

Federal Research Centre “Komi Science Centre
of the Ural Branch of the Russian Academy of Sciences”



Young Scientists Initiative

1st Multidisciplinary Conference
of young researchers and post-graduates

Collection of conference materials

May 12, 2022
Syktyvkar

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This collection of conference materials represents scientific achievements of young scientists in the following areas: Geology, Chemistry, Physics and Mathematics; Humanities; Biology and Physiology.

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“Geology, Chemistry, Physics and Mathematics”

Geochemical study of the Pechora basin paraffin oils

A.A. Ilchenko, D.A. Bushnev

Institute of Geology, FRC Komi SC UB RAS, Syktyvkar

aaderevesnikova@geo.komisc.ru

Geochemical studies of oils and organic matter of oil source rocks of the Timan-Pechora basin were actively developed in recent years. The territory of the south part of the Pechoro-Kozhva megaswell belongs to the Timan-Pechora basin. The main part of discovered and developed deposits of oil, gas and gas condensate in this area is confined to the Middle Devonian-Lower Frasnian terrigenous oil and gas complex (D2-D3f1). Several scientific papers [1] were devoted to determining the composition, type, and level of catagenesis of dispersed organic matter in the Pechoro-Kozhva megaswell. According to studies, the D2-D3f1 complex includes two generation centers: Yugid and Pechorogorod. It was shown that the Pechogorod generation center is characterized by the increased content of the humus component in the initial organic matter, and the oils of this complex are highly paraffinic. Oils containing high concentrations of long-chain n-alkanes (paraffin) are called highly paraffinic oils. These oils are associated with type III kerogen [2], coals or carbonaceous shale's [3]. In the literature, the number of articles about oils with high wax content is rather limited. The reason is that the most of the world's commercial oil reserves are formed from organic matter of marine origin. This work is devoted to the study of the individual composition of biomarkers in the oils of the Middle Devonian-Lower Frasnian terrigenous complex of the Timano-Pechora basin.

Oils of the Pechoro-Kozhva field were chosen as the object of study. Three highly paraffinic oil samples were analyzed using gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS) method after preliminary separation into fractions. Due to the small amount of asphaltenes in the composition of oils, the step with their precipitation was omitted. Firstly, the oil samples were separated into apolar and polar fractions on a glass column filled with alumina. To obtain the apolar fraction chloroform - n-hexane mixture was used; to obtain the polar fraction ethanol-chloroform mixture was used. Secondly, the apolar fraction was separated into fractions of saturated hydrocarbons (eluent n-hexane) and aromatic hydrocarbons (eluent benzene) on a glass column filled with silica gel. The saturated fraction was analyzed by GC. Aromatic fraction was analyzed by GC-MS.

The main difficulty in studying the composition of paraffinic oils is high concentrations of n-alkanes, which affect the quality of the mass spectra of polycyclic hydrocarbons, whose concentration is much lower. To reduce this effect and remove paraffin the “clathrates formation with urea” method was used for the saturated fraction [4]. Thereafter the saturated fraction was analyzed by GC-MS.

To compile the geochemical characteristics of the oils of the Pechoro-Kozhva field, the hydrocarbon composition of aliphatic and aromatic fractions was studied. The distribution of normal and isoprenoid alkanes was studied from chromatograms obtained by GC. The homologous series of steranes (m/z 217), hopanes (m/z 191) and phenanthrenes (m/z 178, 192, 206) were studied after the mass spectra obtained by GC-MS. Further the composition of aliphatic hydrocarbons and aromatic hydrocarbons was considered successively.

Aliphatic hydrocarbons. Firstly, non-cyclic hydrocarbons were studied. In this study, such hydrocarbons include n-alkanes. Monomodal distribution (with one local maximum in the region of alkanes with 15–17 carbon atoms) of n-alkanes was revealed in the composition of the saturated fractions of the studied oils. The concentration of branched alkanes such as pristane (Pr) and phytane (Ph) was low. The value of Pr/Ph was 1.37–1.82 and may indicate oxidative conditions in diagenesis. Secondly, polycyclic hydrocarbons were studied (steranes and hopanes). These biomarkers are successfully applied in the study of oil composition, since these classes of compounds are highly sensitive to temperature changes in the interior of the Earth. The homologous series of steranes includes compounds with 27 to 29 carbon atoms. The distribution of steranes containing 27, 28 and 29 carbon atoms is used to determine the contribution of primary bioproduction. The predominance of each individual compound was reported to indicate the contribution of certain specific types of bioproducts. In this work, the predominance of ethyl cholestane (contains 29 carbon atoms, then holestane (27) and last methyl holestane (28)) was seen, which may indicate a significant contribution of terrestrial vegetation in the composition of organic matter. In the distribution of hopane hydrocarbons, attention should be paid to the high concentration of tricyclic hydrocarbons. The main part of geochemical parameters was calculated using C29–C35 composition hopanes, because of their high informative. In the literature, the sterane/hopane (value was 0.25–0.26) ratio is used to estimate the contribution of phytoplankton and bacteria

biomass to the original organic matter. The predominance of steranes indicates a contribution to higher organisms, while the predominance of hopanes indicates the predominance of bacteria. The values obtained in this study indicate little or moderate bacterial processing of the original organic matter.

Maturity coefficient. To assess the degree of thermal transformation of oils, a number of maturity parameters were used. Coefficient $20S/20S+R$ ($\alpha\alpha$ C29 steranes, value was 0.43–0.53) was calculated using sterane-type polycyclic hydrocarbons. Parameters Ts/Tm (0.93–1.09) and $\alpha\beta$ C31 $22S/22S+22R$ (0.57 for all samples) were calculated using hopane hydrocarbons. Their values fall into the area corresponding to the main phase of oil formation. Thus, all maturity parameter indicate a fairly high level of maturity of the oils of the Pechoro-Kozhva field.

Aromatic hydrocarbons. Homologous series of phenanthrenes was identified in the composition of the aromatic fraction. The structure of phenanthrene consists of three aromatic rings. If one or more hydrogen atoms are replaced by an aliphatic substituent in different positions, then new homologous series are formed. Phenanthrene (P) and homologous series of methyl phenanthrenes (1-MP, 2-MP, 3-MP, 9-MP, the numeral indicates the number of the carbon atom with methyl group). was identified in this study. The methylphenanthrene index (MPI-1, value was 0.69–0.71) was successfully applied to diagnose oil maturity. This parameter was calculated using the formula $MPI-1 = 1.5 \cdot (2-MP + 3-MP) / (P + 1-MP + 9-MP)$. Using the values of this coefficient, one can calculate the vitrinite reflectance index (R_o), which cannot be obtained empirically. The theoretically expected the reflectance of vitrinite (R_o) value was calculated based on the available the methylphenanthrene index MPI-1 values according to the formula: $R_o = 0.60 \cdot (MPI-1) + 0.37$. The parameter R_o value is 0.78–0.80. The calculated values were compared with the catagenesis scale; they corresponded to the middle stage of the main phase of oil formation.

Thus, the composition of Pechora basin oils biomarkers was analyzed. The results of the study confirmed the presence of a large amount of paraffin in the oils. This is likely to be the result of terrigenous component contribution to the composition of the source material. The composition of the saturated fraction showed the predominance of C29 sterane, the predominance of hopanes over steranes, and relatively high concentrations of tricyclanes

in relation to the homologous series of hopanes (m/z 191). The values of geochemical maturity coefficients indicate a moderate level of thermal transformation of the studied oils.

