

LANDFORMS AS A PIVOTAL COMPONENT OF THE WORLD NATURAL HERITAGE SITES: CASE STUDIES IN RUSSIA

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Abstract

The paper reflects the pivotal role of the landforms in the creation of the World Natural Heritage (WNH). The following Natural sites and its landforms are investigated on the example of Russia: Virgin Komi Forests with stone idols of the Man-Pupu-Ner plateau and the summit ridge of Manaraga; Volcanoes of Kamchatka with Kluchevskoy Volcano and Uzon Volcano Caldera; Lake Baikal with Aya Bay, Shaman Cape and Outlet of the Angara River and the Shaman-Rock; Putorana Plateau with the Ayan fjord lake and the largest waterfalls in Russia as well as Lena Pillars National Park with the Saamys Kumaga tukan and the Kira Tas Valley naled. The analysis of WNH of Russia according to the criteria of Outstanding Universal Value is presented.

Keywords: Landforms; Komi Forests; Kamchatka; Lake Baikal; Putorana; Lena Pillars: World Natural Heritage; Russia

Introduction

Since the second half of the XX century, in connection with the increase in the anthropogenic pressure on the environment the geographers, geologists, biologists, etc. began to pay significant attention to environmental issues. Particular emphasis is placed on the problems of identifying and preserving the natural heritage of outstanding value to all of humanity [1-4].

As it is noted by *P. Migoń* [5] the landforms (surface relief) is “the basic building block for the physical landscape”. Moreover, the specific landforms are present in many successful World Natural Heritage nominations [6].

The aim of this exploration is to research the different types of landforms being the pivotal components in the creation of the World Natural Heritage in Russia.

Materials and Methods

UNESCO Convention on the Protection of the World Cultural and Natural Heritage was adopted in 1972, and by mid-2019 the total number of properties included in the World Heritage List (the List) had already reached 1121 (in 167 countries of the world), 869 objects of which were characterized by cultural values, 213 - by natural and 39 have mixed status: cultural and natural heritage.

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At present, Russian participation in the prestigious world codex of globally significant monuments is very considerable - 28 World Heritage Sites, 11 of which are natural and 17 - cultural. It should be noted that the majority of World Natural Heritage sites of Russia (with the exception of two) are located in the trans-Urals part of the country (Fig. 1 and Table 1). This is quite naturally explained by the objective circumstance that in Siberia and the Far East of Russia nature was best preserved in contrast to the highly developed and highly urbanized European part.

