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### Preservation of Geological Material and History of Karst Formations Discoveries in the Pechora-Severouralskiy Speleological Area and Adjacent Territories \*

Irina S. Astakhova<sup>1</sup>✉, Cand. Sci. (Geol.-Mineral.)

Liliya R. Zhdanova<sup>2</sup>, Research Assistant

<sup>1, 2</sup> Institute of Geology of Komi Science Centre, Ural Branch of the Russian Academy of Sciences, ul. Pervomayskaya, 54, Syktyvkar, 167982, Russia

<sup>1</sup>astakhova@geo.komisc.ru ✉, ORCID: <https://orcid.org/0000-0002-4964-2181>

<sup>2</sup>lrzhdanova@geo.komisc.ru, ORCID: <https://orcid.org/0000-0001-8961-5842>

**Abstract.** The paper describes the history of discovery and study of karst formations of the European North of Russia. More than 100 karst formations have been identified. The main periods in the history of exploration of caves and grottoes of the Pechora Urals are reflected. The first caves descriptions which were made by travellers and scientists in the 18th–19th centuries are given. During that period the most famous caves were Uninskaya and Kaninskaya caves. The main karst formations were discovered and described at the beginning of the 20th century. Geologist V.N. Mamontov discovered 4 caves on the Pervokamennaya River. Systematic geological studies by V.A. Varsanofyeva in the Northern Urals allowed her to discover small karst formations in the upper reaches of the Pechora on the Ilych and Unya rivers. In 1960, B.I. Guslitzer discovered the largest cave in the Northern Urals — the Medvezhya Cave. Promising and little-studied areas of karst are the Bolshezemelskaya Tundra, the Polar and Nether-Polar Urals, Pai-Hoi and Timan. Only a few small caves and grottoes are known on these territories. Most of the karst is located in specially protected areas. The caves are unique paleontological monuments of nature. The funds of the A.A. Chernov Geological Museum of the Institute of Geology contain 12 monographic collections of paleofaunistic material with a volume of more than 30 thousand storage units. The remains of vertebrate caves consist of bones of mammoth fauna and small mammals.

**Keywords:** *history, karst, cave, grotto, Northern Urals, Timan, natural heritage, paleontology, museum*

#### Introduction

The European North of Russia is the most interesting large region with diverse conditions for the karst and caves development, covering the northeastern part of the East European Platform with the adjacent Timan Ridge, the northern part of the Ural system with a geological continuation (Pay-Khoy uplift) and the island chain (Vaygach, Novaya Zemlya) [1, Astakhova I.S., Zhdanova L.R., p. 40]. Within the northern Cis-Urals, the Chernyshev, Pay-Khoy and Timan ridges contain intensively dislocated rocks, among which carbonate and sulfate strata are widespread, which are favorable for the karst formation. Mineral composition, strong fracturing and shearing

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of rocks, intense exogenous processes predetermine a huge variety of karst formations [2, Lavrov I.A., Andreychuk V.N., p. 8].

More than 100 karst formations are known in the European North of Russia [3, p. 70]. The largest part of karst forms is developed within the Pechora River basin. Karst funnels, karst ravines, caves, niches, sheds, and karsts were found there [4, Gladkova I.G., Guslitser B.I., p. 145]. The largest ones have their own names, but most of the objects remain unnamed due to their insignificance (Fig. 1). Thus, the density of craters within the Upper Pechora basin reaches several hundred per 1 km<sup>2</sup> [5, Gladkova I.G., Guslitser B.I., p. 201]. The best known caves of the Pechora, Unya and Ilych rivers are Medvezhya (480 m) and Uninskaya (390 m) — archaeological sites of the Upper Paleolithic with clusters of bones of the Pleistocene fauna (cave bear, tiger lion, etc.) [3, p. 15]. Kaninskaya Cave is a sanctuary of the Bronze, Early Iron and Middle Ages, as well as a place of discovery of animal remains of the Pleistocene and Holocene [6, Murygin A.M., p. 93]. The largest vertical cave in the Northern Urals is Shezhimskaya (the total depth of the well and the hall is 20 m). Quite often there are buried caves (Pervokamennaya and Tufovaya), the remains of destruction in the form of small grottoes and arches (Arka cave in the Sukhoy Log on the Unya River, an arch at the mouth of the Pikhtovka River) [7, Guslitser B.I. et al.]. However, the results of the study and the history of the discovery of karst formations remain largely unpublished, so the data given from the study of caves may be incomplete.

