



## The most valuable geosites of Belarus

Valery VINOKUROV\*, Mikhail KOMAROVSKY\*

**Abstract.** Quaternary deposits are the most spread formations on the territory of Belarus. They were formed during the Pleistocene glaciations, and now they completely cover the territory of the country with thickness up to 320 m. The standard Pleistocene and Holocene outcrops, large boulders and expressive landforms are very typical here and form an essential part of the most scenic landscapes of Belarus. Ten most interesting nature “zakazniks” (protected areas with some unique nature elements without administrative authorities — “Category IV” in IUCN classification), and monuments situated in various geological regions of Belarus are suggested to be included in the list of the most important geosites of the Middle European Lowlands. The protected objects in the areas of the landscape “zakazniks” include: expressive end-moraine ridges and hills of standard morphology with groups of lakes found in glacial marginal runoff valleys, outcrops of lake, lake-boggy and peat deposits of the Holstein, stratotype sections which show the interglacial deposits, one of three locations of the Devonian dolomite appearance on the earth surface, one block of a conglomerate and three largest erratic glacial boulders.

**Key words:** geoconservation, network of European geosites, Pleistocene deposits, unique exposure of Devonian dolomites, Belarus.

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**Streszczenie.** Osady czwartorzędowe są najbardziej rozpowszechnioną formacją na terenie Białorusi. Powstały podczas zlodowaceń plejstoceńskich i tworzą zwartą pokrywę (do 320 m) na obszarze kraju. Standardowe odsłonięcia plejstoceńskie i holoceniowe, wielkie głazy oraz wyrazista rzeźba są typowymi elementami i tworzą główną część najbardziej malowniczego krajobrazu Białorusi. Dziesięć najbardziej interesujących obszarów chronionych tzw. zakazników (tj. obszarów chronionych z unikalnymi obiektami przyrodniczymi — kategoria IV wg klasyfikacji IUCN) i pomniki zlokalizowane w różnych regionach geologicznych Białorusi są kandydatami na listę najcenniejszych geostanowisk Nizin Środkowoeuropejskich. Obiekty chronione na terenie obszarów chronionego krajobrazu obejmują: wzniesienia moren końcowych oraz pagórki ze standardami morfologicznymi wraz z jeziorami w dolinach lodowcowych będących dolinami marginalnymi, wychodnie holsztyńskich osadów jeziornych i torfowych, profile stratotypowe pokazujące osady interglacjalne, jedną z trzech lokalizacji dolomitów dewońskich na powierzchni ziemi, jeden głaz zlepieńców oraz trzy największe głazy narzutowe.

**Słowa kluczowe:** geostanowiska, europejska sieć geostanowisk, osady plejstoceńskie, unikalne odsłonięcie dolomitów, Białoruś.

Quaternary deposits are the most widely spread geological formations in Belarus. They cover the territory of the country with thickness up to 320 m and constitute basic forms of relief. During the last million years an influence of the continental glacial covers and erosional and accumulation processes in the interglacial periods caused the formation of a wide range of genetic types of Quaternary deposits and forms of relief and a unique completeness of geologic sections. Among the glacial boulders, which are nearly the only representatives of the crystalline rocks on the territory of Belarus, the so called leading boulders are especially interesting. The glacial erratic blocks, because of their mineral composition and structure, are easily

identified. At the same time, rocks forming the erratic blocks are referred to the specific areas of the bed-rocks exposure. Therefore they allow for tracing directions of movement of ice-sheets. Stratigraphic, palaeontologic and geologic monuments of the nature are: interglacial sections of the Pleistocene, outcrops of the pre-Quaternary deposits and glacial boulders, which reflect perfectly the evolution of nature in the Cainozoic and more ancient stages of development of the Earth's crust. A surprising combination and variety of the glacial forms of the relief are distinguishable features of this territory. Combination of relatively fresh forms of the relief of Poozerie, denuded relief of the Belarusian highlands and of the Polesse depression formed by the Vistulian, Warthian and Drenthian glacial covers correspondingly can be observed there. That is why the “zakazniks” and monuments of the nature, which reflect this most important feature of the territory of Belarus, are proposed to be selected and put in the list of the world heritage.

