia, Yakutia and in West Siberia occurred in the Early Würm, but it is also thought that it happened in Germany and in the region of Great Lakes during the Late Würm. However, these two opinions are not in all cases supported by the results of investigations, especially by the isotopic dating. Therefore the possibility of getting acquainted with the sections at Čeremošnik and Levina Gora, which have an essential significance for the designation of the time of the Kalinin glaciation, was so very important for the participants of the Symposium. It should be mentioned that the sections were perfectly prepared for the demonstration, and general impression was univocal, though unecspected for me as I believed that the question of determining the age of the Kalinin glaciation simply did not exist.

Not in all the three sections: Čeremošnik 202, Čeremošnik 203, and at Levina Gora two cycles of sedimentation are distinctly seen, which I consider very important for the genetical interpretation. The first cycle begins with post-moraine sands and finishes with gyttja and peat. Besides, in the section 203 (230?) on the both sides of the gully it is seen that sands and gyttja occur in the fossil erosional depression. The wood remnants[1] found in peat in the section 202 have been analysed in the VSEGEI Laboratorium and dated on the phase of early spruce and their age is not less than 60,300 years (LG—58). These results confirm undeniably the opinion that the peat-bog belongs to the Mikulino Interglacial and not to the Malogošeksninian Interglacial as it has been thought so far.

[1] I. I. KRASNOV and E. P. ZARRINA's samples.

In the base of the second sedimentation cycle there is marked an erosional surface covered with sands overlain by silts with an abundant admixture of debris. In my personal opinion the silts often referred to as the moraine material of the Kalinin glaciation have a very complicated alluvial—colluvial—solifluxion origin; they are the results of a rapid infilling of depressions as a result of increasing slope processes in the periglacial zone.

If we had seen only the section 203, the version of a moraine left by the thin glacial lobe in the marginal zone of the Kalinin glaciation would be probable though the lack of any glaciotectonic disturbances in deposits of the first sedimentation cycle denies such a possibility and the cyclic character of deposits in the section does not permit to regard the Mikulinian sediments as a detached block transported by ice-sheet.

But the undeniable synchronism of all the three sections confirmed by the isotopic dating of the wood remnants from the section 202 as well as the survey of the section at Levina Gora decidedly militate against the morainic origin of silts of the second sedimentation cycle. In the section at Levina Gora the mechanism of enriching silts in rock fragments is clearly seen. In section 217 the silts are almost deprived of debris. However, in the section 214 below the undercut slope there can be noticed a number of debris that give the silts a moraine character, but down the river the rock fragments disappear against. Thus, the „Kalinin moraine" is simply a local facies — a subaqueous strand of cones and land-slips that entered onto the slope undercut by water.

It comes clear that the presence of deposits of the Kalinin glaciation in the section examined is by no means ascertained. It is possible that in the areas situated northwards the moraine of the late stage of the Moscow glaciation is regarded as the Kalinin moraine. This presumption is the result of analysis of the exposure near the Altynovo village and of the recent field studies which have shown that moraines of the Bologovsk stage near the Kubensk lake mantle the lacustrine deposits; the age of these sediments has been determined by the isotopic dating on ca. 21,000 years B. P. (personal information of E. M. VIGDORČIK and V. G. AUSLENDER). Consequently, the situation in the European part of the USSR is exactly the same as in West Siberia.