### ***Caves of the Pechora Urals***

The first reliable data on the caves of the Northern Urals date back to the 18th century. During that century, they were not the goal of research by scientists and travelers, but they came into view during geographical and ethnographic studies of the region. The discovery and history of studying the caves of the Northern Urals begins with academic expeditions. In 1771–1772, I.I. Lepekhin and N.Ya. Ozeretskovskiy made a trip to the north of the European part of Russia to study the natural resources of the regions, cities and population, historical monuments, mines and factories. Describing the Bolshezemelskaya tundra, I.I. Lepekhin paid attention to the antiquities of the Samoyeds living in the Arkhangelsk province. “The entire Samoyed land in the current Mezen okrug is filled with desolated dwellings of some ancient people. They are found in many places, near lakes on the tundra and in forests near rivers, in mountains and hills in the form of caves with door-like openings. Stoves and fragments of iron, copper and clay household items and, moreover, human bones can be found in these caves” [8, Lepekhin I.I., p. 203]. Later, historical writings of the late 18th and early 19th centuries mention caves as dwellings of the local population [9, Krestinin V.V., p. 11]. This is confirmed by the information collected in 1837 by the traveler A.G. Schrenk. In his report, he provides detailed information about “caves that are located on the lower Pechora and in various other places” and which the Russians call “Chudskie caves ... which undoubtedly owe their name to the river Pechora” [10, p. 327]. He notes that these caves are man-made and represent the most convenient and most natural kind of dwellings. The traveler cites the

information received about the location of the Chudskie “caves”: near the mouth of the river Indiga, near village Chuchepala on the middle Mezen, near the mouth of the river Pechora, in the Kara river basin, near the mouth of the Korotaiha river. Other researchers also mention underground dwellings [11, Latkin V.N., p. 151; 12, Uvarov A.A., p. 207].

Only at the end of the 18th century, academician I.G. Georgi, a member of the “Physical Expedition” together with P.S. Pallas, noted that “... there are large, but not yet explored caves in the Pechora [...] and to the west of the Pechora, at its latitude, there are limestone mountains with many abysses and grottoes” [7, Guslitser B.I., p. 9].

The study of the caves of the Northern Urals was associated mainly with the development of geological academic research in the 19th century. The first reliable information about the karst of the Pechora territory is contained in the article of the geologist A.N. Chekletsov, who carried out “geognostic” surveys on the western slope of the Northern Urals. The author paid attention to the significant development of limestones and karst forms on the territory of the Cherdynskiy uyezd, noting that the Uninskaya cave is the most extensive among these caves. The cave consists of “several tiers, mutually interconnected by narrow passages. The walls of this cave are decorated with various incrustations of carbonic lime” [13, p. 171].

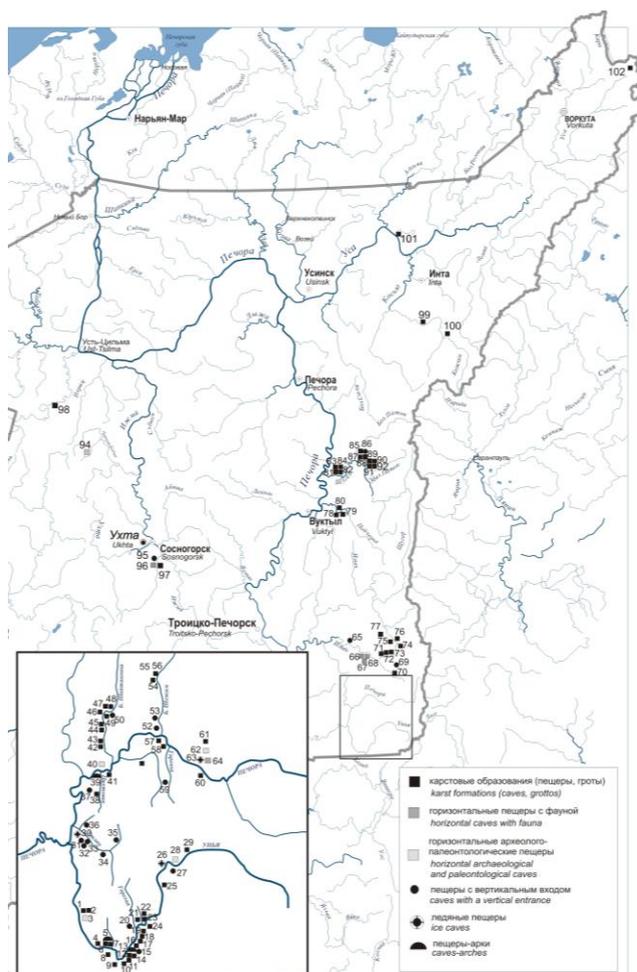


Fig. 1. Schematic map of the caves of the Pechora Urals and adjacent regions (based on the materials of I.G. Gladkova, B.I. Guslitser (1965); D.V. Ponomarev (2001)). Caves: 3 — Pervokamennaya; 5 — Arka; 16 — Kremennaya; 26 — Lednik; 28 — Uninskaya; 39 — Pikhtovaya; 40 — Kaninskaya; 52 — Shezhimskaya; 54 — Talaya; 56 — Dvoynaya; 61 —

Dalnyaya; 62 — Medvezhya; 63 — Ledyanaya; 64 — Tufovaya; 87 — Sher-Kyrta; 94 — Eshmesskaya; 96 — Sedyuskaya; 101 — Adakskaya.

