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Geological and geomorphological studies for projecting the “Orilskyi” national geopark

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This article explains the necessity of creating the Orilskyi National Natural Park. A national park is a universal and one of the most efficient forms of organizing nature reserves in the region. According to all criteria, the studied territory deserves the status of national park (according to the IUCN international classification of nature reserve territories – II category (“national parks”). We have analyzed the historical preconditions for creating a park and highlighted the significance of the first scientific grounding for this proposal developed by the non-governmental organization “Ecological-tourist union “Orlan”. The problems of creating the Orilskyi national park are considered here in the context of recognizing the geological environment as an important component of the environment, which must be protected and maintained since objects of geological heritage are no less important than any other component of the nature reserve fund (NRF). We have proved the necessity of conducting geological and geomorphological researches for the project, studying not only geologically essential objects of the NRF, but also objects, which despite being not significantly outcropped, are characterized by an interesting and unique history of geological development, peculiar manifestations of different geological processes, including volcanism, traces of ancient glacial epochs, erosive and accumulating effect of river processes, deluvial, proluvial, colluvial and other processes on slopes, peculiarities of sedimentogenesis, imprinted in rocks of different lithological compounds, saturation of rocks with fossil fauna and flora, significance in understanding the secrets of past geological periods, etc. We have found and analyzed peculiarities of tectonics and neotectonics of the projected national park, which have formed the deep structure of the region and peculiarities of the current landscape. We have defined clear patterns in the relationship between biodiversity and geodiversity. Their unified relationship defines the natural value of any territory and its potential as a tourist attraction. We have identified the stratigraphic sequence of the geological formations which form the territory of the park from Precambrian to Holocene rocks, and describe in brief each of the identified stratigraphic units. This article presents for the first time the significance of the Orilskyi National Park as an important natural nucleus of an ecosystem of national significance – it is situated on the crossroad of two of the most important transnational wildlife corridors of the Pan-European Ecosystem – Dnirovskyi meridional and Ukrainian steppe latitudinal corridors, and also is the main part of the interregional conjunction of territory between left bank Naddniproviskyi Forest-Steppe and Steppe, and between the basins of the Dniro and Siverskyi Donets.

Keywords: geological environment, Nature Reserve Land, ecological network, tectonics, stratigraphy, geodiversity, geopark, geosite.

Геологічні та геоморфологічні дослідження під час проектування національного природного парку «Орільський»

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Доведено необхідність створення Орільського національного природного парку як найбільш універсальної та однієї з найбільш ефективних форм організації природоохоронних територій у регіоні. Досліджена територія за всіма критеріями відповідає статусу національного природного парку. Проблема проектування національного природного парку «Орільський» розглянуто у контексті визнання геологічного середовища як важливої складової довкілля, гідної захисту і збереження як об'єкта геологічної спадщини не менше, ніж будь-який компонент природно-заповідного фонду (ПЗФ). Обґрунтовано необхідність проведення геологічних і геоморфологічних досліджень під час проектування не тільки видатних із точки зору геології об'єктів ПЗФ, а й таких, що за поганої відслоненості характеризуються цікавою і неповторною історією геологічного розвитку, своєрідністю проявів різноманітних геологічних процесів і явищ. Виявлено і проаналізовано особливості тектоніки і неотектоніки території проєктованого парку, якими зумовлена як глибинна будова регіону так і особливості сучасного рельєфу, що виникли за їх дії. Встановлено чіткий закономірний зв'язок між поняттями «біорізноманіття» і «георізноманіття». Вперше наголошується, що Орільський національний природний парк це важливе природне ядро екомережі національного значення, розташоване на перехресті двох найважливіших транснаціональних екокоридорів Пан'європейської екомережі – Дніпровського меридіонального й Українського степового широтного, а також він є головною частиною міжрегіональної сполучної території між лівобережним Наддніпрянським Лісостепом і Степом та між басейнами Дніпра й Сіверського Донця.

Ключові слова: геологічне середовище, ПЗФ, екомережа, тектоніка, стратиграфія, георізноманіття, геопарк, геосайт

Introduction. National parks are the most universal and one of the most efficient forms of organizing nature reserves in the world. National parks provide all necessary opportunities for realizing the following strategically important tasks: providing efficient protection for natural ecosystems, landscape diversity, biological and geological diversity across large territories; creating conditions for development of sustainable tourism (socially responsible tourism); support for forms of farming which are friendly to the environment and wildlife; preservation of historical and cultural heritage and cultural traditions of local communities. A national park is a protected natural territory, which has natural complexes and objects not significantly affected by anthropogenic pressure. The species of plants and animals inhabiting a park, together with their environment have a specific scientific value. Usually, national parks cover large territories in picturesque areas. Work is carried out to restore their landscapes, rare and endangered species of plants and animals and also objects of geological heritage are preserved there. Unlike strict nature reserves, national parks are partly open for regular visits by tourists, recreation and ecological education. A national park is a territory which is a state property and which has restricted economic activity for the purpose of preserving the natural environment (Natsionalnyi pryrodnyi, 2016).

In total, there are 2000 national parks in the world, their territory covers 2% of the Earth's land area. Since 1980, national parks projects have been created in Ukraine, which now has 47 national parks. More than half of them were created during the period from 2009 to 2011. During that last wave of organizing national parks, Dnipropetrovsk oblast also had great chances of opening at least one national park in the valley of the Oril river. The main positive precondition for this was the appearance of the first scientific grounding for the project, developed by the non-governmental organization "Orlan". Its activists had already conducted a large amount of scientific research and educational excursions in the basin of the Oril river in the late XX – early XXI centuries (Domrachev, 1999). Using the results of these expeditions, the significant nature conservation value of the valley of the Oril river was revealed, and the first scientific grounding for creating a national park in Dnipropetrovsk oblast was laid (Vad. Manyuk, Vol. Manyuk and Chegorka, 2010; Vad. Manyuk, 2016). On the basis of this research, from 2001

the State Administration of Protecting the Natural Environment initiated the design of cartographic materials for further projecting of the national park, and also provided suggestions to the Ministry of Environmental Protection of Ukraine to include the question of creating the Orilskyi National Park into the list of tasks of the state programme of forming a national ecological network.