As it is well known, the analogue of the Kalinin glaciation is in West Siberia the Zyryan glaciation, whose moraine constitutes the base surface of the marine and alluvial Kargin horizons. Age of these horizons according to the C^{14} dating is between 32,500—43,500 ys. It has come out that also the older boulder clays were reckoned in the moraine if the so-called Zyryan glaciation. For instance, at the mouth of the Ob near the village Salemal a terrace adjoins the Zyryan moraine. The terrace is built of sediments characterized by the pollen spectrum containing wood remnants whose age according to C^{14} is at least 57,000 (LG—13). In the Yenisey valley, the „Zyryan" moraine from the maximum Lower-Tunguskanian stage is joined by the upper Mirnyj terrace built of interglacial deposits whose age is not younger than 59,300 years (LG—21). Parastratotype of the Zyryan horizon near the Malyševka river at the Yenisey mouth is — according to recent opinion — — represented by the glacio-marine deposits of the final phase of the Sančugovian transgression. It is evident that in many cases the late-Rissian moraines — the Yenisey glaciation, called the stage Lower-Tunguska have been reckoned in West Siberia to the early Würmian — Zyryan (pre-Karginsk) glaciation. The Zyryan — — early Würmian glaciation in Siberia is now thought to be associated with the so-called Ermakovian moraine, whose age has been dated by C^{14} on no less than 37,000 years B. P., though this statement is not completely certain. If this moraine turns out to be the analogue of the Lower-Tunguskan one — which is quite possible — it will be clear that in West Siberia the maximum expansion of glaciation occurred in the Late Würm; it is so-called Nyapan or Malokhetian stage of the glaciation. Simultaneity of this stage with the Bologovskian stage of the Valdai glaciation has been stated by the dating of wood remnants found in the glacio-fluvial Dudinka sands in top part of the Nyapan moraine. Their age is 26,900±1,300 years B. P. (LE—600).

At the end of my pronouncement I would like to emphasize the perfect organization of the Symposium and especially excellent preparation of exposures and the indisputably great profit from the discussion between the representatives of two disciplines: cryolithological and stratigraphical-paleogeographical.

V. A. Novskij: CONTRIBUTIONS TO THE DISCUSSION

The complex method of research on the Quaternary sediments may prove useful in future. There was given a more detailed characteristics of the Mikulinian interglacial sediments occurring in the gully of Čeremošnik.

All the geological sections were perfectly prepared, and thoroughly examined by the scientists from the Department of Geography of the Moscow University and from the Geological Office. Results obtained by the appliance of the complex method of research were excellent. Only few problems have not been univocally solved till now because of the complicated geological structure and inaccessible locality. Among these is the problem of the origin of the deposits overlying the Mikulinian interglacial sediments in the Rostov Yaroslavskij region. The following part of the discussion will be devoted to this problem.

The best exposures are in the left wall, close to the head of the right branch of the big gully near Čeremošnik (the sections of the Moscow University: 200, 206, 207). The moraine overlying the interglacial sediments shows the structure which is not altogether uniform. Its lithologic composition is not uniform either. The primary structure of this moraine is altered by secondary processes. Directly above the lense of Mikulinian muddy-lake material occurs clayey yellowish moraine sand enriched in limonite. This occurs also in the neighbouring exposures almost on the same level.

The hypothesis on the land-slide character of the moraine displacement is thus excluded. The moraine was supposed to mantle the muddy-lake sediments, but this hypothesis is further shaken by the absence of geomorphic features which could have proved the existence of land-slides in the past as well as at present.

Another section in the right wall of the same branch, near the section 201 (Moscow University), farther towards the mouth of the gully, completes the above mentioned sections. Unfortunately, due to the lack of time, this exposure was not shown to the members of the excursion. I would like to mention my own data according to the sections of the year 1967. The profile (fig. 1) shows that:

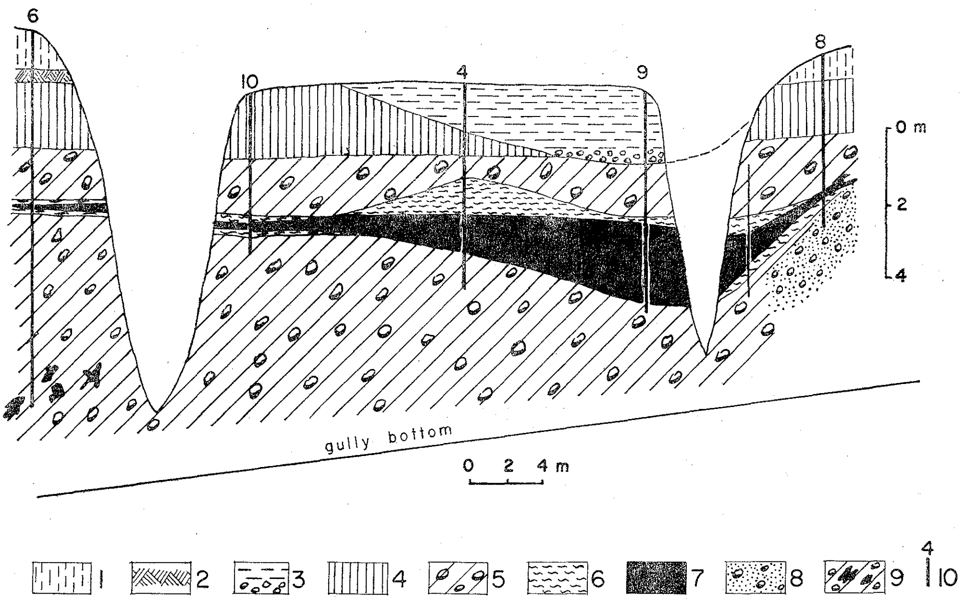


Fig. 1. Profile of the right face in the branch of the gully near Čeremošnik

1. colluvial clayey sands and silts; 2. fossil soil; 3. stratified clayey "gully" alluvium, and silts with pebbles and stones at the base; 4. covering silts; 5. moraine: yellow brown and brown grey boulder clay and clayey sands; 6. interglacial (Mikulino) sediments; clayey silts; 7. interglacial (Mikulino) sediments: peat and gyttja; 8. sands and pebbles; 9. inclusions of grey clayey silts and peat in the moraine; 10. sections made by the staff of the Geography Department of the Yaroslavl Pedagogical Institut

1. the Mikulinian muddy-lake sediments are overlain by the moraine (or are inserted into it), and are not connected with the material filling the fossil system of gullies, the traces of which may be seen in the present landscape;

2. these sediments were being eroded to the greater or smaller degree, what resulted in the rapid thinning of deposits;

3. the small lenses of clayey silts with peat occur in the moraine (section 6, and others).

Near the village of Levina Gora the attention of the participants was attracted by the deposits composed of grey and brown silts, heterogenous sands, containing inclusions of gravels and stones; they show peculiar net-like texture. These deposits are exposed on the left undercut bank of the river Sara at a depth of 4 m from the terrace edge. It must be stressed that they contain mainly material from the bedrock. Disturbances bearing the features of glacial disclocations are observed at the base, including the Mikulinian muddy-lake sediments. I agree, therefore, with A. I. Moskvitin that these deposits, despite its unusual appearance, are the local moraine of the penultimate (Kalinin) glaciation. Final solution of this problem will be facilitated by the comparative examination of the physical properties and mineral composition of the deposits under discussion. This work has been successfully undertaken by Mrs. A. A. Vvedenskaya, Mrs. N. G. Sudakova and others. New exposures should be made, too, in the direction of Levina Gora from the already existing ones. This will give way to some explanation of the conditions of the deposits.

I. Lieberoth: CONTRIBUTIONS TO THE DISCUSSION

(A) On point 4 of the excursion: Čeremošnik (August 11th, 1969)
Profile structure:

VI. Loess (discordantly overlying the humus zone)
V. Loess (completely altered by a humus zone that developed wedge-like disturbances into the underlying Dernopodzol, partly up to the lower end of that Dernopodzol)
IV. Clayey loess (completely changed by the development of a Dernopodzol, also called *lessivé* or *Fahlerde*, with a well developed A_2/B_t horizon)
III. Displaced moraine-like material
II. Peat
I. Moraine

Interpretation by time: The leaders of the excursion assigned the materials as follows: the moraine lying at the bottom of profile to the Moscow glaciation; the peat layer to the Mikulino interglacial; and the upper series to the Valdai glaciation and to the post-glacial. From the pedological point of view the Dernopodzol is well developed; according to our present knowledge it could develop only during an interglacial period (Mikulino or Holocene). This opinion was substantiated by the pedologists (M. A. Glazovskaya, J. C. F. Tedrow, I. Lieberoth). The author believes that the overlying humus layer has developed in a new, more recent loess, since the ice wedges which are rather big in some places are filled exclusively with that material. The described "humus zone overlying Dernopodzol" complex, therefore, is a soil complex, i. e. a sequence of two immediately overlying, but separate soils. If the Dernopodzol were a post-glacial soil, there should have been certain periods in the Holocene when (1) a repeated loess covering, (2) a drastic change of climate (first the conditions for the formation of Dernopodzol, then for chernozem), and (3) an intense formation of ice wedges would have been possible. All these three possibilities are unlikely. Furthermore, today in the Rostov—Uglič area Dernopodzols rather than chernozem-like soils prevail as recent soils even on loess-like material. This, too, speaks against a post-glacial formation of the humus zone. The exclusion procedure therefore only leaves the interpretation of Dernopodzol as a Mikulino interglacial soil and of the loess in which it had developed as belonging to the Moscow glaciation. This interpretation is even supported by the fact that the above described "humus zone overlying Dernopodzol" soil complex represents a common fossil soil complex of Eem/Early Würm (Mikulino/-Old-Valdai) that is characteristic of Central and Eastern Europe.