In 1847, the Uninskaya Cave was visited by a geographical expedition led by E. Hoffmann, who carried out extensive work in the Northern Urals. In his report, E. Hoffman described in detail his visit to the cave. This description is of historical interest as a document about the first scientific survey of a cave in the Pechora Urals. "Having passed a narrow passage, we entered a gallery closed at the opposite end by a wall, the floor of which was strewn with stone fragments. Between them, however, I soon found a bear's vertebra. To the left, near the entrance to this gallery, there was a hole big enough for one person to pass" [14, p. 23].

The expedition of E. Hoffmann, on their way up the right tributary of the middle Pechora, discovered caves in the valley of the Shchugora River. The diary gives a description of the limestone outcrop at the Nizhnie Vorota (Uldor-Kyrta): "The layers, collapsing, produced caves, and in one of them, which had a depth of 10 to 11 sazhen, we still found a large amount of ice, which, however, according to the guides, does not melt for a whole year" [14, p. 247]. Caves were also found upstream of the Shchugora river, in the limestone rocks of the Srednie Vorota.

Since 1980s, interest in the Pechora Territory has increased due to geological surveys, but the study of caves was conducted only occasionally. In 1874, geologist P.M. Burnashev was searching for eolian placer in the upper Pechora and its tributaries. In his work, he gives a description of the Uninskaya Cave from the words of local residents: "Small caves ... are quite common; but one of them, located on the right side of the Unya River, 10 versts below the mouth of the Imperatorskaya River, attracts special attention in terms of its vastness: it consists of many underground passages that intersect in different directions and are located on several floors, which is why this cave is very similar to underground workings. Some residents of Pechora, who visited this cave out of curiosity, say that they walked through its labyrinths for more than 8 hours with a torch, but could not reach the end. In order not to get lost in it, they put various notes on the turns and reached the inner reservoir in the form of a lake in the vast emptiness of the cave. They noticed some strange footprints leading into the lake, and superstitiously, ascribing them to a strange creature in the cave, returned in fear" [15, Burnashev P.M., p. 70]. In 1888, E.S. Fedorov visited the Pechora region and mentioned the Uninskaya Cave [16, p. 369]. Thus, the Uninskaya Cave has been known for quite a long time and has been visited by the local population and travelers at different times.

In 1900, folklorist N.E. Onchukov visited the Kaninskaya Cave, located on the right bank of the Pechora River, about 2 km upstream from the mouth of the Pikhtovka River and 47 km upstream from the mouth of the Unya River. He writes: "4–5 versts away from Sobintsy, my drivers and me got out of the boat, and everyone went into a collapsed cave, 10 sazhen above the water in the mountain, clearly visible from the river" [17, p. 34]. At the mouth of the cave, they found up to 70 white "apparently boiled" skulls of horses and other animals. N.E. Onchukov notes that this

cave was visited, in particular, by “Manchi (Voguly)”, who used it as a sacrificial place. The cave was collapsed, but the traveler managed to crawl 5–7 fathoms from the mouth.

In 1911, geologist A.A. Chernov with a group of students of the Moscow Higher Women's Courses examined the Uninskaya Cave. This group included V.A. Varsanofyeva, who would later carry out geomorphological research of the Upper Pechora. In the same years, a mining engineer V. N. Mamontov visited the Unya River, carrying out geological and engineering surveys of the projected Solikamsk–Ukhta railway. He described 4 insignificant caves. “The largest one is located at the mouth of the Pervokamennaya River, 1.5 sazhen from the water level, and has the following dimensions: 3 arsh. width, 4 arsh. length and 2.5 arsh. heights” [18, Mamontov V.N., p. 82]. He was the first to discover caves at the mouth of the Pervokamennaya River.

After the October Revolution, in connection with a broad study of the mineral resource base of the Urals, extensive geological and geomorphological studies were carried out, which significantly expanded knowledge about the caves. Since 1921, systematic geological research began in the basin of the upper and middle Pechora basins. V.A. Varsanofyeva explored caves in the upper Pechora on the Ilych and Unya rivers. On the watershed between Unya, 6 km east of the village Ust-Unya, V.A. Varsanofyeva examined two small caves. One of them has a vertical entrance at the bottom of a sinkhole, and the other one starts in a narrow pit [19, p. 97–98]. In the same years, the Uninskaya Cave was inspected and described again. In 1926, under the guidance of V.A. Varsanofyeva, N.N. Jordanskiy studied a large grotto in a karst log near the Nizhnie Klyuchi, above the confluence of the Shezhim River to Pechora (later the log was named after Jordanskiy, and the cave was named Medvezhya) (Fig. 2). Several small caves were discovered on the Unya River. Of those, the arch in Sukhoy Log, near the mouth of the Pisanaya Poteryakha River, and Kremennaya Cave with two exits, located above the Belyy Mokh Stretch are particularly interesting (Fig. 1, 16). A small cave with two exits is above the mouth of the Nizhnyaya Poteryakha River [20, Varsanofyeva V.A., Jordanskiy N.N.].

