

PHYSICAL-MECHANICAL AND TECHNOLOGICAL FEATURES OF AMBER EXTRACTION IN THE RIVNE-VOLYN REGION OF UKRAINE

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Abstract

The main challenge facing the mining industry is to ensure the growth of minerals by enhancing mining in the most efficient open and underground way based on the widespread introduction of advanced technology and mining equipment.

In today's economic conditions, the efficiency of the mining equipment can be increased by substantiating the rational factors that affect the process of hydro mechanized production and improvement of existing technological equipment based on the application of the automatic control system of hydro-erosion. However, well-known mining technologies do not allow the full extraction of amber due to the imperfection and lack of effective technology for the complete extraction of amber from amber-containing deposits.

The complexity and the large number of possible production processes and the specifics of the operating conditions of the fields indicate that for the exploration and extraction of minerals there is a need for additional research of equipment complexes in the composition of hydro monitors. Increasing the efficiency of such

complexes by reducing energy costs while increasing the range and improving the quality of production requires scientific justification of the parameters of the components of the production complexes of a new technical level.

Physical-mechanical and technological peculiarities of amber extraction in Rivne-Volyn region of Ukraine are presented.

1.1. Physico-mechanical and chemical properties of Ukrainian amber

In the Rivne region, amber deposits are taken out by excavator at the Klesiv field. The extracted rock is delivered to the flushing unit located on the industrial site by road. Initially, the rock enters the loader, from which the conveyor is fed to the screen, equipped with a metal mesh with square cells with a diameter of 5 mm. Above the screen, at a height of 20 cm from the grid, there is a system of tubes into which water is pumped under pressure. It irrigates rocks, washes clay, sand, silicon, fragments of crystalline rocks and amber smaller than 5 mm, bringing them into a specially prepared quarry. Pieces of rock and gem of size 5 mm or more come to the conveyor for development. Here, the amber is separated manually from the breed containing it. Since 1980, more than 100 kg of mineral resources have been extracted from the field since 1980, 95% of the amber produced belongs to the category of jewelry [1-20].

The most energy-intensive and cost-effective process is the removal of cross-breed, which is of great value to the enterprise, but the cost of amber increases.

Amber is a high molecular weight organic acid compound containing an average of 79% carbon; 10.5% hydrogen; 10.5% oxygen (Fig. 1). It's formula $C_{10}H_{16}O$. In the amber, 24 chemical elements (Y, V, Mn, Cu, Ti, Zr, Al, Si, Mg, Ca, Fe, Nb, P, Pb, Zn, Cr, Ba, were detected in the amber (from traces up to 3%) , Co, Na, Sr, Sn, Mo, Yb). Of these, 17 were found in the lowland amber of the Klesiv deposit, 12 in the amber of the Beach section of the Primorsky deposit, 11 and 13, respectively, in the amber of the Curonian Spit and the Carpathian region. The least amount of chemical elements is contained in transparent amber. This mineral may be white, yellow, greenish, blue, red in color, but orange and golden yellow varieties are typical. The mineral is amorphous, soft (hardness of 2.2-2.5 points on the Moos scale), viscous, easily polished and polished. Its density is 1.05-1.096 g/cm³. In terms of

classification, this mineral is representative of the group of combustible minerals - humus coal of the category "lipobiolites". Chemically, it is a high molecular weight compound of organic acids, usually with sulfur impurities. At a temperature of 150 °C amber softens, at more than 300 °C melts. It burns easily, giving off a resinous odor. The mineral has dielectric and heat-resistant properties, in nature occurs in the form of grains and pieces of size from 1 to 10-20 cm or more in diameter, but also find very large pieces - up to 10 kg in weight. The shape of the pieces can be any: drops, icicles, influxes of various irregular shapes, porous plates [13-15, 25].



Fig. 1. Polissya amber

The elemental composition of the amber of the Beach section of the Primorsky (South Baltic) and Klesiv(Ukraine) fields, the manifestations of the Carpathians is close. The average content of the main components (C and H) in them are respectively 80.78% and 10.12%; 78.05% and 9.55%; 79.68% and 10.07%; 78.26% and 9.99%. (Fig. 2).

