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QUATERNARY DEPOSITS AND ECOLOGICAL MONITORING OF THE ICE AGE PARK IN CARPATHIAN REGION, UKRAINE

An international geopark "The Park of Ice Age" located near Starunia village in Bohorodchany district of Ivano-Frankivsk region is world-famous for being a paleontological site of Pleistocene fauna of the woolly rhinoceroses and mammoth (the Eemian interglacial period – 46000-10000 years ago according to radiocarbon dating C14) and for its mud volcano which is unique in the Carpathian region. This is a geological nature monument with an area of 60 hectares where abandoned ozokerite mine and oil and gas exploratory boreholes are situated. The detailed investigations carried out in 2004-2009 by Ukrainian-Polish expeditions were focused on discovering the possible new sites of fauna fossils and human remains of European early modern humans (EEMH). The future discoveries at the paleontological site of Starunia are extremely important. They intend to carry out ecological assessment of soil, surface and spring waters, atmospheric air, snow, ashes of meadow grasses, radiological screening, and geo-radar sensing to find new locations of extinct mammals. The Starunia area meets all the requirements of a geopark according to UNESCO standards and concepts. The first research findings (1907) included the remains of woolly rhinoceros, mammoth, horse, roe deer and other Pleistocene mammals which were found in the ozokerite mine at the depth of 12 m near Starunia (Bohorodchany district, Ivano-Frankivsk region). In 1914 the scientists from Lviv (Ukraine) and Krakow (Poland) fully appreciated these discoveries and published a set of articles and a monograph. In 1929 the members of the expedition of Skill Academy (Krakow, Poland) found the remains of three more woolly rhinoceroses in the ozokerite mine at the depth of 17 m. Numerous bones of vertebrates (rodents), remains of mussels, a lot of species of insects, beetles, parasitic worms, fleas, butterflies, spiders, snails, vascular plants, mosses, seeds and branches of dwarf birch (*Betula Nana*), alder (*Alnus glutinosa*), and other fossil of tundra flora were also discovered. Polish scientists organized detailed investigations of flora and fauna around Starunia, their results were published in the articles, but World War II suspended this process. The investigations around Starunia intensified the comprehensive study of stratigraphy, paleontology, paleogeography, geochronology and other aspects of the Quaternary Period. In 1932 the International Geological Congress (the International Union of Quaternary Study) was established in Leningrad by INQUA. The main methodological principles of this study dealt with the investigations around Starunia.

Key words: Starunia, ozokerite, Pleistocene, Carpathian region, Quaternary period.

Introduction. Near the village of Starunia, on a small conservation area of 60 hectares, fields of oil, ozokerite (earth wax), salts and the world-famous paleontological location of fossil rhinoceros fossil fauna, mammoths, and other animals that lived for about four thousand years were collected together (glacial) period. The scientific uniqueness of these findings is that in the ozokerite layers of the salt carcasses (and not just the skeletons) of the giant fossil found, they embalmed and retained their integrity along with soft tissues.

The carried out investigations according to the analysis of biological material provided a detailed description of flora and fauna, and of climate conditions of the researched period (Bayger, 1914). In addition, in the 70s of the last century as a consequence of the earthquake in the Carpathian Mountains (Vrancea seismic zone, Romania) the only active Carpathian mud volcano eventuated at the Starunia ozokerite deposit and at the site of paleontological discoveries. Scientist noticed the causal connection between volcano eruptions and earthquake risk on the nearby Carpathian territory. The unique feature of this mud volcano is that it can respond to seismic manifestations in advance before it causes severe destructions and significant damage to the area (Adamenko, Karpash, Zorin, Kotarba, Mosiuk, Kovbaniuk, 2017; Belous, Kiliarovskyi, 1987).

In 2005 the professor of the Department of Ivano-Frankivsk National Technical University of Oil and Gas (IFNTUOG) O. Adamenko proposed an idea to create the Park of the Ice Age at the Starunia area (Adamenko, Krizhanivskiy, Stelmach, Mischenko, Zorina, Zorin, Ambrozyak, 2005b), (fig. 1), which might include appropriate infrastructure based on scientific, health, medical, recreational

establishments as well as the museum of large mammals and other flora and fauna fossils of the Quaternary (glacial) period/Similar parks function in the Czech Republic, Austria and other countries. The Ice Age Park in Ukraine has the following unique features: a) cognitive value for visitors and tourists; b) extraordinary historical, natural, and scientific peculiarities of the Starunia area; c) investment attractiveness. Such a park will provide firstly not recreational potential of Starunia but scientific and cognitive background of the area, and finally will propose a kind of salt-mud-ozokerite therapy and treatment (Alexandrowicz, 2004).