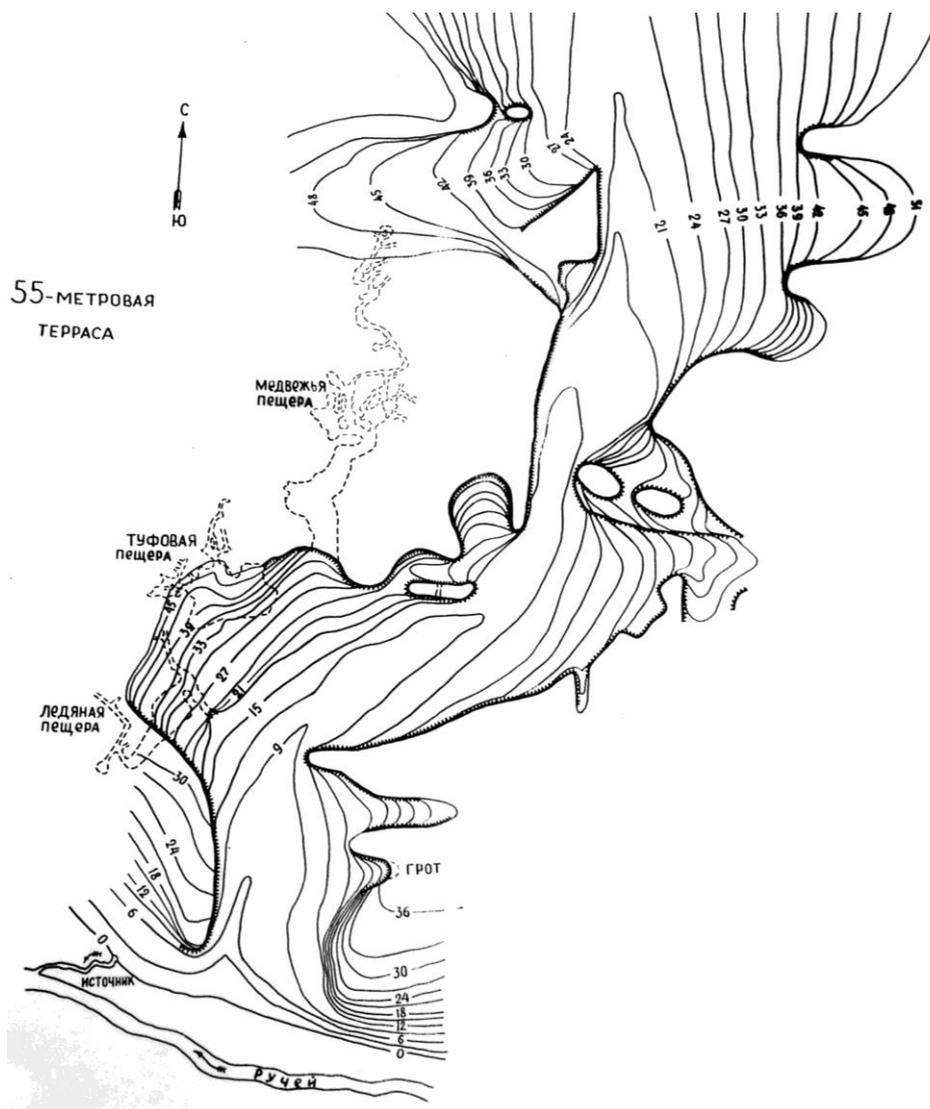


Fig. 2. Sketch of Iordanskiy Log by B.I. Guslitser, 1960–1964 [4, p. 200].

There was almost no information about caves in the Ilych River basin until the mid-20th century. In the literature, only underground voids are noted in an outcrop on the river. The literature notes only underground cavities in the outcrop on the Shezhim Ilychskiy River and in the rocks in the lower reaches of the Ispered-dikost-yol brook [21, Varsanofyeva V.A., p. 201]. In 1947, together with V.A. Varsanofyeva, V.S. Lukin carried out geomorphological observations in the basin of the upper Pechora. They discovered the Uninskaya Arch (Fig. 1, 37). V.S. Lukin visited the Uninskaya Cave and the caves on the river Utlan. He discovered the Lednik cave on the right bank of the river Unya below the mouth of Dubrovaya River (Fig. 1, 26) and the Snezhnaya Cave on the slope of the left bank of the Garevka River to the south of its inflow into the Pechora River (Fig. 1, 59). The generalizing results of the caves and karst study were given by V.A. Varsanofyeva in her work on the geomorphology of the Komi ASSR, in which she indicated the Kaninskaya, Uninskaya caves and Utlan-Parma [22, p. 283–284]. Thus, by the mid-1950s, about 15 karst formations were known on the Unya, Malaya Pechora and Ilych rivers.

