I. ARCHAEOLOGICAL, PALAEOGEOGRAPHIC, AND GEOMORPHOLOGICAL RESEARCHES IN THE LAKE SASYK (PANSKOYE) REGION[1]

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From 1965 the Palaeogeographic Detachment of the Tarkhankut Expedition headed by the authors of this section investigated Lake Sasyk (Panskoye)[2] and its close neighbourhood. At first, the object of the investigations was defined as collecting data for the reconstruction of the ancient natural landscape in the vicinity of the lake contemporaneous to those Greek settlements of the 4th and early 3rd centuries B.C. that had been identified in our preliminary surveys. However, during the progress of this work the original task was necessarily enlarged. The investigations resulted in the discovery of more or less certain additional information on the centuries-old history of the formation of the lake and landscape of the micro-region under consideration embracing the area of about 25 square kilometres on the south coast of the Karkinitskiy Bay.

Earlier, the lake and its neighbourhood had been studied by the geographer A.I. Dzens-Litovskij[3] in 1932, the oceanologist V.V. Longinov[4] in 1947, and the geographer P.D. Podgorodeckij[5] in the late 1950s. They established that the lake was probably formed at a late stage of the Quaternary period as a result of ingression of the sea into a synclinal vale. However, these scholars had no absolute chronology benchmarks to provide a reliable basis for identifying the detailed geomorphological and landscapical evolution. Only archaeological objects could present such benchmarks but those had not yet been discovered. Therefore the proposed hypotheses on the lake's formation in the late Holocene were not reliably dated on the absolute scale.[6] The discovery in 1962-1975 of settlements dating to different periods – from the Neolithic to the early Hellenistic – enabled us to obtain 'narrow' chronological benchmarks and to propose a new chronological and qualitative model of the evolution of the micro-region. However, it was necessary for this purpose to carry out new interdisciplinary research, and the results of our work are presented here.

1. A Brief Geomorphological Description of the Lake Sasyk (Panskoye) Region

The shallow, saltwater Lake Sasyk (Panskoye) is situated at latitude 45° 33' 45" north and longitude 32° 45' 30" east. It occupies a shallow basin stretching from south-west to north-east. Its northern section is separated from the western creek of the Bay of Yarylgach (called Sasyk Bay) by a sand and shell barrier (Pls. 177-179, *A*).

The barrier is 0.75-0.8 kilometres long and 160 m wide.[7] The lake is 4.3 kilometres long; the maximum width, in the north-western sector, is 2.175 kilometres, while the average width is 1.1-1.25 kilometres; the maximum depth, in the centre (before the digging of a channel through the barrier), was 1.0 m.[8] The area of the lake's surface is about 4.5 sq kilometres and the total area of the catchment basin is 57-58 sq kilometres.[9]

The first exact topographical map of the lake and its neighbourhood was drawn (to a scale of 1 : 42 000) in 1890 and published in 1899 (Pl. 178). It remains an important source both for palaeolandscapical analysis and for identifying archaeological objects, and was also

used in the preparation of the contemporary 1 : 10 000 general archaeological and topographical chart.

In general, the region of the lake coincides in terms of its structure with the Yarylgach Syncline which runs from west-south-west to east-north-east. To the east, the synclinal axis crosses the low isthmus between the lake and the southern creek (called Lake Maloye-Solenoye) of the Bay of Yarylgach (Pl. 177).

Stretching along the north-western side of the lake there is a rather low flat-topped plateau with gentle slopes that in some places reach up to 20 m above sea level (Pl. 179, *A*).[10] This plateau, 1.25-1.5 kilometres wide, separates the basin occupied by the lake from the sea. Facing onto Karkinitskiy Bay, and formed of limestone, the whole northern coast of the plateau is being intensely eroded and is therefore receding at a fairly considerable rate. The southern side, which slopes gently down to the lake, is more stable. The erosion platforms with active cliffs alternate here with shores of accumulated material consisting of sandy or soft mud beaches. The whole area described above is covered by a thin but very productive horizon of soils of the southern chestnut-coloured chernozem type containing detritus minerals.

To the south, the lake is bordered by a low-lying plain about 2.5 kilometres wide. It rises smoothly to the south and is bounded by the heights of the Ğangul *Uval* having a maximum elevation of 137 m.[11] The northern slopes of the uval are furrowed by *balkas* (gullies) (Pl. 178). The largest of these – the Karlav Balka – originates at the top of the *uval* and, running down its slope, falls into the south-eastern corner of the lake. A gently sloping gully designates the origin of another – the Sasyk Balka – which falls into the western corner of the lake. The beds of several more *balkas* are hidden under Holocene sediments. During periods of intense rain solid materials are washed steadily down the *balkas* and gullies from the northern slopes of the Ğangul *Uval* to the plain, levelling the latter and forming its soil layer. Fine grained sediment is transported to the lake, and together with sediment supplied from the north it gradually fills the lake basin.

The area surrounding the lake is formed of upper Miocene or lower Pliocene (N^3_{1m}-N^1_{2p}) limestones in slightly sloping layers. To the south this area is limited by the Ğangul Anticline (or Kara-Burun Anticline after A.I. Dzens-Litovskij), the vault of which has outcrops of dense Sarmatian limestone (N^1_{3srm}). On the southern and south-western sides of the lake the Pontic limestones/shell-rocks (N^1_{2p}) are covered with a fairly thick (1.5-2 m) layer of loose Quaternary deluvial and proluvial sediments ($Q^1_{del}{}^a$). The latter consist of red-brown and yellow clays and loams.

In the northernmost part of the isthmus between the lake and the southern side of the Bay of Yarylgach the loose sediments are very scanty. Only a thin mineral soil layer has developed on loams (southern chestnut-coloured chernozems) on the bedrock of limestones of the Pontic layer.

The territory's relief clearly reflects its geological structure, to which the system of ancient settlement is excellently well matched. Greek settlements and rural houses of Panskoye I, II, III, and IV, as well as Stone Age sites (the Yarylgach-Northern Site), and those of the late Bronze Age of the 4th and 3rd centuries B.C. and of the early Medieval periods (the Yarylgach Eastern Settlement) are either located on a low structural denudation plain not exceeding 0-3 m above sea level, or actually lie below the present-day sea level (Pl. 179, *A*). Such a concentration of ancient sites can hardly be accidental.

2. DESCRIPTION OF THE ACTIVE CLIFFS ON THE SHORES OF YARYLGACH BAY AND LAKE PANSKOYE

V.V. Longinov's, V.P. Zenkovič's, and P.D. Podgorodeckij's descriptions present only the most general characteristics of the eroded shoreline of the south-western inlet of the Bay of Yarylgach and Lake Panskoye, and do not go into any detail. To check our previous observations we made a detailed description of the three active cliffs on the eroded shoreline. On two of the cliffs there are remains of archaeological objects.