\*Institute of Geological Sciences of the National Academy of Sciences, Geological Museum, 7 Zodińska, 220141 Minsk, Belarus

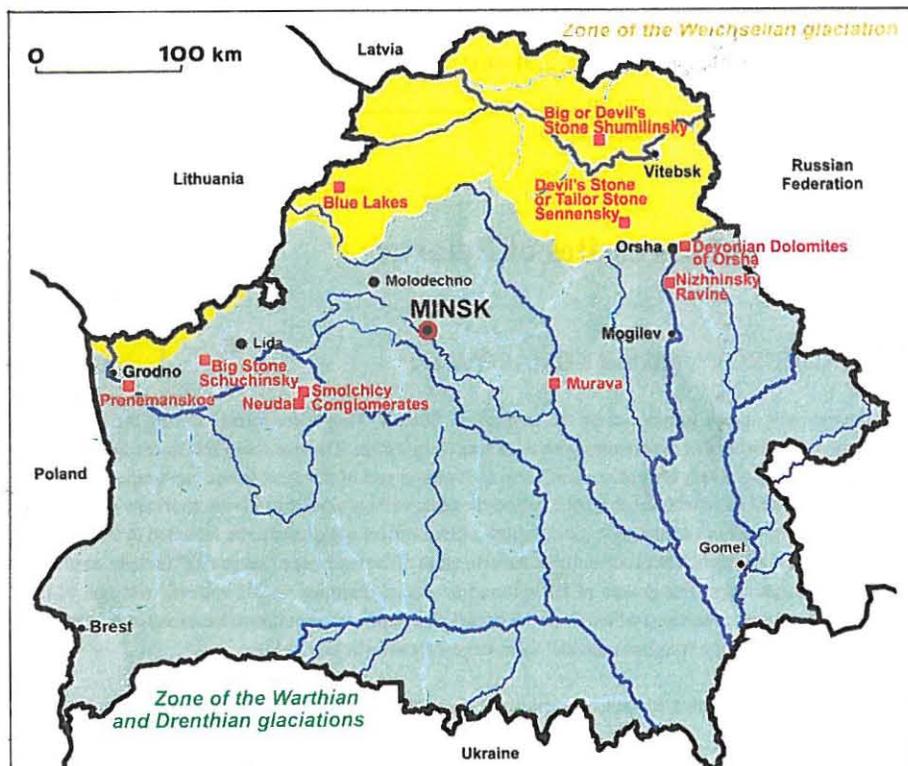


Fig. 1. Layout of most valuable geosites in Belarus on the background of glaciation zones

### Geosites of Belarus

Ten the most remarkable geosites from different geomorphological regions of Belarus should be included into the global cadastre (Fig. 1). All these objects of an inanimate nature have been carefully studied by specialists and are available for tourists.

**1. Blue Lakes** situated in the north-western part of Belarus, Minsk Province (191–215 m a.s.l.; 54°57'N/26°24'E — geographic co-ordinates of the object's centre).

*Main features:* complex of glacial landforms formed by Vistulian (Weichselian) Glaciation.

The site represents an exceptionally beautiful lake region with the area of 15 km<sup>2</sup> (length — up to 5.5 km, width — 5.0 km). The absolute altitude of the lake water level and of the valley bottom range from 159 up to 178 m. The maximum altitude of the ridges and extended hills between the lakes reaches 191–215 m a.s.l. The combination of classic ridges and hills with a group of lakes in glacial valleys is a typical complex of the marginal glacial formations of an ice-tongue, which came from the north-east creating mentioned forms 15–20 thousand years ago. The unique character of the landscape consists in the morphologically distinct contours, variety of landforms as well as in the wild untouched nature. The landscape provides valuable information about the dynamics and processes of the final stage of degradation of the Vistulian (Weichselian) Glaciation.

The glacial complex includes the terminal moraine ridges, hills and shallow gullies of glacial extrusion between ridges. Each gully has a ridge or hill — they form pairs. Lakes of the

depths up to 30–37 m occupy the lowest parts of gullies. Pressure ridges and hills are formed by the edges of scales and anticlinal folds. The widths of the gullies range from 0.1 to 0.5 km, the lengths reach up to 3 km. The ridges and hills have relative altitudes of 50–65 m, the narrow protuberant ridges are steep (up to 45°). From 8 to 30 parallel systems of “shallow gully — edge” are identified across the lobe extent. Swells of the end moraines in the central part of the moraine amphitheatre of the glacial tongue are cut by the valley of the Stracha river, which appears sometimes as a narrow and deep canyon (up to 30–40 m).