The content of succinic acid in Baltic amber (succinate) ranges from 3 to 8%. Depending on the type of amber, it is distributed differently. In transparent amber, succinic acid contains from 3.2 to 4.5%, in Bastardo - from 4.0 to 6.2%, in bone amber - from 5.5 to 7.8%, in the oxidized crust - 8.2 %. Amber composition and structure continue to be studied. The volatile part (about 10% by weight) has been known for a long time. These are aromatic compounds - terpenes with 10 carbon atoms and sesquiterpenes with 15 carbon atoms in the molecule. According to mass spectrometric studies,

more than 40 compounds are included in amber. Many are not yet known. In amber form, abietic acid and its isomers are isolated from amber. They make up part (20-25%) of Baltic amber in organic solvents. Mineral inclusions in amber are represented by iron sulfide - pyrite and bituminous substance. Among the gas inclusions in the amber composition were found CO₂; O₂; H₂; Ar; Kr; Xe; No, nitrogen predominates. Amber residue, insoluble in any of the known solvents. IR- spectrometry data showed that "succinate" contains lactone (ester) groups, is an ester. In addition, the amber constantly contains succinic acid (about 4%) and impurities of salts (mainly succinic) potassium, calcium, sodium, iron (up to 1%). Thus, amber consists of three groups of compounds: volatile terpenes and sesquiterpenes; soluble organic acids; insoluble polyesters of these acids with alcohols formed from the same acids [12, 19-24].

Amber of Ukraine contains up to 3.19% of sulfur.

Rivne amber differs in its chemical composition. It is the most saturated with impurities and contains 18 chemical elements. In addition to silicon, magnesium, iron, calcium, which are present in almost all deposits, such as lead, zirconium and up to 3.19% sulfur are added. The ash content of Klesiv amber is 8.7%. This affects the quality and color of the cured resin. Amber is a mineral of the class of organic compounds, the coniferous tree resin in the main Paleogene period. Amber composition: volatile aromatic oil, two soluble resin fractions, succinic acid and 90% insoluble fractions. Its chemical formula is C₂₅H₄₀O₄. Amber is an amorphous polymer that has many colors, gives a specific IR spectrum (within 700-1900 cm⁻¹) that distinguishes amber from other similar resins. The melting point $t=365-390$ °C. Specific gravity - 1000-1100 kg/m³ (in the Baltic states there are also 970 kg/m³, and in the Carpathian region - 1220 kg/m³). Well machined. It is insoluble in water (partially in alcohol - 20-25%, ether - 18-23%, chloroform - up to 20%), but it can swell and increase in volume up to 8% during long stay in it. Completely decomposes in hot concentrated nitric acid, can be softened at $t=100$ °C.

The cost of the amber depends on the uniqueness of the amber specimens and is determined by a peer review team.

To determine the cost, a technique has been developed that includes the classification of amber pieces by shape (shape A, B, C, D), size (1 to 5) and color (Color1, Color2, Color 3 and Color 4).