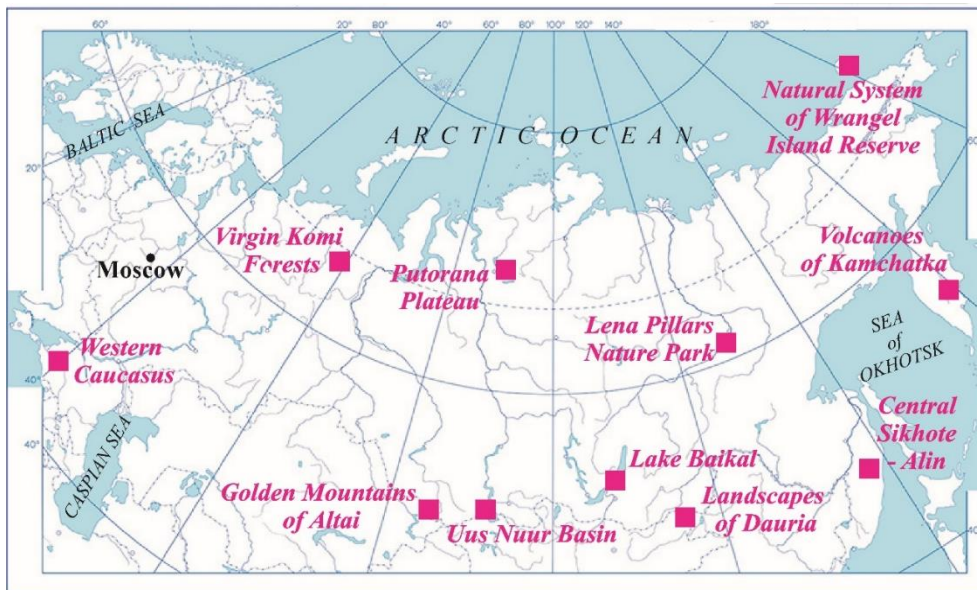


Fig. 1. Russian World Natural Heritage Sites layout

Table 1. World Natural Heritage sites of Russia

N	Name of Property	Date of inscription	Criteria	Area of the Property, ha
1	Virgin Komi Forests	1995	VII, IX	3.280.000
2	Volcanoes of Kamchatka	1996, 2001	VII-X	3.995.769
3	Lake Baikal	1996	VII-X	8.800.000
4	Golden Mountains of Altai	1998	X	1.611.457
5	Western Caucasus	1999	IX, X	298.903
6	Central Sikhote-Alin	2001, 2018	X	1.566.818
7	Uvs Nuur Basin (transboundary with Mongolia)	2003	IX, X	898.063,5
8	Natural System of Wrangel Island Reserve	2004	IX, X	2.225.650
9	Putorana Plateau	2010	VII, IX	1.887.251
10	Lena Pillars Nature Park	2012, 2015	VIII	1.387.000
11	Landscapes of Dauria (transboundary with Mongolia)	2017	IX, X	912.624

In line with The Operational Guidelines, paragraph 77 [7] the study of geomorphology includes objects which contain “superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance” (criterion vii of Outstanding Universal Value), as well as being “Earth's outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features” (criterion viii).

As indicated by Table 1, five World Natural Heritage sites of Russia are suited to these requirements, in the frameworks of which the landforms were set up using the classic geomorphological methods: comparative-morphological, morphogenetic, morphostructural etc.

Results and Discussion

The Virgin Komi Forests

The dense north-taiga forests of the western slopes and foothills of the Northern and Subpolar Urals, almost unaffected by economic activity, became the first natural site from Russia inscribed on the UNESCO World Heritage List under the name of the Virgin Komi Forests. This site combines two adjacent protected areas: the Pechora-Ilychsky Biosphere Natural Reserve (one of the oldest in Russia, founded in 1930) and the Yugyd-Va National Park (created in 1994).

The “visit card” of the Pechora-Ilychsky Reserve are seven whimsical columns - the weathering pillars on the Man-Pupu-Ner plateau. The pillars lined up in a compact group in the direction NW on a flat plateau of the treeless Man-Pupu-Ner mountain range (Mal. Bolvano-iz), which is translated from the Mansi language as “Small Mountain of Idols” (Fig. 2) (62°15’N and 59°17’E). The absolute height of the terrain is 720m, the height of the pillars varies from 20 to 50m.

Stone outcrops are composed of micaceous quartzite-schists dated from Lower Riphean-Upper Ordovician. Rocks are 85-95% composed of quartz and 5-15% muscovite with an abundance of hematite [8, 9]. Over many thousands of years the rocks surface has literally been affected by the processes of temperature and frost weathering under conditions of negative average annual air temperatures (-3°C). Its absolute amplitudes achieve more than 55°C with a significant annual precipitation (over 1000mm, of which 40% falls in the cold period). The processes of biogenic weathering also have a modeling effect on the pillars shape: the Mansi "idols" are generously covered with associations of scale lichens (*Rhizocarpon geographicum*).

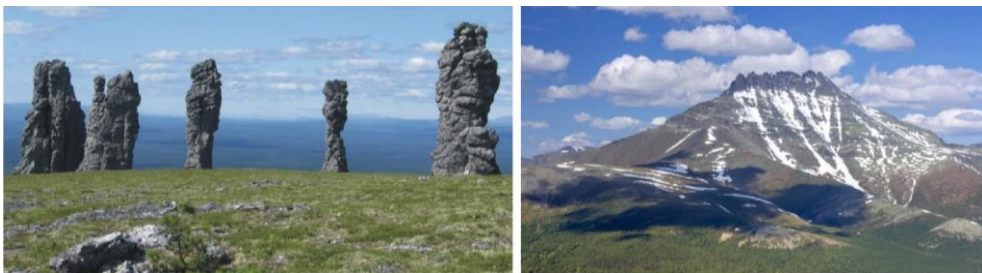


Fig. 2. Landforms of the Virgin Komi Forests: (left) - Rocky idols of the Man-Pupu-Ner Plateau (photo A. Butorin), (right) - the crest of Manaraga (photo E. Shubnitsina)