At that time, in Europe, an organization was being formed, the establishment and further activity of which would justify the significance of preserving not only wildlife, but also inanimate nature, i.e. the geological environment with the full diversity of its components (Vol. Manyuk, 2015, 2016). Such an organization, recognized all over the world, is the European Association for the Conservation of the Geological Heritage (ProGEO). Its first international symposium was held in Digne, France, in 1991 (Vol. Manyuk, 2006). The convention of a special working group, which was held with the support of UNESCO, approved the historical „Declaration of the Rights of the Memory of the Earth”. In 1995, Ukraine joined ProGEO, contributing to successful realization of some important ideas written in the Declaration. In particular, when acknowledging the need for creating a national park in Dnipropetrovsk oblast, the geological structure and peculiarities of the landscape were for the first time seriously considered as important components of the natural environment (Vad. Manyuk et al., 2010). During the composition of the “Programme for Forming a National Ecological Network in Dnipropetrovsk Oblast for 2003-2015”, in contrast to many other oblasts, not only biodiversity, but also geodiversity was considered: “Preserving the full diversity of natural and semi-natural landscapes, populations of local flora and fauna, geological relics, diversity of natural soils and restoring populations of rare and endangered species of biota in the region” (Vad. Manyuk, Vol. Manyuk and Obuhova, 2003). Since then, any work towards designating a territory as an object of the nature-reserve land and further processes according to “Programme of Ecological Network” has been followed up by professional geological and geomorphological studies with corresponding cartographic and text materials. For examples of completed reserve projects we can mention the following: the Marianivsko-Kulebivskyi reserve, dishes Levshynskoho, Chornecha, Tatarka, Zhitlova, Rekalova, Zmiina, Kobylina; areas along the rivers Bazavluk, Mokra Sura, Saksahaniia, and many others (Fig. 1,2).

Fig. 1 The spherical jointing in weathered granites of Rekaliv landscape reserve complex

Fig. 2 Middle Bazavluk. Metabasite outcrop of Surske

But, unfortunately, the process of forming the park was delayed for an unspecified period of time, and after 2001-2002, for the second time, the question arose only in 2008, along with the start of the social process of forming networks of new national parks all over Ukraine. At that time, the President of Ukraine signed a number of decrees in order to advance the process and ensure full support from state institutions for measures for creating national parks. One of those decrees also mentioned the Oril's'ky National Park in Dnipropetrovsk oblast as a top-priority object (Ukaz Prezidenta, 2008).

Unfortunately, due to lack of financing on one hand, and some opposition by particular regional institutions on the other hand, the National Park failed to open at that time. Only beginning with 2015, due to constant attention from the ecological and scientific community, and support from the Department of Environmental Protection in Dnipropetrovsk Oblast State Administration, did the Oblast Council allocate the necessary costs for carrying out the project of creating the park, which included detailed scientific grounding, a set of cartographic materials and the materials of agreement according to the requirements of the current legislation for creating national nature parks in Ukraine.

In order to implement the project, during July-November of 2015 a scientific group was formed and a complex study of the entire territory of the Oril river in Dnipropetrovsk oblast and certain adjacent areas in Kharkiv and Poltava oblasts was conducted. On the one hand, the study discovered many new areas with rare and relic ecosystems, populations of rare animals and plants, included in The Red Book of Ukraine and other red lists (including some species, which

had not previously been recorded for the Oril river valley). These areas are especially interesting from a scientific point of view and especially significant from a nature protection point of view. A number of interesting botanical natural relics was discovered, a number of new or yet unstudied outcrops of rocks was found, which adds new elements for understanding the geological history of Pryorillia. On the other hand, the study found substantial evidence of massive damage caused to the integrity of natural ecosystems or their total destruction following harmful illegal and uncontrolled exploitation of nature. The evidence discovered indicates that the only way to preserve the unique nature of Pryorillia is to create a national park in the basin of the Oril with implementation of full nature protection measures and defining the management responsible for preserving the natural and historical-cultural heritage across its entire territory. In total, during 2015, more than 30 expedition field routes of different levels of complexity were realized, more than 50 key areas in all types of landscapes and habitats on the territory of the projected park were examined, more than 20 thousand scientific and artistic photos were taken, around 100 geobotanical samples and descriptions of landscape types were made, dozens of entomological and ichthyological samples were taken, a great amount of cartographic data and satellite photos was analyzed, more than 250 literature sources were analyzed, etc. Only the most important material, accumulated during this year's project was used to write 6 volumes of scientific justification, which will form the basis for the further creation of the park, organization there of monitoring researches on biodiversity, systematic nature protection, organization of tourism, etc.

The complexity of research is clearly illustrated by the composition of the group - it included botanists and geobotanists, ecologists, a hydrologist, an entomologist, an ichthyologist, an ornithologist, a mycologist, a climatologist and geologists. The involvement of geologists in such projects, and correspondingly in the significance of the studies' results, is an exception rather than common practice. For many years, not only in Ukraine, but also in the majority of European countries, the designation of valuable objects of the natural environment was made on the basis of wildlife, geological heritage was either not considered or was ignored (Vol. Manyuk, 2014). The situation slightly changed after establishment of the European Association for the Conservation of the Geological Heritage, but interest in geological natural relics and in geology on the whole has arisen only after the first geological parks were opened (Vad. Manyuk, Vol. Manyuk, 2010, 2011, 2012).

The first geological reserves are those in Reserve Geologique de Haute-Provence Provence (France), Natural History Museum of Lesvos Petrified Forest (Greece), Geopark Gerolstein/Vulkaneifel

(Germany) and Maestrazgo Cultural Park (Spain) (Zouros, 2004). These parks, like any similar park, have geological content as their determinant, and all existing 69 geoparks in 23 countries of the world became significant centers of geotourism development (UNESCO Geoparks, 1999; Understanding and Conserving, 2016).

The presence of outcrops on the territory of the planned Orilskyi National Park, or number of outcrops of different ages in this territorial unit is in itself not enough for creating a geopark, but the geological structure of the territory is quite complicated and diverse. The history of its geological development covers the time from the Precambrian age (3.2 billion years) to modern Quaternary deposits.

Presentation of general material. In structurally tectonic aspect, the territory of the planned National Park is situated in the area of conjunction between the Middle-Dniprean megablock of the Ukrainian Shield and the Dniprovsko-Donetska depression. The structure of Dniprovsko-Donetska depression includes the south slope and pre-slope parts of the central zone, which are separated by the Myhailivskyi deep fault (Fig.3).

Fig. 3 Tectonic scheme of the National Park (Mahdalynivskyi, Tsarychans'kyi and Yurievskyi regions)

The entire area is characterized by a double-structural level tectonic structure. The lower level is composed of metamorphic, ultra metamorphic and intrusive formations of crystalline basement. The upper structural level, which belongs to the platform mantle, is full of Paleozoic-Cenozoic deposits. The Precambrian structural level is a basement of metamorphic and intrusive formations of the Paleoarchean, Mesoproterozoic and Paleoproterozoic epochs. The formations of this level in the south-west part of the park outcrop to the pre-Quaternary surface with a depth of bedding of only 20 m, and in the east part of the territory, in the area of Yablunivka village, they lie at depths of more than 9.8 km.