Since 1955, the Ural geological team was formed in the Komi branch of the Academy of Sciences of the USSR under the leadership of B.I. Guslitser. Its purpose was to study the geomor-

phology and quaternary deposits of the Upper Pechora basin. During four expedition seasons, the group has examined and described all previously known caves on the Unya River and in the upper reaches of the Pechora. More than 40 new karst formations were discovered (Fig. 1, 10–21, etc.). In 1959, B.I. Guslitser examined the Pikhtovskaya arch, which was previously discovered by V.A. Varsanofyeva (Fig. 1, 39). The arch is located in the Sukhoy Log in the Unya River valley, 200 m below the mouth of the Pisanaya Peteryakha River [23, p. 124]. Since 1959, B.I. Guslitser and archaeologist V.I. Kanivets began to excavate cave monuments in the Pechora Urals. Pits were closed up in the Uninskaya and Kaninskaya caves in order to clarify the stratigraphy of the deposits and to reveal the cultural layers of ancient sacrificial places [7]. In 1960, excavations were carried out in the Medvezhyya Cave (Fig. 1, 62), the largest of the known karst cavities in the Pechora Urals (Fig. 3). The remains of ancient mammals were found in the cave, and a study of an Upper Paleolithic site was carried out. The age of the cave, the formation of which began at the end of the Neogene, was determined [5, p. 240].



Fig. 3. B.I. Guslitser (left) near the entrance to the Medvezhyya Cave. Collection of the Geological Museum named after A.A. Chernov.

Along with these excavations, other caves of the Upper Pechora basin, both previously known and newly discovered, were studied — in the Jordanskiy Log in Ledyanaya (Fig. 1, 63; Fig. 4), Tufovaya (Fig. 1, 64), Shezhimskaya and Talaya caves (Fig. 1, 52, 54) and a grotto (Fig. 1, 57) on the right bank of Bolshoy Shezhim river, Pervokamennaya Cave and cavities (Fig. 1, 4) near the Ust-Berdysh village on the Unya River, caves on Tyagly river in 3.5 km from Garevka village (Fig. 1, 36), small caves on the right slope of the Gorelaya River (Fig. 1, 20) and above the Dubrovnaya River (Fig. 1, 27), several small caves on the Ilych River (Fig. 1, 71–73). On the Utlan River tributaries, B.I. Guslitser found several small caves (Fig. 1, 33–35).



Fig. 4. Ledyanaya Cave. Sculptural forms [5, p. 235].

In 1962–1963, B.I. Guslitsker carried out geomorphological studies on the Ilych River, during which small caves were discovered. Three of them (Figurnaya (Fig. 1, 66), Azhurnaya (Fig. 1, 67), Anyuskaya (Fig. 1, 68)) begin as entrance grottoes, in the deposits of which numerous bones of Pleistocene mammals were found [24, Guslitsker B.I.]. Thus, the Figurnaya Grotto was discovered next to the Azhurnaya Cave. A description of a large canopy located on the Podcherem River, 150 m downstream of the B. Drovatnitsa River, was also made. In 1963, speleological exploration began on the Schugor and Podcherem rivers, tributaries of the Middle Pechora. On the Podcherem River, in its lower reaches, V. I. Kanivets examined four grottoes near the confluence of the Bolshaya and Malaya Drevyatnitsa streams (Fig. 1, 78–80) [6, Murygin A.M., p. 94]. In 1965, B.I. Guslitsker discovered 15 caves and grottoes near the Verkhnie, Srednie, Nizhnie gates on the Shchugor River, among which the most significant is the Sher-Kyrta Cave (Fig. 1, 87), which is located above the mouth of the Bolshoi Patok River [6]. The grottoes in the Shchugor river valley are not more than 100 m from each other, at different heights from the water's edge. In the 2000s, D.V. Ponomarev conducted studies of fouling in the grottoes where the remains of small mammals were found [23].

#### ***Arctic Karst formations***

Karst formations in the Cis-Urals Arctic, and, in particular, the Polar speleological region, remain poorly studied. Most often, karst forms are confined to river valleys and slopes, which are observed in the upper reaches of the Vorkuta, Usa, Malaya and Bolshaya Usa rivers. They are represented by funnels and small caves.

Noteworthy is the Verkhneusinskiy area, formed by Devonian and Carboniferous karst rocks. Thus, the first data on caves in this area are given in the works of V.N. Latkin: “Under Adak Mountain... there are caves on this shore; one of them is in a cliff, ten meters above the river hori-

zon of water. I went up to it; there is a place for 13 people in the cave. There is another cave a little lower down the river" [11, p. 151]. The processes of karst formation in this area are described in the works of the well-known researcher of the Northern Urals A.V. Zhuravskiy, who was carrying out geological and geographical works in 1904–1905. He found a cave with preserved ancient items on the left tributary of the Adzva River in Pymvashora. Archaeological excavations were carried out there later, in 1994–1995. The site is a small ruined rock cave with a height of 30 metres. The work by Voinovskiy-Krieger (1946) briefly mentions karst phenomena in the area of limestone development in the Elets River basin [22, Varsanofeva V.A., p. 283]. There is another cave on the Usa River, 2 km below the village of Adak. Adakskaya I Cave was discovered and described in 1969–1971 by V.I. Kanivets and is a sanctuary. Adakskaya II Cave is located on the left bank of the Usa River, between the settlement of Adak and the village of Adak (Fig. 1, 101). Exploration works revealed flint objects (arrowhead, scraper, plate) and a bone arrowhead. The length of the rock massif with grottoes and caves along the Usa River is about 5 km. The height of the rocks reaches 40 m. In 1984, a natural reserve of national importance "Adak" was organized.