I. The active cliff of the northern eroded shore of the isthmus, 100 m from the boundary of the Panskoye I necropolis (Pls. 179, *B*, 180, *1-3*). The height is 2 m above the shoreline. In its base it has pronounced wave-cut niches. The shore is subject to continuous erosion and is receding. Our long-term observations have shown that the rate of the retreat reaches about 0.05 m per year, which coincides approximately with the rate observed by us at other areas on the north-western coast of the Tarkhankut Peninsula.[12] The stratigraphy of the cliff is as follows:

1. Loose spongy limestone/shellrock (N^1_{2p}). The upper horizon is strongly weathered (so called '*knock-down rock*'). It is being actively destroyed by the surf, especially during storms.
2. Humus-enriched (detritus-containing) grey turf-covered loam. This forms the soil, and reaches a thickness of 0.5 m; small pebbles worn smooth by the sea sometimes occur within the layer. Among individual finds the fauna of the period of the neo-Black Sea transgression (shells or fragments of *Venus*, *Pecten*, *Ostrea*, very seldom *Solen*) is represented. Flint chips and tools of the Crimean Neolithic or Aeneolithic (?) periods are found in the layer, and these were mixed up with sea-worn pebbles, fragments of the '*knock-down rock*', and shells (Pl. 179, *A.VI*). However, the tools are washed out only from the upper horizon 0.2-0.4 m below the surface. A closer study showed that all the materials are most probably redeposited. There is no pronounced archaeological layer nor are there any pottery finds here. The area over which the flint tools and chips are disseminated stretches about 50 m along the shore and up to 10-20 m inland. In terms of shape and type, the flint chips and tools found here do not differ much from those from sites identified as the late Mesolithic or Neolithic Crimean culture of the 'Shell Accumulations' type (Pl. 180, *4*). However, in contrast to other known sites, shells of such typical land snails as *Helix* have not been found here.

II. The active cliff on the northern bank of Lake Sasyk (Panskoye) near rural house Panskoye III (Pls. 179, *B*, 181, *1*). The height is 2 m above the lake level.

1. Loose red limestone/shellrock of the Maeotis (N^3_{1m}). The upper part passes gradually without a pronounced boundary into:
2. Eluvial horizon: cartilaginous heavy red-brown loam containing detritus of limestone. The transition to the above layer is gradual.
3. Thin 'velvety' loess-like plastic loam typically pink, containing carbonate inclusions. In its upper part it is enriched with humus. The loam may be used for pottery-making.
   The floor of the lake is only 0.6 m deep (August, 1976) when measured 15 m from the precipice of the cliff. The floor consists of a limestone bench devoid of covering sediments. Further out a layer of grey lacustrine silts begins (very thin at first, then thickening towards the centre of the lake) and covers the surface of the limestone bed. At a dis-

tance of 3.5 m from the brink, fragments of stone roof tiles were found at the bottom, and approximately 5 m from the shoreline – dressed stones from buildings destroyed as a result of the erosion.

Panskoye III, as it was found, is the remains of an individual rural house of the second half of the 4th century B.C., situated on an inclined surface in otherwise flat country. It was excavated in 1978.[13] The house was deserted and disassembled probably at the turn of the 4th and 3rd centuries B.C. but we have no reason to suppose that it stood on the bank of the lake. Such a supposition would contradict not only the presence of wall remains and roof tiles which had fallen onto the bottom of the lake from a height of about two metres, but also the orography of the area (the outlines of the relief of this area and the neighbouring lower bank areas), as well as the features of the flat bench. All of this enables us to suppose that the bank which is being actively destroyed by the waters of the lake and approaching the ruins of the long deserted Greek rural house is a relatively new formation dating to the period when the lake level was higher than the present-day one. Possibly the absence of wave-cut niches in the base of the brink also provides evidence in favour of such a supposition.

III. Active cliff on the south-eastern bank of Lake Panskoye (Pls. 179, *B*, 180, *5*). The height of the brink is 2.5 m. After digging a channel through the barrier and some lowering of the water level in the lake, the erosion of the banks stopped (according to our 10 year-long observations).

1. Basic red limestone/shellrock (N^3_{1m}). In its upper part it has a gradual transition into:
2. Bright-pink crumbly, heavy and viscous, loam with inclusion of limestone debris. The fragments have a varying extent of weathering: with some only bright-red stains with fine crumbles are preserved. The layer is 0.8 m thick. It passes gradually but with a marked boundary into:
3. Horizon of dark grey loam with sparse crumbles and fragments of limestone; in its upper part the layer contains humus. Thickness 1.7 m.

   After levigation the loam from layer 2 is quite suitable for ceramic production.

3. Research on the Western Bank of Lake Maloye-Solenoye (the Settlement of Yarylgach-Eastern)

In 1975 the settlement of Yarylgach-Eastern[14] was discovered and investigated 0.8 kilometres east of the settlement of Panskoye I on the opposite side of the isthmus between Lakes Sasyk and Maloye Solenoye (Pl. 179, *A.VII*). The settlement is located on a low shore partly inundated by the sea during storms and seasonal wind-tide fluctuations of sea level (Pl. 181, *2-3*) at marks from 0 to +0.5 m above the sea level (from -0.4 to +0.1 m in the Baltic heights system). A considerable part of the settlement's cultural layer has probably now been washed out and its remains are at the bottom of Lake Maloye-Solenoye. We discovered pottery and flint tools at the bottom of the lake as far as marks -0.2-0.3 m (relative to the sea level registered in August, 1975) at a distance of 8 m from the shoreline.

The ceramic material gathered from the surface of the settlement, on the bank and adjacent lake floor, is mixed. Most of it is dated to the late Bronze Age period. However, single finds (including those from the bottom) belong to the early Hellenistic period (in general the 4th-3rd centuries B.C.) and to the early Medieval Age (7th-8th centuries A.D.). To gain insight into the cultural and natural evolution of the area we sank three stratigraphic pits.

Pit 1. 2 × 2 m, 0.70 m deep. The pit is located 125 m from the shoreline at the boundary between the steppe area and the plough-land, at mark +1 m above sea level. The surface is covered mostly with grey Crimean steppe wormwood of Lerche (*Artemisia lerchiana*).

In the western half of the pit, from the surface down to the depth of 0.30 m, there is light grey loam containing humus, fine shells and sand; in the upper part it is turf-covered. It was formed directly on the surface of dense yellow loam and is cropping out in the eastern part of the pit where it gives place to humus-containing grey loam down to a depth of 0.30 m. Similar to the sandy loam, it is turf-covered and also composes the present soil which has been formed on pure yellow loams. In total, 19 very fine fragments of hand-made pottery dating to the late Bronze Age period were found in both layers.

The sand loam layer most probably indicates the existence of a beach at the mark of about +0.5 - +1 m, relative to the present sea level. In the western half of the test pit the sand loam is absent. All these facts seem to indicate, therefore, that the ancient coastline was related to a higher sea level than the present.

Pit 2. 3 × 5 m, depth 0.20 m. It is situated 100 m from the shoreline at the mark of about +0.75 m above sea level. On all this area, in the turf horizon at the same level 0.20 m below the surface, there are small flat limestone fragments lying pell-mell and mixed with pottery, sea and land shells and the small animal bones. This layer lies on yellow-grey humus-containing loam.

Over a hundred small fragments of handmade pottery dating to the late Bronze Age period (Pl. 181, *5*) and several flint flakes were found between the stones. The manner in which the stones are scattered resembles the pattern found on the floor of the lake not far from the banks. Probably, here too, these are remains of structures submerged and eroded sometime in antiquity.

Pit 3. 2 × 3 m, depth 0.70 m. It is situated 40 m from the still-water boundary, at the edge of an area of sloping bank which is being inundated and eroded (during storms the bank is flooded and washed out). On a wide stretch of beach along the edge of the bank (0.1 to 0.7 m high) small flat stones (Quaternary limestones) washed out from the eroded layer are scattered among tussocks covered with *Salicornia*. Also here fragments of handmade and wheel-made pottery, flint flakes, as well as single fragments of Chersonesean and Herakleian amphorae, small fragments of black-glazed vessels and rims of fish-plates, were picked up from the surface.