The level consists of two structural stages. The lower stage belongs to the pre-greenstone phase, which consists of metamorphous formations of the Aul series with granitoids of the Dnipropetrovskiy complex. The upper structural level belongs to the greenstone Mesoproterozoic epoch of Middle Prydniprovie and is represented by metamorphous formations of the Konkska series with intrusive rocks of the Verhivtsevskiy and Surskiy complex, and also Bilozerska suite with manifestations of the intrusive Varvarivskiy complex. Granitoids of lower stage consist of the Tsarychanskiy anticlinorium. The formation of the upper stage is connected with filling and accumulating volcanic and volcanogenic-sedimentary rocks of greenstone rift structures. The upper structural level – platform mantle, with structural incongruity lies in the lower (Precambrian) structural level. It includes three stages. The structure of the level is characterized by three regional surfaces of structural nonconformity – the first relates to structural nonconformity between Precambrian rocks and Dnipro-Donetsk depression (DDD) deposits, the second – between Paleozoic and Mesozoic deposits of DDD, the third – between Cenozoic-Quaternary cover and formations embedded below. The first stage was formed due to the Hercynian phase of orogeny and is characterized by involvement of Pa-

leozoic deposits. The second stage is related to Alpine tectonic activation and is represented by Mesozoic deposits. The third stage is characterized by involvement of Cenozoic-Quaternary deposits. The structure of the upper stage includes two parts with areas of different sizes – area of South onboard and pre-board parts of the Central zone, which are separated by the Myhailivskiy deep fault. The South board of DDD includes rocks of low and middle sections of a hard coal system, which are characterized by terrigenous section and accumulation of a rhythmically structured layer with typical alternation of sandstones, argillites, siltstones with limestones and beds of hard coal. Tectonic dislocation is higher compared to the Mesozoic structural stage – here a number of faults are registered. This causes increase in thickness of the stage near the eastern border (Fig. 4).

The area of pre-board part of the Central graben covers the territory north of the Myhailivskiy deep fault. The geological section of the Paleozoic structural stage, unlike the board of DDD, is characterized by a fuller thickness, beginning with Upper Devonian rocks to Upper Carboniferous rocks. Apart from deep faults, the area here includes tectonic structures, which are absent within the onboard territory of DDD. First of all, this relates to numerous dome structures, common for all the area of the Central graben. The best known are Zachepylivskiy, Myhailivskiy, Hupatskiy, Riaskivskiy, Yuriivskiy, Kremenivskiy, Vynohradivskiy and others (Fig. 3). The main part of the dome structure is brachy-axis in form with dip angle between the limbs from 15 to 45°. Another specific tectonic form connected with the Lower stage is saline diapir. In the area covered by this research the Riaskivskiy and Pereshchepynskiy domes were identified. The extent of the fault tectonic is different for each structural level and each stage. The most dislocated fault structures are the lower level, crystalline basement, and Paleozoic deposits of second level. The Mesozoic and Cenozoic stages, which have slight shifts along the

Fig.4 Geological section of Mesozoic sediments Orilsky National Park

activated old deep faults or which have neotectonic deep faults, were practically not affected by disjunctive tectonic. The basement's largest deep-seated fault is the Dniprodzerjyns'ky deep-seated fault, which expands more than 300 km from the edge of the park's southern border. It is well distinguished in geophysical fields and is prominent in decrypted satellite photographs. The fault tectonic of Paleozoic stage is characterized by a series of faults, developed within the Kalmius-Nesvitaievsk structural-facial zone (SFZ), which are secondary according to the extent of effect upon the geological structure. These are the Mohylivskyi, Hrabivskyi, Chaplynskyi and Ulianivskyi faults. The Myhailivskyi deep fault is determinant in tectonics of Paleozoic rocks. Rapid downward shifting of Paleozoic deposits and Mesozoic rocks took place along the fault towards the axis of DDD. The Mesozoic (middle) structural stage is practically the same territorially as the Paleozoic stage and is characterized by the absence of faults. Tectonic activity of Alpine cycle caused formations of antiforms in the area of the pre-board part of the Central graben. These structures include, first of all, the Levnentsivsko-Nehvoroshchanska antiform, which is characterized by a swell-like structure and flat-lying angle of dip between the limbs, which equals 5-15°. Its development was caused by upward shifting. An important role in fault (disjunctive) tectonic manifestations was played by the Mahdalynivskyi, Holubivskyi, Karabynivskyi, Bulahivskyi and other faults (Fig. 3). Morphological studies have shown that during the Neogene-Quaternary period low-amplitude neotectonic movements occurred. This is witnessed by deformations of lengthwise and diametrical profiles of rivers and their tributaries, changes in intensity of erosion process within certain tectonic blocks, etc.

The oldest stratigraphic Precambrian deposits of the basement are represented by significantly metamorphically altered formations of the Bazavlutska rock mass of Aulska seria of Paleoproterozoic era (AR₁bz). In some places the rock mass appears as buttes of different shape and size around ultrametamorphic granitoids of the Dnipropetrovskyi complex (Fig. 2). A section of Bazavlutska rock mass is an alternation of biotite-amphibolic gneisses, amphibolites and pyroxene-amfibole-plagioclase crystalline schists with general thickness of more than 3 km. The Bazavlutska rock formation is overlapped by highly structural and stratigraphically dislocated Konkska seria, which forms greenstone structures. Granitoids of ultrametamorphic Dnipropetrovskyi complex, which are the most significant in the crystalline basement's

structure, are represented by two associations: *plagiomigmatite-plagiogranite* and *diorite-plagiogranite* association. Autochthonous granitoids are divided in two phases: the first includes plagiomigmatites of biotitic, more rarely of amphibole-biotitic compound, and later – the second phase, which includes more homogenic plagiogranites of different compound. The diorite-tonalite-plagiogranite association ends the process of forming the complex.

Over a period of time (around 2 billion years) the Precambrian rocks of the basement were affected by intense weathering. A thick weathering crust was formed. It has a surface type of distribution (Fig. 5).

Fig. 5 Map of weathering crust of crystalline basement rocks (north and south-eastern parts of the National Park "Orilskyi")

1. Michailovskiy depth fault with the direction of the plane of slip line;
2. rock weathering izopach; 3 - area of distribution of end products weathering crust;
- 4 - area of distribution of intermediate products of weathering crust;
- 5 - area of distribution of primary products weathering crust;
- 6 - the area lack of products weathering crust

The thickness of the weathering crust is controlled by the ancient pattern of the basement and by tectonic dislocations. In the valleys of rivers with shore lines at

The Phanerozoic sedimentary sheath, which is situated higher, is represented by Paleozoic, Mesozoic and Cenozoic erathems. A section of Paleozoic erathem within the territory under consideration is represented by Devonian and Carboniferous systems, which belong to the Kalmius-Nesvitaievskaya structural-facial zone (Fig. 6).

Devonian deposits lie deep (from 1460 to 2644 m) within the south SFZ of the central polyzone of the DDD, where their southern border of distribution coincides with the Myhailivskyi deep fault. They are deposited with stratigraphic and structural dislocation on Precambrian formations. Devonian rocks are represented by Frasnian and Famennian stages, and appear as a terrigenous-carbonate Suprasalt section with layers of rock-salt. The thickness of the Devonian layer fluctuates between 650 to 1300 m and increases in the north-west. Its lithologic composition is of breccia, anhydrite, clay shale, lime stone, sandstone and rock-salt. Ichnianska rock formation, which belongs to Livenskyi horizon of Frasnian stage, with structural and stratigraphic dislocation is embedded on crystalline Precambrian formations, and is overlain by Kalaidyntsevska rock formation of the Famennian stage. It is represented by large crystalline rock-salt of dark-grey and black colour. Also, apart from salt, the section has interlayers of grey sandstones of arkosic compound with nonuniform-grain psammitic structure. The Kalaidyntsevska rock formation belongs to Yeletskyi horizon of Famennian stage, embedded with stratigraphic dislocation on Ichn'avs'ka rock formation and is overlain by terrigenous Horobtsivska rock formation. It is characterized by a tephaceous section varying in thickness from 255m to 968m. In lithologic aspect, the rock formation is represented by arkosic sandstones, gravelites, siltstones, with rare argillites, and rare interlayers of conglomerates. Horobtsivska rock formation of Famennian stage are embedded with a perturbation on the Kalaidyntsevska rock formation. Horobtsivska svita is characterized by motley colour and compound: gravelite ferruginized by brownish arkosic sandstones, siltstones and argillites.