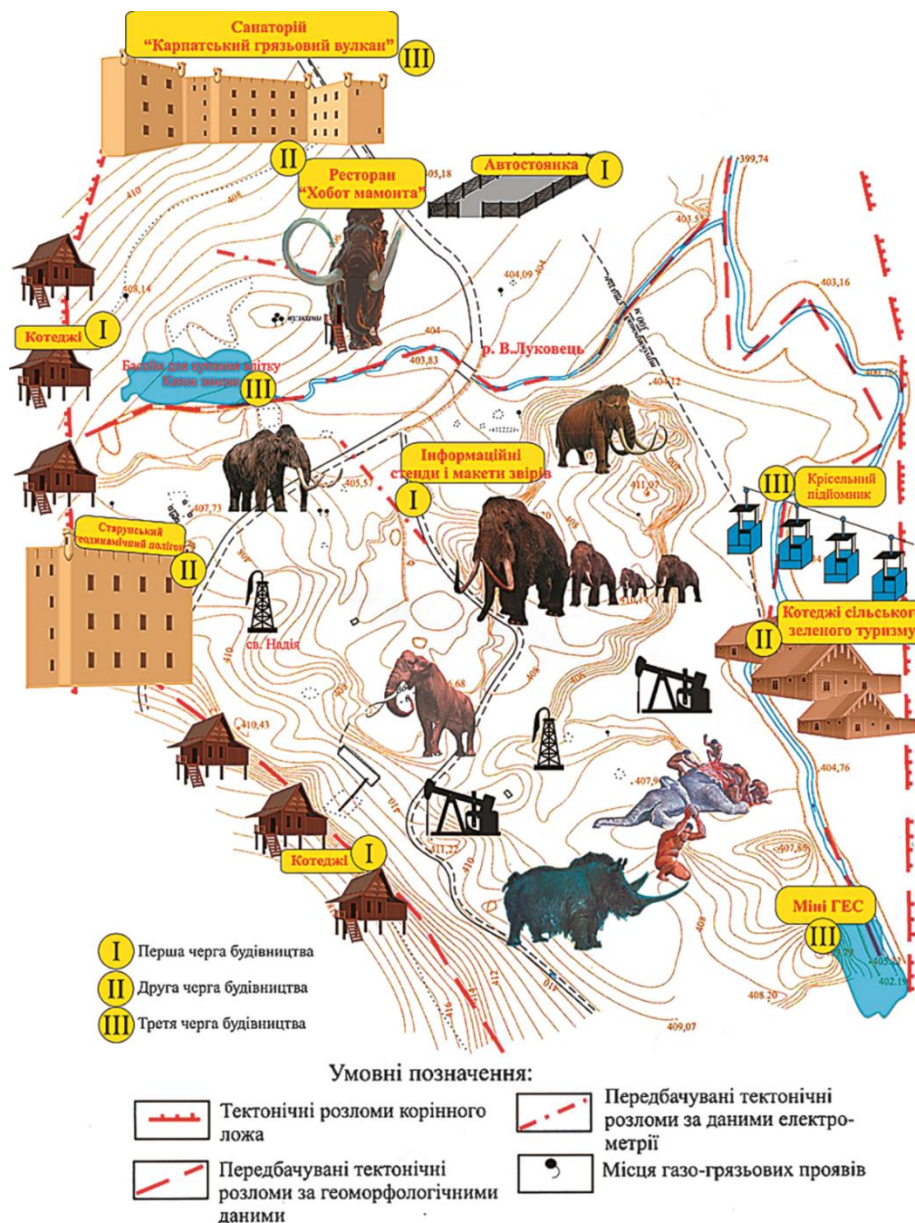


Fig. 1. The project of ecological-tourism center “Ice Age Park”

The university (IFNTUOG) has been promoting this idea for 15 years. There is an open exposition "Starunia: Park of the Ice Age" in the university's museum that presents interesting facts and details about the park with the help of modern visual and multimedia means to all visitors. By the way, the museum mineralogical collection has a great national and scientific value. The scientists take part in different TV programs, radio broadcast, publish the information about the Starunia area in newspapers and on websites. Unfortunately, the idea of a successful business project to create the park of the Ice Age in Starunia is still waiting for the realization and investment.

The results of the investigations show Starunia is waiting for future discoveries. In 1907 the first researchers of the Starunia paleontological site (Bayger, 1914) noted the probable causes why Pleistocene mammals had sunk into the salt lake enriched in ozokerite, studying the remains of the woolly rhinoceros. It is worth mentioning that in 1914 professor M. Lomnitskyi wrote about a round hole in the skull of the

woolly rhinoceros, and about a piece of wooden spear burned with a fire and cut by a sharp object that had been found nearby. These facts prove the existence of Cro-Magnons (European early modern humans). It seems that the animal could have been unsuccessfully hunted by Cro-Magnons (EEMH) and due to the unique chemical consecration of Pleistocene mud, the conditions for perfect preservation of mammals had been produced.

