



ROSTEC STATE CORPORATION
Kaliningrad Amber Combine
Joint-Stock Company



CLASSIFIER

of the Baltic amber of the Primorsky deposit





*"The best way to explore something
is to discover it yourself."*

*George Pólya,
Hungarian, Swiss and American
mathematician, popularizer of science*



SET
of scientific and practical
researches and classification
of Baltic amber
of Primorsky deposit
of Kaliningrad Amber Combine

The Power of the Sun - The Gift of the Earth - The Heritage of Russia



*He who loves his work
turns it into art*

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INTRODUCTION

The purpose of the classifier of Baltic amber of Primorsky deposit is system classification of succinite by mining-geological, extraction, technological, natural, gemological, spectrometric, physical, mechanical, and geochemical properties taking with the consideration of application in jewelry production and other areas of deep processing of amber. Large-scale work on the classification and standardization of products progressively released by the Combine, is carried out in order to protect the rights of consumers. The next stage is the assignment of personal electronic codes to unique nuggets and jewelry made of amber.

The document also considers the potential of using Baltic amber in commercial, medical, tourist, practical, production and scientific activities.



ЯНТАРНЫЙ КОМБИНАТ

2022



75 лет
мы делаем мир красивее

HISTORICAL BACKGROUND

Kaliningrad Amber Combine Joint Stock Company is the only enterprise in the Russian Federation and the largest enterprise in the world that conducts commercial open-pit extraction of Baltic amber at the Primorskoye deposit.

After the end of the Second World War by the decision of the Soviet Government (the resolution of the Council of Ministers of the USSR No. 2599 dated July 21, 1947), the enterprise was established to resume industrial extraction and processing of the Baltic amber.

Over the years of hard, painstaking and creative work, the company's employees have not only mastered and improved the technologies of industrial extraction of Baltic amber, but also recreated and significantly upgraded numerous techniques of artistic treatment of amber.

Raw amber and various finished amber products manufactured by the Combine are traditionally sought-after and enduringly popular both in the Russian and international markets.





President of the Russian Federation Vladimir Putin pays special attention to the progressive development of the amber industry of our country. The numerous changes taking place in recent years in the industry and directly at the enterprise are aimed at a constant increase in the volume of production of Baltic amber and in the volume of its domestic processing.

Since 2013, the Joint Stock Company has been a part of the ROSTEC State Corporation. Currently, the company not only successfully exercises extraction of raw amber, but also processes it at its own jewelry production facility which was significantly upgraded in 2021.

A variety of amber jewelry and numerous amber souvenirs are sold exclusively through the own chain of branded stores and official representative offices, one of which is located on Arbat Street in Moscow.

In 2022, Kaliningrad Amber Combine will celebrate its 75th anniversary. Many years have passed since the first amber was mined by the company's employees on the shores of the Baltic Sea. But life does not stand still, and with a glorious past and a worthy present, the enterprise and its employees are moving confidently into the future.