Open problems: Now a new problem arises, however, as to the classification of the basal layers of Čeremošnik. The questions of the paleopedologist to the Quaternary geologist therefore are: (1) is the classification of the past layer into the Mikulino interglacial really warranted?, (2) loess and moraine — may they be older than generally assumed?

(B) On point 8 of the excursion: Kiryanovo (August 12th, 1969)

Profile structure:

IV. Eolian sand (2 in fig. 28; in small wedges it penetrates into the older or younger covering silts)

III. Fine silt (younger covering silt; only left in wedges and pockets that from above penetrates into the clayey fine silt)

IIa. Thick transition horizon showing indistinct boundary with overlying material

II. Clayey fine silt (older covering silt; 4 in fig. 28)

I. Moraine (7 in fig. 28)

Interpretation: When interpreting that exposure it has to be born in mind that four different layers lie one above the other (Fig. 1): I. the weathered material of the Moscow moraine (officially regarded as the moraine material lying at the bottom of the profile), II. an older clayey fine silt, III. a younger fine silt found in remains only, but easily distinguished as a separate material, and IV. an eolian sand. The younger fine silt originally must have formed one continuous layer overlying the older clayey fine silt. During a phase of intensive cryoturbation it was then worked as pockets into the older clayey fine silt. In part this was connected with slight intermixing, but in all cases the pocket content showed a lighter texture (less clay contained). Since hardly anything of the younger fine silt is left above the pockets, it must have been carried off in a denudation phase following cryoturbation. That layer of fine silt seems to have very thin only; in few places, however, it is in lenses still preserved in its original constitution, i. e. as silty loess-like material without sand (III). Only then was the eolian sand blown in from the Volga river valley one kilometre away. Finally, there was another phase of cryoturbation in the course of which small, closely spaced wedges (frost fissures?) developed emerging from the eolian sand. This latter frost soil phase must still have occurred in the glacial, presumably in its final stage (late Valdai).

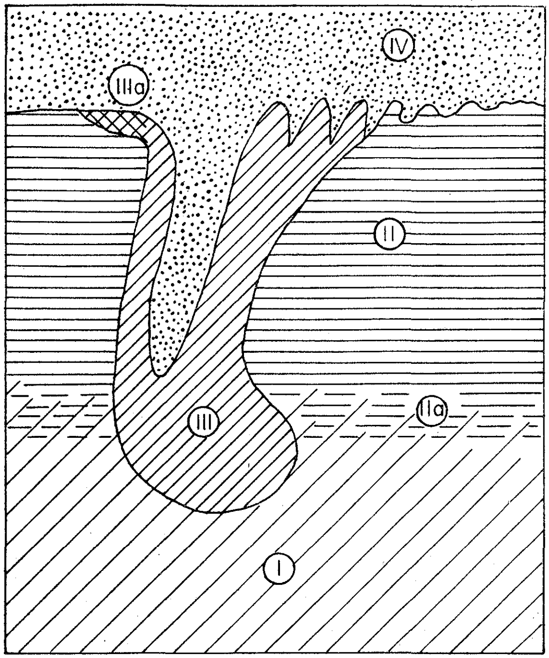


Fig. 1. Detail of section at Kiryanovo

Explanations in the text

Open problems: The origin of material and soil may be interpreted to some extent. Thorough analysis of texture and mineralogical composition might corroborate these findings. Pedological measures alone are not sufficient to identify the precise periods of time when the described phases have occurred.