The stratigraphy of the pit (when measured from the present-day surface) is the following (Pl. 181, *4*):

1. 0.00-0.10/0.20 m. Turf pierced with *Salicornia* roots. In contact with the lower layer there are irregularly-lying small flat stones (limestone). The finds are represented by wall fragments of early Hellenistic Chersonesean and early Medieval amphorae.
2. 0.10/0.20-0.35 m. Dark grey humus-containing loam. In the layer, small fragments of seashells were found. On the sole, ashy spots were revealed. There are fragments of early Hellenistic and Medieval pottery, those of a glass bracelet, and handmade pottery of the late Bronze Age.
3. 0.35-0.40/0.45 m. Grey debris-containing loam. In this layer, late Bronze Age pottery and several flakes were found.
4. From the depth of 0.40-0.45 m viscous loams containing limestone begin.

Thus, during the existence of late Bronze Age settlements and a settlement of the 'Saltovo-Mayatskaya' Culture many centuries later, the sea level must have been lower than it is now.

Later, when the 'Saltovo-Mayatskaya' settlement came to an end, this level rose to about 1-1.5 m higher than the present-day level, inundating and eroding a part of the latest settlement.

4. INVESTIGATION OF THE NORTH-EASTERN LAGOON OF THE LAKE (THE SETTLEMENT OF PANSKOYE I)

All the scholars mentioned above gave quite similar descriptions of the broad accumulative sand-and-shell barrier, which separated the lake from the Bay of Yarylgach, and of the eroded shorelines of the bay and lake with active cliffs. However, the boggy lagoon at the north-eastern part of the lake with inactive cliffs facing towards the lake remained totally unheeded. The lagoon is separated from the lake by a secondary narrow barrier of undoubtedly later origin than the principal one. Already this fact is a direct indication that the lake level was higher in the period when the secondary barrier was forming than the present-day level. Judging by the inactive cliffs on the lagoon's banks, this level may have exceeded the level of 1967 by more than 0.5-1 m. At the end of the 19th and beginning of the 20th century one could extract table salt from the lagoon and the contiguous part of the lake. Here special pools were established to evaporate the lake-salt. Remains of the former are preserved at the lake bottom and are clearly discernible in aerial photographs. Judging from aerial photographs taken in 1956 and 1972, as well as our regular observations which started in 1965, it was only in the second half of the 20th century that the lake level lowered, and the lagoon was considerably reduced in size. After the lake joins the sea by way of a navigation canal, the level of the lagoon was even more reduced. By 1969 a small islet remained in the lagoon which was found to be the remains of a house submerged and destroyed by erosion in the northern outskirts of the settlement of Panskoye I (house U14).

By 1969 the islet in the lagoon (Pl. 182) had a length of about 30 m, with low shoal banks which were flooded during seasonal fluctuations of the water level. In the centre of the islet a precipitous residual rock 0.7 m high remained, bounded on all sides by low active vertical cliffs. By 1970 the dimensions of the residual rock were 9.4 × 5.5 m, its area was about 35 sq m. At first glance the islet seemed to be a natural formation. However, careful examination and subsequent excavation of the residual rock showed that there had been a house typical of the second half of the 4th and turn of the 4th and 3rd centuries B.C. at Panskoye I. Several walls of the house were preserved in its northern part.

The geological and archaeological stratigraphy of the residual rock containing the remains of house U14 (Pl. 183, *1*) is as follows:

I. limestones and shellrocks of the upper Pontic layer;
II. 'destroyed rock' (the surface of the limestones which are being eroded and destroyed, mixed with yellow loam). Thickness about 0.1 m;
III. pure pale-yellow plastic loam. The layer thickness is about 0.3 m;
IV. buried soil, 0.12-0.15 m thick, formed on layer III;
V. archaeological cultural layer formed by remains of a 4th century B.C. house (U14). Thickness 0.4 m. The layer contained shells of Helix;
VI. turf layer formed over the remains of house U14 (0.1-0.15 m).

Layers III-VI are strongly saline. Halophytes prevail among the vegetation covering the surface of the islet, and in the upper part of the soil layer present-day seashells are found.

Thus, before the eroding began of the remains of house U14, located now in the centre

of the lagoon, the level of the water surface in the lake must have been lower than the present-day by minimally 2-4 m or even more (if one takes into account the thickness of the sand and shell sediments in the secondary barrier). The house undoubtedly stood on land which was not then flooded or submerged. Later, at a time unknown to us, and after the house had fallen into ruin (evidently in a fire at the turn of the 4th and 3rd centuries B.C., and not for any natural reasons) the lake level rose considerably and became 0.5-1 m higher than it is now. By the time of our studies, however, the water level in the lagoon again lowered.

On the north-east of the described islet in the lagoon – at the northern edge of the settlement – there are remains of the northernmost house at Panskoye I (house U13). They lie on the edge of an inactive and turf-covered cliff up to +2 m high above the lake level of 1970. In antiquity (but after house U13 fell into ruin in the 3rd century B.C.), the remains of the cliff were subjected to active erosion. Later, however, this ceased. The water level in the lake abruptly sank. By the beginning of our excavations less than half the structural remains of the building were preserved, the other remains were washed out by the previously higher water levels.

In addition to the area described (U13), inactive cliffs were identified by us on the lagoon banks, both in the northern and north-western areas of the settlement. They were registered also at the south-western side of area U7 where during the excavations a 'beach' layer of fine lacustrine shell-sand was found covering the remains of the building dating to the early 3rd century B.C. and the cultural layer corresponding to these remains. The lower layers of the settlement together with the building remains are submerged and stretch under the sediments into the lagoon to a depth of one m. Finally, analysis of aerial photographs enabled us to identify the remains of buildings that had covered a considerable part of the present-day lagoon and which were situated in positions that followed the general layout of the settlement. This indicates that sometime between the early 3rd century B.C. (when Panskoye I fell into ruin) and the present century, the water level in the lake for a considerable period was higher than the present level. Probably it was during that period that the western and north-western parts of Panskoye I were submerged and destroyed by erosion; also the shallow lagoon in the north-eastern part of the lake and the secondary narrow sand and shell barrier which separated the lagoon from the rest of the lake were formed. Later the lake level gradually lowered until reaching the present-day mark.

5. VISUAL AND GEO-ACOUSTICAL INVESTIGATION OF THE BOTTOM IN THE SOUTH-WESTERN PART OF THE BAY OF YARYLGACH

The present-day entrance into the Bay is bounded by two low promontories with a distance of 3.3 kilometres between them. The Bay cuts 2.7 kilometres inland. According to V.V. Longinov and V.P. Zenkovič, the limestones are traced down to a depth of nine m at the bay bed (the bench) and farther down they are covered by a layer of sand and shells. Opposite the barrier of Lake Panskoye, the sands protrude more than a kilometre reaching a depth of 10 m. It is in this place that the south-western spur of the Bay separated from Lake Panskoye by the barrier is formed.

In 1969 the bench adjoining the shore near cliff 1 (*cf.* above) was visually examined. At a distance of about 200 m from the shore, and at a depth of 2-3 m, a terrace in the limestones was discovered stretching parallel to the shore. In the base of the terrace the remains of what seemed to be wave-cut niches were discovered. This gave reason to suppose that the bottom of the south-western spur of the Bay of Yarylgach could have preserved traces of submerged, eroded steep shores in the limestone bedrock.

In 1972 visual underwater examinations using echo depth-sounder PEL-3 were carried out.[15] The instrument enabled us to observe on the registering paper two sequentially reflected signals – from the bottom surface and from hard rocks below the sediments down to a depth of 5-8 m. Two profiles were taken: 1) – in the west-east direction across the Sasyk Bay at its broadest part parallel to the barrier of Lake Panskoye (profile length 1225 m); 2) – east-west, 330-180 m south of profile 1 (length 1020 m). The results of deciphering the records are presented on Plate 183, *2*. They confirm the visual observations. The presence of underwater terraces and the possible remains of wave-cut niches suggests that the sea level in the Holocene period was either constantly rising or fluctuating to an unknown degree, but tending in general to rise.