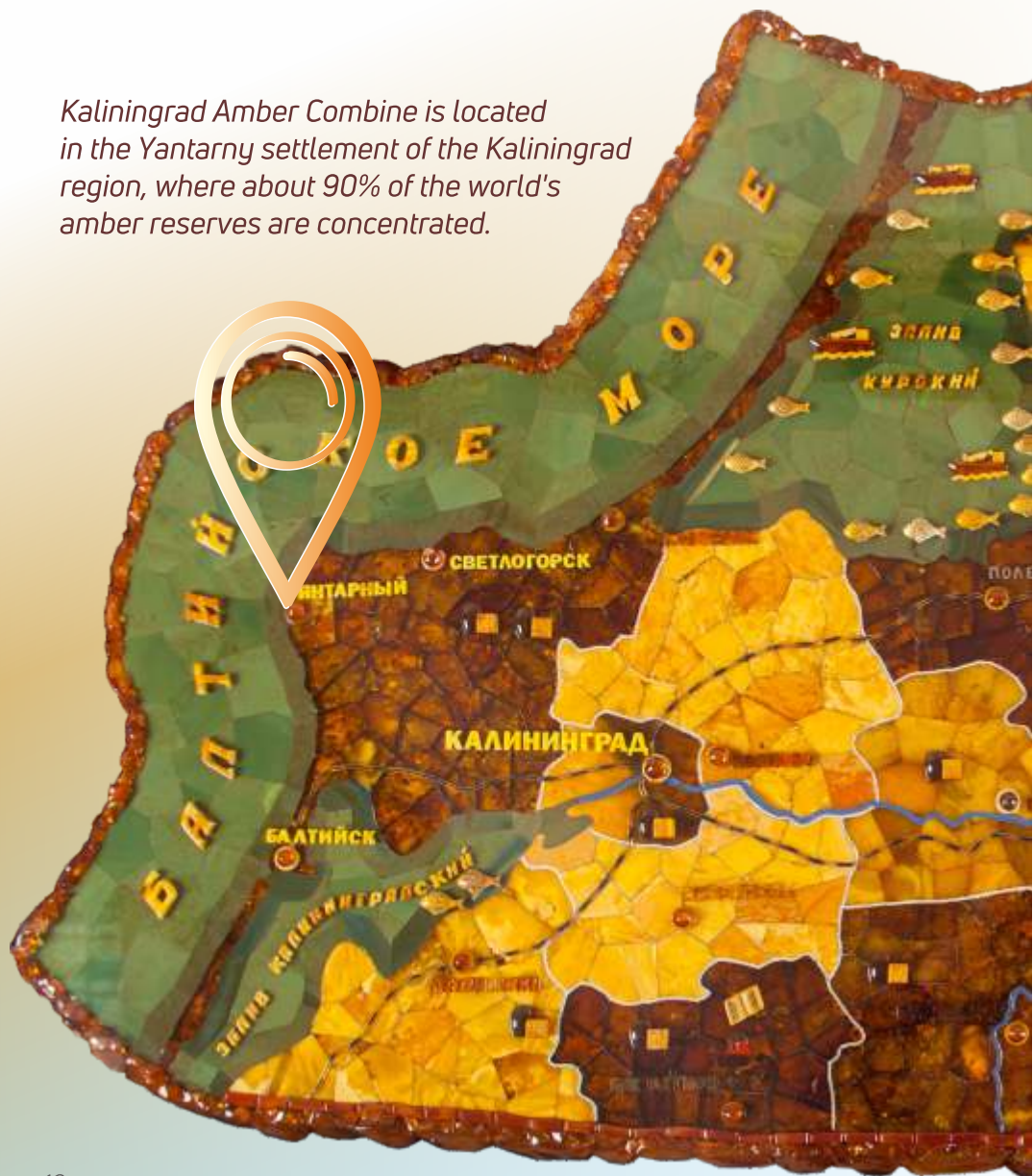
“Amber is a piece of art of the plant kingdom.”