The Polar Ural speleological area remains poorly studied, scientists have been conducting speleological research only in recent decades. Small karst formations are confined to limestones, marbles and slates [26, Kadebskaya O.I., p. 146]. Thus, the Zveroboy Grotto is located on the eastern slope of the Yangana-Pe ridge of the Polar Urals (Fig. 1, 102). The grotto is small in size: 1 m high, 1.5 m wide, 3 m long. The grotto was discovered in 1995 by a field team of the Institute of Plant and Animal Ecology, Ural Branch of the Russian Academy of Sciences, led by N. G. Smirnov. Besides, in the western part of the Yangana-Pe ridge, a narrow low (from 0.1 to 1.0 m high) cavity 12 m wide and more than 10 m long was found [23, Ponomarev D.V., p. 10].

In the Bolshozemelskaya tundra, within the Chernov uplift, karst funnels are known in the Silurian, Devonian and Carboniferous carbonate deposits, and a small cave was found on the Kara River in the Pay-Khoy speleological area. [27, Chermnykh V.A., Yushkin N.P., p. 29].

### ***Karst formations of the Subpolar Urals region***

The issues of karst formation within the Subpolar Urals remain poorly studied, and information in the literature is scattered. The first information on karst was noted by G.A. Chernov on the Syvya River in Silurian limestones. "The entrance to the cave is 0.5 m wide and 1 m high. The cave goes straight into the shore with a declivity of the floor. The latter is covered with small pointed pieces of dolomite. The length of the cave is 8 m. It ends with a deep vault, up to 50 cm in diameter" [22, Varsanofyeva V.A., p. 321]. D.V. Ponomarev, an employee of the Institute of Geology of the Komi Scientific Centre, Ural RAS Department, has been conducting karst formations in the Kozhim River basin since 2011. He gave a description of the locality Kozhim-1 and 2 (Fig. 1, 99) on the right bank of the Kozhim River in Ordovician limestones. One is located 5 km above the mouth of the Syvyu River, another is located 1 km downstream from the Kayuk-Nyrd rock.

Sokolinyy Grotto is located 1.5 km from the mouth of the Limbekhayu river in the rock outcrop (Fig. 1, 100). Small mammal teeth were found in the Kozhima River valley [28, Ponomarev D.V., p. 334].

The Lemvinskaya cave is situated on the right bank of the Lemva River, 20 km below the mouth of the Malaya Nadota River. The cave was formed in carboniferous limestones and has a length of 207 m. It was explored in 1978 by A.Z. Bikbaev [2, p. 15].

### ***Caves of the Timan Ridge***

Devonian and Carboniferous limestones in the Pechorskaya Pizhma River basin within the Middle Timan Range contain relatively small grottoes. Pizhma-1, 3 and 4 sites (Fig. 1, 98) are located in Carboniferous calcareous rocks, the outcrops of which extend for 400 m along the left bank of the Pechorskaya Pizhma River. The grottoes are located at a height of about 50 m from the water's edge [25, Ponomarev D.V., p. 12]. They contain remains of Late Pleistocene and Holocene vertebrate fauna.

Several grottoes in the Devonian limestones are known on the Southern Timan. Sedyu-1 and Sedyu-2 are located just a dozen meters from each other on the right bank of the Sedyu River (a tributary of the Izhma River) at an altitude of about 10 m from the river's edge, about 1 km downstream from the Sedyu village in coastal outcrop of Paleozoic reef limestones. The site of Sedyu-1 is a small grotto with an entrance width and height of 1 m and a depth of 5 m. Excavations were carried out in 2003 and the remains of Late Quaternary mammal, bird and other vertebrate fauna were found [29, p. 15].

The most famous cave on Timan is Eshmesskaya Cave, located between the Belaya Kedva and Belyy Eshmes rivers (Fig. 1, 94). It is about 12 m long and 4 m wide, 3 m high at the entrance and 1 m deep. The Eshmes Cave was first mentioned in the 1920s. In 1924, Pavel Vokuev, a fifty-year-old hunter from the village of Poromes, accidentally discovered a cave with wooden idols, one of which was taken by him. In 1926, the famous ethnographer D.T. Yanovich delivered the idol to the Komi Regional Museum (now the National Museum of the Komi Republic). It was not until the summer of 1965 that the archaeologist V.E. Luzgin attempted to find the Eshmesskaya Cave. An important role in the rediscovery of this archaeological monument belongs to Ukhta resident V.P. Torlopov, who organised an archaeological expedition in 1981 [30, p. 49]. Excavations were conducted by A.M. Murygin in 1982, during the works a great number of beaver bones and skulls, 29 bone arrowheads, 1 flint arrowhead, 35 silver and bronze items were found. The cave was a cult place in the late Iron Age [6, Murygin A.M., p. 96].