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Mineralogy of copper sulfides of the Volkovsky deposit (Middle Ural)

A.I. Morokhin

Institute of Geology, FRC Komi SC UB RAS, Syktyvkar

alexey.morokhin@gmail.com

The Volkovskoye deposit is located in the Sverdlovsk Region, 26 km northwest of the city of Nizhny Tagil, in the northeastern part of the Volkovskoye gabbro-diorite massif of the same name in the Middle Urals. The deposit is usually divided into four sections: Northwestern, Volkovsky, Intermediate, and Lavrovo-Nikolaevsky [1]. Ores are subdivided into iron-vanadium and copper-iron-vanadium types of ores, the latter being the main object of mining the deposit for copper. In view of the manifestations of signs of hypergenesis from the surface of the deposit, when calculating the reserves, the ores are divided into three technological grades according to the content of oxidized copper (Cu^{2+}): primary – with an oxidized copper content of less than 20%; mixed – from 20 to 50% and oxidized with an oxidized copper content of more than 50%. Actually, the ore mineralization of the deposit with accompanying gold-palladium mineralization is represented by titanomagnetite in association with apatite, the main copper minerals are bornite, chalcopyrite, as well as minerals of the chalcocite and covellite series [2]. Earlier, in order to identify the possibilities of identifying technological types and grades of ores, detailed studies of copper sulfides were carried out at the Lavrovo-Nikolaevsky site of the Volkovskoye deposit, where 3 varieties of bornite were identified and characterized – orange, pink and purple, differing in the ratio of Cu/Fe and $\Sigma \text{Me}/\text{S}$ [3].

The main purpose of this work is the mineralogical characterization of copper sulfides in industrial grades of ores of the North-Western section of the Volkovskoye deposit. In the course of the work, methods of ore microscopy were used (microscope POLAM – P312 and Nikon Eclipse E400 POL in reflected light), the composition of copper minerals was determined using a scanning electron microscope VEGA 3 TESCAN (Tescan, Czech Republic) with an energy dispersive spectrometer VEGA 3LMN, INCAENERGY 450 (analyst E.M. Tropnikov). The research was carried out at the Central Collective Use Center Geonauka, Institute of Geology of Komi Scientific Center UB RAS (IG FRC Komi SC UB RAS, Syktyvkar, Russia).

The studied copper mineralization in industrial grades of ores of the

North-Western area is characterized by finely dispersed dissemination of irregular shape. Microscopically, similar morphological features of copper sulfides in mixed and primary ores, and corrosion patterns of substitution of copper minerals in oxidized ores were identified.

Bornite has a predominantly xenomorphic appearance; the predominant part of the mineral is concentrated in intergranular spaces of titanomagnetite, apatite, and silicates. Rarely, euhedral crystals of bornite are observed in titanomagnetite, and rounded forms included in apatite grains are relatively rare. An insignificant part of bornite develops along the periphery of titanomagnetite grains, along cracks, or along the boundaries of ilmenite plates, while replacing magnetite. In places, bornite is confined to veinlet mineralization in association with chalcocite.

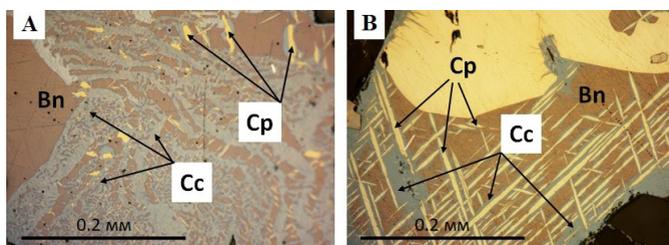


Fig. Bornite of the Northwestern area: *a*) graphic structures of intergrowths of chalcocite and bornite; *b*) granular intergrowths and lattice structures of the decomposition of chalcopyrite in bornite. Reflected light. Bn – bornite, Cp – chalcopyrite, Cc – chalcocite.

In more detailed optical studies of the surfaces of bornite from the Northwestern area, three of its varieties were also identified – orange, purple and pink bornite, which differ in chemical composition and form paragenetic associations with other copper sulfides, in general, similar to the bornite of the Lavrovo-Nikolaev area of the Volkovskoye deposit [3].

In the chemical composition of the bornite varieties, there is a small but stable excess of iron, with a consistently low copper content, as well as a different ratio of copper and iron compared to the stoichiometric one ($\text{Cu/Fe} = 5 \text{ at.}$). At the same time, bornite of all varieties is characterized by a stably underestimated ratio of the sum of metals in relation to sulfur – $\Sigma\text{Me/S} = 1.44 \text{ (at.)}$, with a stoichiometric ratio of 1.5 (at.).

The first variety of bornite, orange bornite ($\text{Cu/Fe} = 4.69 \text{ at.}$), is closely

associated with chalcopyrite, which forms rims, grains of rounded and irregular shape in bornite.

The second variety, purple bornite ($\text{Cu/Fe} = 4.82 \text{ at.}$), is most often associated with chalcocite in the form of intergrowths, rims, and graphic intergrowths (Fig.a), sometimes “flame-like” chalcopyrite segregations are noted in it [4].

Pink bornite ($\text{Cu/Fe} = 4.76 \text{ at.}$) is associated with chalcopyrite in the form of rims, granular intergrowths, lattice structures of decay, and “flame-like” segregations (Fig.b). Minerals of the chalcocite-covellite series are noted in the form of rims in the structures of chalcopyrite decay, as well as along cracks and contours of bornite grains.

Deviations in the compositions of bornite varieties in the association of copper minerals from stoichiometric ratios can reflect not only different conditions of the ore-forming process, but also determine the enrichment, which is important when isolating industrial grades and enriching copper ores of the North-West area and when putting into operation a new stage of the deposit.

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Phase transition of a viscous liquid between two parallel planes

I.O. Mashin¹, N.A. Belyaeva²

¹Institute of Physics and Mathematics, FRC Komi SC UB RAS, Syktyvkar

²SyktSU, Syktyvkar

ilya.mashin@gmail.com

Introduction. The problems of mathematical modeling of the liquid flow processes is widely studied in hydrodynamic section of mathematics. Despite the popularity of such problems, scientists have not yet researched all the liquid flow variations. For example, the Navier-Stokes equations of the motion of viscous newtonian liquid have no explicit solutions. However, some specific cases of these equations can be and have been explored.

For example, the model of viscous flow over the cylinder is described in the work [1]. Modeling of uncompressed liquid flat flow in an area with circle or rectangle form is explained in work [2]. Model of three-layer plate interaction with viscous incompressible liquid layer under foundation vibration is considered in the work [3]. All these models use the Navier-Stokes equations with different physical liquid parameters and conditions. Regardless of a big number of works with the Navier-Stokes equations, there still exist a lot of unsolved problems linked to the modelling processes of a liquid flow with the same theory.

The purpose of this research is the development of a mathematical model of a liquid flow between two parallel planes and the analysis of the numerical experiments with this model.

Statement of Problem. We consider the phase transition process (freezing) of viscous non-isothermal incompressible liquid flowing between two parallel planes. This can be described with the Navier-Stokes equation for an incompressible liquid with variable viscosity:

$$\frac{\partial \bar{V}}{\partial t} + (\bar{V}, \nabla) \bar{V} = -\frac{1}{\rho} \text{grad}(p) + \mu \Delta \bar{V} + 2(\text{grad}(\mu), \nabla) \bar{V} + \text{grad}(\mu) \times \text{rot} \bar{V} \quad (1)$$

Here $\mu = \mu(T)$ is viscosity which depends on temperature T . $\bar{V} = (V(y, t), 0, 0)$ is velocity of the liquid layer. It has only the x component that depends on a height of liquid layer y and time t . In addition, we need an equation for temperature. It is the heat-transfer equation:

$$c\rho \left(\frac{\partial T}{\partial t} + \bar{V} \text{grad}(T) \right) = \text{div}(k \text{grad}(T)) + \sigma'_{ik} \frac{\partial V_i}{\partial x_k} \quad (2)$$

We add no-slip border condition to the velocity, which means that the speed of flow on upper and lower planes are equal to zero

$$V(0, t) = V(h, t) = 0. \quad (3)$$

The initial condition for the temperature is: T

$$(h, 0) = T^*, \quad (4)$$

where h is the height of the upper plane, T^* is the phase-transition temperature, which is equal to zero in our problem. The temperature below the upper bound is equal to the specified temperature $T^0 > T^*$. The system of motion equation (1) and heat-transfer equation (2) with border conditions (3) and initial conditions (4) is the mathematical model of the flow of viscous non-isothermal incompressible liquid between two parallel planes.