6. Resistivity Survey at the Barrier between the Lake and the Bay

Resistivity surveying, according to the Palaeogeographic Detachment program, was carried out in 1970.[16] The object was to determine the general character of the relief of the bedrock (limestone) below the loose accumulative sediments in the barrier. For that purpose resistivity surveys using Method of Symmetrical Electroprofiles (AMNB apparatus) were conducted along the middle of the barrier. At three points along the profile line, vertical electric sensing was carried out. The curve of the apparent resistance obtained through the surveys showed that the surface of the bedrock under the barrier has two abrupt dips. One is near the western edge of the barrier. The second is nearer to the eastern edge, very close to the remains of the settlement of Panskoye I (Pl. 184, *1*).

Analysis of the geophysical records, combined with consideration of the region's morphology, enabled us to suppose that two *balkas* cut deeply down into the limestone possibly lie below the barrier. However, this supposition could be checked only by core drilling.

7. Drilling in the Lake Bed and Barrier

The first drilling on the barrier and the lake bed was carried out by A.I. Dzens-Litovskij in 1933. He drilled one borehole on the barrier and two boreholes in the lake.[17] In 1972 large-scale drilling works on the barrier and in the lake were carried out by the Crimean Interdisciplinary Geological Prospecting Expedition.[18] In total, 85 boreholes were drilled, of which 72 were made through two profiles along the barrier and 13 in the lake (Pl. 184, *2*). The latter were made using a sea pontoon percussion drilling device. The boreholes were sunk along two profiles crossing the northern part of the lake parallel to the barrier. The first profile was located 225 m and the second 350 m south of the barrier. All the boreholes, both at the barrier and in the lake, were taken down to the bedrock limestone. This afforded us the opportunity to examine the materials from the drillings,[19] which enabled us to build the surface relief of the bedrock covered with silt and sand deposits.

Two more boreholes in the lake were drilled by order of the Palaeogeographic Detachment of the Tarkhankut Expedition. Here is their description:[20]

Borehole 1 (Pl. 184, *2-4*). It is located 350 m south of the barrier and 1050 m south-west of the settlement of Panskoye I. The depth reached from the water level in the lake was 17 m. The following layers were passed:

1. 0-0.90 m – brine (salt water with high salt concentration)
2. 0.90 – silty fine sand containing shells
3. 2.40 – pure sand of middle size with a rich content of shells
4. 4.90 – greenish grey silt with a rich content of broken and intact shells
5. 5.60 – grey loamy silt with intercalations of sand and very small quantity of broken shells
6. 7.50 – greenish grey silt with frequent intercalations of sand containing broken and intact shells and organic remains; there was a smell of hydrogen sulphide
7. 13.60 – dark grey silt with intercalations of shells
8. 14.40 – light grey pure loam
9. 16.40 – surface of limestone N^3_{1m}

Borehole 2. Located 455 m south of the barrier and 1100 m south-west of Panskoye I. The depth reached from the lake level was 11.5 m. There were the following layers:

1. 0-0.90 m – brine
2. 1.0 – grey thin silt
3. 2.90 – silty sand containing shells
4. 3.30 – greenish grey silt
5. 4.30 – grey loamy silt
6. 5.60 – greenish grey silt containing organic remains and smelling of sulphuric hydrogen
7. 11.00 – surface of limestone N^3_{1m}

The relief of the surface of the bedrock, drawn by us on the basis of the results of the drillings, showed that in the northern part of the lake and below the bulk of the barrier there are beds of two buried *balkas* deeply cut into the tertiary bedrock limestone (Pl. 185, *1*). One of the *balkas* – the Palaeo-Sasyk Balka – stretches along the modern north-western bank of the lake and runs farther along the long axis of the latter. At its point of origin which may be traced on land, the *balka* falls into the south-western corner of the lake. The depth of the *balka* under the barrier and in the lake reaches 17.4-16.0 m below the lake level of 1972. The other – Palaeo-Karlav balka – runs along the north-eastern and eastern banks of the lake. It is the lower submerged part of the Karlav Balka, which takes its origin at the northern slope of the Ğangul Rise near its top and now falls into the south-eastern corner of the lake (*cf.* Part I, p. 20). The maximal depth of the buried *balka* – cut deeply into the limestone in the lake – is 16 m, and under the northern part of the barrier it reaches 19 m. The bed of the *balka* stretches along the present-day bank (an inactive cliff) within 300-350 m south-west of the settlement of Panskoye I. In the south-western part of Yarylgach Bay, both of the *balkas* buried under the sea and the lake sediments merge together. This can be clearly seen from the isobaths of the surface of the shell and sand deposits in the Bay (Pl. 185, *1*).

8. DREDGING WORKS

After the geological prospecting, also in 1972, building of a maritime canal across the barrier for an intended sea port started.[21] During works at a distance of 175 to 210 m south of the southern bank of the barrier, and 750 m west of the bank at Panskoye I (in the lagoon with the inactive cliff), different archaeological artefacts were found in the dredger buckets. From a depth of 3.5 m the following objects were picked up, mixed with greenish grey lacustrine silts (corresponding to layer 4 in boreholes *1* and *2*, *cf.* above) which covered the ancient surface of the bedrock limestone.[22]

1. Stones with dressed surfaces evidently used in masonry (the main bulk of the material found).
2. Fragments of flat Sinopean rooftile – 6 pieces.
3. Fragmentary amphorae. Over 300 fragments, mostly from walls. The overwhelming majority of the identifiable fragments (rims, stems and handles) belonged to Chersonesean amphorae of the first and second type, according to S.Yu. Monachov's classification.[23] A small number of fragments of amphorae from Herakleia Pontike (?) and Sinope were found. It was impossible to identify a considerable part of the material because of strong salinity and the corresponding structural changes in the sherds.
4. Fragments of wheel-made commonware of various closed and open shapes. Over 50 samples. According to their formal features they are all similar to the vessels from house U6 at Panskoye I.
5. Small body sherds of black-glazed ware. 8 samples. Very poorly preserved.

The materials from the lake floor undoubtedly indicate that some settlement (a rural house similar to Panskoye III?) existed at this place – the watershed between two *balkas* near the left slope of the eastern *balka* (Pl. 185, *2*). This settlement must have existed simultaneously with the settlements of Panskoye I and Panskoye III. Later, probably some time after its ruination, the settlement was submerged and covered by lacustrine sediments and the barrier which shifted to the south. Exactly when this event took place is unknown, but it is fairly certain that it was considerably later than the 3rd century B.C.