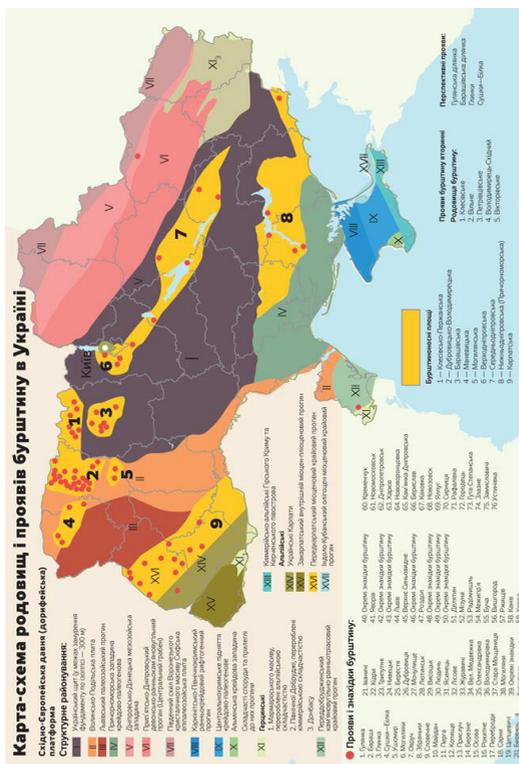


Fig. 2.. Map of amber manifestations in Ukraine

1.2. Geological features of the location of amber deposits

In nature, amber occurs in the form of amorphous bodies of various shapes and sizes. The weight of amber found in nature can range from grams to several kilograms. And the largest Burmese amber in the world can be seen in the Natural History Museum in London weighing 15 kg 250 grams.

Small deposits are located on the Gdansk Bay in Poland and on the North Sea coast in the Netherlands, Germany and Denmark. The content of the gem in the Stubbenfeld field on the island of Usedom is 0.357 kg/m³. Depth of occurrence of blue earth 80-100 m from the surface.

The Paleogene layers of the Southern Baltic are only part of the vast amber horizon, which is exposed in Belarus (in the Minsk and

Grodno regions) and in Ukraine (the Klesiv deposit in the Rivne region). The presence of this horizon is confirmed by drilling operations carried out in Poland, in particular in the Eastern Seaside and in the vicinity of Braniewo, as well as in the Western Pomerania between Slupsk and Koszalin. The German researcher G. Conventz considers that amber breeds continue in the western direction to the coast of England [15-23].

Amber has been known in Ukraine for a long time. Its first developments are known near Kiev (Mizhgirya and Vyshgorod districts) and in Volyn (near modern Klesov). In 1870, 50 pieces of gem of different sizes weighing just over 800 grams were found in one layer near Kiev. Amber was washed by the Dnieper and other rivers with floods, carried away by melt and rain water from beams and ravines. In the distant times, its extraction not only satisfied local demand, but also made it possible to export it to ancient countries along the shores of the Mediterranean Sea and to the eastern states. However, the surface development of small Kiev deposits available for miners was gradually developed and forgotten [15-17].

Small manifestations of amber have long been known in the western regions of Ukraine on the territory of the present Lviv and Ivano-Frankivsk regions. In the tertiary deposits of Lviv and its environs, amber was found in the middle of the last century. Amber was not only mined in the Dnieper and its tributaries, in Volyn and Carpathian, but also cultivated in these places. Amber in composition and properties is not inferior to the Baltic. Therefore, it was sometimes called the Kiev succinates.

Amber is now found in Neogene deposits, which cover sulfur ores in the Yazivsky, Nemyrivsky, Rozdilsky and Podorozhny fields and in the Rechychansky sulfur manifestation. More than 2000 pieces of gem from millimeter to 25 cm have been accumulated in the quarry of the Yaziv deposit.

Amber is colorless, yellow-white, yellow, brown-yellow, light and yellow-brown, transparent, translucent and opaque. Changes in the degree of transparency of the stone by section were observed. Transparent amber is concentrated in its middle [15-19].

In geotectonic terms, the Klesiv Amber Zone is located at the junction of the northwestern slope of the Ukrainian Crystalline Massif, Volyn-Podilskyi Plate and the Pripyat Basin and has a two-

tier structure. The morphology of the present surface of the crystalline base is determined by its structural position on the northwest slope of the shield.

On the project area, the crystalline foundation is covered with Cenozoic and Quaternary sediments and has absolute marks of 130-170 m above sea level, gradually sinking in the northern and western directions with a slope of 10 m per 1 km. The general tendency to dive is complicated by some local elevations of the projections of the shield. The crystalline foundation is the ultra-metamorphic, metasomatic and intrusive formation of the lower and middle Proterozoic.