It should be mentioned that in the 70s of the last century Ukrainian scientists found, researched and described the sites of primitive people's settlements (their tools, signs of human habitation, etc) dated 10-50 000 years ago. Thus, there are some significant reasons to find remains of Cro-Magnons (EEMH) at the Starunia area, among them: a) the content of bitumen and salt is favourable for human remains preservation; b) human remains may represent ancient hunters, ritual victims of human sacrifice or criminals who were punished by throwing to die into ozokerite mine.

It is very important, from the point of the scientific aim, to find the remains of mammals and of ancient people Cro-Magnons (EEMH). These fossil discoveries of the past have power to become a world-wide scientific sensation due to studying of human origin and to glorify researchers, investors, explores and country where all these deposits were landed.

The first research findings (October, 1907) are connected with the remains of the woolly rhinoceros, mammoth, horse, roe deer and other Pleistocene mammals which had been found in the ozokerite mine at the depth of 12,5 m near Starunia (Bohorodchany district, Ivano-Frankivsk region). In 1914 the scientists from Lviv (Ukraine) and Krakow (Poland) fully appreciated these discoveries and published a set of articles and a Monograph (Bayger, 1914).

In 1929 the members of the expedition of Skill Academy (Krakow, Poland) found the remains of three more woolly rhinoceroses in the ozokerite mine at the depth of 17,6 m. Numerous bones of vertebrates (rodents), remains of mussels, a lot of species of insects, beetles, parasitic worms, fleas, butterflies, spiders, snails, vascular plants, mosses, seeds and branches of dwarf birch (*Betula Nana*), alder (*Alnus glutinosa*), and other fossil of tundra flora were also discovered (Szafer, 1930). The World War II suspended the process and results of investigations of flora and fauna around Starunia (Kotarba, 2005). In the postwar years 1945-1969 ozokerite mining was continued around Starunia and Dzvinych (Ivano-Frankivsk region, Ukraine) and the petroleum exploration was carried out but its deposits weren't enough for oil exploitation in industrial use (Adamenko, Stelmach, Zinchuk, Kotarba, 2005a).

In March, 1977 as a consequence of the earthquake in the Carpathian Mountains (Vrancea seismic zone, Romania) the first and still the only mud volcano eventuated at the Starunia ozokerite deposit (pic.4) In the years 1977-1988 professors of IFNTUOG N. Bilous and V. Kliarovskyi (Belous, Kliarovskyi, 1987) who studied the mud volcanism around Starunia registered that area of 60 hectares as a geological monument of country importance. Such geologists as O. Adamenko, O. Stelmakh, H. Stelmakhovych, N. Shevchyk, V. Kolenchenko (Department of General Geology, IFNTUOG) were involved to the study of Starunia concurrently. They were joined by D. Drahant (Chornobay, Drygant, 2009) and others paleontologists of the Natural History Museum of the Academy of Science of Ukraine (Lviv, Ukraine); by L. Matskevych (2005), an archeologist of the Institute of Ukrainian Studies after I. Krypnyakevych of Academy of Sciences of Ukraine; by B. Vasylenko and I. Kochkyn archeologists of Ivano-Frankivsk Vasyl Stefanyk Pedagogical Institute. There were discovered several sites of ancient humans of the late Paleolithic, Mesolithic, and Neolithic (Kuc, Rozahski, Goslar, Kubiak, Kotarba, 2005).

In 1988-1989 the researchers of IFNTUOG (O. Adamenko, O. Stelmakh, L. Mykhalska, I. Mykhailuk) carried out a detailed investigation of Starunia on the financing of the Ministry of Education and Science of Ukraine. Accordingly, topographical survey (1: 10 000 (by R. Pylypiuk)) and radiometric survey (by V. Stepaniuk) have been completed around the Starunia area.

Material and Methods. In 2004 two Ukrainian-Polish expeditions were organized under O. Adamenko (professor of department of ecology of IFNTUOG) and M. Kotarba (president of Polish society "Geosphere", professor of AGH University of Science and Technology (Polish Akademia Gorniczo-Hutnicza im. Stanisława Staszica) guidance. In 2005 the research results of both expeditions were published in the monograph (Kotarba, 2005).

In 2006 - 2009 most core samples were obtained by drilling 33 core boreholes to study in details cross-section II and I of fluvial terraces and the Velyky Lukavets river valley that was reflooded. Using modern tools and equipment, geological and geomorphological, geophysical and geochemical studies were continued. Radiocarbon ages of sediments suggest the minimum age dated between 46 - 10 000 years ago (Kuc, Rozahski, Goslar, Kubiak, Kotarba, 2005). The analysis of pollen diagrams,

paleocarpological and malacofauna complexes determined the Late Pleistocene age of mammoth and woolly rhinoceroses (Sokolowski, Stachowicz-Rybka, 2009).