The Carboniferous systems of the Kalmius-Nesvitaevska rock formation is formed by Lower and Middle Carboniferous, in the formations: Lower Carboniferous – Mezhyvska rock formation $C_{12}(B)$ and Samarska rock formation $C_{13}(C)$, Middle Carboniferous – Mandrykivska $C_{21}(F)$, Mospynska $C_{22}(G)$, Smolianenivska $C_{23}(H)$, Bilokalytvynska $C_{24}(I)$ and Kamenska $C_{25}(K)$ rock formation. The hard coal deposits of this SFZ are characterized by monoclinial embedding with dip of bedding at an angle of 2-4°, sometimes to 12-15°. According to lithological compound, the dominating components are argillites, siltstones and sandstones with rare areas with stable interlayers of limestones and coal. The greater part of the Middle Carboniferous rock formations contain layers of coal. The section of Srebninsko-Krasnohrad-

ka SFZ, which is located north to the Myhailivskyi deep-fault, includes Lower Carboniferous, including: Slakivska (C_{1sv}), Piskivska (C_{1ps}), Solohivska (C_{1sl}), Vasylykivska (C_{1vs}) rock formation, and also layers of siltstones (C_{1a}), Middle Carboniferous – layer of argillites, siltstones and sandstones – C_{2aa} , lower subformation – C_{2vb1} and upper subformation – C_{2vb2} of Velykobubnivska rock formation, layer of rhythmical reimposing of siltstones, sandstones, argillites and limestones – C_{2ap} . Upper Carboniferous is represented here by the Isaievska rock formation – C_{3is} .

The Permian system within the Asselian stage of lower section is embedded on hard coal terrigenous formations of the central zone of DDD. Lithologically it is composed of rock-salt, anhydrite, dolomites with rare limestones and siltstones of the Slavianska, Mykytivska and Kartamyska rock formations with thickness of 1.6 km. The only place, where salt diapir expels rock-salt and other rocks of the Permian system practically to the surface (under the cover of anthropogenic rocks), is the upper ravine Zhukova near Pereshchepine town.

Above, not corresponding with stratigraphic perturbation, a dislocated complex of Mesozoic erathem is embedded; it is represented by Triassic and Jurassic systems (Fig. 7). The Triassic system is characterized by a motley sandy-clay section with monoclinial deposits at a slant of 1° to 3° on a trimming surface of hard coal deposits. Sediments of Triassic system are divided into deposits of Lower and Upper sections. Their general thickness is up to 430 m. The lower Triassic section includes Induan and Olenekian stages. Deposits of the Induan stage are represented by the section of the Dronivska rock formation – T_{1dr} , Olenekian stage – by lower substage of Serebrianska rock formation – T_{1sr1} . The Dronivska rock formation of Induan stage is characterized by a motley compound and occupies the lower part of the Triassic section. The Dronivska rock formation includes three benches. Organic remains are represented by charophytes, *Ostracoda parts*, *Phyllopoda*. *The maximum thickness of the upper bench of deposits reaches 62 m, average thickness near the Myhailivskyi deep-fault is 45 m.* The Middle Triassic section is represented by Anisian and Ladinian stages, which correspond to upper subformation of the Serebrianska rock formation – T_{2sr2} . Nyzhnoserebrianska subformation of Serebrianska rock formation occupies the greater part of the Triassic deposits' distribution area. It belongs to III zone according to charophytes (*Porochara triassica* (S a i d) G r a m b.) and is embedded, correspondingly, on the upper part of the Dronivska rock

vided), middle and all stages of upper section, which is divided into rock formations. The Middle section includes Bajocian, Bathonian and Callovian stages, which correspond to Orelska (J_2or), Pidluzhna (J_2pd) and Kamenska (J_2km) rock formations, to the lower subformation of the Solohivska rock formation and Ichnianska rock formation, which belong to the lower part of the Solohivskyi horizon and Callovian stage correspondingly. Due to their insignificant thickness, they outcrop as a quite narrow stripe on the surface of Precallovian formations. The thickness of the Jurassic deposits is up to 690 m (in the area of Yablunivka village). The Jurassic section mostly consists of quartzitic and quartz-glaconite sands and sandstones, clay with interlayers of siderites with secondary interlayers of carbonaceous clays. The stratigraphic division of the Jurassic deposits into stages is well attested by numerous discoveries of the fossils *Bivalvia*, *Ammonoidea*, *Belemnitida*.

Cretaceous deposits have a limited distribution in the area of the south west SFZ of DDD, where they fill the core parts of brachy-synclinal folds. Also, in the north-east corner, deposits enclose the Mesozoic section and are monoclinaly embedded with flattened dip angles towards the central part of the DDD. The Cretaceous system consists of lower and upper sections. The general thickness of the Cretaceous sediments fluctuates between 0 to 181.5 m. The lower section includes Aptian and Albion stages, which are represented by the Leliakivska and Buromska rock formations correspondingly. The Leliakivska rock formation consists of lacustrine-continental sediments – quartzitic fine-grained and coarse-grained sands and sandstones of grey and dark-grey, sometimes greenish-grey colour. There are scattered interlayers of grey and dark-grey clays. It is embedded in the stratigraphic dislocation on the Veneslavivska rock formation of the Upper Jurassic epoch, and is overlapped by Buromska rock formation with stratigraphic dislocation. The thickness of the Leliakivska rock formation deposits on average is 38-39.0 m and fluctuates between 16 and 47 m. The Continental Aptian stage includes embedded stratigraphically dislocated Buromska rock formation, which belongs to the upper part of the Albion stage of the Lower Cretaceous section. The section of rock formation is composed of quartzitic and glaconite-quartzitic grey and greenish-grey sands of fine-grained structure with interlayers of siliceous-quartzitic sandstones and dense clays of grey and greenish-grey colour. Often phosphorite concretions are found. The age of the rock formation

and its stratigraphic location is determined through the discovery of *Gumbelitra cenomana* (Keller) foraminifera's. The thickness of the rock formation fluctuates between 41 m and 45.5 m.

Cenozoic erathem is represented by Paleogene, Neogene and Quaternary systems, which are embedded with a fairly large perturbation on rocks of crystalline basement or on deposits of hard coal, Triassic, Jurassic and Cretaceous systems within three SFZ: Prydniprovsk, South-west and Central (Fig. 8).