Methods of solution. We consider our system in a Cartesian coordinate system. We also use the Euler method of solvation. For this we add the two-dimensional grid infinite in time with time step $\Delta\tau$, and height step $\Delta\eta = 1/n$, where n – amount of points of approximation. Finally, simplifying the equations (1)–(2), conditions (3)–(4) and making them dimensionless, then using the Euler method, we get the following equation for the temperature in the (i, j) point of grid:

$$\Theta_{i,j} = E_i \Theta_{i-1,j} + F_{i,j} \quad (5)$$

where

$$E_i = \frac{\Delta\tau}{\varepsilon\Delta\eta^2 - \Delta\tau E_{i+1,j} + 2\Delta\tau} \quad (6)$$

$$F_{i,j} = \frac{\Delta\tau F_{i+1,j} + \Delta\eta^2 \varepsilon \Theta_{i,j-1} + \Delta\tau \Delta\eta^2 \delta E U^2}{\varepsilon\Delta\eta^2 - \Delta\tau E_{i+1,j} + 2\Delta\tau} \quad (7)$$

$$E = e^{-\Theta_{i,j-1}}, U = \frac{u_{i+1,j} - u_{i,j-1}}{\Delta\eta}, \varepsilon = \frac{\lambda R T^{*2}}{\alpha \rho E \Theta^*}, \delta = \frac{E h^4 b^2}{R T^{*2} \lambda \mu(T^*)}$$

Similarly, for the velocity:

$$u_{i,j} = G_{i,j} u_{i-1,j} + H_{i,j} \quad (8)$$

where

$$G_{i,j} = \frac{E'\Delta\tau}{\varepsilon_1\Delta\eta^2 + E'\Delta\tau(2 - T + G_{i+1,j}(T - 1))} \quad (9)$$

$$H_{i,j} = \frac{\varepsilon_1\Delta\eta^2 u_{i,j-1} + E'\Delta\tau H_{i+1,j}(1 - T) + \Delta\tau\Delta\eta^2}{\varepsilon_1\Delta\eta^2 + E'\Delta\tau(2 - T + G_{i+1,j}(T - 1))} \quad (10)$$

$$E' = e^{-\Theta_{i,j}}, T = \Theta_{i+1,j} - \Theta_{i,j}, \varepsilon_1 = \frac{\lambda RT^{*2}}{\mu(T^*)E\Theta^*}, \mu(T) = \mu_0 \exp\left(\frac{E}{RT}\right)$$

In (6)–(10) ε , ε_1 , δ are dimensionless parameters, which contain physical characteristics of the liquid. Therefore, varying these parameters changes the process of phase transition.

The last values of coefficients being known from the border and initial conditions, we can calculate all coefficients E , F , G , H recurrently from i to $i-1$. Then, (5) and (6) are to be calculated. However, for performing calculations computer powers are required. An application for solving this problem is written on C# programming language in the Visual Studio 12 environment.

Results and discussion

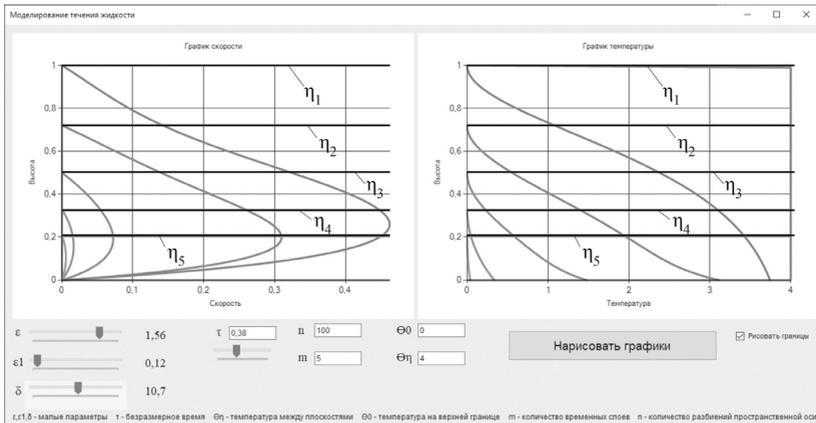


Fig. Test results.

Here we have an example image containing two line graphs showing the portrait of phase transition. Y axis is the height and X axis is the velocity

for the left graph and the temperature for the right. The letters $\eta_1-\eta_5$ indicate the border between liquid and solid surface in each of five moments of time. With the given parameters $\varepsilon = 1.56$, $\delta = 10.7$, $\varepsilon_1 = 0.12$ and time $\tau = 0.38$ the process gets its maximum velocity nearly of 0.48 in the first time period and crucially decreases to zero by the end. The temperature graph images the similar behavior of temperature decreasing steadily. Certainly, we may declare that the process is not finished with the specific parameters.

The resulting model of viscous liquid in phase transition process satisfies the main purpose of this work. The results of numerical experiments performed with the application can be used in the various areas of studying the liquids. And the whole experience of this work may become a part of further researches.

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Genetic types of interglacial fluvial sediments in the northern regions of the Pechora lowland

V.A. Isakov

Institute of Geology, FRC Komi SC UB RAS, Syktyvkar

Isakovvlad94@gmail.com

The Quaternary deposits of the Far North have attracted the attention of researchers since the first stages of the development of geological science. They are represented by a wide range of rocks, the genetic interpretation of which is far from always unambiguous, which often leads to incorrect paleogeographic reconstructions [1].

Diagnosis of genetic types of deposits is not only one of the most important goals of the lithological study of continental sedimentary formations, but also the basis for the dissection and correlation of Quaternary deposits sections, reconstruction of paleogeographic conditions of their formation in the Neopleistocene, and the conduct of geological survey and geological prospecting work [2].

The Quaternary deposits were studied in the northwestern and northeastern Bolshezemelskaya tundra in the coastal outcrops of the Kuya and Padymeityvis rivers. In the Kuya River basin, fluvial deposits were investigated in twenty coastal outcrops, and in the Padymeityvis River basin, in four outcrops.

Based on the classification of genetic types of continental deposits and the genetic diagram (d_{cp} and S_c dependence diagram), it was found that alluvial, fluvioglacial, and marine deposits are distinguished in the Kuya and Padymeityvis rivers basins.

Fluvioglacial deposits were studied in the northwest and northeast of the Bolshezemelskaya tundra in outcrops K-6/2, Pd-2, and Pd-3, where they are exposed mainly in outwash valleys [3].

In outcrop K-6/2 fluvioglacial deposits are represented by interbedding of micrograined light-beige gently undulating sands and gray-brown sandy loams. They are characterized by a medium degree of material sorting ($S_c = 0.33-0.52$) and large particle size ($d_{cp} = 0.132-0.481$ mm).

The mineral composition of the heavy fraction is characterized by an epidote (27%)-garnet (23%)-amphibole (21%) association, which makes it possible to attribute their formation in the northwestern part of the Bolshezemelskaya tundra to a large extent due to the erosion of glacial deposits

of the Fennoscandinavian glaciation center.

In outcrops Pd-2 and Pd-3, fluvio-glacial deposits are an interbedding of gray fine-grained sands and gray-brown loams. They are characterized by medium to good material sorting ($S_c = 0.27-0.71$) and particle size ($d_{cp} = 0.061-0.769 \text{ mm}$).

The heavy fraction of fluvio-glacial deposits of the Padymeityvis River is represented by siderite (11%)-ilmenite (16%)-garnet (20%)-epidote (39%) mineral association similar to the underlying vycheгда moraine.

Alluvial deposits identified both in the northwest and northeast of the Bolshezemelskaya tundra are different, depending on the size and type of rivers, hydrodynamic conditions, and their periodic changes.

The coastal alluvium facies lies at the base of outcrops K-3, K-6/1, K-13, Pd-4 and is characterized by a medium to good degree of material sorting ($S_c = 0.33-0.52$) and large particle size ($d_{cp} = 0.132-0.698 \text{ mm}$) in comparison with other facies varieties of alluvium. The coastal facies is characterized by the predominance of sand and gravel material, as well as cross-bedding.