The scientific significance of the landscape consists in the fact that this area reflects a scale structure of the ice-tongue oriented in the south-west direction. The shallow valley and edge relief were formed as a result of scale thrust deformations. Expressive terminal moraines and hills covered with forests, large glacial

valleys with lakes, narrow valley in the form of canyon, give this region a specific, unique scenery. Since 1972 the described area has been protected as a landscape “zakaznik” arranged to preserve a group of small lakes and the valley of the Stracha river, located among a picturesque complex of the hills and the valleys of the Belarusian Poozerie region (Levkov & Karabanov, 1992).

**2. Neuda** situated in the Korelichy Region, Grodno Province (171–175 m a.s.l.; 53°30'N/25°59'E).

*Main features:* glacitectonic zone of the Warthian Glaciation, fossiliferous deposits of the Eemian Interglacial.

The area is 5.4 km<sup>2</sup>. The site has a typical landscape of the Warthian Glaciation (Figs. 2, 3). The base of the landscape is formed by the hill ridge, deep valley of the Neuda river and erosional shallow valley (Timoshkovichy Ravine) with the famous outcrop of the interglacial Eemian deposits. The hill chain represents the pressure end-moraine. Its height is about 30–41 m, length 5.5 km and width 1 km. Steep-sloped relief in the highest part of the area and steeply inclined relief on the slopes, which are strongly cut by the valleys and ravines, give the surface a highly dissected appearance. In the precipices of the gullies and the valleys one can see the internal structure of the ridge which is formed by moraine and fluvio-glacial deposits of the Warthian ice-sheet. They are strongly dislocated in the form of the scales and folds. Such structure and relief resulted from changes in pressure and extrusion of the drifts on the edge of the Warthian ice-sheet.

There is a very special and unique nature object on the territory of “Neuda” site. It is a marvellous “Timoshkovichy

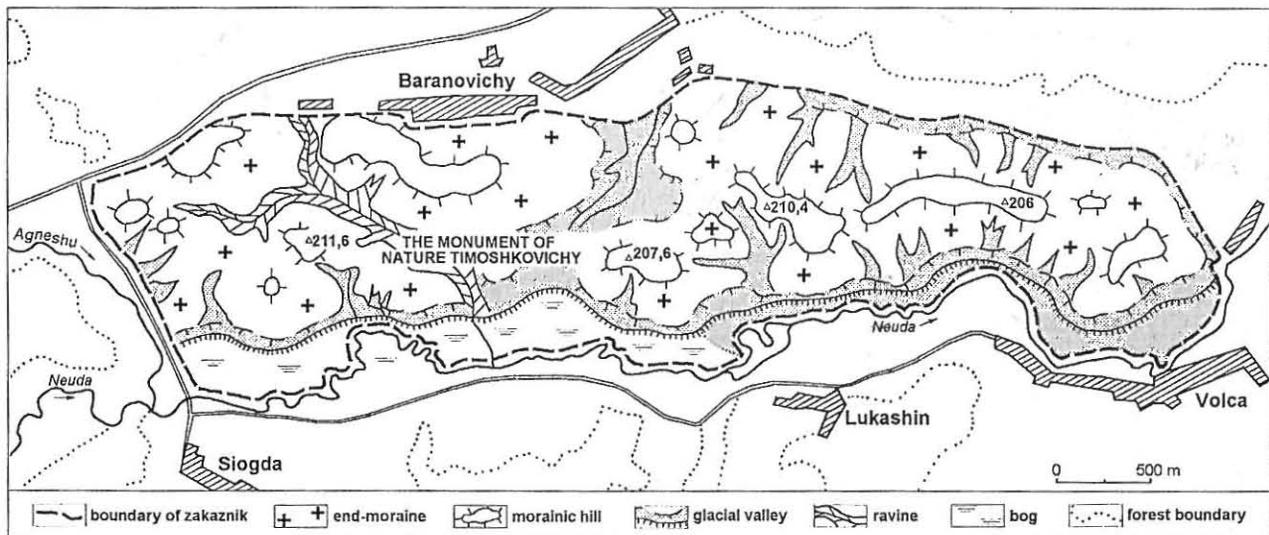


Fig. 2. Neuda Landscape "Zakaznik"

Ravine" with the outcrop of deposits of the Eemian Interglacial. The peat, lake sandy loam and marls are seen in the form of the lenses of the thickness up to 8 m along the ravine. These deposits fill the depressions of the surface of the Warthian moraine and are overlain with loess. The outcrop has been investigated since 1903, and a lot of significant scientific results have been published about its deposits.