*Mikhail Lomonosov,
the first prominent Russian natural scientist*

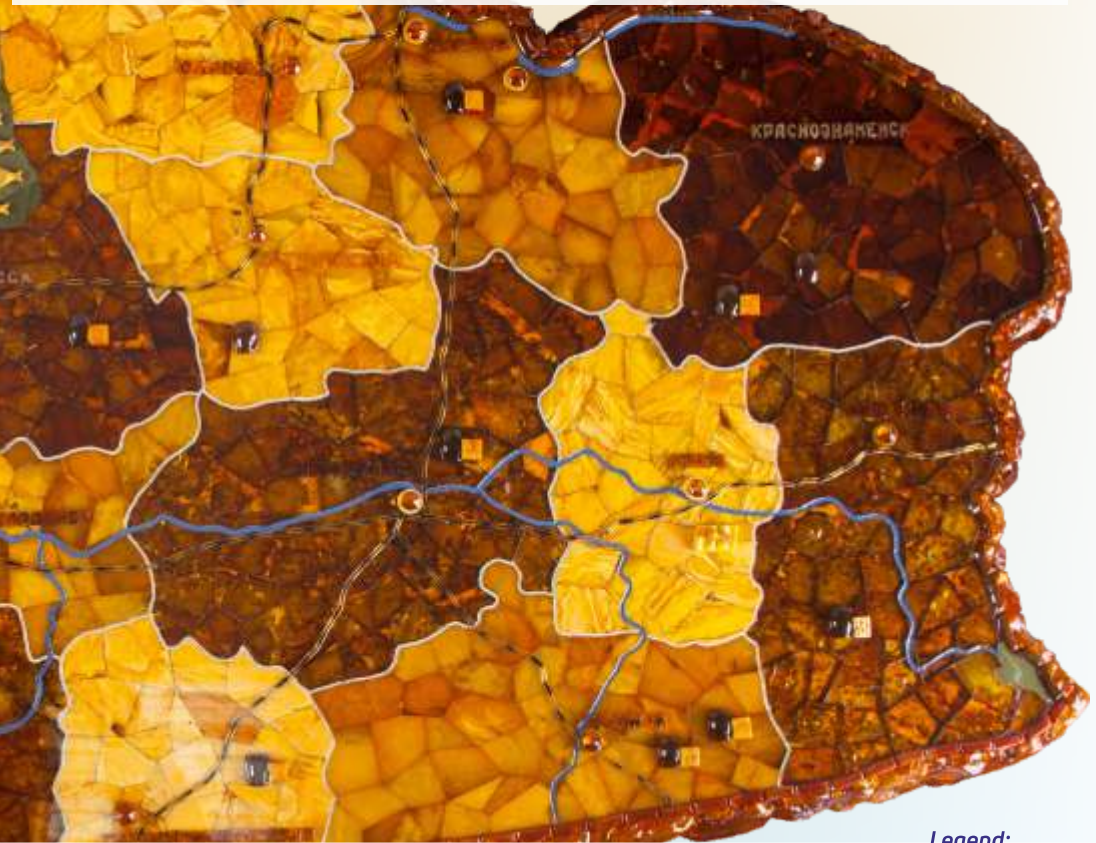
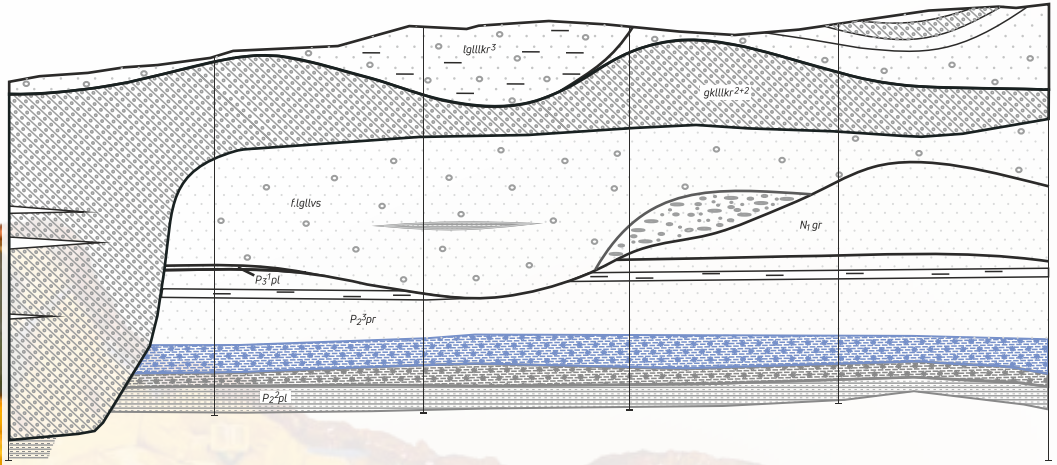
**Mining, geological
and technological
classification
of Baltic amber
of the Primorsky
deposit**

The age of the mined amber exceeds 40 million years. Amber is extracted by the open-pit method in the Primorsky open pit, the largest amber pit in the world. The Amber Combine produces an average of 500 tons of raw materials annually. Total reserves of Primorsky and Palmnikensky deposits are estimated at 116 thousand tons.

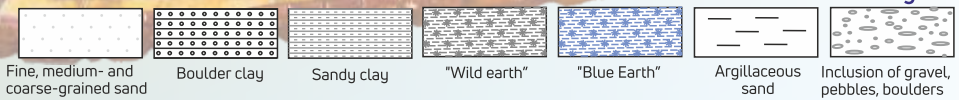
Kaliningrad Amber Combine is located in the Yantarny settlement of the Kaliningrad region, where about 90% of the world's amber reserves are concentrated.



Typical geological section of the amber stratum



Legend:





Geological factors of the Baltic amber deposit of the Primorsky deposit

License for subsoil use	Technical boundary (mining allotment), Ha	Amber formation	
KLG 02479 TE	Act No. 58k dated December 30, 2015, 1338.5 ha	Blue Earth (Wild Earth)	
Depth of occurrence along the bed top (m)	Bed width (m)	Reserves in category A+B+C ₁	
		Balance reserves (tons)	Off-balance reserves (tons)
44.3-65.0	0.5-17.9	56123.0	29540.6

Paleogene stratigraphic scale

System	Section (era)	Stage (century)
Paleogene	Eocene	Priabonian
Series	Designations	Age, million years
Prussian	P ₂ ³ P-f	40.4-44.0

Geophysical parameters

Density, g/cm ³	Mohs hardness	Fracture
1.05-1.09	2-2.5	Conchoidal
Melting point, °C	Softening point, °C	Line
250-450	100-150	Bold colourless