The Paleogene system includes Eocene and Oligocene sections. Eocene is represented by Buchats'ka seria, Kyivs'ka and Obuhivs'ka suite. The Buchatska suite is distributed in the territory of DDD and Ukrainian Shield within Prydniprovsk, south-west and central SFZ. Prydniprovsk SFZ is characterized by continental compound of Buchatska seria, and south-west and central SFZ include marine types of Buchatska seria in Kostianetska rock formation. Continental deposits of Buchatska seria are distributed in buried paleodepressions of crystalline basement and are represented by subaqueous continental facies: alluvial, lacustrine, alluvial-lacustrine, swampy parts of the Prydniprovsk SFZ paleoriver deltas.

In the south-west and central SFZ, the Buchatska seria is represented by the grey, brown-grey to grey glaconite-quartzitic carbonaceous sands of the Kostianetska rock formation. Marine shallow-water terrigenous sediments of the Kostianetska rock formation are embedded horizontally with angular displacement and stratigraphic dislocation on Paleozoic, Mesozoic rocks of crystalline basement. The thickness of the marine deposits is quite stable and fluctuates between 40 m and 60 m towards the axial part of the paleodepression. The age of the rock formation was determined through the identification of foraminifera: *Spilectammina* ex gr. *variata* Vassil., *Bulimina mitgarriana* Balch and others.

The Kyivska suite is distributed throughout the projected park, apart from the area contiguous to the Dnipro, where the crystalline basement is lifted high. It is embedded transgressively without notable perturbation on the Buchatska seria and is characterized by a fairly uniform lithological compound, where light-green-grey marl with glaconite and secondary interlayers of green-grey limestone clays dominate (Fig.9). The thickness of the Kyivska rock formation deposits is 20-25 m. The age of the rock formation is determined by the remains of fossil Mollusca, Foraminifera and nanoplankton. The bottom of the rock formation includes small concretions of phosphorites.

The absolute top level of the deposits is at 40-55 m. Mollusca identified: *Spondilus buchi* P h i l i p p i, *Nucula bowerbankii* S o w., *Spondilus ceptemcostatus* S l o d k. and other Foraminifera - *Robulus* sp., *Anomalina* (*Pseudovulineria*) *acuta* var. *taurica* S a m o i l o v a, A. cf. *flazenensis* N u t l a l l and others. Nanoplankton zones *Reticulofenestra umbilica* with two subzones: *Discoaster bifax* and *Diascoaster saipanensis* prove the Middle Eocene age of the Kyivska rock formation marl.

Oligocene rocks of the studied territory are represented by Mezhyhirska and Berekska rock formations in marine and coastal-marine facies. They are embedded horizontally with stratigraphic dislocation on the Obuhivska rock formation and

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of the bench are characterized by horizontal micro-bedding, which is emphasized by thin (0.5-1.0 cm) interlayers of greenish-grey clay, which interchange with sand after 10-12 cm. The age was determined through spore-pollen analysis.

The Neogene system is represented by Miocene and Pliocene sections (Fig.10). The Miocene section

begins with the Novopetrivska rock formation, which according to lithological features and according to fossil fauna from the studied territory is represented by middle and upper subformations. The upper subformation includes mostly quartzitic yellow grey sands of average-fine-grained structures, which are clayey and micro-bedded with lenses of gravel.

Fig. 10 Geological section of Orilskyi National Park.

Sometimes, the upper part of the section is represented by ferruginized sand with interlayers of sandstones on ferriferous-clayey cement (Fig.11).

Also, the overlying beds of sand often include layers of grey finely dispersed clays with typical surfaces of colloidal varnish. The section of these clays can be observed in the outcrop on the slope of the Bohatenka river. The middle subformation is characterized by dominant distribution of quartzitic, light-grey, fine-grained, well sorted sands, with different types of cross-bedding, with lenses of coarse sands and thin interlayers of grey, often kaolinious clays (Fig.12). The rock formation has a ubiquitous distribution, except in the valley of the Oril river, where it was completely washed out and replaced by alluvial deposits.

Fig. 11 Section sand of Upper novopetrivska subsuite

Fig. 12 White quartz sand of Middle novopetrivska suite. Urochysche "Wall"

parts of the Sarmatian sections include sands which are significantly clayey, consolidated, of green-grey colour. They gradually transform into sandy, often ferruginized clays. An impoverished microfauna has been identified in the sands : *Meandroloculina* ex gr. *bogatshovi* *B o g d a n o w i c z*, *Discorbis* *risilla* *B o g d a n o w i c z*, *Elphidium* sp., *Eponicles* sp., *Nubecularia novorossica* *Karrer* et *S i n z o w* is typical for Miocene. The layer of motley clays has a limited distribution in the distant , south of the Orel valley , areas of watershed divides, where they were not affected by Quaternary erosion. Motley clays are embedded mostly on middle Sarmatian sandy layers, sometimes on sands of upper subformation of the Novopetrivska rock formation, and are overlapped by layers of reddish-brown clays, and in other paces by Quaternary sediments and are correlated with Upper Miocene deposits. The section of this layer is composed of clays of greenish-grey, yellow-green colours with scours of hydroxides of iron of brown, cherry red and ochre tones. Roofs of thickness often include druse and crystalline gypsum, oolites of manganese oxides. The thickness of the clays is 2-8.5 m.

A layer of Pliocene red-brown clays ($N_2\check{c}b$) is characterized by a very small area of distribution – only on areas of watershed divides in the north-east and south-west parts of the territory. It is represented by clays and sandy clays. The layer of red-brown

clays is clearly distinguished in section by its typical brown-red or red-brown colour. The layer of red-brown clays is intensely eroded; its surface is inclined to the west or north-west with an absolute level from +119 m to +99.2 m, and the clays of Prydniprovskia SFZ (between points +137-119 m) have the highest hypsometric level. The thickness of the red-brown clay layer is 2.5-6.0 m.

The Quaternary system is represented by subaerial and subaquetuous deposits of rocks of different genetic types, which are typical for glacial and periglacial zones (Fig.13).

The section of system involves Eopleistocene, Pleistocene and Holocene sections. Its lower limit is 1.82 ml years old. The Eopleistocene section includes Kryzhanivskyi and Shyrokynskyi fossil red-brown soils, which interbed with Berezanskyi and Illichivskyi climatoliths of lacustrine origin. Lithologically, these are clays and heavy loams with carbonaceous concretions and dendrites of manganese oxides. The Pleistocene section is characterized by interbedding of yellow-ochre loess and loess loams, formed during cold glacial periods with fossil soils of warm interglacial epochs. According to regionalization of the Quaternary deposits, the south-west part of the projected park is in the subzone of maximum glaciation of the Dniprovskia glacier zones, and north-

Fig. 13 Map of Quaternary sediments

In the out-glacier zone, Pleistocene deposits are represented by lower, middle and upper sections. Upward, these are Pryazovskiy, Martonovskiy, Sulskiy, Lubenskiy and Tilihulskiy climatoliths of lower section of Neopleistocene rocks; Zavadiivskiy, Dniprovskiy, Kodatskiy and Tiasmynskiy horizons of middle sections, and also Prylutskiy, Udaiiskiy, Vitachevskiy, Buzkiy, Dofinivskiy and Prychornomorskoy Kryomers and Thermomers of upper sec-

КОРЕЛЯЦІЙНА СХЕМА

[illegible]

Примітка: * тільки на розрізах, схемі будови та літолого-стратиграфічних колонках
 ** тільки на літолого-стратиграфічних колонках

Fig. 14 Stratigraphic scheme of Quaternary sediments

its of the lower part were destroyed by formation of exarational processes of glacier and by glacio-fluvial flows. During the formation of subaerial deposits of watershed divides in the Oril valley and its tributaries, subaquetious formations of the first (Desnianska) and the second (Vilshanska) and the third (Trubizka) above flood-plain terraces and floodplains.