Sedyuskaya Cave, the largest in the South Timan, with a length of more than 500 m, was also part of the Sedyusky canyon; it was discovered in 1902 by the famous traveler V.A. Rusanov. Unfortunately, it was destroyed by blasting in the middle of the last century.

### ***Paleontological material of caves and grottoes of the A.A. Chernova Geological Museum***

Caves are widespread in limestones and dolomites of Paleozoic age in the Northern, Polar, Subpolar Urals, Timan and on the Chernyshev Ridge. Loose cave deposits hide a large number of bone remains of Pleistocene and Holocene mammals, birds, reptiles, amphibians and fish. The works of A.K. Agadzhanian, V.I. Gromova, B.I. Guslitser, K.I. Isaichev, V.A. Kocheva, E.A. Kuzmina, D.V. Ponomareva, I.V. Kryazheva, etc. are fundamental in terms of studying the vertebrate formations of the region for the purposes of Quaternary stratigraphy.

Many researchers at the Institute of Geology, Ural Branch of the Russian Academy of Sciences, have discovered new caves and grottoes in the north-eastern part of European Russia, and studied the bone remains. B.I. Guslitser, a senior researcher at the Institute of Geology, Candidate of Geographical Sciences, has been studying Quaternary deposits and geomorphology in the northeast of the European part of Russia for many years. He made a great contribution to paleontology, the discovery of Late Paleolithic human sites and many caves and grottoes [5].

Part of the paleofaunal material of the caves, discovered by B.I. Guslitser, was studied by his colleagues. Thus, most of the material on the Quaternary theriofauna, published in the works of V.A. Kochev, consists entirely of the collections of B.I. Guslitser. V.A. Kochev, senior researcher at the Institute of Geology, Candidate of Biological Sciences, was engaged in the study of fossil remains of small mammals for the purposes of stratigraphy of Quaternary deposits. V.A. Kochev traced the evolution of the dental systems of ungulate lemmings of the region in the Neopleistocene and revealed the features of the composition and structure of rodent assemblages from Late Quaternary cave deposits [29]. D.V. Ponomarev, a senior researcher at the Institute of Geology, Doctor of Geological and Mineralogical Sciences, studies the Neopleistocene mammals of the region. He made an empirical generalization on large mammals, showed the history of the development of the theriofauna of the region.

The systematic study of Pleistocene and Holocene vertebrates in the northeast of the European part of Russia led to the accumulation of unique collections, which are represented in the funds of the A.A. Chernov Geological Museum, Institute of Geology, Komi Science Center, Ural Branch, Russian Academy of Sciences.

The faunal remains of caves found on the territory of the Komi Republic are represented by bone accumulations of Pleistocene and Holocene mammals. The remains of vertebrate caves consist of large bones of animals of the so-called mammoth fauna: mammoth, cave bear, Ural horse, woolly rhinoceros, primitive bison, reindeer. Small mammals are more often represented by bone remains of four taxa: ungulate (*Dicrostonyx Gloger*) and Siberian (*Lemmus sibiricus Kerr*) lemmings, narrow-skulled voles (*Lasiopodomys gregalis Pallass*) and Middendorf voles (*Alexandromys middendorffii Poljakov*) [28, Beznosov P.A., Ponomarev D.V., pp. 4–5].

The species composition of the fauna of the largest Medvezhya Cave includes 34 species of mammals, birds, etc. [31, Beznosov P.A., Ponomarev D.V., p. 4], and the number of taxa of the

Pleistocene fauna of all the caves of the Pechora Ural reaches 42 species of mammals, birds, etc. [5, p. 259]. Paleontological material of the Northern Urals caves of the A.A. Chernov Geological Museum is presented in 6 monographic author's collections with a volume of more than fifteen thousand items. Monographic collection donated by B.I. Guslitser to the museum's funds, consists of large bones of Pleistocene mammals from the Medvezhaya, Kaninskiye and Uninskiye caves. The museum's exhibitions from the caves of the Northern Urals demonstrate large bone remains of six species of mammals from four orders of vertebrates. These are large bones: cave bear (*Ursus spelaeus* Rosen) (Fig. 5), reindeer (*Rangifer tarandus* Linnaeus), cave lion (*Panthera spelaela* Goldfuss) (Fig. 6), Siberian musk ox (*Ovibos pallantis* N. Smiths), beaver (*Castor fiber* Linnaeus), ungulate lemming (*Dicrostonyx guilieilmi* Sanford), Ural horse (*Eguus uralensis* Kuzmina).

Material on the Quaternary theriofauna studied by V.A. Kochev, transferred to the museum and kept in five collections. The number of bone remains from the Medvezhaya, Studenaya, Kaninskaya and Uninskaya caves of the Iordanskiy log is more than 15000 storage units. The collections mainly consist of bone remains and molars of three taxa of small mammals: ungulate (*Dicrostonyx Gloger*) and Siberian (*Lemmus sibiricus* Kerr) lemmings, underground vole (*Microtus subterraneus*). Based on this material, V.A. Kochev developed an original method for assessing the degree of development of the molars of ungulate lemmings by calculating a special coefficient. He proposed to use an ocular transporter to measure angles on teeth, traced the evolution of the dental systems of ungulate lemmings of the region in the Neopleistocene and revealed features of the composition and structure of rodent complexes from the Late Quaternary deposits [32].