The deposits of the near-channel shallow are found in the middle part of the outcrops K-3, K-4, K-6/2, K-13 and Pd-4. These sediments are characterized by high values of sorting coefficient ($S_c = 0.51-0.83$) and average particle diameter ($d_{cp} = 0.132-0.280 \text{ mm}$). This facies is dominated by sandy material. They are characterized by large cross, choppy and sinuous bedding.

The floodplain facies was studied in outcrops K-3, K-6/2, K-9, K-13, K-15/1 and Pd-4. The sediments of the floodplain facies are characterized by medium to good sorting coefficient ($S_c = 0.35-0.59$) and fine grain diameters from 0.040 to 0.105 mm. It is characterized by sinuous and horizontal bedding.

The mineral composition of the heavy fraction of alluvial deposits of the valley of the Kuya River is represented by a garnet (27%)-epidote (26%)-amphibole (20%) association, and in the valley of the Padymeityvis River — epidote (39%)-garnet (14%)-ilmenite (7%) association.

Thus, alluvial deposits in the northwest and northeast of the Bolshezemelskaya tundra are represented by sediments of the same type in granulometric composition. Differences were noted only in the mineral composition, which is associated with different sources of material removal.

Marine deposits were studied in outcrops K-15/1 and Nd-2. In outcrops K-15/1 marine sediments compose the lower part of the section, where they lie under the polar till and are represented by subhorizontal brown sands and clays with inclusions of fragments and whole shells of marine mollusks. Sands

and clays are rather well sorted — $S_c = 0.46-0.49$. The average particle diameter does not exceed 0.083 mm . The fine grain diameter, horizontal bedding, and the presence of marine mollusk shells may indicate that sedimentation took place in fairly calm conditions, in the shelf zone of the sea. The heavy sand fraction is composed of amphibole (20%)-garnet (21%)-epidote (25%) mineral association.

In outcrops Nd-2, they mainly compose the lower part of the section, where they lie under the vychegda till. Their characteristic features are not only a relatively large average grain diameter ($d_{cp} = 0.142-0.930 \text{ mm}$) and medium to good sorting ($S_c = 0.33-0.63$), subhorizontal and cross bedding, but also the presence of well-preserved whole shells of marine molluscs in the sediments, which is a diagnostic sign of sedimentation in coastal marine conditions.

The mineral composition of the heavy fraction is represented by amphibole (10%)-siderite (11%)-garnet (24%)-epidote (25%) association. The high content of titanium minerals (up to 10%) indicates the regular enrichment of marine sediments with minerals from the Northeastern terrigenous mineralogical province.

Thus, marine deposits in the northwest and northeast of the Bolshezemelskaya tundra have a number of differences in mineral and granulometric composition, which indicates different hydrodynamic conditions of sedimentation.

As a result of comprehensive studies of interglacial fluvial deposits in the northwest and northeast of the Bolshezemelskaya tundra, their textural, structural, mineralogical characteristics were obtained and the genetic affiliation of the sediments was established. Alluvial, fluvioglacial, lacustrine, and marine types of deposits in the northwestern and northeastern parts of the Bolshezemelskaya tundra have been identified and compared. The facies division of the alluvium was carried out.

Fluvioglacial deposits in the study area are represented mainly by outwash valley. The underlying glacial boulder loam served as the main source of material for fluvioglacial sediments. For this reason, the differences in the mineral and granulometric composition of fluvioglacial deposits in the northwestern and northeastern parts of the Bolshezemelskaya tundra are due to their formation at the expense of moraines from different feeding glacial provinces.

Alluvial deposits are represented by sediments of the same type in terms

of granulometric composition both in the northwest and in the northeast of the study area. Differences are recorded only in the mineral composition of the heavy fraction, which is associated with different sources of material removal during their formation.

Marine deposits compose mainly the lower part of the sections and are overlain by polar or vychedga till. Variable granulometric and mineral composition both in the northwest and northeast, subhorizontal and horizontal bedding, the presence of a complex of fauna characteristic of marine sediments of the Upper Cenozoic of the Barents Sea coast are diagnostic features of marine sediments.

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Preparation of diethylene glycol ether of pyropheorbide *a* from pheophetin *a*

E.A. Chernysheva, D.V. Belykh

Institute of Chemistry, FRC Komi SC UB RAS, Syktyvkar

echer93@mail.ru

The relatively low toxicity of chlorophyll *a* derivatives increases their attractiveness as active ingredients in medical preparations. However, such compounds are insoluble in water. Therefore, hydrophilization reactions of chlorophyll *a* derivatives are of great interest. In the literature [1], it is reported about transesterification reactions of the ester group of the exocycle of methylpheophorbide *a* with various alcohols, which proceed well at room temperature in the presence of sulfuric acid. Similar interesterification of pyropheophytin would reduce the number of steps in the preparation of these compounds. In this work, we studied the interaction of pyropheophytin *a* with diethylene glycol in the presence of acid.

Synthesis of 17-esters of pyropheophytin *a* was carried out by heating with DEG in the presence of sulfuric acid. It has been established that, pyropheophorbide *a*-17-diethylene glycol ether is formed as a result of the transesterification of the ester group of the exocycle of pyropheophytin *a*.

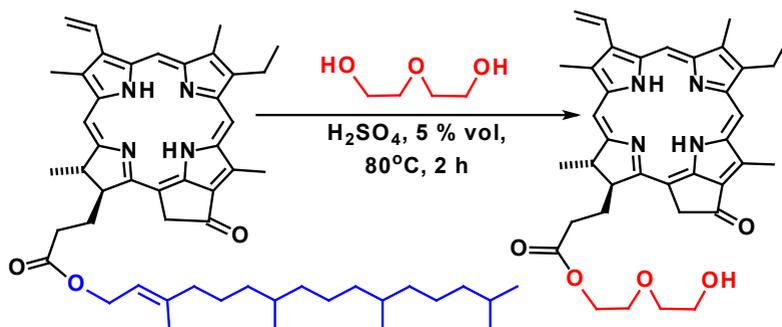


Fig. Transesterification of the ester group of pyropheophytin *a* with diethylene glycol.

Analyzing the results of the transesterification reaction of the ester group of the exocycle of pyropheophytin *a* with diethylene glycol, it can be concluded that the transesterification proceeds relatively well, with a yield of 40% of the initial pheophytin after column chromatography. Thus, in this work, the target compound was obtained in a smaller number of stages compared to

the previously described method. The structure of all the obtained compounds was confirmed by ¹H NMR spectroscopy.

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Synchrotron studies of the carbonized sponge scaffold and copper-carbon catalyst based on it

O.V. Petrova¹, S.V. Nekipelov¹, V.N. Sivkov¹, D.V. Sivkov¹, H. Ehrlich²

¹ Institute of Physics and Mathematics, FRC Komi SC UB RAS, Syktyvkar, Russia

² Institute of Electronics and Sensor Materials, TU Bergakademie Freiberg, Freiberg, Germany

teiou@mail.ru

The development of synthesis technology of nanostructured carbon materials is an urgent task in modern material science. The materials such as Carbon nanotubes (CNT) are characterized by high chemical inertness, heat resistance, conductivity, hardness and strength together with large surface area, makes them very perspective for usage in technical, chemical and ecological application as fillers for metal matrices and as a base of catalysts. On the other hand CNT are rather expensive to obtain, can't be fabricated on a large scale. They don't have 3D spatial structure and their production requires complex equipment and multistep synthesis process. These facts lead to the search of a new source for nanostructured materials synthesis. Moreover, the source material should have specific characteristics such as renewability, non-toxicity, natural origin, resistance to high temperature without loss its nanoscale architecture and structural integrity and it should be ranging from centimeter to meter scales. It is well known that for this purpose the natural silk and other protein-based material which contain collagen or keratin in its structure can be used [1-3].