In April 2019, experts Volodymyr Ivashchuk (Transient, Kyiv) and Anatoliy Chernov (Taras Shevchenko National University, Kyiv) performed geo-radar sensing, which showed the prospect of electromagnetic waves in order to find out layered structure and construction of underground relief, distributions of paleo-swamps and to discover new mammoth fauna sites.

The authors suggest continuing the future discoveries at the paleontological site of Starunia. They intend to carry out ecological assessment of soil, surface and stream waters, atmospheric air, snow, ashes of meadow grasses, radiological screening, and geo-radar sensing to find new locations of extinct mammals.

In 2006-2009, M. Kotarba organized the drilling of 33 wells with a depth of quaternary deposits (up to 10-20 m) with 100% core extraction. The geological and geophysical, geomorphological, and geochemical studies, the results of which were published in 2009 in the book "Interdisciplinary studies (2006-2009) at Starunia (Carpatian region, Ukraine) – the area of Discoveries of Woolly Rhinoceroses" (2009). The most important result was the detection of areas where they could at a depth of 5-20 m in bituminous impulses not yet found remains of giant mammals, and maybe hunters on them - Cro-Magnon.

In 2015-2018 at the Staunun paleontological site in the study of ecologists and geologists IFNTUNG AN Adamenko, TO. Zorina, V.M. Omelchenko, TV Kalinium from ecological-techno-geochemical state Soils, surface and groundwater, snowfall, surface layer radiation, etc., using drone observations. On the initiative of O.M Karpash with the participation of D.O. Zorina, I.I. Kovbanyuk, M.V. Mosyuk and IFNTUNG Architects created a model of the future Ice Age Park at the University Geological Museum and published in 2017 the monograph "Old Woman: Ice Age Park". In 2018, the old rhinoceros rhino # 1 was restored to life in the Lviv Museum of Natural Sciences of NASU, which was widely reported in the media.

The network of ecological research includes geo-ecological profiles and geo-ecological landfills. The latter are sampling points for various types of analysis to identify man-made pollution. The results of the analyzes are summarized in the databases of environmental information, and on their basis they build elementary and component ecological-techno-chemical maps, the computer integration of which "builds" a map of the current ecological situation and ecological state of the environment.

Results and discussion. Analysing the area of distribution of various environmental components and the location of man-made objects - power lines, product pipelines, etc., we offer a network of environmental studies of 4 environmental profiles of northern-eastern south-western orientation and 3 geo-ecological profiles of western-eastern orientation there are 133 geo-geological landfills - sampling points for different types of analysis to determine the content of pollutants. At the points of intersection with the profiles of linear technogenic objects (transmission lines, product pipelines), the number of samples increases, the network thickens. This is necessary to cover all possible differences in the distribution of geocomponents and their changes depending on the geo-ecological substrate.

Starunia geoecological polygon is situated in Boruslav-Pokutia zone Precarpathian territory and it's the basis of oil-bearing zone.

The Quaternary part of the geological section from top to bottom is represented by the Miocene molasses of the Oratory area, often of saline, impregnated ozokerite. Below is: the so-called flysch – multiple rhythmic alternation of sandstones, siltstones and mudstones in the ages from the Upper Cretaceous to the Lower Miocene (Stryi-Minilitic world).

The Boryslav-Pokut (Inner) zone of the Pre-Carpathian Bend is a complex of roofs, slanted one by one in a northeast direction. The zone to the south-west borders with the Skibovy Carpathians, and to the northeast - to the Siberian, and further to the Bilche-Volytska (Outer) deflection zone, which borders to the northeast with the Eastern European Platform. Oil and gas is associated with several horizons of the menyllite world (Oligocene-Lower Miocene) and the Middle Eocene. Several oil and gas fields are located in the immediate vicinity of Staroun - Gvizdetskoye, South-Gvizdetskoye, Monastyrchanskoye, Nnovskoye, Pasichnianskoye, Bytkov-Babchinskoye. To the northeast of Staruni there is another deposit of ozokerite - Dvzynyatske, and to the north of it there is the Starunskoye deposit of natural salts.

A quarter of the geological section has only been studied in recent years, after well drilling and core exploration. The geological map of Quaternary sediments was made by OM Adamenko, TV Kaliniy and M.I Mosuk 2017 (Fig. 2) using aerospace information and unmanned aerial vehicle drones.