(C) *General remark*

In periglacial research, too, further progress will be achieved only through the combined application of several techniques. Proper interpretation of ice-wedge and cryoturbation zones will, for example, only be possible if, apart from morphological examination of the phenomena, substratum genesis and soil formation are considered as well, with methods of chemical, physical and mineralogical analysis being applied to confirm the results. On the other hand, in former periglacial areas genuine progress in soil-genetic research will only be achieved if the periglacial processes are taken into consideration that have taken place in the soils. Having taken these findings into due account, important new results have been achieved in the German Democratic Republic in recent years in the fields of both periglacial research and soil genetics.

ČEREMOŠNIK, LEVINA GORA
DISCUSSION SUMMARIZED by N. G. SUDAKOVA

K. K. MARKOV, M. A. GLAZOVSKAYA, V. A. ZUBAKOV (USSR), R. GALON, A. JAHN (Poland), I. LIEBEROTH, G. RICHTER (East Germany) emphasized that the accumulation of deposits covering the sediments of the Mikulino (Mgin) Interglacial took place under periglacial conditions associated with the Valdai glaciation. The area discussed was not covered by the Valdai ice-sheet. Many arguments were quoted to back up this opinion.

A. CAILLEUX (France) called attention to the character of relief which favoured the development of slope processes.

J. DYLIK and other debaters pointed to the character of deposits, their structural and textural properties. They stressed that the well-developed, irregularly stratified and weakly sorted solifluxion deposits, occurring in the top part of exposures, are characteristic of the whole periglacial zone.

J. BÜDEL (West Germany) also considered the deposits discussed as typically non-glacial, resembling the alike deposits in Europe.

G. RICHTER pronounced the opinion that the silts with boulders overlying the peat originated as a result of the activity of slope processes (solifluxion) and of the fluvial and eolian ones and encouraged to making borings in the interfluve areas. V. A. ZUBAKOV thinks that in the Čeremošnik gullies and at Levina Gora two sedimental cycles can be distinguished. The second cycle has in his opinion initiated by the deposition of a pseudomoraine which can be associated with the sedimentation on slopes and in water basins.

V. A. NOVSKIJ and S. L. BRESLAV connect the area with the extension of the Upper-Pleistocene glaciation, and they think that the silts with boulders lying stratigraphically above the Mikulino series should be considered as belonging to the Kalinin moraine. Therefore, S. L. BRESLAV admitted that this "moraine" is not typical. The silts with boulders visible at Levina Gora were deposited in lakes in the marginal part of the glacier descending into surface depression. S. L. BRESLAV stated that in the Upper Volga region the non-typical moraines are quite frequent. V. A. NOVSKIJ emphasized valuable achievements of the staff from the Geographical Department applying the complex examination of mineral composition of the moraine. According to V. A. NOVSKIJ the determination of physical properties of the glacial- and non-glacial deposits is of great importance.

M. A. GLAZOVSKAYA spoke about the origin of loess-like material taking as an example the loess from Tyan-Šan. The loess dust coming into being as a result of physical weathering is transported by winds and deposited on the surface of glaciers forming characteristic streaks on the ice. During the glacier melting, in its frontal zone the solifluxion plays an important role in the sedimentation of material. M. A. GLAZOVSKAYA called attention of the participants to the development of fossil soils in the section 230. Opposite to LIEBEROTH'S opinion she does not think that the horizons with an increased quantity of humus in the Mikulino clays (section 202) displaying distinct upper and lower limits should be regarded as fossil soils.

S. A. STRELKOV fully accepted the bipartition of loess-like silts in this area. In his opinion the division of silt into two generations according to their age is quite correct.

E. P. ZARRINA touched the subject of the new dating of the Mikulino (Mgin) Interglacial sediments.

A. L. WASHBURN (USA) proposed to take these unique exposures under preservation and carrying on the investigations.

Russian scientists who were charged with the preparation of the excursion met with a high regard of the participants for the done. A very important effect of the discussions on the exposures was the opportunity of getting acquainted with opinions of scholars investigating the present-day glaciated area and periglacial zone. It is of great worth for further paleogeographical research in the Russian Plain area.