In the current work we hypothesized that bath sponge scaffold [4,5] can be converted to carbon at high temperatures without loss of its form or structural integrity. More over its specific surface area will increase due to the appearance of nanopores. And further this material can be used as a base of catalyst. The main fibrous component of bath sponge scaffold is specific protein from "collagen suprafamily", named spongin. The structure of spongin has multiple levels comprising single fibers up to 100 *nm* thick composed of nanofibers. These structures are combined into complex hierarchical 3D networks of high macroporosity. Spongin exhibits specific structural and mechanical properties and futhermore it can withstand temperatures up to 1200°C in an inert gas environment without loss of its hierarchical 3D structure that makes this material very suitable for further higher temperature

modification.

In the study the structure and chemical changes of spongin scaffolds during its carbonization at 400–1200 °C together with the atomic and chemical composition of complex composite catalyst (carbonized spongin)/(Cu and Cu₂O) based on carbonized sponge scaffold with copper covering were investigated by the Near edge X-ray absorption fine structure (NEXAFS) spectroscopy [6] and other complementary methods made by our co-authors.

The NEXAFS studies were carried out at the Russian–German beamline (RGLB) of BESSY II synchrotron radiation source [7] in total electron yield mode (TEY).

Pristine, carbonized and metalized spongin scaffold sample preparation and its preliminary study were carried out at Institute of Electronic and Sensor Materials (IESM), TU Bergakademie Freiberg). The carbonization of preliminary cleaned spongin scaffold was carried out by direct heating at 1200°C for 1 hour under Ar flow. The Scanning electron spectroscopy (SEM) images of the pristine, carbonized and metalized spongin scaffold samples are shown in [Figure 1](#).

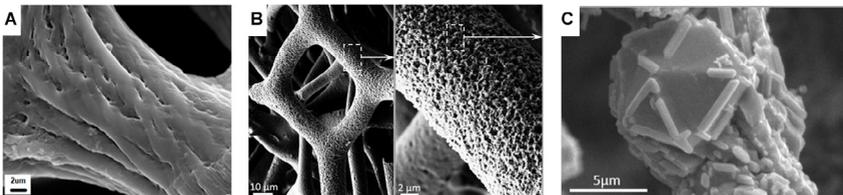


Fig. 1. SEM images of native (A), carbonized (B) and metalized by copper electroplating (C) sponging scaffold samples.

The preliminary study indicates that carbonized material resembles amorphous graphite and may also contain ordered graphite-like domains. Therefore, the purpose of this work is to determine the phase of the carbon placed in this material and the mechanism of spongin scaffold transformation during heating by NEXAFS-spectroscopy.

[Figure 2](#) show the absorption cross section spectral dependence of the native spongin and spongin carbonized at different temperature together with benchmark spectra in the NEXAFS in the region of C 1s and N 1s absorption edges. After carbonization any structure in N 1s NEXAFS spectra disappears which indicate the nitrogen atoms removal, degradation of peptide bond and

hence destruction of organic compounds during carbonization.

The C 1s spectra show us the transformation of peak at 285–286 eV during heating processes. In native sponge spectra this peak is associated with aromatic rings structure but for the annealed sample it became sharper and moved towards higher energies, to the right and indicates the presence of hexagonal structure. The same structure is also observed in HOPG, CNT or graphite. It means that during heating process within sponging scaffold the inorganic compounds are mostly removed, organic compounds are destroyed and transform into hexagonal graphite structure.

At the same time occur the oxidation of some carbon atoms and formations of few amount of carbonate anion (290.3 eV). NEXAFS spectroscopy data is well correlated with XPS, Raman spectroscopy and XRD data [5]. The combining of all results allows us to establish that under higher temperature treatment sponging scaffold transform into 3D microfibrous and nanoporous turbostratic graphite.

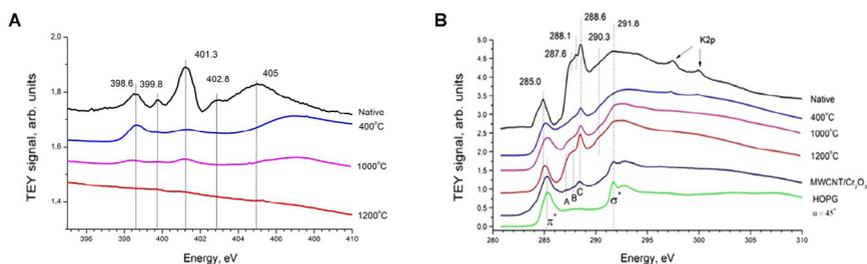


Fig.2. N 1s (A) and C 1s (B) NEXAFS spectra of native and carbonized spongin heated at different temperatures, HOPG, and nanocomposite MWCNT/Cr₂O₃.

In Further application this unique carbonized material with spatial 3D structure built of microporous and nanoporous turbostratic graphite can be metalized with copper by electroplating method. After electroplating with copper for 30 s, the 3D carbonized scaffold resembles the shape and architecture of the initial material before metallization. The detailed analysis of this material shows that 25 *at.*% of the copper on the surface of carbonized spongin was in the form of cuprous oxide. The rest part of the copper was in the metal form. This (carbonized spongin)/(Cu and Cu₂O) hybrid material demonstrates excellent catalytic properties with respect to the reduction of *p*-nitrophenol in both freshwater and marine environments.

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Development and validation of analytical methods for the creation of drugs based on components of plant raw materials and their synthetic analogues

J.E. Shutova

Institute of Chemistry, FRC Komi SC UB RAS, Syktyvkar

Os203@yandex.ru

The level of development of modern medicine makes it possible to treat and prevent a wide range of diseases. At the same time, the diseases themselves, allergic reactions, new mutations and strains develop at a much faster pace, becoming immune to existing drugs. Multi-stage cooperation of scientists from various fields: clinicians, pharmacologists, chemists, analysts allows you to create new drugs based on both plant materials and its synthetic analogues. Within the framework of the current global situation, combined drugs are a promising direction, simplifying treatment systems for both the doctor and the patient.

According to statistics, on average, all the stages of research and development required to make a new drug available to patients take more than 12 years, while most of the developed compounds never reach the market. The research stages are shown in **Figure**.

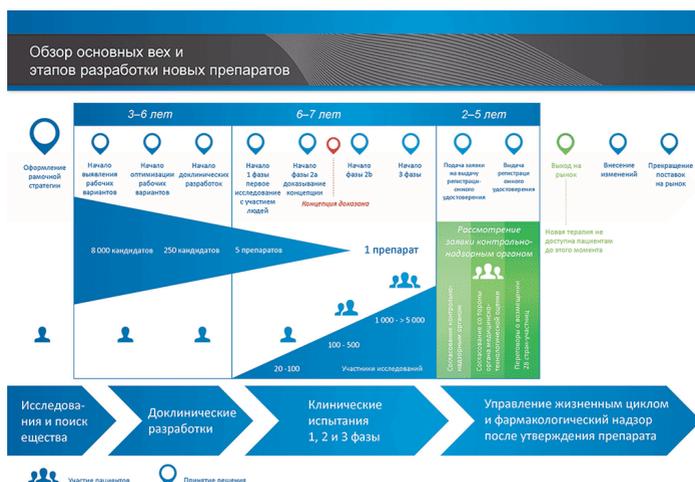


Fig. The research stages.

This work is aimed at the development and validation of analytical methods for herbal medicinal raw materials and its synthetic analogues, in

order to create universal areas of work that increase the speed of the stage of preclinical studies of the created molecule or their combinations.

Regardless of the type of feedstock: synthetic or vegetable, the following stages of development and analysis are distinguished:

- Technology development:

Tablets / hard gelatin capsules / injection solutions.

- Validation of equipment and processes.
- Development of technological regulations.
- Preparation of drug samples for pharmaceutical expertise, preclinical studies, clinical studies, stability studies.
- Carrying out work to determine stability under normal conditions and preparing a report.
- Carrying out work to determine the stability during accelerated aging and preparing a report.
- Preparation of a pharmaceutical development report.
- Analysis of the medicinal product, input analysis of raw materials.
- Study of the chemical composition of plant materials.