Mining factors of the Primorsky deposit of Baltic amber

Method: open pit mining					
Development system					
Stripping: combined development system			Mining: hydraulic excavation method		
Equipment used					
Esh 11/70	Esh 10/70	Auto stripping	Esh 6/45	Hydromonitor GMN-250	Pump GrUT-2000/63
Mining and transportation equipment capacity (thousand m ³ per year) (tons per year)					
1396	810	1900	332.14	600	
Walking excavator ESH 6/45			Hydromonitor GMN-250		
					



Walking excavator
Esh 11\70



Hydraulic excavator
Kamatsu PS-300

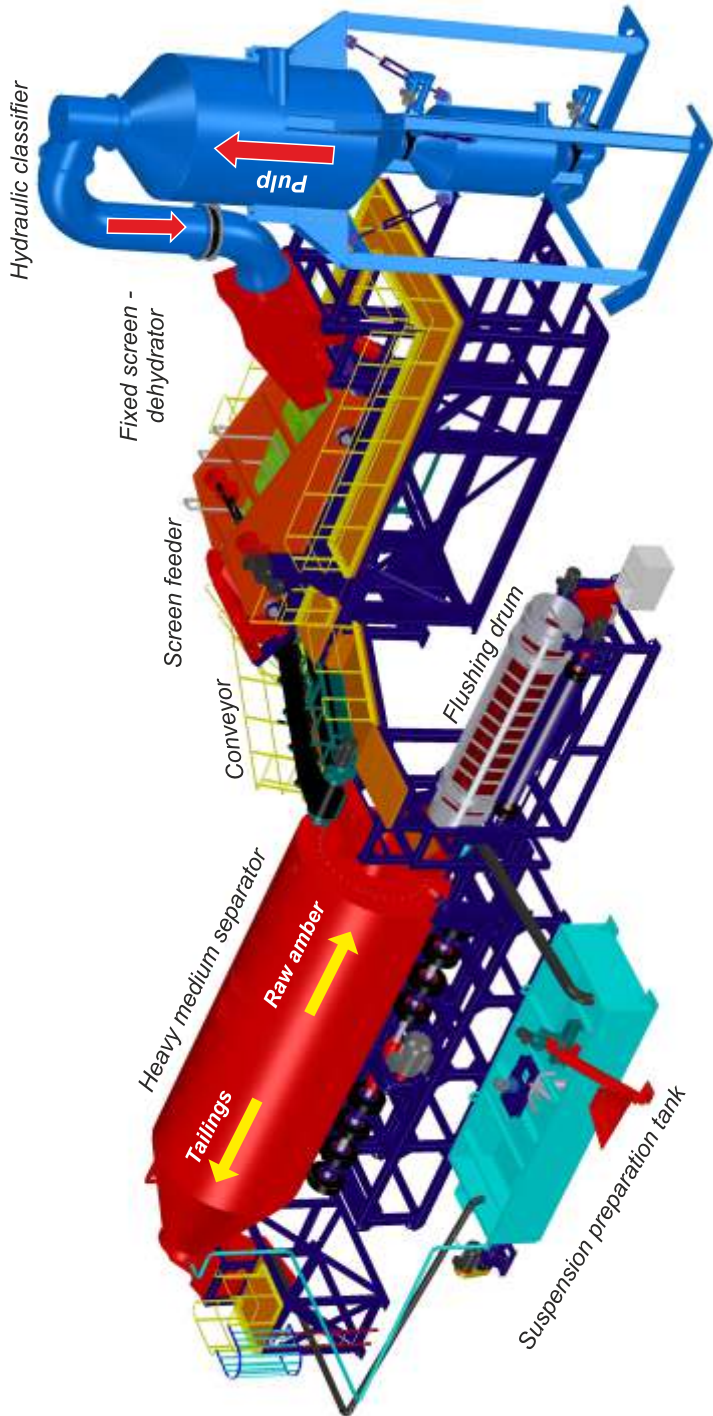


Mining dump trucks
VOLVO A30D



Walking excavator
Esh 10\70

MOBILE AMBER EXTRACTION UNIT.



*"Oh, if you, little fly, could talk!
How different all our knowledge of the past world would have been.*

*Immanuel Kant
German philosopher, Enlightenment thinker*

**Classification
of Baltic amber
of Primorsky deposit
by natural,
physico-mechanical,
optical and geochemical
properties**