The outcrop nature of the relief of the foundation with the development of oval, isometric or irregular projections of Precambrian rocks with an area of 1 to 10 km, separated by relatively narrow (first hundreds of meters) and elongated (first kilometers) depressions, was established. In modern relief, they correspond to wetland valley sections, the relative excess of the projections of the basement over adjacent depressions averages 10-12 m. On the bark of weathering crystalline rocks lies a discontinuous layer of bluish-gray, sometimes greenish-gray, dense, viscous clay up to 2.5 m. The age of the clay is Lower Oligocene. Two layers of glauconite-quartz sands of oligocene age of different color shades, which are productive horizon, lie on the clays and in the places where they are absent, on the bark of weathering crystalline rocks. The lower layer of amber-bearing rocks is represented by fine-grained sands of dark gray, sometimes greenish in color and medium-grained sands of dark gray with a bluish-gray tint. The rocks are water-saturated, the thickness of the layer varies between 1.0-6.0 m. In the lower part of the section, thin (2-3 cm) layers of humus substance of black color are noted.

The upper amber-containing layer is represented by fine-medium-grained gray, light-gray sands, saturated with water, containing a considerable amount of humus substance, unevenly distributed throughout the formation. In the section there are small (1-3 cm) layers of lenticular clay layers, as well as plant residues and roots. The average layer thickness is 2.0 m. Oligocene sediments are covered by the Quaternary formations, which are represented by light yellowish-gray, gray, light gray fine-grained quartz sands of

fluvioglacial genesis. The thickness of the Quaternary sediment layer varies from 1 to 8 m.

The hydrogeological conditions of the Klesivskoye deposit are relatively simple, with the ubiquitous upper aquifer of groundwater, which is fed by atmospheric precipitation. Water-bearing rocks are represented by fine-grained sands of Quaternary and fine-grained sands of Oligocene age. The power of the horizon reaches 12 m. At the bottom it is a pressure swimmer. Most of the territory of the watershed is dark greenish gray clay of the Early Oligocene age or structured kaolinized crust of weathering crystalline rocks.

According to the Ukrainian geologist V.I. Panchenko [15-19] The Klesiv amber field is located in the framing zone of the Proterozoic crystalline rocks of the northwestern part of the Ukrainian Shield by sedimentary Paleogene formations. The placer consists of several sections, two of which are open pit. The productive horizon of the deposit consists of three sand layers composed of grained quartz sands, which are unequally enriched with clay, organic material and amber. The lower layer is sporadically enriched with glauconite, which gives the amber rock a blue tint. Amber pieces reach the size of 10 cm. According to V.I. Panchenko and O.S. Tkachuk, the content of amber in the field - from 15 to 310 g/m³ and even 1000 g/m³, the average - 50 g/m³. The distribution of amber is uneven, the maximum concentration at the base is thicker. The annual extraction of amber at the Klesiv deposit does not exceed 140 kg. In a short time Klesivsky amber gained recognition in the domestic and foreign markets.

Unlike the Baltic amber, Klesiv is far from the sea. It can be predicted that at the Paleogene time near the village was the seashore. The position of the ancient coastal strip in Volyn is recorded by other amber finds in the area. It is known that vertical tectonic movements of the Earth's crust occurred at the boundary of the Eocene and Oligocene, which led to transgression (onset) and regression (indentation) of the sea. German researcher f. Kaunhoven found that in the tertiary period in the present Kaliningrad peninsula the interpenetration of sea and land changed 19 times.

In the post-Oligocene time, amber deposits were exposed to the effects of denudation factors; it was carried out by the waters to new deposits. In the glacial age in the south of the Baltic, part of the deposits was detached from the main deposit by a moving glacier.

Glacial waters and moraines spread pieces of amber rock across Europe. The yields of such rocks coincide with the boundary of glacial sediments, which lie on the boundary of tertiary and quaternary sediments. This process is associated with finding small amber deposits in Poland and Germany.

Amber-bearing rocks on the underwater slope of the Kaliningrad Peninsula are nowadays exposed to the active action of sea waves. A lot of amber is thrown on the beach on much of the southern Baltic coast. Researchers say that the fluvio-glacial, marsh, and coastal sediments of Cenozoic age are associated with amber in Belarus. Two amber-bearing regions - Polissia and Mikashevichy-Zhytkovytska - have been identified in Belarus by the totality of paleotectonic, facial-paleogeographic data and the results of the experiment.