In accordance with modern requirements for the production of medicines, it is necessary to use validated analytical methods, in turn, validation is an experimental proof that the technique is suitable for solving the intended problems. Validation of an analytical method is carried out both when a new methodology is introduced in the development of new drugs, and when the conditions for the analysis of drugs change, changes in the production process that affect quality or reproducibility. The practical value of validation is that in the process of developing new methods, it is possible to identify their shortcomings in a timely manner and significantly improve the methodology in the early stages.

Processes and procedures should be subject to periodic critical revalidation to ensure that they continue to deliver the expected results.

Validation is an integral part of “quality assurance”, showing that the manufacturer understands the reasons for process variability and, in particular, understands what parameters need to be controlled to ensure process stability. Effective validation is based on risk management and the state of the art.

The characteristics of analytical methods, determined for the purpose of their validation, and the corresponding criteria for the suitability of validated methods intended for quality control of medicinal products:

pharmaceutical substances and medicinal products are regulated by the general pharmacopoeial article of the State Pharmacopeia of the Russian Federation.

During validation, an analytical method is evaluated according to the following characteristics, selected taking into account typical recommendations:

- specificity;
- detection limit;
- quantitation limit;
- range;
- linearity;
- trueness;
- precision;
- robustness.

Thus, the purpose of this work is: the development and validation of analytical methods for the analysis of drugs.

Based on the purpose of the work, the following tasks were set:

- 1) information search for relevant domestic and foreign literature, its analysis and the formation of a literature review;
- 2) input control of raw materials, selection and justification of the form of the medicinal product;
- 3) justification of the technological process of creating a medicinal product;
- 4) development of analytical methods based on the physicochemical properties of the feedstock and auxiliary components;
- 5) validation of analytical methods;
- 6) development of a draft regulatory documentation for a medicinal product.

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Evaluation hydrophobized polypropylene and polyester fibers as an oil sorbent

N.V. Ushakov, E.V. Udoratina, A.V. Kutchin

Institute of Chemistry, FRC Komi SC UB RAS, Syktyvkar

rentervation@gmail.com

Introduction. The relevance of researches in the field of environmental protection and rational use of nature resources is growing due to the increase of human impact on the environment. Among the most important areas of studies are waste recuperation and oil spill remediation.

Crude oil and oil refining products are known to be the main pollutants of waterbodies. For this reason, researchers are looking for new methods of oil remediation and improvements of existing methods.

Plastic recycling is the most promising method of reducing plastic wastes pollution of the environment. The development of new materials based on recycled plastic contributes to increase of plastic recycling range. The interest to the application of plastic waste in the production of oil sorbents has recently become very strong [1].

The main property of oil sorbent is buoyancy. Sorbent buoyancy affects extraction of sorbent from oil spill site. High buoyancy also reduces water sorption, which leads to the increase oil sorption. High buoyancy can be achieved by hydrophobization of polymer surface or by creating composition materials based on polymer fibers [2].

The aim of this work was to study oil and water sorption properties of hydrophobized polymer fibers. The hydrophobization method used in this study was developed at the Institute of Chemistry, FRC Komi Science Centre RAS and applied to lignocellulose-based materials [3].

Materials and methods

Materials. The polymer fibers are based on polypropylene (PP) and polyethylene terephthalate (PET, polyester). The fiber material was the polyester fibers with different linear density: 0.33 *tex* and 0.8 *tex* and the polypropylene fibers with linear density of 0.33 *tex*. The hydrophobization agent (HA) was a mix of fatty acid salts with sodium stearate as the main component. The molar mass of HA was taken as 202.

Synthesis of sorbents. In brief, polymer fiber (ca. 0.35 g) and hydrophobization agent was stirred in 250 ml beaker containing 200 ml of deionized water under the temperature 60°C. After 1 h potassium alum was

added. The amount of HA and potassium alum was eqimolar. After 30 *min* the fiber was retrieved and was air dried at room temperature for 24 *h*.

Oil sorption experiments. Polymer fiber (ca. 0.04g) was immersed into crude oil and was left for saturation for 10 *min*. After saturation, sorbent was withdrawn from oil and was left for draining for 1 *h*. Next, the sorbent was weighted.

Oil sorption experiments. Polymer fiber was placed onto water surface and left for saturation for 10 *min*. After saturation the sorbent was weighted.

The sorption capacity of sorbent was calculated by using the following formula:

$$SC = \frac{W_1 - W_0}{W_0}$$

where *SC* (g/g) is the sorption capacity, W_1 is mass of wet sorbent, and W_0 is mass of dry sorbent.

The scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX) analysis were performed by TESCAN VEGA 3 SBU.

Results and discussions. Four sorbents based on polyethylene terephthalate and two sorbents based on polyethylene were obtained. Fourier-transform infrared spectroscopy (FTIR) spectra was obtained in order to witness the presence fatty acid salts in sorbents. FTIR spectra presented in [Fig.1](#) and [Fig.2](#).

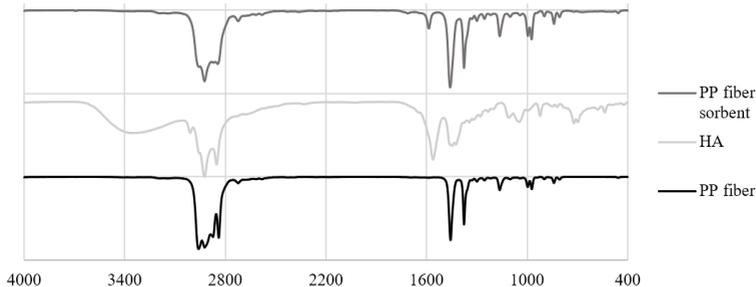


Fig.1. FTIR spectra of polypropylene fiber, PP sorbent and hydrophobization agent

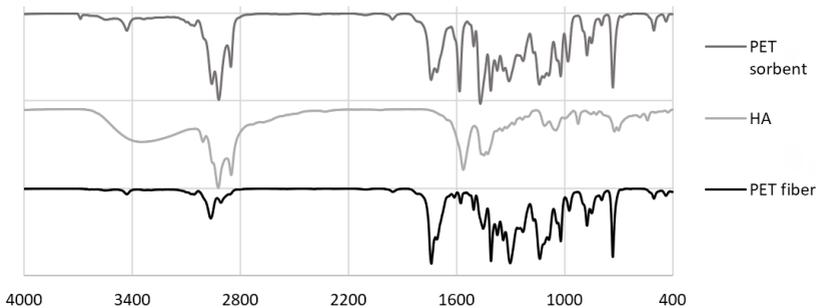


Fig.2. FTIR spectra of polyethylene terephthalate fiber, PET sorbent and hydrophobization agent.

As can be seen from the FTIR spectra graphs, the hydrophobized fiber got new bands (1580 cm^{-1} and $2850\text{--}2900\text{ cm}^{-1}$). These bands are related to HA. The bands within the range $2830\text{--}2950\text{ cm}^{-1}$ correspond to C-H stretching. The 1580 cm^{-1} band corresponds to C-O stretching in COO^- group. The emergence of new bands in fiber spectra reflects the presence of fatty acid salts in the synthesized sorbents.

Oil sorption capacity measurement results are presented in Fig.3.