The peat, marls and sandy loam from this outcrop are rich in fragments of fossilized plants, deposits of molluscs and ostracodes. Remnants of insects were found as well. The Eemian small mammals unique for Belarus were detected in the outcrop. Nearly 120 species of plants, 63 species of entomofauna and 11 species of animals (6 small mammals and 5 amphibians) were found among fossilized remnants. All of them belong to the Western Belarusian type of silvan landscapes with the predominance of broad-leaved species and small species of animals.

This section of interglacial deposits has an important scientific significance as the basic section of paleo-watershed. It shows the geologic evolution of development of both the lake itself and adjacent regions of the western part of Belarus at the end of the Warthian Glaciation and during the whole Eemian Interglacial. The process of formation of landscape took place during the Warthian Glaciation, through the marginal accumulation in the near-end zone of the ice-tongue. Later, the processes of thermo-karst, lake accumulation, accumulation of loesses, as well as slope processes had a predominant importance. The described area is located in the interior of the Neuda Landscape "Zakaznik".

**3. The outcrop Nizhninsky Ravine** in the Eastern Belarus, 1 km to the north of the town of Shklov, Mogilev Province (175–176.3 m a.s.l.; 54°16'N/30°20'E).

*Main features:* organic deposits rich in fossil, Voigtstedt Interglacial.

On the basis of data of the complex studies of this reference section, the Shklov Interglacial in Belarus was defined (analogy to the Voigtstedt). As far as to the extent of the detailed character of the palaeontologic study of this interglacial, this section has no counterparts in Belarus; numerous scientific works have been dedicated to it, including the monograph (Goretsky *et al.*, 1987).

The ravine has a length of 700 m, depth 30 m (in the estuary). The lens of the interglacial deposits of the Shklov Interglacial extends along the ravine on the distance of 30 m. Its thickness is up to 13 m. This lens is represented by two thick (up to 3 m each) layers of peat, gyttja and sandy loam which are separated by the interlayer of loam. Interglacial deposits are laid between two upper moraines and deformed by glacial foldings. Organogenic and humus deposits are characterized by the exceptionally wide range and variety of the remnants of fossilised plants, insects and shells of ostracoda. 220 taxons of polynoflora, 195 species and forms of plants of macroflora, 109 species of beetles and 16 names of ostracoda were detected.

A great scientific significance of the proposed outcrop consists in the fact that it has allowed to prove a stratigraphic position of the Shklov Interglacial horizon in the Elster-1–Elster-2 intermoraine interval, and to form a notion of multiple interglaciations with nearly equal climatic optima in the Lower Pleistocene.

The outcrop is one of very few Voigtstedt sections of interglacial organogenic deposits, which is accessible for studying. The Nizhninsky Ravine outcrop gives a possibility to tell about evolution of nature within the Belarus territory in the Elster-1 late glaciation time and during the Voigtstedt Interglacial.

**4. Prenemanskoe (Zhidovshchizna, Kolodzezhny Ravine)** the Neman river valley, 3 km to the east of Grodno (150–195 m a.s.l.; 53°38'45"N/23°56'55"E).



Fig. 3. Relief of Neuda Landscape “Zakaznik” — view from the north on the valley of the Neuda river. All photos by V. Vinokurov