1.3. Technological features of amber extraction from amber-containing deposits in Ukraine

According to studies [15 - 23], three zones and four regions with industrial concentrations of amber have been identified in the Rivne region. All of them belong to the Pripyat Basin of sedimentation, which at the same time with the accumulation of marine sediments in the Oligocene epoch (about 35 million years ago) formed large-scale amber deposits. The total area of distribution of productive amber-containing horizons in the Rivne region is 3810 km², which is 18% of its territory.

Two fields of amber have been explored in the Rivne region: Klesiv in Sarnensky and Vilna in Dubrovtskyi districts, which are being developed today by the state enterprise "Amber of Ukraine" [15-19].

Further increase in amber reserves - raw is possible due to the completion of the stage of prospecting and prospecting and evaluation work on the sites "Fedorovska" and "reclamation" within the Klesiv field and sections of the Volodymyrets amber-containing zone, where the Rivne geologia field works.

The largest amber fields of "Klesiv", "Vilne", "Vladimir-Oriental" contain at least several hundred tons of amber raw materials, of which 128 tons of industrial reserves have been explored. Two of

them are operated: Of "Ukraine", "Vladimir-East"- LLC" Center "Sunny Craft". Official amber production in 2015 was 4.5 tons.

In the Klesiv field, amber is extracted in open-pit mining (Fig. 3). Amber lies in sandy soil. Depth - up to 15m. A granite quarry with a large water supply is located near the deposit. The deposit is located close to roads and mains. During the six months of 2003, 230 kg of mineral was extracted from SE "Amber Mines". And for 2006, the extraction of amber is 3200 kg per year, achieved through the use of amber extraction of a new excavator ES-5/45 and stable funding from the state budget. In 2006, the volume of work in the quarry was: mines - 23.6t/m³; rock mass - 17,466 t/m³; reclamation per month - 0.5 ha. [45-53]

However, due to lack of financing, as of January 1, 2017, "Ukrburstin" is practically not functioning and is bankrupt.

Polissya amber differs in its chemical composition. It is the most saturated with impurities and contains 18 chemical elements. In addition to silicon, magnesium, iron, calcium, which are present in almost all deposits, such as lead, zirconium and up to 3.19% sulfur are added. The ash content of Klesiv amber is 8.7%. This affects the quality and color of the cured resin. The characteristic of amber is presented in item 1.2. [16-21].

Amber is used to make jewelry varnishes, paints, from amber to make medicines. In 1998, the first stage of the Rivne Jewelry Factory was put into operation, which, in addition to amber jewelry, produces succinic, glutaric acid and volatile aromatic oil, which is used in pharmacy.



Fig. 3. Preparation of the array for extraction of amber in the quarry by excavation

The potential amber reserves in the area are much larger. According to the results of the prospecting and evaluation work of the Rivne CCP of the SE "Ukrainian Geological Company", the estimated resources of amber in the Dubrovysf, Sarny and Volodymyrets districts are more than 1400 tons.

Number and total area of sites for which special permits for geological exploration were issued, including experimental and industrial development of subsoil for subsoil users as of the beginning of 2016: state - 3 and 46.5 km²; private - 2 and 68.4 km², respectively. The total area of prospective sites for amber offered by "Ukrainian Geological Company" for geological study is about 800 km². Thus, 685 km² of amber sections of the region are not controlled and are the object of unauthorized development.

The total area of sites affected by unauthorized amber production as of 2010 was more than 500 ha. Now it is estimated to exceed more than 1000 hectares and growing, but their records and audits are not maintained.

1.4. Conditions for the formation of amber deposits in the Rivne-Volyn region of Ukraine

Amber accumulation conditions within the Oligocene sedimentation basin of the Rivne, Volyn, and Zhytomyr regions are determined by the peculiarities of the geological structure of the northwestern slope of the shield and the features of the structural and morphological structure of different parts of the Mezhygorsk Sea. The discovery of industrial amber deposits in Ukraine began with the discovery in 1980 of the Klesiv deposit, which is still active today. Further exploration and evaluation activities within the Klesiv amber-bearing area over the last 30 years have expanded information on its geological structure and conditions for the formation of primary amber deposits.