Natural properties of the Baltic amber of the Primorsky deposit

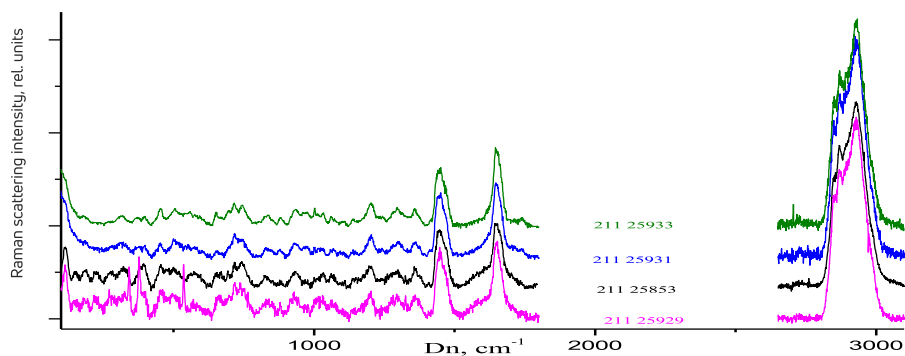
Physical, mechanical and geochemical properties of Baltic amber	
Relative hardness, Mohs scale	2 to 2.5
Density	1.05 to 1.09
Strength	Friable
Cleavage	No
Fracture	Conchoidal, viscous
Crystal system	No / amorphous
Morphology	Most often, it is found in the form of flattened and elongated precipitates that are not susceptible to genetic interpretation, there are precipitates in the form of teardrops, icicles, overlaps, pieces of amber with a cross-section of crescentic, lenticular and wedge-shaped, bearing more or less clear prints of wood
Geochemistry	Baltic amber is a high molecular weight compound of organic acids containing on average 79% carbon, 10.5% hydrogen, 10.5% oxygen. Its formula is $C_{10}H_{16}O_4$. Amber contains 81 g of carbon, 7.3 g of hydrogen, 6.34 g of oxygen, a little sulfur, nitrogen and minerals. 24 chemical elements (Y, V, Mn, Cu, Ti, Zr, Al, Si, Mg, Ca, Fe, Nb, P, Pb, Zn, Cr, Ba, Co, Na, Sr, Si, Sn, Mo, Yb) were found in the Baltic amber in the form of impurities (from traces to 3%). Of these elements, unchanged amber contains Al, Si, Ti, Ca, Fe, Mg, Cu, and weathered amber contains only the first five elements

Optical properties of the Baltic amber of the Primorsky deposit

Optical properties of amber

Colour	Yellow, orange, red, brown, white, greenish, bluish, black. Mostly ranges from greenish-yellow, yellowish-orange, orange-red to red-brown
Transparency	Transparent, translucent, non-transparent.
Glance	Pitch
Fluorescence	Bluish-white to yellowish-green
Light refraction index	1.539-1.545
Optical nature	isotropic
Birefringence, dispersion, pleochroism	no

Spectrogram





*"Amber passes through all ages and
peoples to this day as a brilliant gem."*

*Alexander Fersman
mineralogist, geochemist,
academician of the Russian Academy of Sciences.*

Classification of the Baltic amber of the Primorsky deposit according to the standards of the Kaliningrad Amber Combine



Classification of unique Baltic amber

Pieces of amber of undefined shape, partially or completely covered with oxidized crust, weighing not less than 1000 g of all colors and shades typical of natural amber.



Unlimited quantities are allowed:

- natural inclusions of organic and inorganic origin
- through internal and surface cracks and cavities (porosity)
- volumetric surface layers of dirty, foamy, and layered amber

Commercial classification of Baltic amber

Pieces of amber of undefined shape, partially or completely covered with oxidized crust, weighing not less than 1000 g of all colors and shades typical of natural amber.



Requirements for sorted ornamental amber.

Parts of amber of indefinite shape, partially or completely covered with oxidized crust, weighing from 5 to 1000 g. Depending on the grade, surface and internal cracks, surface and internal inclusions of organic and inorganic origin, in different percentages are allowed.



Requirements for fractional/ screened amber.

Pieces of amber of undefined shape, partially or completely covered with oxidized crust, with a width of pieces less than 23 mm

Requirements for teardrop shaped amber



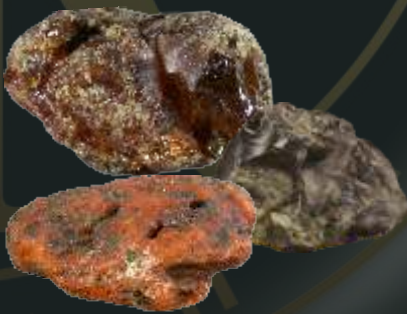
Pieces of spherical, peri-spherical, teardrop-shaped, oval, symmetrical fantasy shape, completely covered with oxidized crust

Requirements for amber with inclusions



Pieces of amber of undefined shape, partially covered with oxidized crust, and containing completely or almost completely intact inclusions of flora and fauna