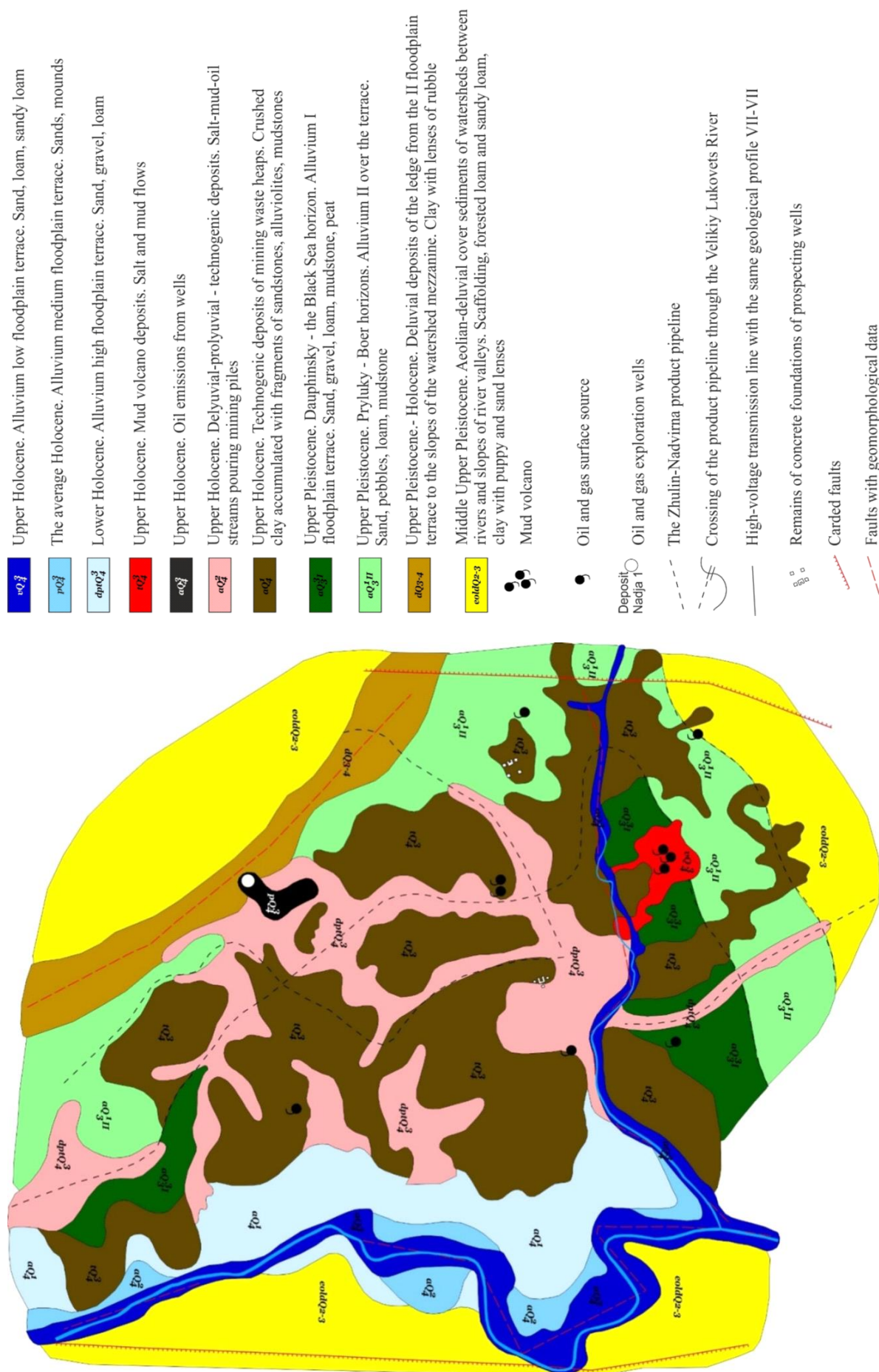


Fig. 2. Quaternary sediments

The southeastern part of the study area is occupied by the slopes of the watershed, which is covered by eolian-deluvial forest loam. The same slope is along the eastern boundary of the Old Geodynamic Landfill. Lukavets Big river valley with II and floodplain terraces (upper Pleistocene), folded river beds, gravel and sands at the bottom of the section, and most of them are dark gray, often bituminous, peaty mudstones that fill the recessed. The remains of four hairy rhinos, mammoths and others were found in the lower sections of the alluvium section and the terrace.

Archaeological research. In 1976-1982, the Precarpathian Archeological Expedition of the Institute of Social Sciences (now known as the I. Krypiakevych Institute of Ukrainian Studies, Lviv) of the National Academy of Sciences under the leadership of LG Matskev (LG Matskey, 2005). comprehensive research in the vicinity of the village. Elder. As a result, 12 partially 2-3 layered stands were found near the paleontological site, in which at least 17 ancient human settlements from the Paleolithic to the Middle Ages were traced. So, for thousands of years, the territory has been conducive to the settlement of our ancestors who hunted large animals.