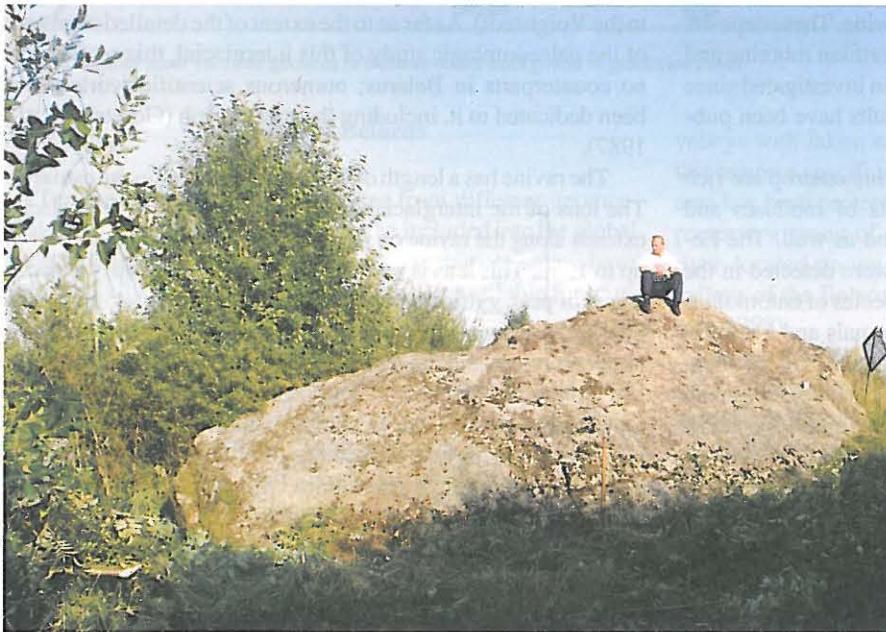


Fig. 4. Geological monument — Big or Devil’s Stone Shumilinsky — the largest erratic boulder of rapakivi granite in Belarus



Fig. 5. Geological monument — Big Stone Schuchinsky — rapakivi granite boulder

*Main features:* deposits of the Holsteinian Interglacial, rich in fossils.

The site is a reference section of interglacial deposits of the Holsteinian, located on the right bank of the Neman river. The locality was exposed in 1872, well studied, numerous literature and the special monograph has been dedicated to it (Iakubovskaia, 1976).

The gully has the length of 1,5 km and depth of 30 m (at the estuary). The lens of interglacial rocks emerges to the surface at the sides of the gully at the distance of 620–680 m from the river and extends 270 m along it. Interglacial lake and bog deposits (gyttja, peat and loam) are 9 m thick. These deposits fill the depression on the surface of the Elster-2 moraine and are overlain by the Drenthian fluvioglacial sand, gravel-pebble deposits.

The value of the section consists in the fact that organogenic and humus deposits contain a lot of remnants of fossilized wood, bushy and grassy plants, folds of diatoms, residues of ostracoda and insects. There is nothing similar among the famous outcrops of the Holsteinian deposits of Belarus. About 200 species of phanerogamous and highest sporophyte, 96 species of diatoms and 26 species of ostracoda were determined there.

The data of studies of this section throw light on palaeogeography of the Elster-2 late glaciation and Holsteinian interglacial period, confirm the fact that there were two climatic optimum stages in the evolution of nature. The completeness of the geologic chronicle, its detail studies allow to consider the site as a parastatotype of the Holsteinian interglacial period for the western region of Belarus.

**5. The outcrop Murava** on the right bank of the river Beresina, 30 km down of Borisov near the village of Murava (160–170 m a.s.l.; 54°02′55″N/28°49′50″E).

*Main features:* stratotype of Eemian alluvial deposits abounding in fossilised flora.

The locality has been investigated since 1928. It is considered as one of the most studied sections of the country. Interglacial deposits are revealed in the 20 m high exposure, in the upper part of the small gully, cutting the third terrace above the flood plain. Interglacial deposits are confined to bed sands. Above them the periglacial alluvium of the thickness of 7–8 m occurs. The lens of interglacial deposits (4.7 m) extends on both sides and on the bottom of gully for 15 m. It is represented by oxbow foliose peat, gyttja, humus and sandy loam.

The section is a stratotype for the Eemian alluvial site, its fossilised flora is one of the richest Eemian flora in Belarus. Basing on fossilized remnants of 97 species of trees, bushy and grassy plants characteristic for the beginning of the climatic optimum and the end of the Eemian, the interglacial period were determined. The geologic outcrop shows the geologic evolution of the valleys of the basin of the Black Sea, illustrating the fact that the most ancient (lake and oxbow) facies of alluvium of the 3rd terrace of the Beresina river refer to the Eemian Interglacial, and that young periglacial alluvial sand is related to the first half of the Vistulian Glaciation.

**6. Devonian dolomites of Orsha** in the city of Orsha on the bank of the Dnieper river (154.4 m a.s.l.; 54°30'30"N/30°26'20"E).

*Main features:* Devonian dolomites with plant remains and rich fauna.