These are alluvial sands, clayey-sandy deposits of oxbow lakes, loams and sand terraces, proluvial-deluvial deposits of ravines, steep banks and small erosional forms, lacustrine-swampy deposits. The Dniprovskiy climatolith consists of glacier formations, which are embedded horizontally on Quaternary deposits and are widely distributed in the glacier zone. The climatolith includes a composed complex of genetic types, which lay in the basis of its more detailed division. The Dnirovskiy climatolith is divided into lower, -middle, and upper Dnirovskiy stades. The lower stade is composed of fluvio-glacial sediments – $fP_{II}dn_1$ (Fig.15). The rocks of the lower stade are easily identified through their typical grey, dirty-grey colour, which is caused by debris of organic substance and rounded coarse-grained material. In secondary deposits, well maintained seashells of freshwater Mollusca, and also spicules of sponges, Foraminifera and Radiolaria were found.

The middle stade is represented by lacustrine-glacier moraine (ground) and fluvio-glacier deposits, which correspond to middle and upper benches of “Shevchenkivska suites” - $Ig P_{II}dn_2$. In section, they are distinguished by the clearly manifested character of lower and upper contacts – they are embedded on fluvio-glacier sands, and are overlapped by ablation moraine. The section of the lower part of the Serechnodnirovskiy climatolith section is completed by lacustrine-glacier deposits, which overlap ground moraine. The upper stade is represented by boundary moraine - $gkP_{II}dn_3$. Its outcrops are represented best on Kalytva hill. Fluvio-glacial deposits are found in flow buttes and spread under boundary glacier formations of Kalytva hill. They are represented by quartz-

itic fine, -medium grained light-grey sands with large content of debris of granite, limestones, sandstones, quartzites. The substance compound is represented by quartz, fieldspars, and glauconite in small amounts. Fluvio-glacial deposits of Kalytva hill are dislocative, cross-bedding, diverse according to granulometric compound, sometimes include carbonaceous remains of plants, fragments of petrified wood. An important feature of the glacier dislocations of Kalytva hill as end moraine formation is the erratic mass of Paleogene rocks among Quaternary deposits. They are identified through drilling, and also they are outcropped in the north-east part of the Kalytva hill.

Kalytva hill consists of dislocative fluvio-glacial, lacustrine-glacial sediments with a significant, according to the size (to giant), erratic mass of Paleogene rocks. These layers of rocks frequently cross-bedded one another in scale form, causing folds. The only fluvio-glacial deposits which remained undislocated are those which are embedded directly under the ablation moraine. On a limited scale, on higher areas of watershed divides, under the Dnirovskiy horizon, Kodatskiy fossil soil ($P_{II}kd$) and Tiasmynskiy forest-type loam ($P_{II}ts$) are embedded. Their general thickness is 5-7 m.

Deposits of upper section of Neopleistocene rocks are common in the watershed divide of the Oril's Left Bank. They consist of the Trubezka Vilshanska and Desnianska levels. They are a rhythmical interchange of loess horizons (Prychornomorskiy, Buzkiy and Udaikiy) and fossil soils (Dofinivskiy, Vitachevskiy and Prylutskiy) with general thickness 9-15 m. Fragments of Upper Quaternary loam section can be seen in small quarries in Zinkivshina village, and in Novopidkriazh. Subaquetious deposits of upper section consist of the lower part of Desnianska ($a_1P_{III}ds$), Vilshanska ($a_2P_{III}vl$) and Trubizka terrace ($a_3P_{III}tb$), distributed along the left slope of the Oril river. Alluvium of the Trubetska terrace extends as a large stripe along the Oril valley and the edge of the watershed divide. In the base of alluvial thickness, gravelites

Fig. 15 Geological section of Quaternary sediments

are embedded. They lie as conglomerate of 0.4-0.5 m thickness. Debris material is represented by granites, gneiss, quartz, flint stones, carbonates, and are 0.5-1.0 cm in size, sometimes to 2.5-4.5 cm. The general thickness of the terrace is 10-15 m. Alluvium of the Vilshanska terrace is distributed on the left bank of the Oril river and is adjacent to Trubetska terrace. It is separated from Desnianska terrace by a ledge, which is controlled by structure contour +65-70 m. The basis of the section (mouth facies) includes deposits of gravelites of 0.4-0.5 m thickness, which are composed of debris of carbonaceous and crystalline rocks. Its lower part (thickness – 4-6 m) is represented by quartzitic medium-grained sands of grey, light-grey colour with a yellow tone, with small addition of coarse fraction. The general thickness of the terrace deposits is 9-11.5 m. The upper part of the section is composed of dark-grey aleurites and sands, which are very clayey, humic, often carbonaceous. Its thickness is not significant – 0.7-1.7 m, but in some cases it reaches 4-5 m. The section of terrace is completed by sandy clays of grey colour with interlayers of mule, and carbonaceous clays with remains of carbonized vegetation. The thickness of clays fluctuates between 1.0 to 1.5 m. The general thickness of the Desnianska terrace is 10-12 m.

The Holocene series is represented by a wide range of genetic types: eluvial, alluvial, lacustrine, Aeolian, proluvial, swampy and alluvial-deluvial type. On watershed divides, Holocene eluvial rocks are represented by common oligohumic chernozem, and in the valley of the Orel river, is represented by a wide range of different soils: alluvial meadow solonetic, meadow-swampy, sabulous and clayey-sandy chernozems, turfy sandy soils which are developed on hillocks, and by meadow chernozems on 1-2 terraces, etc. Lacustrine and lacustrine-swampy (lbH) facies of artificial water reservoirs and the floodplains of the major rivers and their tributaries are clayey-sludge formations of dark-grey and black colour, often with additions of sandy fine-grained fractions, usually with clearly manifested horizontal bedding caused by interchange of viscous plastic, sandy, more friable clays and sand itself. The thickness of the lacustrine deposits is from 0.5-1.5 m to 3-5 m. The latter are characterized by argillaceous-sabulous-loamy compound, nonuniformity, poor sorting or no sorting, debris texture, additions of carbonaceous material and hillside diluvium. The alluvium deposits (aH) have small areas of distribution and are timed to low floodplains of the Oril and its tributaries. Alluvial facies includes channel and floodplain subfacies. The latter are