This opens the possibility of searching the Old Man himself from the Cro-Magnon Era to later eras. Such finds can be found in settlements and ancient marshes. Stationary excavations have so far been carried out only on the Mesolithic and Neolithic 1649 m2 sites. More than 5,000 artifacts and faunistic remains have been found (Old Woman and Vorotsiv Culture - Old Woman). It is advisable to spend, writes L.G. Matskev (LG Matskey, 2005), excavations at the Stairs of Stare IV and XI, located closest to the findings of hairy rhinos and mammoths.

Malacofauna, paleocarpological and palynological studies (Kotarba, 2005, 2009) have shown that the Quarantine of Staruni is characterized by repeated alternation of periods of cooling with tundra flora (Butela nana and others) and warming of the Ice Age.

On the territory of 60 hectares of natural and ethno-cultural monument the old woman of the creation of the Ice Age Park has three consecutive stages (Fig. 3). Perhaps is the formation of information stands and models of ancient animal inhabitants of Staruni and its surroundings - mammoths, rhinos, deer, etc. from decorative boxwood shrubs and other materials. There is also a parking lot located to the right of the entrance to the Ice Age Park, cottages for rural green tourism are being built.

The second stage is the creation of a three-storey building of the Starun Geodynamic Center with a conference room, laboratories and offices for further research of endo- and exo-geodynamic processes, which have taken place and continue their activity in the natural environment of the region: seismic, modern tectonic movements, mudslides, mudslides anthropogenic geomorphological processes. "Park" contains models of oil "rocking chairs" and gas wells, cottages are being built on the left bank of the river (Lukavets Velikiy, restaurant "Hobot Mamonta").

The third stage includes: a) three-storey sanatorium "Carpathian mud volcano" for mud-salt-ozokerite treatment and use of 11 types of mineral waters; b) chair lift on mountain Golitsa for skiing in winter and forest for mushroom and berry tourism in summer; c) facilities for generating electricity from alternative energy sources for the Park and for sale to the state grid, including: small hydroelectric power plant on the Velikiy Lukavets river solar panels on convenient slopes of the monument, wind power installations on the eastern outskirts of the monument and heat pumps on some side exits Crater of mud "Starunya volcano".

This is how the authors present the geotourism project "The Park of Ice Age".

What is the significance of the Ice Age Park for a particular village, an interesting region of the Carpathian region, in the whole state of Ukraine? The initiation of further scientific research, education and recreational activities in the area of Starunia will certainly help in solving the following problems:

- environmental protection - raising the status of Staruni from the lowest category of nature reserve fund - nature monuments to the highest category of an international Geopark according to UNESCO heritage standards;

- scientific - reconstruction of paleoecological conditions of biota development over the last 100-150 thousand years, which is important for forecasting global climate change;

- tourist and recreational - justification of the development of ecological tourism, rural green tourism and tourism business in general in the near to the Ivano-Frankivsk recreation zone, the direction of international tourist routes to Starunia Geopark "Ice Age Park";

- therapeutic - expanding the possibilities of salt-mud-ozokeritotherapy and the establishment of a sanatorium "Carpathian mud volcano" in Starunia;

- historical and cultural - preservation of both natural and historical and cultural heritage;

- socio-economic - creation of new jobs for the population of Staruni and neighboring united territorial communities, improvement of demographic situation, reduction of anthropogenic (technogenic) impact on natural ecosystems and population health.

In 2019, an ecological-cultural project "Small Cities - Great Impressions" of the Stara Zagora Village Council and the Association of Rural, Settlement Councils and United Communities of Ukraine, the Ministry of Culture of Ukraine with the participation of the Ivano-Frankivsk National Technical University of Oil and Gas was implemented. To simulate the figures of mammoth, rhino, deer and hunter-cutter, the technique of Topiar Art, known since Roman times, was used. On October 26, 2019, a festival took place - the opening of the Ice Age Park in the presence of 17,000 visitors. The real implementation of the scientific idea in life began (fig. 3-5).