The Klesiv deposit in tectonic terms is located within the lowered part of the Osnitsky block - the Klesivsky ridge [15-19, 24]. The negative structure is small in size (according to geological survey work - 240 km²), has a shape close to a regular quadrilateral and is bounded by faults. It is separated from the shield by Shakhinskaya [15], and in the west it is framed by Miliachka meridional local tectonic zones. Within this inherited decrease, mostly all (except for

the manifestation near Perebrody village in the north of the district and the Tomashgorod manifestation in the east) are located at the present time manifestations of amber within the Klesiv amber-bearing area.

The productive sediments of the Klesivskoye deposit cover a strip of width from 200 to 700 m, which can be traced from the southeast to the northwest between the outcrops to the domizhigir surface of small projections of the foundation. The length of the amber-enriched strip is more than 2 km. The outcrops of crystalline rocks among the inter-mountain deposits are insignificant in size and in the inter-mountain times represented numerous abrasion islands [15] with an area of about 50%.

Productive for industrial contents amber bearing thickness is the thickness of the sand of the early and middle Oligocene age [15-17]. The sediments are usually confined to paleosecretions between the crystalline projections of the basement and lie on low-thickness (up to 15 m) thick sediment deposits represented by glauconite-quartz sands and clays. The thickness of the sedimentary sediments decreases at paleo-elevations (see Fig. 4), where they are represented by clays or clays, which are underlain by sand with a small thickness. Amber sands are productive in amber, mainly fine-medium-grained, gray, dark gray, greenish-gray, sometimes containing up to 3-5% flint and fragments of crystalline rocks. Amber fragments of various shapes and sizes, with oxidation crust up to 1-2 mm. The sizes are preferably 1-2, rarely 5-10 cm. The capacities (according to the data of the Association "West Quartz Samotsvit") range from 1 to 420 g/m³.

Amber-containing deposits of this amber-bearing area contain a small (preferably 0.5-1%) amount of glauconite. According to the Institute of West Quartz Samotsvites [15-23], in the studies of the electromagnetic fraction of samples, the frequency of detection of glauconite is 69%, including 50% - in the light fraction. Glauconite of the light fraction is mostly rounded and rounded-angular, rarely - in the form of splices, which indicates the erosion and washing of bottom sediments formed in the conditions of the deeper deep shelf of the Obukh Sea.

According to the NGO "West Quartz Samotsvites" [15-19], the lower part of the horizon (700 m in length) of the Great Pugach of the Klesiv deposit is represented by sand of fine, medium-grained

mostly greenish-gray color, with a glauconite content of up to 5%. The power varies from 1-2 m to 5-6 m. Among the sand there are dark gray to black stripes (2-3 cm), enriched with scattered carbonaceous material and, preferably, with amber. Amber is mostly run-in. At the base of the horizon there are pebbles of foundation rocks and black flint (3-5%).

The upper part of the horizon is represented by sand of fine- to medium-grained gray, with light gray streaks; carbonaceous organic matter is scattered unevenly, clays of 1-2 cm thick are found and fragments of carbonaceous wood are chaotically arranged. Capacity from 0.5 to 1.6 m.

According to lithological and paleogeomorphological studies Maydanovich [15] clays mark the beginning of the transgression of the Berek Sea, and bluish-gray sands, which also revealed the broken fragments (1-5 cm) of flint and gray quartz, carbonaceous matter and amber, refer to its regressive stage.

However, during the last two decades, the materials of the search and evaluation works of the Rivne of the Ukrainian Geological Company on the manifestations of Oleksiyivka and Tomashgorod made it possible to investigate in more detail the structural and morphological conditions and the litho-facial conditions of the formation of amber in the northwest.