widely distributed within expansions of floodplains up to 500-700 m. The alluvial layer is composed of quartzitic sands of up to 14 m thickness. The lower part of the section includes deposits of coarse sands with pebbles and gravel of quartzitic compound. The upper part of the section is composed of humic fine-grained sands, aleurites. Aeolian sands (vH) have a limited distribution in the lower flow of the Oril valey. The area of distribution of the Trubizka and Vilshanska terraces also includes so-called hillocks, which are located, at the same time, at all levels of terraces as sandy hills or group of hills, which are united in ridges. They are represented by fine-grained sands, with additions of medium-grade, slightly clayey quartzitic sands. They are friable, well sorted, light-grey with yellowish tone. As the saturation of humus increases upward, they gradually change to brown types. The thickness of the light part of the section is 1.0-2.5 m, thickness of the brown part is 3.0-4.8 m. In general, the thickness of the Aeolian sands fluctuates between 3.0 to 7.5 m. Alluvial-deluvial deposits (adH) fill the bottoms of small erosional forms (small rivers, ravines, steep banks, lowlands, washouts) with temporary gullies. The latter are characterized by clayey-sabulous-loamy compound, non-uniformity, poor sorting or no sorting, debris texture, additions of carbonaceous material and slope deluvial deposits. The deposits are laminated due to interchange of interlayers of sand clay, chernozem, loam and other. The alluvial-deluvial deposits are low capable, their thickness is 1.5-7 m. Occasionally, among them, ferruginization and hydroxids of manganese are found. Technogenic formations (tH) are composed of rocks of different lithological compound, genesis and age. They had been formed due to agricultural activities. According to types, they are bulky, filling, inwashed, deposits of mixing (agrotechnical), deposits of buildings and structures, deposits of horizon, technogenically altered. Within the park, bulk type is considered to include mostly terrigenous deposits of transport, protectoral and constructional bulks like sand, gravel, pebble, gruss which appear as swells, dams, gibbous-steeply-sloping forms of landscape. Filling types are facies of linear geological bodies, which are formed after filling in steep banks, trenches, ditches; punctual types which appear after filling in wells, sumps after drilling, pits and surface types – after filling in lake basins, swamps after land reclamation. Inwash deposits, formed due to hydraulic monitors, are located on the Dnipro's shore area and are represented by dams and constructional grounds. The terraces of the Oril and watersheds are rich in agrotechnical

deposits, which were caused by shifts of agricultural mechanism of the soil layer, addition of organic and mineral fertilizers. Technogenically-caused deposits include deposits of different genesis, which were formed due to various processes. These are Dni-pro-Donbas canal, and various extensive irrigation systems and the new channel of the Oril river. These deposits have a fluctuating thickness (from 1 to 15-20 m), chaotic compound and various forms.

Geomorphological regionalization is considered in accordance with the general scheme of regionalization (Fig.16). According to tectonic regionalization, the greater part of the territory is situated within DDD and is represented by a part of the province of the Prydniprovsk depression. The province includes the Prydniprovsk alluvial depression (A-I-1), which is a component of the area of the Serednypriprovsk alluvial depression on a washed-out Paleogenous-Neogene base (A-I). The valley of the Oril river east from Nehvorosha village is situated within the Orilska alluvial plain (A-II-2), which belongs to the Poltavsko-Karlivska insignificantly broken plain. Upper parts of the left slope of the Oril river valley with tributaries and ravines and adjoining parts of the watershed divide belong to the Mahdalynivskiy insignificantly broken plain (A-II 3). In the area of the Serednypriprovskiy alluvial depression, also the following areas are substracted: Tsarychanska alluvial flat plain and fluvio-glacial and moraine deposits (A-I-II-6) of the Yahotynska insignificantly broken plain (Fig. 16).

Morphostructures of lower orders, which are inherited by local structures of post-Devonian deposition – Katerynivska and Leventsivska, are poorly manifested in the modern landscape, but are defined by morphometric studies.

Morphometric studies indicate that sign (degree of elevation or depression) and amplitude of the recent shifts define the direction of fluvial processes upon the erosion or accumulation or whether depth erosion or lateral erosion take place in the basin of the Oril and its tributaries. Correspondingly, the Orilska erosional-accumulating plain is characterized by significantly dominating processes of accumulation, typical abnormal extensions of the valley of the Oril and its biggest tributaries, intense meandering of water courses, lowland areas, terracing of the valley, formation of numerous oxbow lakes, swamping, etc. Studies have also shown that the valley of the Oril river in its upper flow (to Orelka village) inherits the Orelsko-Udaiskiy deep fault, and in the middle flow it flows parallel to the Myhailivskiy deep fault.

In the modern landscape, the following types of landscape are: structural-denudation, erosion-accumulating, Aeolian and gravitational. Structural denudation of the landscape is represented by watershed divide plateau, areas of which within the territory of the park conjunct with the left slope of the Oril valley. Its structure includes Paleogene, Neogene and Quaternary deposits. Denudation of the landscape develops on the slopes of the plateau. There is no straight boundary between the plateau and its slopes, there is a gradual lowering of the plateau's surface towards the river and ravines. The surface of the plateau lowers in a north-westerly direction from +115 m to +76 m (the surface of second terrace).

The main geomorphological form is the valley of the Oril river. Its modern appearance was formed by the activity of the Dniprovskiy glacier and erosion-accumulating processes during the post-glacier period. The valley of the river, which is characterized by a gradual stream gradient, wide not deep profile, is formed by erosion processes and has adjusted itself to fault tectonic zones. Morphometric studies indicate that sign and amplitude of the most recent shifts define the direction of fluvial processes upon the erosion or accumulation or upon whether depth erosion or lateral erosion take place in the basin of the Oril and its tributaries. Correspondingly, the Poltavsko-Orilska erosion-accumulating plain has significantly dominated processes of accumulation, typical abnormal extensions of the Oril valley and its main tributaries, intense meandering of water courses, lowland areas, formation of numerous oxbow lakes, swamping, etc. The long term tendency of the Ukrainian shield to lift with lowering of the Dniprovskiy graben at the same time is caused by the shifting of the Oril valley during the late Pliocene-Quaternary period from south to north and towards east, and the domination of accumulation processes upon the erosion processes is manifested. The surface landscape of the plateau and left slope of valley of the Oril river is intensely divided by lateral ravines, including ravines Vasetskoho, Vodiana, Dubova, Kilchenka, Bohatenka, Bezverha and by small erosion forms.

The largest right bank tributaries of the Oril are the rivers Nehvoroshanka, Lypianka, Orchyk, Berestova, Bohata and the Zhuchyha, Komisarova, Mozharka ravines, whose mouths extend into the north edge of the park. The largest among them are the Lypianka, Orchyk, Berestova. They are characterized by a longitudinal profile of equilibrium, very gradual stream gradient, significantly meandering channel with areas of swamping and loops in pre-mouth areas.