Requirements for amber black varnish



Parts of undefined shape partially covered with oxidized crust. More than 50% of the piece volume is allowed: deep penetrating surface and internal cracks, deep and numerous cavities, voluminous surface layers of organic and inorganic origin and internal mud inclusions in unlimited quantities, internal saccharoid property of pieces, pieces of amber of loose, layered, foamy, and chalky structure

Basic terms and types of Baltic amber of Primorsky deposit

Natural amber

Amber that has been machined without any change in its natural form

Modified amber

Amber that has only been heat-treated or pressurized. Amber changed its physical properties, including the degree of transparency and color

Unique amber

Pieces of amber weighing at least 1000 g of all colors and shades typical of natural amber

Souvenir (landscape) amber

Amber of matte and semi-matte color with shaped multi-tone stains, pieces of ivory amber

Matte amber

Amber, which does not allow light to pass due to the accumulation of air bubbles. It is of opaque uniform color ranging from honey to orange, different degrees of homogeneity

Transparent amber

Amber of any yellow tones, transparent, vitreous structure, transmitting light rays

<i>Sorted amber</i>	Amber, divided into types by certain weight, size and quality properties
<i>Unsorted amber</i>	Amber, cleaned from sandy-clay rock and other impurities, washed, dried, completely or partially covered with oxidized crust
<i>Black amber varnish</i>	Amber pieces containing unlimited organic and inorganic inclusions
<i>Substandard amber</i>	Amber sifting with a grain size of less than 4 mm produced as a result of screening
<i>Amber fraction</i>	Dimensional or weight properties of amber
<i>Grade</i>	Presence and quantitative content of mud inclusions, cracks, cavities
<i>Layered amber (amber inclusion)</i>	Amber consisting of several layers and containing mud inclusions, inclusions of flora and fauna. Inclusions are rare, with internal water droplets



"We see amber as the next luxury item in a row..."

Gaius Plinius Sr.

Roman encyclopedic writer

Classification of the Baltic amber of the Primorsky deposit according to standards of jewelry production



Baltic amber colour palette



Transparent



Lemon



Honey



Cognac



Dark cognac



Cherry



Green



Semi-matte



Matte



Landscape

Baltic amber processing

<p>Section</p>	<ul style="list-style-type: none"> - Manual sorting of amber by type (quality), volume, color and weight - Mechanical sorting of amber using a vibrating screen
<p>Stone cutting section</p>	<p>In the bleaching area of the stone cutting section, amber is bleached (hardened) in autoclaves under pressure at a temperature of 200C.</p> <p>The semi-finished product is manufactured in several stages:</p> <ul style="list-style-type: none"> - cutting amber using a sawing machine - machining using a grinding machines - manual polishing using a stone-cutting machine. <p>The process of beads drilling is exercised in the drilling section. Quenching takes place in drying furnaces n compliance with the quenching scale. Parts made of amber are polished manually or mechanically in drums with wooden filler</p>
<p>Ball calibration section</p>	<p>The amber is cut using a sawing machine, and machined using a grinding machines to a spherical shape. The spherical beads are machined to manufacture a calibrated ball. Grinding is performed in small-sized grinding drums. Drilling is performed using a machine</p>
<p>Amber machining section</p>	<p>The amber machining section includes section of drum units and manual sorting.</p> <p>Mechanical treatment of fine-fraction amber is carried out in special units (drums) of own manufacture using abrasive wheels. Amber fr+4, fr-11.5, fr+11.5 is processed in three operations involving supplying flowing water to drums and intermediate heat treatment in autoclaves. Each operation corresponds to a different type of abrasive wheel used. The resulting product is screened on an own-produced vibration unit (using a sieve of the required diameter) and sorted manually into several types of semi-finished products in the form of beads</p>

Process operation terms

<i>A semi</i>	Finished product is a product that has passed one or more stages of the technological process without being brought to the degree of readiness.
<i>Autoclaving</i>	The process where cracks and air bubbles are sealed under the influence of temperature and pressure in the amber makes the amber compact, more transparent, and less fragile
<i>Tinting</i>	The process of re-autoclaving with the use of air, as a result of which the surface of amber acquires a darker shade. After removing the tint from one of the part planes, a green shade of amber is obtained
<i>Закалка</i>	Thermal effect on autoclaved transparent amber which acquires the following gradation of shades depending on the duration of the heat treatment: lemon (light yellow); light cognac (light brown); cognac (brown, tea); dark cognac (dark brown); cherry (dark maroon); green (black backlight)
<i>Matting</i>	The process of saturating amber with water under certain temperature and pressure, where the amber color turns opaque uniform from cloudy yellow to white, with varying degrees of homogeneity
<i>Coloring</i>	The process of coloring pressed amber with dyes
<i>Pressure molding</i>	The process in which ground amber is heated and pressed in sealed moulds, followed by cooling
<i>Enameling</i>	Application of an enamel coating on an amber semi-finished product (insert) to obtain an appropriate shade
<i>Gem cutting</i>	Processing of amber in order to give it a given shape with faces
<i>Ageing</i>	Giving the surface of natural matte amber a richer yellow color