DISCUSSION

A.I. Dzens-Litovskij's hypothesis (1936) on the formation of Lake Panskoye and confirmed by V.V. Longinov's (1955) and V.P. Zenkovič's (1958, 1960) works, is true in its general lines. The lake was formed by the ingression of the sea into a synclinal depression. However, the natural history and correspondingly the change of landscapes, at least during the period under discussion, proved to be considerably more complex than it had seemed earlier. Thus, for instance, it is impossible to prove P.D. Podgorodeckij's hypothesis (1960) about a continuous expansion of the lake's bed during the historical period and, in that scholar's opinion, continuing even now owing to exclusively tectonic processes.[24] The results described above enable us to suppose, with a fair degree of probability, that the formation of the lake and the fluctuations of its water level in the prehistoric and historic (the late Holocene) periods, are not connected with tectonic factors but rather are connected first and foremost with secular fluctuations of the Black Sea level, the amplitude of which is probably influenced by the general process of the secular rise of the level of the great ocean. With regard to the neo-tectonic movements in the late Holocene period, these evidently remained insignificant on the Tarkhankut Peninsula.[25] Judging from long-term measurements of the water levels, and geodesic observations, the tectonically active region of the mountainous Crimea is subjected to a relative rising of the water level at a rate of about +1 mm per annum (not taking into account the eustatic factor!). Hence the probable present-day positive movement of the core of the Ğangul Anticline must occur at a rate not exceeding 0 – +1 mm per annum.[26] At the same time, according to long-term observations, the sea level continues to rise in all parts with a considerable average rate of 30 cm per century. At several monitoring stations located on the northern and north-eastern coasts of the Black Sea, *i.e.* both in neutral and active tectonic zones, a sea level rising rate of 20-50 cm per century has been registered.[27] Therefore, changes in landscape, inundation, submersion, and erosion of ancient seaside settlements

and sites should be accounted for by fluctuations of the water level in the Black Sea during the Holocene period, rather than tectonic phenomena.[28]

The drilling data showed that the abruptly falling beds of the two main *balkas* (and their lateral branches) which merge in the northern part of the lake are deeply cut into the bedrock (tertiary limestones). The *balkas* in their lower part are filled with silt and sand and shell matter of the barrier down to depths of -16 – -19 m relative to the sea level at the moment of drilling. It means that the formation of the *balkas* took place during the period when the level of the Black Sea was considerably lower than the values mentioned above. Most probably the *balkas* were formed during the period of the intensive thawing of glaciers in the East-European Plain. The glaciers actually made gorges in rocks, which were in due course transformed into rias owing to the rising sea level, and later, in the course of secular fluctuations of the water level, were buried under loose sediments and then under the lake formed above. We suppose that these *balkas*, as well as the similar short and steeply falling *balkas* with 'suspended' mouths situated on active limestone cliffs on the northern coast of the Tarkhankut Peninsula (seven *balkas* on the Ğangul landslip coast), are the remnants of the upper reaches of the remaining tributaries of the original Dnieper which had been active until the glacier thawing ceased and the Black Sea level approached that of the present day.[29]

Probably, the history of the formation of the contemporary Lake Panskoye (Sasyk) begins only after the break of Mediterranean waters through the southern straits (Bosporos) which is supposed to have taken place about 4000-5000 years ago[30] and the transformation of the Black Sea from a closed neo-Euxine basin into an open one with a gradual rise in its water level.

Examination of the morphology of the coast to the north of the necropolis of Panskoye I (*cf.* description of cliff 1) shows that there was a Neolithic site – the settlement of Yarylgach-Northern. The flint inventory which contains microliths – Kukrek type inserts and points (Pl. 180, *4*) – finding direct parallels in the upper layer of the Shan-Koba cave in the foothills of the south-western Crimea and at the settlement of Frontovoye I in the eastern Crimea – enabled us to suppose that the site (settlement?) was occupied during the second half of the Boreal period, *i.e.* about 6000-5500 B.C. [31] E.N. Nevesskij proposed a theory which describes the general course of the transgression of the Black Sea (that in his opinion was uninterrupted). According to this theory the period of the site's occupation coincides with the Neo-Euxine stage of the transgression, identified by Nevesskij on the basis of sample sediments from the bottom of the shelf. According to Nevesskij's data, during the mentioned period, *i.e.* about 7500-8000 years ago, the sea level within the waters of the present-day Karkinitskiy Bay must have been 40 to 35 m lower than it is now.[32] The eustatic curve proposed later by V.A. Karpov on the basis of studies of the shelf in the north-western Black Sea area, suggests that at the same time a regression took place. For the period from 8000 to 7500 years ago the sea level dropped from -12 to -22 m.[33] In any case, if either one of the mentioned calculations is true, the Neolithic site or settlement was evidently at the watershed between the two large *balkas*. Judging by the data obtained from the drillings in the lake, the bed of the original Karlav Balka on the west of the Neolithic site was at that time filled with water and grey-green silts were accumulated on the bottom.

If one assumes P.V. Fedorov's hypothesis on fluctuations in the Black Sea level during the Holocene period to be correct, then in the period of the *neo-Black Sea transgression* the sea level exceeded the present-day one by about 2-2.5 m.[34] Fedorov dated the maximum level of this transgression first to the second, and later, to the third millennium B.C. Such evaluations of the sea level seem to find confirmation in the investigations of K.K. Šilik on the western coast of the Bug liman (neighbourhood of the ancient Olbia) which is not far from the region under discussion.[35] If it is so, then about four millennia ago the area of the Neolithic site of Yaryl-

gach-Northern must have been situated on a shallow sea bed, submerged and eroded. In terms of Fedorov's hypothesis, the re-deposited state of the flint inventory mixed with sea fauna, as well as the presence of sandy loam in the soil layer, may find their logical explanation.[36]

The materials from the Yarylgach-Northern site do not enable us to prove or disprove the absolute date of the maximum stage of the neo-Black Sea transgression according to Fedorov's scheme. These materials just corroborate Fedorov's evaluation of the general dynamics of the sea level fluctuations in the late Holocene period and suggest that during the neo-Black Sea transgression the whole area of the synclinal basin now occupied by the lake was inundated by the sea. The drillings showed that the barrier must have existed in that period. However, the barrier had probably moved further to the south and had a gap. Hence, one can be fairly certain in supposing that the general landscape of the region under consideration at the stage of the neo-Black Sea transgression, according to Fedorov's hypotheses, must have corresponded roughly to the third stage (B) of the Bay of Yarylgach development according to Zenkovič's extrapolation. The difference is, though, that Zenkovič on the basis of the contemporary average rate of rising sea level supposes that such landscape could be formed in the remote future in the case of uninterrupted transgression.[37] However, our data suggest that Zenkovič's third stage (B) already existed in antiquity and corresponded to Fedorov's neo-Black Sea transgression stage, at which stage the Black Sea level was higher by about 2-2.5 m than it is now.

E.N. Nevesskij also assumes that during the period (which he calls the *Kalamitan*) of an acceleration of the continuous transgression, there was probably a brief time where the Black Sea level exceded the contemporary one. According to his calculations this occurred about 2500-3000 years ago, but one may not rule out that it was still earlier – about 3000-3500 years ago.[38] In the latter case, Nevesskij points out, that his 'graph of the transgression becomes in essence very close to that of Fedorov and the maximal rise of the sea level in the Kalamitan period may correlate with the neo-Black Sea (after Fedorov) peak of the transgression (at its second stage)'.[39] However, concerning the water area under discussion (Karkinitskiy Bay), Nevesskij supposed that 3000-2000 years ago the sea level here was from -12 to -9 m lower than the present-day level, and during 'the Kalamitan Transgressional Rise' in the second millennium B.C. (about 4000-3000 years ago) it rose from -20 to -12 m.[40] This supposition of Nevesskii concerning the Karkinitskiy Bay, and correspondingly the Bay of Yarylgach, is at complete variance with both Fedorov's curve and our data obtained on the basis of examining the Neolithic site of Yarylgach-Northern. The first date proposed by Nevesskij for his Kalamitan period does not actually correspond to the neo-Black Sea transgression of Nevesskij but rather to the Phanagorian transgression of Fedorov when the Black Sea level dropped below its present-day value. The latter period may be characterised by the following data and conclusions:

The second stage of the formation of the landscape in the micro-region studied is characterised by materials from test pits at the settlement of Yarylgach-Eastern. In comparison with the present-day sea level, these materials directly indicate a considerably lower level during the period when a large stationary settlement existed dating to the late Bronze Age. Closest parallels to the pottery from this settlement, represented by fragments of decorated handmade vessels (Pl. 181, *5*) and flint inventory, are to be found among the Lower Dnieper variety of the Multi-Cylinder Pottery Culture.[41] Chronologically speaking, researchers of that particular culture date the pottery within the range 1650-1500 B.C., *i.e.* about 3600-3700 years ago.[42] This date corresponds to the end of the Kalamitan period when, according to Nevesskij's theory, a slowing down of the transgression took place; that is to the period when, according to his calculations, the sea level in the Karkinitskiy Bay would have been lower

than the present level by -8 to -7.5 m.[43] The same period corresponds to the original stage of the Phanagorian regression according to Fedorov. From Fedorov's curve – improved by Šilik – it follows that the sea level may have been lower in approximately the last quarter of the second millennium B.C. by 1 to 3 m than it is now.[44] However, the settlement, as it is mentioned above, is dated to the second quarter of the second millennium B.C. Hence, the time of the neo-Black Sea's minimum regression would seem to vary by about 500 years.

The considerations presented above do not, however, confirm the eustatic curve proposed by P.F. Gožik and V.A. Karpov and obtained on the basis of studying the bottom sediments on the north-western Black Sea shelf. According to this curve the supposed Black Sea level in the period under discussion was about 0 to +1 m.[45] If this was correct, dwellings covering at least half of the area of the Yarylgach-Eastern settlement would have been submerged.

As evident from the above discussion, the maximum of the neo-Black Sea transgression can hardly be dated to the second millennium B.C. Most probably it took place earlier – in the third (if not the fourth) millennium B.C., as it was pointed out *inter alia* by Fedorov in his paper of 1963. Already in the first half of the second millennium B.C. an intensive process of the lowering of the sea level had probably begun. The settlement of the Multi-Cylinder Pottery Culture, situated on the flat country could only have been occupied when the sea level dropped considerably lower than present-day levels. At that time Lake Maloye-Solenoye could not have existed. Instead, there must have been a low, flat maritime vale, the bed of which was 1-2 m lower than the present shoreline. Accordingly, most of the area occupied by the modern Lake Panskoye must have been drained and the barrier must have been situated north of its present-day location. It would seem that our data concurs with the initial stage of the Phanagorian regression when, according to P.V. Fedorov, the sea level began to go down.[46]

The draining of the basin occupied now by Lake Panskoye, which began in the second millennium B.C. during the Phanagorian regression, was probably completed by the beginning of the first millennium. According to the original hypothesis of Fedorov, assumed by many scholars, minimum regression must have occurred towards the middle of the first millennium B.C. However, on the basis of the above considerations, as to the beginning of the Phanagorian regression, its minimum stage must be dated not to the middle but to the first half or even the beginning of the first millennium B.C. In other words, this minimum regression probably coincided with the original stage of the Greek colonisation of the coasts of Pontos in the seventh century B.C.[47]

There is no common opinion on the level of minimum Phanagorian regression relative the average present-day 'zero' of the Black Sea. It is evident now that the first evaluations of -2 to -3 m (apropos, those proposed by archaeologist A.N. Karasev on the basis of studies of the submerged remains of the Lower City in Olbia, and then assumed by P.V. Fedorov and most other scholars)[48] were understated. Later, Fedorov cautiously supposed that the sea level lowered to about -3 to -5 m.[49] According to our subsequent evaluations the level in the Karkinitskiy Bay was about -4 m in the fourth century B.C.[50] On the basis of geomorphological studies of the Lower Bug area Fedorov and Šilik first defined the minimum Phanagorian regression as equal to -6 m.[51] Later on, Šilik decided in favour of A.B. Ostrovskij's hypothesis based on studies of the Caucasian coast of the Black Sea (a regression ranging from -8 to -10 m).[52] Based on these values, Šilik supposed the sea level to be lower than the present-day level by 8 to11 or even 12 m.[53] Recently, based on the newest Gožik-Karpov's curve, I.V. Brujako and V.A. Karpov supposed that the minimum Phanagorian depression (-12 to -13 m) had been reached already at the turn of the second and first millennia B.C., and by the

beginning of the Greek colonisation of the northern Black Sea coasts, *i.e.* by the seventh century B.C., the sea level was 10-12 m lower than it is now, remaining relatively stable until the third-second centuries B.C.[54]

Our benchmarks are dated to the fourth – early third centuries B.C. Firstly, the present-day bed of Lake Maloye-Solenoye (the max. depth of which is about 0.5 to 1 m) was undoubtedly dry land then. This is evidenced by traces of the Greek occupation of the area dating to the late Bronze Age period which cover the remains of the settlement of Yarylgach-Eastern. Secondly, the whole western part of Panskoye I is now submerged by the lake within an area of not less than two hectares.[55] Thirdly, the remains of the settlement (or rural house) of Panskoye IV dating to the fourth or early third century B.C. were found at the watershed between ancient *balkas* at a depth of 3.5 m and were covered with lacustrine sediments. All this suggests that the water level in the lake was a minimum of 4 to 5 m, or probably more, lower in the fourth century B.C. than it is now. Taking into account the depths in the centre of the lake and the accumulation rate of sediments (formation of the lacustrine silts) of about 1 to 2 mm per annum, obtained as a result of studies of a typologically similar group of salt lakes in the north-western Crimea,[56] it can be assumed with a fair degree of probability that by the time Greek settlements began to appear here at the turn of the fifth and fourth centuries B.C. the lake did not exist. Probably, in its place there was a low maritime vale furrowed with deep *balkas*. The barrier had probably moved further out into the sea and one cannot rule out that it was broken and that the mouths of the *balkas* presented ria-like inlets. An approximate reconstruction of the topography of the region of Panskoye I and Panskoye IV corresponding to sea levels of -4 and -8 m is shown on Plate 186.

A low sea level probably remained some time after the settlements of Panskoye I, III and IV had fallen into ruin around 270 B.C. These ruins were situated on dry land. Then, the sea level began to rise and evidently exceeded the present one. This resulted in a submerging of the basin and the formation of Lake Panskoye and the Bay of Yarylgach widened considerably and the barrier between the lake and the bay moved to the south. It was possibly in that period that the formation of a landscape similar to that of the present took place.

After that, there was a period during which the water levels in the sea, and correspondingly in the lake, exceeded the contemporary level by a minimum of 0.5 to 1 m. This is directly indicated by the formation of a secondary barrier in the northern corner of the lake and the separation from it of the lagoon which submerged the western part of Panskoye I including the inactive cliffs facing the lake and the remains of house U14 that are now in the drained lagoon. The same is also suggested by the traces of buried sand and shell, undoubtedly accumulative beach drifts in the south-western lake-side area (U7) of Panskoye I and at the settlement of Yarylgach-Eastern. These drifts directly indicate the existence of a beach at mark +1 m relative the modern level.