Mountain peak Manaraga (65°02’N and 59°45’) is a “visit card” of the Yugyd-Va National Park (Fig. 2). Manaraga is defined as a jagged crown at an altitude of 1662.7m. From the Nenets local language the “manaraga” is translated as “similar to the front paw of a bear”, and in Komi language the mountain is called “sizim-yura-iz” (seven-headed). Both of them are not far from the truth: the crest of Manaraga resembles a “bear's clawed forepaw raised up”.

In the summit ridge of Manaraga, composed of gneisses, quartzites and metamorphic schists of the Late Proterozoic age, the seven teeth (claws) are distinguished from the north-east to the south-west: North Tower, Main, Shovel, Head, Sail, Little finger and South Tower, each with a height of more than 60m.

The mountain peak of Manaraga was plotted on the geographical map by the Hungarian ethnographer Antal Reg during an ethnographic expedition to the Urals in 1843-1845. For more

than 80 years, Manaraga was considered as the highest peak of the entire Stone belt - the Ural Mountains. Only in 1927 A.N. Aleshkov proved that Mount Narodnaya (1895m asl.) is more than 200m higher than Manaraga.

Volcanoes of Kamchatka

This huge mountainous Kamchatka peninsula stretching from the North to the South for more than 1200km, was discovered by Fedot Popov (an associate of the great pioneer Semen Dezhnev) in 1649. As for today, Kamchatka is world-wide known through its inimitable nature, and above all by the volcanoes [10, 11] located inside the Pacific volcanic ring, to which about 60% of active volcanoes on the Earth are appropriated.

Kluhevskoy Natural Park and Kronotsky Biosphere Reserve are the main protected areas of the “Volcanoes of Kamchatka” site.

Kluhevskoy Volcano (Klyuchevskaya Sopka) (56°03'N and 160°39'E, 4688m asl) is one of the most famous landforms of the property explored, which is located in the boundaries of the Kluhevskoy Natural Park. Kluhevskoy (Fig. 3) is known as the highest active volcano in the Eurasia and as one of the most active, productive and powerful volcanoes in the world. By its activity it is the second in the world only after the Kilauea Volcano of Hawai'i Volcanoes National Park.

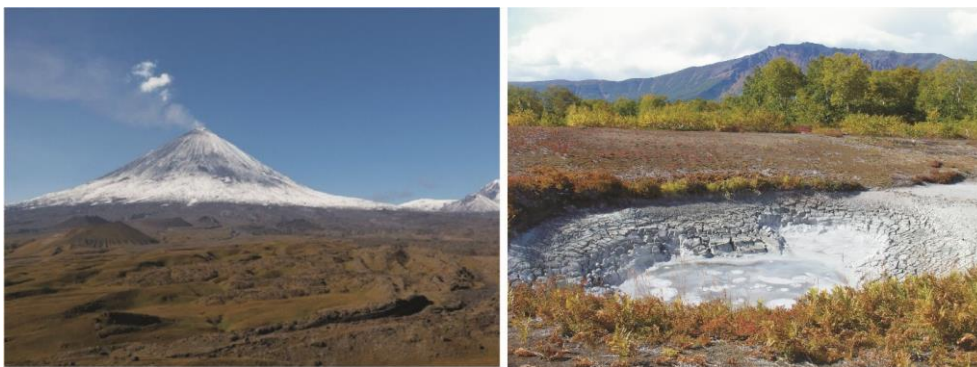


Fig. 3. Landforms of the Volcanoes of Kamchatka site: to the left - Kluhevskoy Volcano “breathing” (photo Yu. Demiyanchik), to the right – Uzon Volcano Caldera mud pool (photo N. Maksakovskiy)

The volume of Kluhevskoy Volcano is about 250km³, the average magma flow rate varies from 60 to 106 million tons per year. The volcano appeared in the Holocene on the slopes of two more ancient giant volcanoes: Krestovskiy and Kamen, his age is appreciated to 7000 years [12].