The lower part of the productive horizon is attributed to the terrigenous deposits of the shallow-coastal zone of the Kharkiv Sea, formed at the beginning of its regressive stage (inter-mountainous time). The upper part is thicker - to sediments formed in the open sea. The litho-facial section reflects the transition from sediments formed in the conditions of the channel of the sea to the sediments of the flooded coastal zone of the islands - mezhigirska thickness, represented by sand dark greenish-gray, fine-medium-grained (lower thickness), alternating with gray clay.), which is higher up the section and towards the Paleo Islands (w. 660) is replaced by sand bluish-gray, clayey. The sediments are represented by gray and bluish-gray sand formed simultaneously with the upper thickness within the blurred terrigenous zones of the Paleo Islands. Probably a bluish color of the sediment was acquired by erosion of the bark of weathering crystalline rocks.

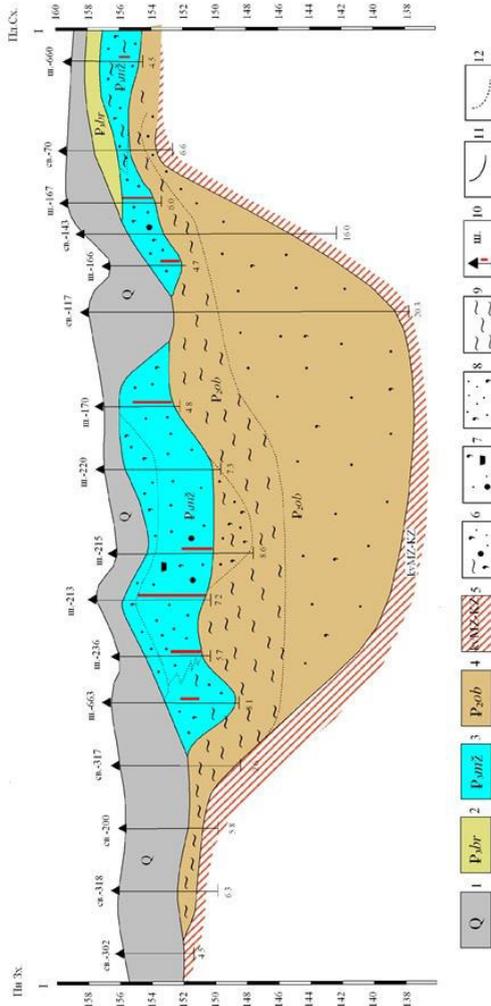


Fig. 4. Lithologic-facial section of the Pugach section of the Klesiv deposit along line I-I: 1 - Quaternary deposits; 2 - sediments of the Upper Oligocene Bereh world; 3 - facies of the terrigenous zones of the littoral of the open shallow shelf of the Mezghirsk Sea; 4 - sediments of the Upper Eocene Obuchian world; 5 - bark of weathering of crystalline rocks; 6 - sand fine-grained, clay; 7 - sand; 8 - sand fine-grained, clay; 9 - clay; 10 - wells, their numbers and depths, amber detection intervals; 11-12 - borders: 11 - geological; 12 - lithological.

According to the Department of Fossil Flora of the Institute of Geological Sciences of the Academy of Sciences of Ukraine [45-49, 69], the age of the sands of the productive strata is lower-middle Oligocene.

To the northeast of the Pugach site, on the Dune site, the productive thickness forms a layer to local decreases in crystalline base. There is an increase in the power of the underlying clay and an increase in the capacity of the most productive thickness.

In terms of litho-facies, the Klesiv deposits are classified as terrigenous facies of the shallow-shelf coastal zone formed within the straits between islands and island beaches, as well as submerged terrigenous zones of islands.

At the Fedorovsky manifestation, located south of the Klesiv deposit, the productive sediments are represented by sands of fine-medium-grained mostly gray, dark gray color, with glauconite (up to 5%). There are also flint and fragments of crystalline rocks (3-5%) in the size of 0.4-1.5 cm, strips (1-15 cm) of black carbonaceous material with high amber content.