Most probably this second rise of the waters which submerged most of the settlement of Yarylgach-Eastern, together with a layer of late Bronze Age and materials of the fourth and third centuries B.C. which covered the settlement, may be assigned to the Nymphaeum transgression proposed by Fedorov. It would seem, however, that the latter transgression reached its maximum earlier than Fedorov supposed in his monograph (*i.e.*, about 1000 years ago).[57] The correction proposed by Šilik, who supposed that the maximal level of the Nymphaeum transgression (fourth century B.C.) was about 0.7 m lower than the present-day one,[58] contradicts our data. Our data conform rather to the hypothesis that the peak of the Nymphaeum transgression ended at about the middle of the first millennium B.C. having reached the mark of 0 to +1 m.[59] It was probably during that period that the waters of Lake Panskoye expanded to their maximal dimensions. This resulted, as mentioned above, in the formation of the north-eastern lagoon which submerged and eroded the northern and west-

ern parts of Panskoye I. Simultaneously the formation of the secondary – inner (lake-side) – barrier, which separated the lagoon from the rest of the lake possibly took place. It is also during that period that a rapid 'wearing down' of the northern coast of the lake was possibly occurring.

Then a new regression evidently began. It was identified by K.K. Šilik who called it the Korsun' Regression. On the basis of materials from excavations in Chersonesos, he dated its beginning to the fifth-sixth centuries B.C. and its minimum (-3 m) to the 13th-17th centuries A.D.[60] The occupation of the settlement of Yarylgach-Eastern – including its now submerged part – in the early Middle Ages (600-700 A.D.), indicates that the minimum regression was evidently reached earlier. [61]

A new rise in the water level – the transgression which still continues – began according to some conceptions in the 13th-14th centuries A.D.,[62] and according to others in the 17th-18th centuries.[63] The latter date seems hardly possible, though. Judging by maps the lake already existed almost within its present-day limits at the end of the 18th or the beginning of the 19th centuries.

CONCLUSION

All the considerations stated above enable us to suppose with great assurance that the lake did not exist when the first Greek settlements appeared in the micro-region discussed at about the turn of the 5th and 4th centuries B.C. In its place there was a flat, low maritime vale (basin) with very fertile soils formed on silts, and carbonate chestnut-coloured soils of the southern chernozem type at more elevated parts of the vale. The basin itself was furrowed with a system of fairly deep and narrow *balkas*. It is highly possible that the lower mouth parts of these *balkas* were filled with water and presented narrow ria-like bays typical of a bay coast (Pl. 186). The Bay of Yarylgach was considerably lower. The barrier evidently existed but had moved to the north. It is quite possible that it was not closed. On the north, and on the south, the basin was protected by low, slightly sloping heights which provided for a very propitious microclimate, milder than that on the surrounding heights. The palaeobotanic evidence shows that the beds of the *balkas* were covered with bush and forest vegetation. Some of these plants were identified as downy oak (*Quercus pubescens* Willd.), beech (*Fagus sp.*), juniper (*Juniperus sp.*), fruits of wild oleaster and possibly of wild almond-tree, and also seeds of wild-growing vines (*Vitis silvestris* L.).[64]

The fertile soils and microclimate were favourable for growing grain and legume crops, as well as vines. The bush and forest vegetation gave fuel and building materials. There was an abundance of both common building stone and dense rock (Sarmatian limestones) for stone artefacts, as well as of clay. Therefore, taking all these facts into consideration, occupation of the described microregion would have been most attractive. That is why it was here that something like an oasis arose with Greek rural settlements, the core of which being the large coastal settlement of Panskoye I. It is quite possible also that there are remains of other rural houses or small villages on the bottom of the lake.

NOTES

1. Sections 1 and 2 are by N.S. Blagovolin and A.N. Ščeglov; the rest by A.N. Ščeglov.
2. This lake appears under three names in the geographic nomenclature of the Crimea. On maps of the 19th and first half of the 20th centuries it is designated with a neutral word *Sasyk* (*cf.*, *e.g.,* the military topographical map of the Tavricheskaya Province, scale 1 : 42 000, sheet VIII-3 (1899); Map of the Crimea (scale 1 : 1 000 000) published in 1820 by the Military Topographic Department; also: Kurnakov, Kuznecov, Dzens-Litovskij and Ravič 1936, 108). This Turkic hydronym designated in the local toponymy different nameless shallow sea-side salt lakes and lagoons. At the beginning of the 20th century the lake acquired in the literature the parallel formal name of 'The Public Sasyk Salt-Marsh' (Kurnakov, Kuznecov, Dzens-Litovskij and Ravič 1936, *ibid.*); however, about the same time it began to be called Lake *Panskoye* (*i.e.*: *the landlord's lake*) in the local Russian and Tartar milieus. It is this, the latest by origin hydronym, that became fixed in modern cartography (*cf.*, *e.g.*, Map of the Crimea, scale 1 : 200 000, published by the Ukrainian Aero-Geodesic Enterprise, Kiev 1993). In the scientific literature both of the names – *Sasyk* and *Panskoye* – are used.
3. Kurnakov, Kuznecov, Dzens-Litovskij and Ravič 1936, 108-110.
4. Longinov 1955, 151-165; Zenkovič 1958, 147 ff.; 1960, 142-145.
5. Pidgorodec'kyj 1961, 181-183.
6. Thus neither V.V. Longinov nor V.P. Zenkovič, *e.g.*, mention the chronology of the events in their works. Zenkovič (Zenkovič 1958, 147 ff., fig. 81) describes the supposed stages of the development of the Bay of Yarylgach and the positions of the barrier between the latter and the lake at both lower and higher than present sea levels but does not mention the corresponding absolute dates. P.D. Podgorodeckij (Pidgorodec'kyj 1961, 181) outlines in general terms that the formation of the bays that were later separated from the sea by barriers took place at the end of the Quaternary period owing to a transgression of the sea.
7. The width of the barrier (from 450 to 600 m) stated by P.D. Podgorodeckij (Pidgorodec'kyj 1961, 181) is erroneous.
8. The values stated differ slightly from the data presented by Dzens-Litovskij who made the first description of the lake (*cf.* Kurnakov, Kuznecov, Dzens-Litovskij and Ravič 1936, 108 ff.). This author, evidently basing his data on a map of an old plane-table survey at his disposal, indicated the lake's length as equal to 4.5 km and the width 2.15 km. However, he personally measured the maximal depth of the lake (1.05 m). Our data are based on contemporary topographic maps at scales of 1 : 25 000 and 1 : 10 000, and on our own depth measurements.
9. Kurnakov, Kuznecov, Dzens-Litovskij and Ravič 1936, 108 (57.5 sq km).
10. The height marks of dry land are presented in the Baltic system of heights if measurements relative the present-day sea level of 1969-1972 are not specially specified. In terms of the Baltic system of heights, the long-term mean level of the Black Sea taken by us as zero is equal to -0.4 m. Actually, the mean sea level by 1972 was -0.46 m relative to the Baltic 'zero' according to observations of the Hydrologic Service (Archives of the Institute 'Chernomorproekt', Odessa, inventory no. 179002).
11. In the Baltic system of heights.
12. *Cf.* Ščeglov 1967, 244; 1978, 19.
13. *Cf.* Ščeglov 1987, 240, fig. 2, *II.*
14. The settlement was discovered by A.N. Ščeglov; test pits were sunk by an exploratory detachment of the Expedition (M.Yu. Vachtina, N.K. Žižina). See Ščeglov, Balt, Vachtina *et al.* 1976, 410.
15. The work was carried out by hydrologist G.V. Bazov.
16. The explorations were carried out by students: geophysicist V.V. Glazunov, archaeologists A.I. Aibabin and E.V. Cuckin.
17. On the description, *cf.* Kurnakov, Kuznecov, Dzens-Litovskij and Ravič 1936, 93, 108, 109 fig. 38.