Fig. 16 Scheme of division into districts the Quaternary deposits (on the basis of structural and geomorphological)

The Oril is characterized by a gradual stream gradient, intense meandering at its mouth with formation of numerous bends, oxbowlakes, channels, eriks and areas of swamping. The length of the Oril from Yablunivka village in the east to Yelizavetika in the south-west is 261 km and is characterized by a change of stream gradient from +94m to +55m. Therefore, the average drop in elevation of the stream is 0.15 m/km. Meanders in the valley of the Oril and other lower parts of the tributaries, according to the shape, are as follows: segmented, omega-like, harp, sinusoidal, inverted, loop, chest-like and composed. According to origin, wandering, mostly fossil, ruptured, separated meanders, etc dominate. The width of the meander belt in some places is up to 3.8 km. The dynamics (stages) of meander development can be observed: i.e. formation of meanders, their shifts down the current, partial and full breakthrough, constriction of meanders and their transformation into

loops. The landscape here is characterized by numerous branches, channels, rills, floodplain lakes, areas of swamping. The transverse intersection of the valley is asymmetric. The right bank is steep; the left one is flattened and terraced. The long term development of the river valley in the conditions of a high level of erosion and profile of pitching axis equilibrium caused its intense meandering, incredibly complicated pattern of small erosion-accumulating forms. The change of the Oril's current direction at the right angle towards south-east took place around 250 thousand years ago because of the glacier tongue in the valley of the Dnipro, which obstructed the river's flow. The new mouth of the Oril goes across the first terrace and partly uses the mouth of the Protovcha river. Contemporary alluvial and alluvial-deluvial deposits fill the mouth of the Oril and the bottoms of ravines and smaller erosion forms – washouts, lowlands, steep banks.

An important element of the Oril valley's structure is the terraces, which are seen along the left shore and are characterized by ledges, brows and inner margins, which are clearly substracted. The Desnianska terrace ($a^1 P_{III} ds$) is made of wide swamped depressions. The structure of the second terrace is composed of two layers. The lower layer is of alluvial type and is composed of sands and gravel. The upper layer is subaerial and is composed, mostly, of products of Aeolian origin – sand clays and clays. The terrace's width in different parts of the valley is 0.5-1 km to 4.5 km. In the lower current of the river, the width of terrace is up to 9-12 km. The Vilshanska terrace ($a^2 P_{III} vl$) is located on the left bank of the river and is above the level of the Desnianska terrace by 4-7 m. A specific feature of the Vilshanska terrace is the intense development of areas of swamping. The surface of the terrace is relatively flat with relicts of oxbow lakes, which tend to be overgrown, former channels and branches, with alluvial fans. The surface of the Vilshanska terrace is often completed with forms of Aeolian origin: hilly sands, hillocks, small dune-like formations, which include randomly located weathering pits. The contemporary Aeolian ripples on the open space of the wind-blown sands are orientated according to azimuth 270-290°. The thickness of the terrace's deposits is 13-15 m. The absolute points of the second terrace's surface are 62-73 m. The third, the Trubizka, above the floodplain terrace ($a^3 P_{III} tb$) spreads as a narrow line between the valley and the watershed divide, having a width of 0.3-0.6 km. Unlike the younger terraces, this terrace has a pre-slope location with no insular areas of streamline. The terrace is 7-11 m higher than the level of the second terrace. A typical section has alluvial deposits of the Trubezka terrace overlapped by two loess horizons, Vitachivskiy and Dofinivskiy fossil soils and modern chernozem. Morphological elements of the third terrace mostly lie under upper Quaternary Aeolian-deluvial and eluvial deposits and were identified only after analysing aerospace images and the results of drilling. The thickness of the terrace's deposits is 13-25 m.

Aeolian forms are widely spread in the floodplain of the Oril river and are seen within the Vilshanska and Trubezka terraces and are represented by accumulations of sand as hills, so called "hillocks". "Hillocks" are hills of 2.5-4 m height, sometimes 7 m, rarely does a hill's height reach 10 m. Contemporary Aeolian ripples on the open space of wind-blown sands are orientated according to azimuth 270-290°. Gaps between barkhans are local bases of erosion, therefore form drainless forms.

The largest of the left bank tributaries, the Bahatenka river has the status of landscape reserve of local significance. It flows from Pryvilne village at its head to its mouth in Bahate village and is characterized by a dendritic type of division, small length, asymmetric transverse profile, significantly meandering mouth and extensive cascade of artificial water reservoirs. The largest tributaries: ravine Shyroka, Holodna, Lozova-Lehedyna and Kersonivska. The river's length is 29 km, the area of drainage basin – 207 km².

Landscape forms of technogenic type – first of all, the structure of the Dnipro-Donbass canal, structures of residential areas, raised embankments for railroads and highways, quarries for extraction of sands and loams, dams, weirs and artificial water reservoirs, new mouth of the Oril.

Conclusions. The geological component of the natural environment is the most important, and often, is its determinant. A complicated interaction of various geological processes defines not only the geodiversity of a territory, but also its biodiversity (Wimbleton & Smith-Meyer, 2012). The formation of a new ecological network and creation of new objects of the nature reserve fund faces the problem of accurate study and further protection of not only the wildlife species, but also protection of so-called inanimate nature. Even if the latter is mostly hidden beneath more recent geological formations, knowledge of its geological development history, peculiarities of stratigraphy, tectonic, volcanism, is especially important for any object of natural heritage – from a natural relic to national park.

The studied territory meets all criteria for the status of national nature park (according to international classification of natural protected territories IUCN – category II ("national parks")). Due to the increase in anthropogenic pressure, further degradation and direct destruction of natural ecosystems in the region, this territory requires not only immediate recognition as an object of the nature reserve fund of Ukraine, but also establishment of an institution with staff and implementation of efficient protection of the territory, control of implementing the nature protection legislation and development of ecologically responsible tourism in the region of Steppe Podniprovia. The Orilskyi National Nature Park is an important element of the ecological network of national value, which is situated at the juncture of the two most important transnational ecological corridors of the Pan-European Eco-network – Dnirovskiy meridian and Ukrainian steppe latitude corridors, and

also is the main part of interregional conjunction of territory between left bank Naddnyprianskyi forest-steppe and steppe, and between the basins of the Dnipro and Siverskyi Donets. Discoveries made within the territory of the projected park include valuable and unique natural objects (lakes, limans, rills and swamps); more than 40 botanical relics; more than 30 fauna relics; a number of geological and geomorphological relics, including a unique glacial-moraine hill Kalytva).

The creation of the first national park in Dnipropetrovsk oblast will be an event which several generations of Ukrainian intelligentsia have awaited, and in recent years it has also been anticipated by the inhabitants of local villages. It would spur a new stage of development of regional reserves and nature protection, the point where a totally new tourism will develop, which will be responsible for the environment and cultural traditions. Establishment of a protected territory of the highest rank in Pryorillia, which would be organized according to the watershed principle, should contribute to solving a difficult macroecological and highly important social problem of restoring the hydrological regime of one of the most famous and largest river valleys of the Ukrainian steppe zone. In the future, the successful work and development of the park and its territory requires enlargement of its territory by adding areas of the Oril valley within Kharkiv and Poltava oblasts (or providing alternative conservation objects of the highest rank on the territory of these oblasts).

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