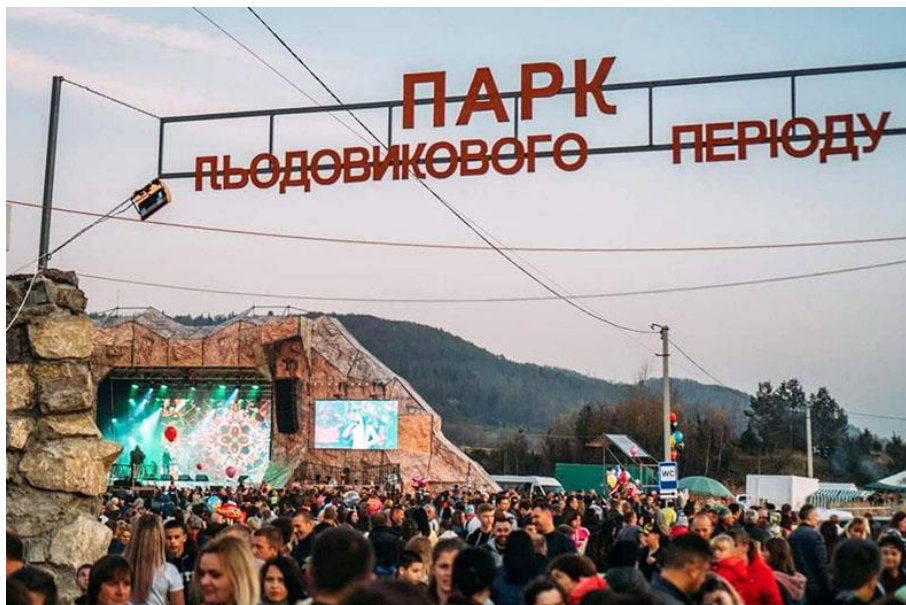


Fig. 3. Opening the Ice Age Park in Starunja village (26 of October, 2019)

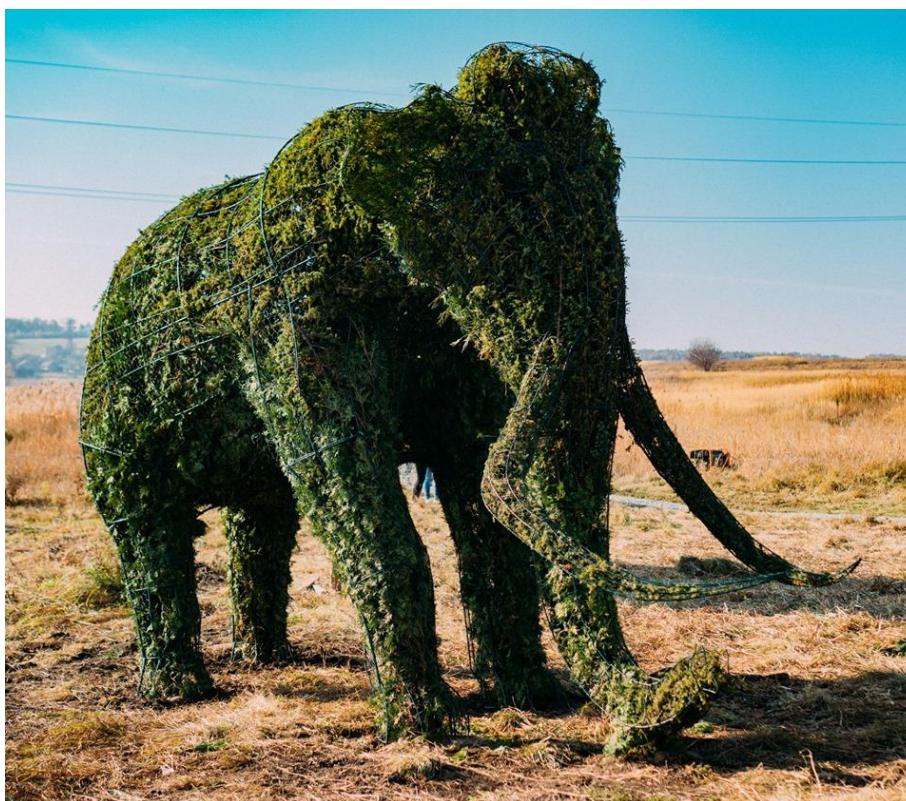


Fig. 4. Mamuthus



Fig. 5. The geo-radar sensing in Starunja (photo by I. I. Kovbaniuk)

The sensation of the festival was four large figures: a mammoth, a rhino, a deer, and a crocodile made in the style of Topiary. It is one of the oldest landscape gardening arts. Masters of Topiary give figures of animals, plants, flowers of various forms of architectural structures, people, etc. Master of Topiary art from Lviv Bohdan Luchka. He studied this ancient, since Roman times, art in France. For the Ice Age Park, four figures were made by a team of 12 specialists for three months, made of durable material - galvanized steel. In the skeleton were young "thuja", the growth of which can be managed by non-specialists: they need to be trimmed to give the necessary shape to the frame planted in the frame. Topiary shapes can be made without a frame, but it will take many years.

For many hours on the 26th and all day of October 27, the theatrical action "Volcano of Life", fiery holographic 3D-show, performances of Carpathian Moths, drummers, folk ethno duets took place. There were enough magical impressions, people's colors, positive energy and so on.

Conclusions. Scientific researches on the geological monument of nature of the national value of "Starunya" should be continued first of all in ecological direction. It is the construction of geological, geomorphological, soil maps in accordance with existing standard requirements for state maps of scale 1:10 000.