CALIBRATED BALLS



Calibrated ball
natural



Calibrated ball
lamina



Calibrated ball
lamina



Calibrated ball
black varnish



Calibrated ball
black varnish



Calibrated ball
transparent



Calibrated ball
transparent



Calibrated ball
light cognac



Calibrated ball
cognac



Calibrated ball
dark cognac



Calibrated ball
cherry



Calibrated ball
lemon



Calibrated ball
matte



Calibrated ball
landscape

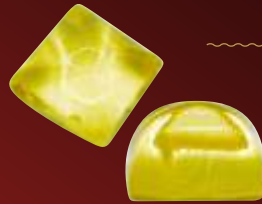


Calibrated ball
natural

CABACHONS



Rounded hardened cabochon
cherry



Round square
landscape



Rounded hardened cabochon
green



Round oval
landscape



Rounded hardened cabochon
cognac



Round marquise
landscape



Rounded hardened cabochon
lemon



Rounded hardened cabochon
dark cognac



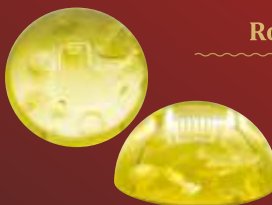
Rounded hardened cabochon
light cognac



Round cabochon
natural



Round cabochon
matte



Round cabochon
bleached

CUBES



Hardened cube
lemon



Hardened cube
light cognac



Hardened cube
cognac



Hardened cube
dark cognac



Hardened cube
cherry



Cube
matte



Cube
lemon



Cube
black varnish



Hardened cube
lemon



Hardened cube
transparent

BATTERED BALLS



Battered ball
matte

~~~~~ grade 1



~~~~~ grade 2



Battered ball
black varnish

~~~~~ grade 1



~~~~~ grade 2



Battered ball
transparent

~~~~~ grade 1



~~~~~ grade 2



Battered ball
landscape

~~~~~ grade 1



~~~~~ grade 2



Battered ball lamina
honey

~~~~~ grade 1



~~~~~ grade 2



Battered ball
light cognac

~~~~~ grade 1



~~~~~ grade 2

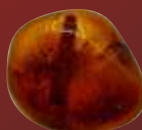


Battered ball
dark cognac

~~~~~ grade 1



~~~~~ grade 2



Battered ball
cognac

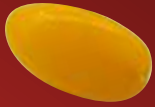
~~~~~



**Battered ball**  
lemon

~~~~~

OLIVES



Olive
matte



Olive
matte



Olive
bleached



Olive
lemon



Olive
light cognac



Olive
cognac



Olive
dark cognac



Olive
natural

PEBBLE



Pebble
matte



Thin rounded pebble
lemon



Thin rounded pebble
bleached



Thin extended pebble
lemon



Thin extended pebble
lemon



Thin extended pebble
light cognac



Thin rounded pebble
cognac



Thin rounded pebble
matte

Thin rounded pebble
light cognac



ARTISTIC INSERTS



FINISHED PRODUCTS



more than

200

jewelry models



more than

100

items of souvenirs



PICTURES, SOUVENIRS





Unique nuggets
Amber Chamber Exhibition Hall
Yantarny

Unique nuggets

Amber Gallery Exhibition Hall
Moscow, Arbat



Unique amber teardrops

Amber Gallery Exhibition Hall
Moscow, Arbat





Scope of industrial application of Baltic amber of Primorsky deposit

Industrial application of Baltic amber.

Similar to mica and porcelain, amber is a dielectric, so it does not conduct electric current. Therefore, about 10% of pressed amber is used in industry as a material for the production of insulators in electrical and radio engineering, and in instrument making. The chemical inertness of amber makes it possible to use it for the manufacture of medical instruments and durable ware for storing active acids, devices and tools for transfusing blood, as well as vessels for blood preservation.

Amber rosin is used to make all kinds of varnishes and enamels. Varnishes YaK-1 and YaK-2 are of particular value. They are particularly resistant to environmental impact and have a strong shine. The varnish is used to cover bottoms of ships, the inner surface of tin cans, floors, and furniture.

musical instruments, wool. Furniture covered with amber varnish retains shine and freshness of polishing for a long time. Famous violin masters of the 16th-18th centuries applied amber varnish to their works. Varnishes are also used in the production of printing inks and as electrical insulation of wires.