A characteristic feature of Kluhevskoy Volcano is his almost constant activity in the summit crater and the rise of side breaks along the radial cracks on its slopes at various hypsometric levels: from 900 to 4300m. There are basalts, andesite-basalts and andesites predominate in the composition of volcanic rocks [13].

The diverse dynamics of the eruptions and the constant volcanic activity allow to consider the Kluhevskoy Volcano as an ideal testing ground for the volcanic researches.

Another famous landform of this World Heritage property is Uzon Volcano Caldera (54°30'N and 159°55'E, 700m asl) which is the largest one on Kamchatka Peninsula. Caldera is located in Kronotsky Biosphere Reserve. This destroyed crater was formed as a result of a powerful eruption in the Late Pleistocene (about 40 thousand years ago) and was occupied by a huge lake, which subsequently leaked out after erosion of the northern wall of the caldera. The caldera was discovered by explorer Karl Ditmar in 1854.

Morphologically, Uzon Volcano Caldera is a cup-shaped basin with a flat bottom by the sizes 10 × 12km which is framed from the South, the North and the West by the steep basalt

walls of 500-1000m height with a maximum one of 1617 m (mountain peak Barany). Recent hydrothermal activity in the form of numerous (more than 100) thermal springs, geysers and warm lakes are actively manifested inside the basin. But, in the eastern part of the caldera there is one of the largest explosion funnel of the Kamchatka characterizing by the diameter of 1.65km, which is filled by the Dalnee Lake [14].

Uzon Volcano Caldera is considered as natural chemical laboratory where the processes of mineral and ore formation occur constantly [15].

Lake Baikal

Lake Baikal (456 m asl) is situated in giant depression stretching to 636 km in the length at an average width of 70 km. His age is dated from the Miocene: at 20–25Ma. The depression occupies a huge ancient graben (tectonic fault), belonging to one of the world's largest rift systems by a length of more than 1000km and a width of 50-80km [16, 17]. A continuous chain of high mountain ranges frames Baikal: Baikalsky, Primorsky, Barguzinsky, Ulan-Burgasy, Khमार-Daban where the highest altitudes of the summits varies from 1746 to 2841m.

The World Heritage Site “Lake Baikal” includes the lake's water surface (3.15 million hectares) and its catchment area within which there are three Reserves (Barguzinsky, Baikalsky and Baikalo-Lensky) and three National Parks (Pribaikalsky, Zabaikalsky and, partially, Tunkinsky) [18]. This “preserving necklace”, on the one hand, performs the most important conservation functions for the lake, and on the other hand, ensures the preservation of the biological and landscape diversity of its natural environment.

Baikal demonstrates many different landforms, the occurrence of which is directly related to the development of the tectonic depression itself, to which is added the influence of exogenic factors, such as water and wind erosion, the erosion-accumulating work of the glaciers, etc. So, at the age of millions of years, his coastal zone still continues to form: its appearance is slowly but inevitably acquiring new outlines, which, however, cannot be observed during the one generation of the people. There are the different coastal forms of a lake relief: bays, gulfs, separate picturesque pillars and the capes as well.

The first one is the famous Aya Bay (52°48'N and 106°37'E) (Fig. 4) located on the western shore of the lake: in his central part. Aya is situated in the Pribaikalsky National Park as well as the other landforms of Baikal one explored below.



Fig. 4. Landforms of the Baikal Lake property: to the left - Aya Bay in winter (photo A. Efimov) and a remnant (from above) of the Ulakhan-Zaba Plateau destructed paleocave (photo E. Trofimova), to the right - Shaman Cape of the Olkhon Island (photo S. Dontsov)

A semi-oval bay by a width of about 600m juts out the land at 800m. From the North-West and the South-East it is protected by the rocky massifs up to 200m altitude above the water plane. A sandy beach by the shape of a semicircle (by the sizes of 5-12m wide) was formed on the gently shore in the western part of the bay. The surrounding landscape is a hilly steppe.