18. The geological prospecting was carried out for designing a canal through the barrier and dredging work in the lake for the intended construction of a sea port in the northern part of the lake. The head of the expedition: N.M. Lovcov.
19. The material obtained from the drillings is preserved in the Research Institute of Sea Design 'Chernomorproekt' (Odessa). The head of the Research Department, P.A. Oskol'skij, kindly put this material at our disposal for examination. We also profited by consultations with the Chief Expert on Geology, E.V. Mal'kovskij. We express our gratitude to both.
20. Drilling was carried out from a sea pontoon percussion drilling device by boring master M.I. Grigoraščenko.
21. The dredging work was done by the dredging convoy 'Yuzhnaya' (captain-director M.G. Lisin). Mr. Lisin, after examining our map of the relief of the bedrock, was of the opinion that the data obtained during the dredging proved our map to be correct and that it was more precise than the technical design documents (geological profile sections) prepared in the 'Chernomorniiproekt' Institute in Odessa.
22. I am grateful to Mr. M.G. Lisin for his kind and prompt invitation aboard the dredger and permission to register the finds.
23. *Cf.* Monachov 1989, 140, pls. I and II.
24. Pidgorodec'kyj 1961, *passim.* The same concerns an incorrect citing of our paper without a reference (Ščeglov 1978): Podgorodeckij 1997, 156.
25. Along the foothills of the Ğangul Rise and around Lake Panskoye, the isobase with the 'zero' value runs on the map of summary amplitudes of neotectonic movements during the Neogene-Quaternary period. *Cf. Ukraina i Moldavija* 1972, fig. 9.
26. *Cf.*, *e.g.*, Blagovolin and Ščeglov 1969, 452. P.D. Podgorodeckij's (Podgorodeckij 1997) conclusion that traces of the settlement of Panskoye IV would indicate the tectonic sinking of the lake's bed at a rate of 2.5 mm per annum during the last 2300 years being based on my summarising publication (Ščeglov 1978) does not follow from the latter. The same applies to E.V. L'vova's supposition that the south-western coast of the Tarkhankut Peninsula sank by 1.5-2 m owing to neo-tectonics during the last 2000 years (L'vova 1978, 99 ff.). The error resulted from incorrectly registered and conceived data from the excavation of a well in tower IV dating to the early 3rd century B.C. at the town-site of Belyaus (*cf.* Daševskaja 1969, 89). Earlier, at the very beginning of our archaeological and palaeogeographic studies we calculated hypothetically the contemporary relative rate of sinking of the northern coast of the Herakleian Peninsula in the south-western Crimea as equal to 2.5-3.0 mm per annum (Blagovolin and Ščeglov 1969, 452). However, it was the total value, which comprised the rate of vertical movements in the tectonically active area of the mountainous Crimea and the supposed rate of the contemporary transgression. It is incorrect to assign this value to vertical movements in the north-western Crimea.
27. *Cf.* Zenkovič 1958a, 106. In the monograph, data obtained during 30 to 35-year observations at three stations (in the cities of Poti, Feodosia and Odessa, *i.e.* in differing neo-tectonic zones) are presented (fig. 38). It is only natural that the graphs do not coincide, however the general trend is undoubtedly indicating in favour of the prevailing effect of eustatic factors. It is a pity that the more recent information has so far not been published.
28. It is very indicative that on the map showing rates of contemporary vertical movements of the earth's crust, not only the region described but also the whole maritime territory of the western Crimea (as well as the north-western Black Sea area), are subjected to sinking at the rate of 0-2 mm per annum. However, the relative rise of the vaulted parts of the ridges on the Tarkhankut Peninsula is equal to 0.2 mm per annum. *Cf.* Sokolovskij and Volkov 1965; *Ukraina i Moldavija* 1972, 51, fig. 10. Thus, the values stated indicate the present-day rise of the sea level rather than any contemporary tectonic movements. Although we do not deny the influence of the latter, their vertical rate is however too insignificant for these movements alone to explain the contemporary advance of the sea.
29. *Cf.*, *e.g.*, Brujako, Karpov and Petrenko 1991, fig. 2.

30. *Cf.*, *e.g.*, Eremeeva 1965, 12.
31. The Mesolithic and Neolithic periods in the Crimean steppe are little known. We have to base our considerations on ancient sites at the foothills of the south-western, central, as well as the steppe zone of eastern Crimea. Our microliths are contemporaneous to the second layer of the sites of Shan-Koba and to the first and second layers of the Alimovsky Cornice (*cf.* Bibikov, Stanko and Koen 1994, 165). *Cf.* also Mackevoj 1977, 69, fig. 12 (Frontovoye I), where, similar to our case, inserts of the Kukrek type were found.
32. *Cf.* Nevesskij 1967, 224, fig. 90. One should take into account that Nevesskij's absolute dates are too roughly defined for Holocene. They are based on changes in sea fauna.
33. Brujako, Karpov and Petrenko 1991, 16. The authors defined the age of the sediments on the bottom of the shelf using the C14 method.
34. Fedorov 1963, 141.
35. *Cf.* Fedorov and Šilik 1968, 90 ff.; Šilik 1975a, 68 ff.
36. We must add that 250 m south of the described outcrop there were accumulations of rounded pebbles and sea fauna found at the same level (about +2 m) in the area of the necropolis of Panskoye I.
37. Zenkovič 1958, 148, fig. 81. This scholar supposed that the event will occur when the sea level rises above 2 to 3 m in the future, if the present mean rate of rising lasts.
38. Nevesskij 1967, 227.
39. Nevesskij 1967, 227.
40. Nevesskij 1967, 224, fig. 90; see also 151 ff., fig. 63, e, ž.
41. *Cf.*, *e.g.*, Berezanskaja *et al.* 1986, 29 ff., figs. 10-13, also with many references.
42. Berezanskaja *et al.* 1986, 39.
43. Nevesskij 1967, fig. 90.
44. Šilik 1975, table (inset). For building the improved Fedorov's curve, K.K. Šilik took into consideration our observations at the settlement of Yarylgach-Eastern, but he erroneously assigned it to the end of the first millennium B.C. instead of to the end of the first half of that millennium, as follows from dating of the archaeological material.
45. Brujako, Karpov and Petrenko 1991, 17; Brujako and Karpov 1992, 88, the table.
46. Fedorov 1959; *Cf.* Šilik 1975, 5 ff.
47. Evidence of this is *inter alia* the material from the archaic Taganrog settlement (the second half of the 7th-6th centuries B.C.) destroyed by the sea in the north-eastern corner of the Azov Sea.
48. Karasev 1948; Fedorov 1959; Blavatskij 1962; Pravotorov 1967; Blagovolin and Ščeglov 1968; Blagovolin and Ščeglov 1969.
49. Fedorov 1963, 141.
50. Ščeglov 1978, 16.
51. Fedorov and Šilik 1968, 92 f.
52. Ostrovskij 1968.
53. *Cf.* Šilik 1972, 1157 ff., fig. 1; 1975, 12; 1975a, 72 f., fig. 11; 1977, 160 f.
54. Brujako, Karpov and Petrenko 1991, 11; Brujako and Karpov 1992, 89.
55. Ščeglov 1987.
56. Pervolf 1953.
57. Fedorov 1963, 141. According to him it took place about 1000 years ago.
58. Šilik 1975, 12.
59. Brujako, Karpov and Petrenko 1991, 13.
60. Šilik 1975, 6 f., the diagram in the inset.
61. According to Bruyako, Karpov and Petrenko (1991, 14) the magnitude of the regression fluctuated within the range of minus 5-6 to minus 2-3 m.
62. *Ibid.* 7. The date given in the text differs from that on the curve in the inset.
63. Brujako, Karpov and Petrenko 1991, 14.
64. Ščeglov, Januševič, Kuz'minova and Čavčavadze 1989, 53, 62, 65.