Amber oil is a mixture of different acids. It is dark brown with a yellowish tinge. The odour is strong and unpleasant. Lighter than water. It is used for the production of amber waterproof oils. Organic paint solvents for the rubber and porcelain industries can be produced from amber oil with the chemical processing. Oxidized amber oil is the primary product for producing strong caprone threads. Some time ago, amber oil was used to protect wood from decay (it was used for impregnating railway sleepers) and as a flotation reagent in the concentration of various ores and coal.

The current range of application of amber acid is very wide, and each new study in this field adds invaluable knowledge to the scientists' collection. For example, in medicine, it stimulates the nervous system, and is used as an anti-inflammatory and antitoxic agent. The ability of amber to prevent hemolysis (the process of destruction of red blood cells) is especially noted by modern physicians. The use of fine mineral particles for cosmetic purposes makes it possible to significantly increase the effects of procedures.



"Amber room"
in children's psychoneurological
sanatorium Teremok
the city of Zelenogradsk



CONCLUSION

Currently, the classification established by the Kaliningrad Amber Combine is of the greatest practical importance, since more than 70% of the amber sold on the world market comes from the Kaliningrad region.

The classifier of the Baltic amber of the Primorsky deposit is not limited to the narrow bounds of application tasks for the establishment of groups and grades of mineral for subsequent determination of their market value. It covers various aspects of present knowledge about the Baltic precious stone and the Primorsky amber deposit in the Kaliningrad region of the Russian Federation: geological description of the deposit, parameters of technological processes of open mining at the Primorsky pit, analysis of natural, physical and chemical, optical and geochemical properties, and it also includes a classification of raw materials complying with the standards of the Kaliningrad Amber Combine for jewelry production and industrial application.

The classifier is a brief popular scientific presentation of a comprehensive study of Baltic amber, where a large group of specialists from the Amber Plant and researchers from KSTU and Nesmeyanov Institute of Organoelement Compounds of RAS took part. With a large number of infographics and illustrations, it tells in an understandable manner about all stages of the production operations of Kaliningrad Amber Combine starting from the extraction to the manufacture of finished products. The classification of standards of jewelry production adopted at the Combine (shape, color and other properties of cabochons, balls, cubes and other amber inserts) for the first time presented to a wide audience is of a special value. In general, the work will not only contribute to the popularization of knowledge about Baltic amber and tell about the achievements of the Amber Combine, but will also help to improve the technological processes at the Combine and improve products quality.

Leading Researcher
of the Kaliningrad Regional Museum of Amber

Z. V. Kostyashova

List of technical literature used for the classifier of Baltic amber of Primorsky deposit

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- S. S. Savkevich Amber. L.: Nedra, 1970.
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- Basic design of Primorsky amber deposit development. Gornye Resheniya LLC, St. Petersburg 2020.
- Conclusion on Raman spectroscopy and IR absorption. Nesmeyanov Institute of Organoelement Compounds of Russian Academy of Sciences, Moscow, 2022.
- B. Yu. Vorotnikov A. G. Bulychev S. A. Yakuta Z.V. Kostyashova G. A. Akimova Synthesis of scientific and humanitarian potentials, technological foresight in the development of the world leadership of Russian amber industry. Materials of the IX International Baltic Maritime Forum Innovation in Science, Education and Entrepreneurship, 19th International Scientific Conference V. 1, 2021 - p.100-109
- B. Yu. Vorotnikov A. G. Bulychev O. I. Karsten T. B. Ezhevskaya Studying amber varieties using FT-801 Fourier transform infrared spectrometer by the method of FTIR spectroscopy. Laboratory and Production, scientific and technical magazine No.2/2019(6) - p.104-109





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We thank Kaliningrad Regional Museum of Amber, State Budgetary Institution of Culture, represented by Director A. S. Zagrebin and Leading Researcher E. V. Kostyashov, for an expert opinion on the classifier of Baltic amber, as well as all project participants, consultants and researchers of the Baltic amber of the Primorsky deposit.

Classifier of Baltic amber of Primorsky deposit developed by the specialists of Kaliningrad Amber Combine JSC and the researchers of KSTU and RAS, covers all processes of the entire production cycle, starting from the geological exploration and extraction of raw amber to the release of finished products. The document is intended to improve products quality and to ensure that all concerned persons and the general public have access to information about the high standards and requirements followed by the enterprise.