The karst Ulakhan-Zaba Plateau (205-210 m above Baikal level) dominates at the northeastern part of the bay. Plateau is composed of Archaean marbles and calciphyres in alternation with the gneisses and amphibolites.

The largest underground karst system of Lake Baikal - Aya-Ryadovaya by a total length of underground galleries of more than 1km and by a depth of 57m is located in the bowels of plateau. The vertical Oktyabrskaya Cave (its depth reaches 20m) was discovered and explored here. Rockfall-block deposits are the main type of the ones in the caverns, but in some places the cave walls are inlaid by the secondary calcite in the form of corallites (2-4cm in diameter) having a condensate genesis. According to the long-term observations realized starting from the end of the XX century the intensity of cave ice degradation in the area of Aya Bay reaches 11.3m² per year [19].

A small arch: evidence of the existence of a paleo-karst system was found on the northern slope of Ulakhan-Zaba (Fig. 4), to 25 m below the plateau's surface.

Burkhan Cape (Shaman Cape is other name of this one) (53°12'N and 107°20'E) (Fig. 4) is the brightest landform of Baikal Lake. Its consists of two adjacent rocks having a form of towers-pylons by a height of 30 and 42m correspondingly connecting with the coast by a low and narrow isthmus only. Geologically the rocky massif of Shamansky Cape is represented by the same rocks as the Baikal coast near the Aya Bay: by marbles and calciphyres in alternation of the gneisses and amphibolites dated from the Archaean.

A small Shamanskaya Cave was formed in 30m cliff in consequence of the weathering processes. Underground cavity by a total length of 12m has a width of 3.0-4.5m and a height of 1.0-6.5m, characterizing by two entrances from the North-East and the West.

There is another famous place of the Baikal: it's a small island: Shaman-Rock (51°52'N and 104°49'E) with an area of 0.05ha. The Shaman-Rock is placed at the outlet of the Siberian Angara River (its average annual discharge at the outlet is 2000m³/s) (Fig. 5) being the only stream that flowing from the lake. The island represents the top of a rock massif by 25m height, which is the remnant of the southern part of the Primorsky Range, destroyed about 50-60 thousand years ago [20] during the Angara Slot formation (namely, of the Angara River outlet).

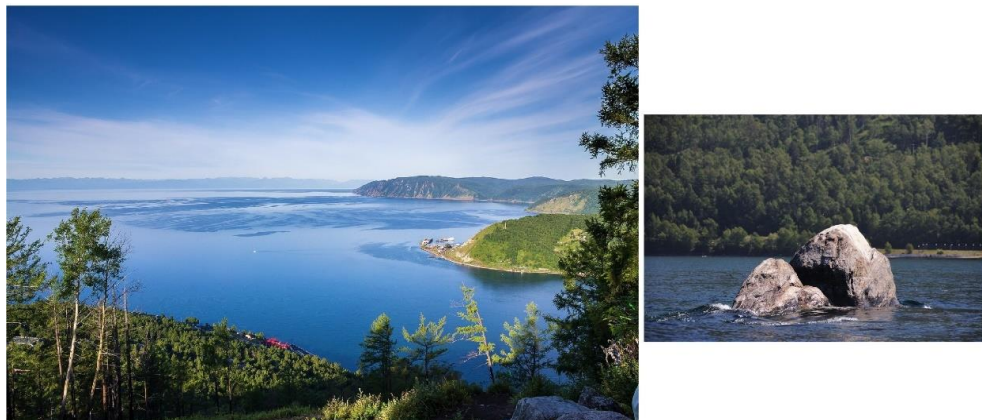


Fig. 5. Landforms of the Baikal Lake site: to the left - outlet of the Angara River (photo A. Kireev), to the right - Shaman-Rock (photo V. Antonov)

The width of the Angara River at the outlet, between two capes (Ustinsky and Rogatka ones) is about 1km. Shaman-Rock, composed of the Lower Archaean gneisses and quartzites, lies just midway between these capes, rising to 1-1.5m (Fig. 5) above the water level in clear weather. Angara River almost never freezes around him, except in cases where the ice is being blown up by the wind from the Baikal Lake, cutting off the river bed by all its width for some

time: from one-two days to a week. Depending on the severity of a winter, the length of the ice leader varies from 5 to 15km attracting thousands of waterfowls here.