Fig. 5. Skull of the cave bear *Ursus spelaeus* Rosen. Medvezhaya cave. 40x18x10cm. No. 562/48. Funds of the A.A. Chernov Geological Museum.

A number of localities, where the remains of the Quaternary microtheriofauna have been found, are known in the Subpolar Urals. D.V. Ponomarev and I.V. Kryazheva present the results of studies of late Pleistocene and Holocene small mammals from cave-type localities on the Kozhym and Shchugor Rivers [33; 34]. The paleofauna of the Subpolar Urals caves is represented in the museum by bone remains of small mammals of Holocene – Late Pleistocene, which were selected

from the Sokolinyy Grotto. The collection consists of 4500 skeletal remains of lagomorphs, insectivorous and cheek teeth of rodents. The assemblage of small rodent remains from the Sokolinyy Grotto consists of several species of the gray vole (*Microtus gregalis*, *Microtus middendorffii*, *Microtus agrestis*, *Microtus oeconomus*); ungulate (*Dicrostonyx sp.*), forest (*Myopus schisticolor*) and Siberian (*Lemmus sibiric*) lemmings; bank vole (*Clethrionomus rufocanus*, *Clethrionomus ex.gr.rutilus-glareolus*) and water vole (*Arvicola terrestris*).



Fig. 6. Fragment of the facial section of the skull of the cave lion *Panthera spelaela* Goldfuss. Medvezhya cave. 17x16x4 see No. 562/29. Funds of the A.A. Chernov Geological Museum.

The study of the Quaternary microtheriofauna from the Timan cave-type localities is the subject of many works by the researcher of the Institute of Geology D.V. Ponomarenko and his colleagues. He studied Late Pleistocene-Holocene mammals from the Pizhma 1, Sedyu 1, and Sedyu 2. The fauna complex of these localities includes almost two dozen species of small mammals from three orders: rodents, lagomorphs and insectivores, as well as large mammals [28, Ponomarev, p. 334]. More than 16000 bone remains of large and small mammals have been gathered in four collections. Collections of bone remains of the Eshmess 1 and Eshmess 2 caves, collected by V.A. Kochev, consist of the bone remains of Pleistocene rodents in the amount of more than 2500 units. The complex of bone remains of mammals in the caves, kept in the museum, consists of representatives of rodents: gray (*Microtus sp.*), red (*Clethrionomus sp.*) and water voles (*Arvicola terrestris*); Siberian lemming (*Lemmus sibiricus*); representatives of mammalian families of shrews (*Sorex sp.*) and pikas (*Ochofona sp.*) and mustelids (*Mustella sp.*).

As paleontological monuments of nature, caves are a unique source of paleomass and taphonomic unification of remains. In the funds of the A.A. Chernov Geological Museum of the Institute of Geology contains 12 monographic collections of paleofaunal material from loose deposits of caves and grottoes of the European North-East of Russia. The total number of bone remains of vertebrates from the deposits of caves and grottoes of the region in the museum's funds

is more than 34000 items. This material, obtained during the excavation of karst formations, is unique in scientific and historical terms.

### Conclusion

Caves as geomorphological objects and manifestation of karst processes are geological and archaeological monuments of nature. Karst formations on the territory of the north-east of Europe are unique sources of information on the history and culture of the peoples and biota that inhabited the territory of the North in the Quaternary period. By the Decree of the Council of Ministers of the Komi ASSR dated March 5, 1973, the Uninskaya Cave was declared a geological natural monument of republican significance. Most of the objects of the Pechora-Severouralsk speleological region, located in the Iordanskiy Log, Medvezhya, Tufovaya, Ledyanaya, Kaninskaya caves, are located within the Pechoro-Ilychskiy reserve. Small caves and grottoes are located on the territory of the Yugyd va National Park (Polar Urals), Pizhemskiy complex reserve (Timan Ridge), Adakskiy complex reserve (Chernyshev Ridge).

Even being in protected areas, it is necessary to take into account the status and regime of protection of speleological objects: both promising and already included in the system of protected areas. Caves can be tourist sites, which serves the development of ecological tourism in the territory. However, it is necessary to take into account the possible use of caves for recreational purposes, establishing certain regimes for the protection of speleological objects: especially strict protection; limited protection without recommendations for mass tourism; limited protection with recommendations for mass tourism [35, p. 55]. Climatic phenomena and tourist trips can have a significant impact on the preservation and development of caves. For a long time, the walls and vaults of caves have been actively exposed to the environment. It is not uncommon to encounter collapsed grotto vaults and landslides that close entrances, so it is necessary to conduct a systematic monitoring of the condition of speleological sites.

Thus, karst processes and products in the European North of Russia remain poorly studied. Promising areas for the discovery of new grottoes and small caves are the Timan Ridge and the northern regions of the Polar Urals, the Bolshezemelskaya tundra and Pay-Khoy.

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