Within the manifestation there are pieces of amber (from 0.3 to 5 - 15 cm) and marked macrofossils - fossilized cones of Pinaceae. The thickness of the productive thickness varies from 0.5 to 11 m. Assuming productive deposits were formed during the flooding of the coastal parts by the sea and the massive removal of amber into the water area. South-east of this manifestation, a paleo-lowering is filled with inter-mountain deposits in the shield. According to Maidanovich I. [15] is the Fedoriv River Paleodolina, in which gray and dark gray inter-mountain deposits without amber are common. Sedations of the Fedorovsky manifestation are attributed [15] to shallow-sea lagoon-delta

Gypsometrically higher occurrence of amber deposits than within the Northern section, less power (Fig. 5) and variability of clayey sands in the southern part of the field with sands bluish-gray, dark-bluish-gray, greenish-gray, finely gray, fine the located fragments of amber indicate the formation of the latter at the base of the bar on the high seas.

Northeast of the Free deposit, with amber content from 0.60 to 242.7 g/m³ (average 56.0 g/m³), rubble amber was found on the Mochulishte manifestation (in 11 wells out of 22 passed, containing 1.0-36.5 g/m³) and Khutirsky manifestation (in 17 holes of 99 traversed, containing 2.2-51.6 g/m³) in dark gray sandy-clay sediments of the Lower Oligocene. Found amber usually flattened shape, mainly angular, slightly run-in and not run-in, with a peel of oxidation to 1mm. It is confined, in an overwhelming amount, to checks of clay and carbonaceous matter. These deposits are also

attributed to those formed during the accumulation of terrigenous material within the surface and underwater parts of the island bar, possibly extending from the field of Vilna in the northeast direction.

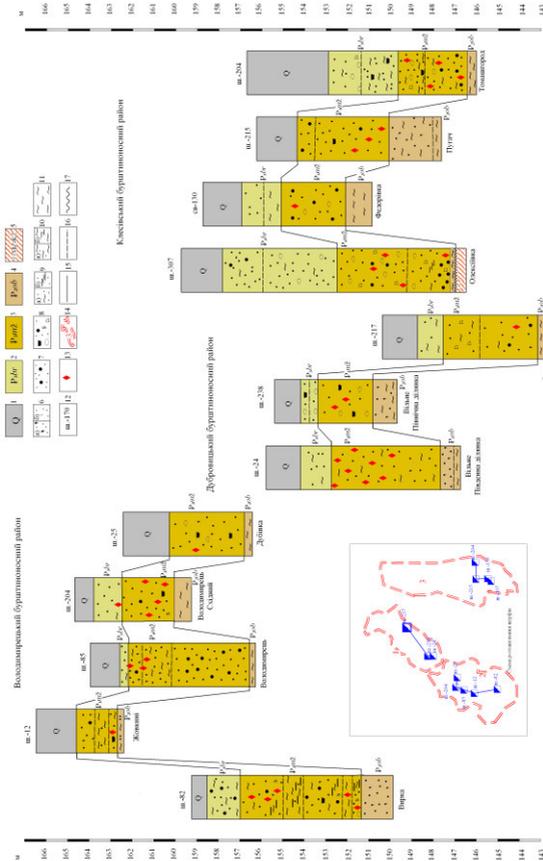


Fig. 5. Correlation scheme of inter-mountain deposits: 1 - Quaternary deposits; 2 - sediments of the Upper Oligocene Berek world; 3 - sediments of the inter-mountainous world of the Lower Oligocene; 4 - sediments of the Upper Eocene Obuchian world; 5 - bark of weathering of crystalline rocks of the foundation; 6 - medium-fine-grained sands: a - with glauconite; b - without glauconite; 7 - the sand is varied; 8 - sands of various types: with gravel, pebble, rubble, sulfide screeds, fragments of carbon or lignitized wood; 9 - sands: a - clay; b - with clay checks; 10 - clays: a - sandy; b - with sand checks; 11 - dense clays; 12 - workings (shur-shurf, st-well) and their numbers; 13 - findings of amber; 14 - borders of amber-bearing areas (1 - Dubrovnyts; 2 - Volodymyrets; 3 - Klesiv); 15-16 - borders: 15 - different ages; 16 - age-old; 17 - break

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