Putorana Plateau

The huge Putorana Plateau spread to 100 km N from the Northern Polar Circle. It is situated in the framework of the highest Northern-Western outlying districts of the Central-Siberian Plateau. The area of the Putorana is nearly equal to the one of such country as the Great Britain.

The history of Plateau explorations is not particularly rich in events. For the first time the Plateau was noted by the Academician A.F. Middendorf traveled through the Taimyr tundra in 1844, and inside the one the expedition of I.P. Tolmachyov penetrated only in 1905. But so far this area remains one of the most deserted on the Earth: there is not even a single settlement here.

Geologically and geomorphologically the Putorana Plateau is a huge basaltic dome terminating by the steep ledges up to 300-500m height to the West, North and East: to the West-Siberian and North-Siberian Lowlands and to the Kotuy Plateau respectively. To the South the Putorana falls down gradually achieving the average level of the Central-Siberian Plateau, which is varying from 500 to 700m asl Mount Kamen (1701m asl) is the highest top of the Putorana located in its central part.

The trapps (step-by-step) relief, widespread here, is the main geological and geomorphological feature of the plateau. This type of relief is observed in another areas of the planet: for example, on the Deccan Plateau (India), in the Paraná Valley (Southern America), etc. But only here, on the Putorana Plateau, the trapps relief appears in the most pronounced, as it is called, classical form. It is a whole complex of high flat-top massifs separated by deep step-by-step valleys of the rivers and lakes.

Three stages stand out in the formation of plateau relief. The first that, pertaining to the boundary of the Neogene-Paleogene, is marked by the intense volcanic activity, which is characterizing by the successive eruptions of basaltic lavas and their crystallization. Then (a second stage) a hard basaltic dome was dissected by a dense network of radially diverging faults (up to 1000m depth) [21], formed in conditions the Neogene-Quaternary uplifts of whole territory. Subsequently these faults were occupied by river valleys and lakes. After all, the third stage includes the intensive denudation processes (wind, water and frost erosion) accompanied by the formation of pronounced step-by-step character of the deep valley slopes (gorges, canyons) because of different resistance to erosion processes of intermittent horizontal basalt and tuff layers. The thickness of the lava cover in the center of the Putorana reaches 1500m as a consequence the outcrops can account to 30 layers: each being determined by a thickness to tens meters.

Putorana Natural Reserve, inscribed on the World Natural Heritage List in 2010, occupies the most elevated part of the plateau by a total area to 1.8 million ha.

According to Evenky language the Putorana is the “lakes with the steep shores”: there are more than 25 thousand lakes here [22] of different genesis: flood-plain, thermokarst, etc., including extremely exotic ones: narrow, stretched along the tectonic faults, named “fiord-lakes”.

Ayan Lake, situated at the center of the Putorana Reserve, is a typical fiord-lake example, sandwiching between the steep banks up to 1 km above the water surface (Fig. 6).

The Ayan is characterized by the maximum water edge altitude of the Central-Siberian Plateau: 470m. The lake stretches picturesquely from the NNW to the SSE to 60km at a width of 1.0-3.0km. In its south-eastern part, almost perpendicular to the main direction, there is an 11km long Kapchug Bay, which is caused by over-deepening of the lake depression along the new tectonic faults. The average depth of the Iyan Lake is 250m. The maximum depths, more

than 300m, are noted in its northwestern part. The total water surface area is estimated to 89.6km². It is a fresh-water lake: its total mineralization does not exceed 100mg/L.

The other fiord-lakes such as the Lama, Glubokoe, Canine, Keta, Kutaramakan, Khantaiskoe and Dupkun join closely to the western borders of the reserve, sometimes “entering” to the protected territory, the largest of which have a length of 100-150km and a depth up to 300-400m.