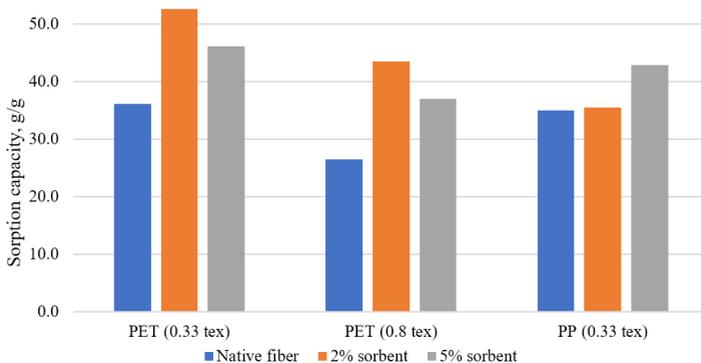


Fig.3. Oil sorption capacities of native fiber and sorbents

It can be seen that the treatment increases oil sorption of fibers. For PET-fiber sorbents the maximum increase of sorption capacity was 46% and 64% for samples with 0.33 tex and 0.8 tex , respectively. Further increase of HA leads to a decrease of oil sorption capacity. For sorbent based on PP-fiber maximum increase of sorption capacity was 22%. Compared to PET-fiber sorbent, oil sorption of PP-fiber sorbent increases with the increase of HA

content in hydrophobizing solution.

Water sorption capacity measurement results are presented in Fig.4.

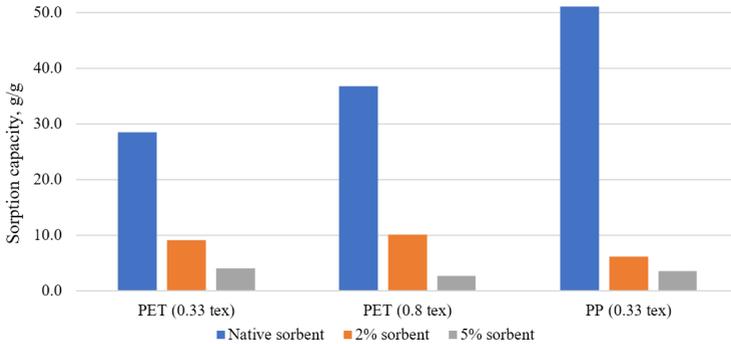


Fig.4. Water sorption capacities of native fiber and sorbents.

As seen from Fig.4, hydrophobization sharply reduces water sorption capability. The maximum of efficiency is observed for sorbents, which were treated by solution containing the highest amount of hydrophobization agent. The water sorption capacity decreases by 7, 12 and 14 times for PET (0.33), PET (0.8) and PP (0.33), respectively. Thus, water sorption decrease leads to an increase of buoyancy.

The SEM and EDX results are presented in Fig.5 and Fig.6.

The white sites on polypropylene-based sorbent depicted in Fig.5 are adsorbed aluminum salts of fatty acids. This is confirmed by EDX analysis obtained from one of these sites. The absence of any signs of hydrophobization agent in PET-based sorbent can be observed. But at the same time hydrophobic properties of PET-based sorbents are marked by FTIR and water sorption measurements.

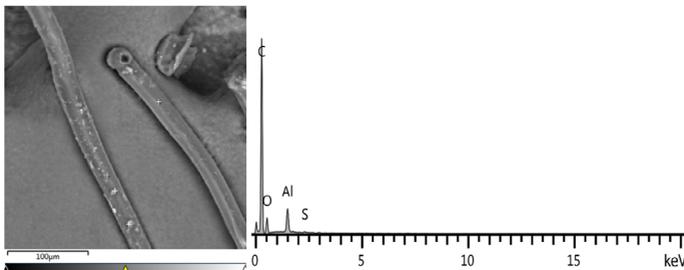


Fig.5. SEM and EDX images of PP-based sorbent.

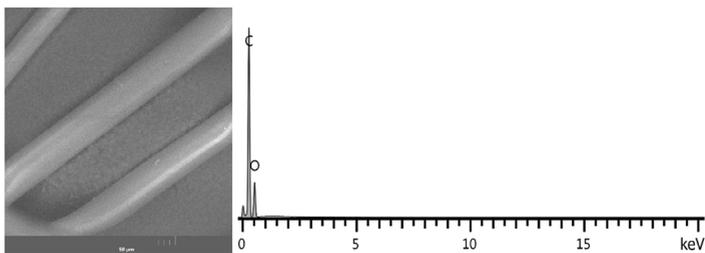


Fig.6. SEM and EDX images of PET-based sorbent.

Conclusions. From the foregoing, the following conclusions can be made.

1. Hydrophobization method of lignocellulose can be applied to synthetic fibers based on polypropylene and polyethylene terephthalate. The presence of fatty acid salts in sorbent was confirmed by FTIR, SEM and EDX analyses.
2. The treatment with higher concentrations of hydrophobization agent is more effective for polypropylene fibers.
3. For PET-fiber sorbents the increase of HA concentration increases water sorption and decreases oil sorption. The water repelling is a more important property for oil sorbent. Thus, increasing of HA concentration in treatment solution leads to more effective results.
4. PP-based sorbents have more affinity to fatty salts of aluminum than PET-based sorbents.

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Problems of determining the regulatory reserve of the power of the Unified Energy System of Russia

A.I. Stepskov

ISE&EPN, FRC Komi SC UB RAS, Syktyvkar

As you know, electrical energy through wires is often compared to water flowing through pipes. But unlike water, electricity cannot be stored efficiently and in large quantities for long periods of time. In fact, as much as it is consumed by receivers, so much of it must be generated at the same point in time. This brings us to the task of distributing and balancing electricity.

Globalization of the electric power industry has led to the creation of unified energy systems (hereinafter – UES) of individual countries or their groups, connected by a common mode of operation of the electric grid. Examples include the Unified Energy System of Russia (hereinafter, the UES of Russia), the European Union's energy systems associations, the North American energy systems associations.

In the UES of Russia, the reliability of ensuring the power balance of each territorial zone can be ensured both by its own power reserves and by the reserves of other zones. In this complex network of interconnections there is a task of ensuring balance reliability in managing the development of power systems of the country and UES of Russia (former USSR), which has always been given due attention when developing a strategy for the development of the electric power industry for the perspective of 5 to 20 years.

Since 2009, in accordance with the Rules approved by the Government of the Russian Federation¹, SO UES JSC, jointly with FGC UES PJSC, annually carries out the “Scheme and Program for the Development of UES of Russia for the Seven-Year Period” (hereinafter referred to as the SIPR of UES of Russia). We can say that since that time a new stage in the task of justification of means to ensure reliability when managing the development of UES of Russia has started. Since 2010, SO UES JSC, engaging reliability experts from other organizations, developed regulatory documents: draft technological rules for power grid operation² (rules of technological functioning – RTF) and new

¹ Rules for development and approval of schemes and programs for perspective development of the electric power industry, approved by Decree of the Government of the Russian Federation, No. 823, dated October 17, 2009.

² Approved at the joint meeting of the Scientific Council of the Russian Academy of Sciences on Problems of Reliability of Power Systems and the Scientific and Technical Board of NP «NTS UES» on 16.05.2011.

methodological guidelines for the design of power system development³. It is clearly stipulated in these documents that the balance reliability calculations of the UES of Russia should be carried out to solve the problems:

- determining the values of standard prospective reserves of generating capacity and reserves of carrying capacity of power grids for the 7-year period (annually);
- forecast of development as part of the development of the General scheme of placement of energy facilities for the 15-year period (once every 3 years).

In the expenditure part of the balance in terms of ensuring reliability, the most important is the characteristic of the normative perspective capacity reserve (hereinafter – the normative capacity reserve). In methodological recommendations of different editions, it corresponds to the normative (calculated) capacity reserve. The normative power reserve of the power system is necessary to ensure reliable functioning of the power system in the future: it is determined during planning of development of the power system and includes repair, compensation and strategic reserves. The division is conditional, and the given components are considered to be independent. This greatly simplifies solving the problem of justification of the normalized capacity reserve.

The complexity of determining the normative power reserve is mainly associated with finding the compensatory power reserve, which depends on many random factors and events. Certainly, all components of the normative power reserve affect the calculated values of reliability indicators. However, only the component of the compensatory power reserve has a probabilistic character and depends on random changes of load, generation and capacity of electric connections, and the other two components are planned deterministic values. Especially the importance of this point is shown when solving the first of the previously listed balance reliability problems.