It is necessary to test the soil cover and eluvium of technogenic deposits of mining waste heaps, to make analyzes of samples for the content of major pollutants - heavy metals, petroleum products, radioactive substances, etc. The same tests and analyzes should be carried out for surface and spring waters, sediments, atmospheric air, rain and snow, and vegetation. Then build appropriate databases, and on their basis - computer (electronic) elemental and component ecological and techno-geochemical maps and maps of ecological situation and geo-ecological zoning. This will allow scientifically sound development of specific environmental measures - both long-term and operational, if required. The method of such geo-ecological analysis can then be implemented in the territories of the local level. There are no similar techniques yet.

The uniqueness of the Starunia Nature Monument and the level of its study already achieved require the task of local authorities and the Ministry of Ecology and Natural Resources to raise the level of Starunia as a geological and geomorphological nature monument to the highest level of conservation - a geopark with international status according to the standards of natural decline UNESCO.

It is necessary to continue the popularization of the old-fashioned phenomenon in order to attract sponsors to create a worthy ecological-geotourism center for our country - the "Ice Age Park".

The authors, staff of the Department of Ecology IFNTUNG, members of the Scientific School of Oleg Adamenko "Rational use and protection of nature" believe that the main task of the Park of the Ice Age is not to search for new burials of embalmed mammoths, rhinoceroses, and maybe even Cro-Magnons by excavating 50 prospective sites depth of 10 m (which is 12,500 cubic meters of earthwork), as suggested by some media, and most importantly - to study the changes of landscapes and climate under the influence of global warming and periodic cooling and warming for forecasting and pursuing these dangerous processes.

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²Дністровське басейнове управління водних ресурсів

ЧЕТВЕРТНІ ВІДКЛАДИ ТА ЕКОЛОГІЧНИЙ МОНІТОРИНГ ПАРКУ ЛЬОДОВИКОВОГО ПЕРІОДУ КАРПАТСЬКОГО РЕГІОНУ УКРАЇНИ

Міжнародний геопарк «Парк Льодовикового періоду», розташований поблизу села Старуня Богородчанського району Івано-Франківської області, відомий на весь світ тим, що є палеонтологічним об'єктом плейстоценової фауни шерстистих носорогів і мамонта (Еемський міжльодовиковий період – 46000-10000 років тому за даними радіовуглецевого датування C14) і завдяки унікальному в Карпатському регіоні грязьовому вулкану. Це геологічна пам'ятка природи площею 60 га, де представлені покинуті озокеритові шахти та нафтогазорозвідні свердловини. Детальні дослідження, проведені у 2004-2009 рр. українсько-польськими експедиціями, були зосереджені на виявленні можливих нових місць скам'янілостей фауни та людських останків європейських ранньомодерних людей (ЕЕМН). Майбутні відкриття на палеонтологічній стоянці Старуня надзвичайно важливі. Вони мають намір провести екологічну оцінку ґрунту, поверхневих і струмкових вод, атмосферного повітря, снігу, попелу лучних трав, радіологічний скринінг та георадарне зондування для пошуку нових місць вимерлих ссавців. Територія Старуні відповідає всім вимогам геопарку за стандартами та концепціями ЮНЕСКО. Перші знахідки досліджень (1907 р.) пов'язані з останками шерстистого носорога, мамонта, коня, козулі та інших плейстоценових ссавців, які були знайдені в озокеритовій шахті на глибині 12 м поблизу Старуні (Богородчанський район Івано-Франківської області). У 1914 р. науковці зі Львова (Україна) та Кракова (Польща) повністю оцінили ці відкриття й опублікували низку статей та монографію. У 1929 році учасники експедиції Академії майстерності (Краків, Польща) знайшли в озокеритовій шахті на глибині 17 метрів останки ще трьох шерстистих носорогів. Численні кістки хребетних (гризунів), рештки мідій, багато видів комах, жуків, паразитичних червів, бліх, метеликів, павуків, равликів, судинних рослин, мохів, насіння та гілок карликової берези (*Betula Nana*), вільхи (*Alnus glutinosa*) та інші викопні залишки тундрової флори. Польські вчені організували детальні дослідження флори і фауни навколо Старуні, їх результати публікували в статтях, але Друга світова війна призупинила цей процес. Дослідження навколо Старуні активізували всебічне вивчення стратиграфії, палеонтології, палеогеографії, геохронології та інших аспектів четвертинного періоду. У 1932 році INQUA створив Міжнародний геологічний конгрес (Міжнародний союз четвертинних досліджень) у Ленінграді. Основні методологічні засади цього дослідження стосувалися досліджень навколо Старуні.

Ключові слова: Старуня, озокерит, плейстоцен, Карпатський регіон, четвертинний період.

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