Fig. 6. Landforms of the Putorana Plateau: to the left - Ayan Lake-fjord (©photo A. Podkoritov), to the right - Kandinsky Waterfall (photo V. Kantor)

The plateau relief gradation is also reflected in the longitudinal profile of the rivers abounding by the ledges: by the rapids and waterfalls. Waterfalls are formed in the river beds, where the streams cut through the solid layers of the basalt, washing away the soft layers of the tuff. Therefore, the greater the thickness of soft tuff layers, the higher is the waterfall, and the cascades of waterfalls are formed in the case of frequent alternation of hard and soft layers.

The highest in the Russia and by different estimations even in the Asia the six-hundred-meter giant is situated on the Putorana Plateau: 15 step-by-step cascade named the Talnikovy Waterfall (68°26' N and 93°17'E). Small stream falls from the South into Dupkun Lake in its central part between two his tributaries: the 1st Gagariya and the 2nd Gagariya Rivers. The watercourse flows from the flat Trapetsiya Mount having 920m asl, but water lake edge is 109m asl. The projection of the river on a horizontal plane has a length of about 1km. The precise geodetic works to assess the height of the giant have not been done to the present day.

The Kandinsky Waterfall-giant (69°21' N и 96°28' E) is also located here, in the Khibarba Valley. The Kandinsky is described by the highest in the Russia “direct water fall of 110m and a width of 6m” [19] (Fig. 6). But the Bolshoy Kureisky Waterfall (68°18' N and 94° 7' E, Valley of the Kureika River) is the most powerful in the Russia: its “height of water fall is only 16m but its width reaches 150m” [23].

Lena Pillars Nature Park

In the middle reaches of the Great Siberian River Lena, to 200km South-West of Yakutsk Town, the famous Lena Pillars are situated (Fig. 7): the stone giants aligned by a monolithic wall over Lena River and its tributaries – Sinyaya River and Buotama River.

In 1994, the areas of the Lena, Buotama and Sinsky Pillars were combined into a single specially protected site, which was called the Nature Park Lena Pillars (transformed into a National Park in 2018). On the 2nd July 2012, the Nature Park Lena Pillars was inscribed on the World Heritage List in course of the 36th session of the World Heritage Committee in St. Petersburg.

Lena Pillars are located in the framework of the Siberian Platform being the most stable area of the Asian part earth's crust of the Eurasia. Two main stages can be distinguished in the formation of the Lena Pillars.

At the first stage, which occurred in the Tonian-Cambrian periods (1000–485Ma), the formation of thick carbonate (dolomite and limestone) strata was carried out in the warm shallow seas of the Siberian continent [24, 25]; therefore, the Lower and Middle Cambrian marine carbonates are the most important rocks of the region by a total thickness of 980-1370m at a distance of over 150km. The second stage of the Lena Pillars formation, which continues to this day, began about 400 thousand years ago: when the southern-eastern part of the Siberian Platform rose to 200m, the Lena River and its tributaries incision was started, and the steep riverbanks were formed [26].

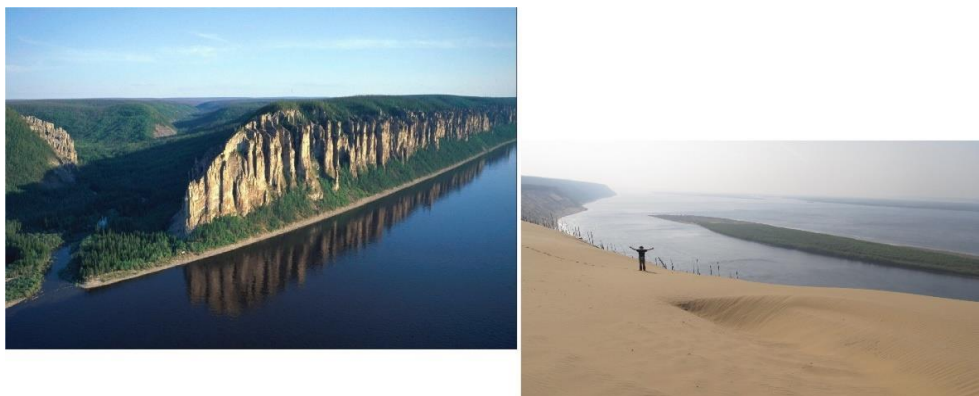


Fig. 7. Landforms of the Lena Pillars Nature Park: to the left – Lena Pillars (photo P. Kolosov), to the right - a blow-out depression on the surface of Saamys-Kumaga tukulana (photo E. Trofimova)