REGION OF UGLIČ: ALTYNOVO–KIRYANOVO
DISCUSSION SUMMARIZED by V. V. BERDNIKOV

The third day of the Symposium was devoted to the review and discussion on the exposures in the neighbourhood of the town of Uglič. On the right side of the Volga the participants of the excursion listened to a short speech delivered by V. V. DAŠEVSKIJ, the director of the Chair of Geological Field-mapping, Geological Survey of Central Regions. After that the participants asked the questions about the material obtained in the course of geological mapping in this terrain.

Afterwards the participants were taken by a boat to the exposure at Altynovo, on the Volga left side. The exposure is one of the most interesting geological sections, in the region of the Upper Volga and has been visited for 30 years.

During the discussion on the data from the exposure presented by A A. VELIČKO, questions about the stratigraphical division and age of individual horizons (S. M. ŠIK, USSR; J. DYLIK, Poland) and about the origin of the series of over-morainic silts were asked.

Much interest was aroused by the data of pollen analyses obtained in the Laboratory of the Geographical Institute of the Academy of Sciences of the USSR (the laboratory under the leadership of V. P. GRIČUK), and presented by Z. P. GUBONINA. On the basis of these data the conditions of the formation of the over-morainic silts have been determined. The participants of the excursion were able to get acquainted in detail with glacio-tectonic disturbances distinctly visible on a 1 km long segment in the Volga left side.

In the afternoon the participants came to Kiryanovo where they were presented the essential area of the investigations on the relict permafrost micro-relief. The results of the investigations on the „relict cryogenic morphology" were presented by A. A. VELIČKO. There were shown the types of frost structures and the first maps of the distribution of these phenomena in the Uglič region.

The participants before being shown the exposures were introduced into the matter by short speeches delivered by V. V. BERDNIKOV, from the Geographical Institute and by V. A. KOTYUKOV, geophysicist from the expedition of geological mapping, Geological Survey of Central Regions. A number of participants were interested in frost structures and their classification (A. I. POPOV, A. G. KOSTYAEV, E. M. KATASONOV, A. A. VELIČKO, A. JAHN, and others). There were made remarks about the comparison of moraine horizons in the section at Kiryanovo with those in the exposures formerly seen (N. S. ČEBOTAREVA, S. M. ŠIK, A. M. CUKUROVA). The origin and nature of over-morainic silts were discussed with great animation both by the specialists concerned with the problem of permafrost and by pedologists. M. A. GLAZOVSKAYA called attention to the upper limit of over-morainic silts and its relation with the soil-forming processes. There were discussed the purpose and meaning of conservation of the section as well as the detailed investigation of silts by means of micromorphological method, and the analyses with regard to the roundness of sand grains, etc.

Attention should be paid to the results of the short excursions organized after the Symposium (18—20 August). The workers of the Yakutian Institute of Permafrost: E. M. KATASONOV and P. A. SOLOVIEV together with V. V. BERDNIKOV from the Geographical Institute of the Academy of Sciences of the USSR visited several times the terrain of the occurrence of frost-fissure polygons. They examined in detail the structures at Kiryanovo and at Okhotino. They observed that in the both sections (40 m long at Kiryanovo, and 20 m at Okhotino) the stones of 0.2—0.3 m in size occur only at 1.6—1.7 m depth; above this horizon the sediments are entirely deprived of stones. In this respect the exposure at Okhotino is very characteristic because the boulders 0.5—0.7 m in diameter are to be found only at the above mentioned depths. E. M. KATASONOV and A. A. SOLOVIEV presume that such a regular occurrence can be explained by the upfreezing of stones in the past active layer. It should be emphasized that the stone horizon corresponds with the depth of active layer determined by the other frost structures. This fact is of great importance. The location of larger stones in the profile can testify to the disturbed or undisturbed (not dislocated) morainal deposits.

Another interesting problem that came out during the examination of exposures was the occurrence of a series of sandy intrusions in the upper parts of morainal deposits. They appear as narrow — 0.5—1.0 cm — vertical or slightly inclined veins, irregularly spaced and penetrating down the morainic clays to 1.0—1.2 m depth. They look like blind channels vertically oriented. In the discussion it turned out that such traces can arise during a gradual, slow upfreezing of stones from the moraine and infilling the channels while the stones were being dislocated.