It is one of three known outcrops of the Devonian age of Belarus. Dolomites are exposed under 12 m thick Quaternary deposits and are visible in the slope of the bank of the Dnieper river over a distance of 100 m. A thickness of the rocks of the Devonian age is about 2.5 m.

The rocks refer to the Sargaev horizon of the Franconian of the upper formation of the Devonian system, and were deposited 375 million years ago. Dolomites contain remnants of fossilized animals and plants. In this outcrop the following fossilized fauna was found — brachiopods: *Atrypa* ex. gr. *reticularis*, *Atrypa velikaya*, *Anatrypa heckeri*, *Anatrypa micans*, *Mucrospirifer muralis*; gastropoda: *Bellerophon* sp., *Naticopsis strigosa*, *Platyschisma* sp., *Pleurotomaria* cf. *undulata*; pelecypoda: *Aviculopecten* (*Lyriopecten*) cf. *ingraiae*, *Avicula* sp.; corals: *Thamnopora angusta*, etc.

The protected area amounts to 300 m<sup>2</sup>.

**7. The block Smolchicy conglomerates** near the town of Korelichy, Grodno Province (175 m a.s.l.; 53°31'50"N/26°02'25"E).

*Main features:* Pleistocene conglomerate.

The conglomerate is formed by the fluvio-glacial sand, gravel-pebble and sand-gravel cemented deposits with boulders, which alternate in the vertical section with each other and has thickness of 0.1–1.5 m. The dimensions of the block are as follows: the longer axis 11.8 m, the perimeter — 23.7 m. It is the largest representative among such forms encountered in Belarus, which reflects the processes of sedimentation with further cementation during ancient glaciations.

The block is protected within the area up to 0.3 ha.

**8. Big or Devil's Stone Shumilinsky** about 0.5 km to the south of the village of Gorki of the Shumilin Region, Vitebsk Province (139,6 m a.s.l.; 53°48'N/24°36'40"E).

*Main features:* the largest erratic boulder of Belarus.

The glacial block is formed of the rapakivi granite with the inclusions of crystals of feldspar in the form of ovoids (up to 9 cm in a diameter) and hornblende. The block has the form similar to a flat-iron and was brought by the ice-sheet from the Vyborg array in Leningrad area of Russia and represents the largest glacial boulder of Belarus (Astapova *et al.*, 1993). The size of its longer axis is 11.0 m, the perimeter — 32 m (Fig. 4). The legends telling about former religious value of the stone have been saved. Until now it is called Devil and it is believed that Devil living in the stone frightens people passing by, and because of that they wander and have problems getting to a destination village.

The erratic boulder is protected as a geologic monument.

**9. Devil's Stone or Tailor Stone Sennensky** 0.6 km to the west of Voronino village, Senno Region, Vitebsk Province (176.2 m a.s.l.; 54°39'30"N/29°52'E).

*Main features:* large erratic boulder of rapakivi granite.

It is a glacial block of rapakivi granite of the Vyborg type. The size of the longer axis is 10.2 m, the perimeter — 26.4 m (Astapova *et al.*, 1993). Four legends about this block exist, two of which are very ancient. According to one of them, the stone sewed garments for a long time.

**10. Big Stone Schuchinsky** in Pugachy village, Schuchin Region, Grodno Province (150 m a.s.l.; 53°48'N/24°36'40"E).

*Main features:* erratic boulder of rapakivi granite.

This block is formed of the rapakivi granite of the Finnish type and was brought with the ice-sheet from the south-western Finland. The size of its longer axis is 8.0 m, the perimeter — 21.9 m (Fig. 5). It is known that the block is immersed into the ground by more than 10 m. It is known, that this block was honoured by our ancestors, 12 pairs were dancing during holidays on it. It has been studied by the geologists since 1935 (Halicka, 1986; Kardymowicz, 1986).

The glacial block is protected as a geologic monument.

## Conclusions

The landscape reserves and geologic monuments of nature described above are the outstanding geologic objects of nature of Belarus. They are preserved in the nearly undamaged state. The specific nature of the geologic structure and the complex palaeontologic, geologic and geomorphologic investigations carried out on a wide scale determined their value for science and preservation of the heritage of the country. These objects of an inanimate nature in our opinion meet the requirements placed on the sites-candidates (Wimbledon, 1996; Wimbledon *et al.*, in press; Vinokurov & Komarovskiy, 1996, 1997) and

deserve to be included into the system of geosites of an international significance.

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