These banks were destroyed by the different exogenic process: weathering, gravity-slope, fluvio-glacial as well as the ground frozen karst [27]. The significant fracturing of the rocks, mainly of the sub-latitudinal and sub-meridional directions [28, 29] play the decisive role in the development of pillars relief.

Lena Pillars (the main ensemble) are stretched at a distance of 35km along the right bank of the Lena River as well as by the sections along her tributaries: right one - Buotama River (Buotama Pillars) and left one - Sinyaya (Sinsky Pillars). The height of the Lensky rocky outcrops exceeds 200m, while the Buotama Pillars and the Sinsky Pillars are somewhat lower, not more than 150m.

Here, in the Central Yakutia a substantial desert is situated, in the area of the continuous spread of permafrost by a thickness of 400-500m [30], in the conditions of a cold, sharply continental climate: the average annual air temperature reaches -10°C , and its annual amplitude is 100°C . These are tukulans (by Evenky language “tukala” means a sand): the extensive arrays of sands, located in the middle course of the Lena River.

Tukulans are the eolian sand fields devoid of vegetation, having the characteristic relief forms: namely, horseshoe-shaped, sickle-shaped, lance-like dunes with the blow-out depressions on the surface (Fig. 7).

There are two tukulans in the framework of the National Park “Lena Pillars”: both are located on the right bank of the Lena River.

The first one, called Saamys Kumaga ($61^{\circ}12'N$ and $128^{\circ}15'E$, 130-135m asl). It has a length of about 5km, a maximum width of 850-900m and a height of 50m. The second tukulana, named Kysyl Elesin ($61^{\circ}14'N$ and $128^{\circ}38'E$, 125-130m asl), is disposed slightly downstream of the Lena River. Kysyl Elesin is characterized by several smaller sizes: its length is only 1.5km with a maximum width of 550-600m. Tukulans consist of dunes by the height of 20-30m, on the surface of which the blow-out depressions by a depth of 8-10m are formed.

Yakut Tukulans are considered as a relics of the Pleistocene frozen deserts that existed here 12.000-27.000 years ago in severe climatic conditions: at absolute minimum temperatures -

100°C and slight precipitation. A strong wind picked up the sand deposits of the rivers and moved them in different directions, forming the dunes. The eolian origin of sand massifs is also confirmed by the round shape of sand grains that compound the dunes as well as by the pebble of triangular shape, found in them, called a dreikanter, which formed, presumably, under the influence of the wind as well [31].

Conclusions

The explorations realized make a practical contribution to the development of concept about landforms as a pivotal component to understanding and recognizing the World Natural Heritage. However, it should be noted that some properties with the World Heritage status, included in the List by other (than VII and VIII) criteria, are also characterized by the expressive landforms. For example [32], in Russia, the Western Caucasus property (criteria: IX, X) is distinguished by a bright alpine relief with dozens of peaks above 3000 m, with powerful glaciers and the deepest caves in Russia. But for the Golden Mountains of Altai site (criterion: X), the “visit card”, on the one hand, is also the alpine landforms, and on the other hand, the high-altitude Teletskoye Lake as well as the huge Katunsky glacier, which occupies the southern slope of the highest peak of the Altai Mountains: Belukha. The Curonian Spit (a Russian-Lithuanian site of World Cultural Heritage, criterion: V) is located within the boundaries of a giant eolian form of relief: on the territory of a saber-shaped peninsula by 98 km long with a width from 400 m to 4 km. The age of this natural formation, with the highest dunes in Europe (up to 60 m), is 7-8 thousand years.

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