For the above reasons it is necessary to update the methodological approaches to determining the prospective repair component of the capacity reserve, as a compromise between the previously existing standards, statistical information on the repairs, reflecting the functioning of the energy sector in the last decade, the balance between market relations and technical needs.

³ Methodological Recommendations on Designing the Development of Power Systems / JSC Institute «Energosetproject», 2012 (approved by NP «NTS UES», Section «Technical Regulation in the Electric Power Industry» in July 2012, but has not yet been approved by the Ministry of Energy of the Russian Federation.

Action of random factors and events can be evaluated by certain reliability indicators, when managing the development – by indicators of balance reliability. That is why, according to [6], the tasks of balance reliability of EPS, including management of development of UES of Russia, include only those, solution of which is connected with necessity:

- to take into account analysis of failures due to emergency damages of system elements (emergency component of compensation reserve);
- accounting for irregular fluctuations and load forecasting errors (load component of compensation reserve).

The development of generating sources and electric connections requires significant financial costs and has inertia. This should be reflected on the levels of redundancy, taken during perspective planning of power systems development, and UES of Russia in particular, and, consequently, on the normative values of the accepted indicators of balance reliability.

When selecting indicators that characterize the balance reliability of EPS, it should be understood that their number should be as small as possible and at the same time sufficient to make management decisions to ensure the required value of indicators of balance reliability at all levels of territorial and temporal management hierarchy.

Conclusion. Currently, there has been a need to develop more detailed requirements for the information support of the task of evaluating balance reliability for the analysis of the development schemes of the EEC of Russia. Here there is a wide range of works in the direction of presentation of initial information on modes of power consumption, especially its random component, caused mainly by temperature factor, on accounting of planned and emergency repairs of generating and network equipment, etc. Moreover, it is obvious that for different time levels of forecasting, the range of initial information, as well as the methodological basis of its accounting should be completely different.

Modern possibilities to justify the means to ensure reliability require updating the methodological approaches to the definition of all components of the regulatory capacity reserve, as a compromise between the previously existing standards, statistical information on emergency and planned repairs, reflecting the functioning of the energy sector in the last decade, the balance between market relations and technical needs.

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Determination of the optical constants of fullerite C₆₀ in the C 1s NEXAFS region

R.N. Skandakov¹, S.V. Nekipelov¹, O.V. Petrova¹, V.N. Sivkov¹, D.V. Sivkov^{1,2}

¹Institute of Physics and Mathematics, FRC Komi SC UB RAS, Syktyvkar

²SPbU, Saint Petersburg

scanick@yandex.ru

Determining the spectral dependences of optical constants (coefficients of absorption, refraction and reflection, atomic form factor) for a wide range of materials and chemical compounds is an urgent task of modern materials science. The spectral dependences of the optical constants in the resonant photoabsorption region demonstrate a complex nonmonotonic character, which leads to difficulties in determining them. Direct measurement of optical constants in the resonant photoabsorption region of ultrasoft X-rays is difficult, but the constants can be determined using the Kramers-Kronig relations (KKR) [1,2]. The relations link the real and imaginary parts of the complex values of the permittivity, refractive and reflection coefficients, and atomic form factor. The imaginary part of the complex refractive index is directly related to the absorption cross section. This means that the measurement of the spectral dependence of the experimental absolute values of the absorption cross section in a wide energy range makes it possible to determine the real and imaginary parts of the refractive indices, the knowledge of which makes it possible to calculate the spectral dependences of other optical constants.

The spectral dependences of the absorption cross sections in the energy range in the region of the C 1s absorption edge (280–320 eV) were measured by the Total electron-yield (TEY) method using a thin-film Ti filter on the Russian-German output channel and synchrotron radiation monochromatization (Russian Germany Beam-Line, RGBL) source BESSY II (Helmholtz Center, Berlin, Germany). Data on the absorption cross sections above and below the C 1s edge in the energy range 10–30000 eV were taken from Henke's tables [3].

Introduction. The resonant nature of the interaction of X-ray radiation with certain chemical elements in the region of the ionization thresholds of internal electrons leads to the appearance of a near edge X-ray absorption fine structure (NEXAFS) in the absorption spectrum, in the vicinity of which anomalous refraction is observed. The refractive index of X-ray radiation with a substance is a fundamental spectral characteristic containing unique information about the material, but since its changes are small in this region

and the energy dependence has a complex nonmonotonic form, it is difficult to determine this characteristic experimentally. The methods currently available for obtaining data on the refractive indices in the NEXAFS region are indirect and aimed at obtaining dispersion correction values for the atomic form factor. It is known that the real and imaginary parts of the complex permittivity, refractive index, reflection coefficient, and atomic form factor are related to each other in a wide energy range by Kramers-Kronig (KK) integral relations [1,2]. These relations make it possible to obtain the dependence of the values of the optical constants in numerical form by integrating over the entire spectral range. In this work, we measured the absorption cross sections in the NEXAFS C 1s region of the C₆₀ fullerite absorption edge, and the optical constants were calculated using tabular data on cross sections outside the resonant absorption region and literature data on the cross sections of C₆₀ fullerite in the optical region of the spectrum.

Results and discussion. The calculations of the spectral dependence of the refractive index $n(E)$ in the C 1s regions of the ionization threshold of fullerite C₆₀ are performed. To obtain this spectral dependence, it is necessary to have data on absorption cross sections in a wide spectral range. Tabular data on the absorption cross sections of the carbon atom in a wide range of 10–30000 eV outside the absorption edges [3] and in the energy range of 0–120 eV from works [4–6] were used for calculations. In the C 1s region of the ionization threshold (280–350 eV), we used the spectral dependences of the absorption cross section measured on the Russo-German output channel and radiation monochromatization on the BESSY II. The absorption cross sections in the energy range above 30 keV were obtained by power law extrapolation of the data in the range of 10–30 keV from [3]. All absorption cross section data used have been reduced to the absolute scale in Megabarns.

The sum of absorption cross sections for C₆₀ in the energy range 0–100 keV per one carbon atom was 6.4. This value agrees well with the sum rule (Thomas-Reiche-Kuhn), is close to the number of electrons in a carbon atom $Z = 6$, and indicates a high reliability and accuracy of the data on absorption cross sections in a wide range of the C₆₀ fullerite spectrum used in the calculations.

Further, using the KK relation [1,2]

$$n(E_0) = 1 + C \frac{2}{\pi} V.p. \int_0^{\infty} \frac{\sigma(E)}{E^2 - E_0^2} dE \quad (1)$$

where $C = 0.83 \text{ eV/cm}^2$ is a constant, and the symbol *V.p.* says that the integral is taken in the sense of an eigenvalue, the dependence $n(E)$ was calculated.

The spectral dependence $n(E)$ was calculated by numerical integration. In this case, the spectral dependence of the absorption cross section in regions far from the absorption edges was interpolated by a power law. The remaining optical coefficients are uniquely determined from the spectral dependences $n(E)$ and $\sigma(E)$.

The results of $n(E)$ calculations and the measured dependence $\sigma(E)$ of the C 1s edge region are shown in Fig.1.

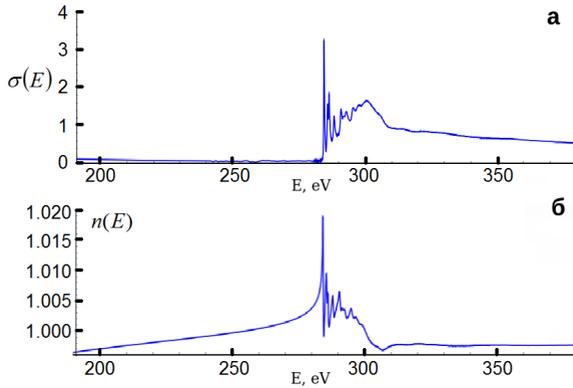


Fig.1. Spectral dependence of the absorption cross section in the C 1s region of the C_{60} fullerite edge in megabarns (a) and the calculated refractive index spectrum (b).

Data on the spectral dependences of the real and imaginary parts of the atomic form factor are presented in Fig. 2.

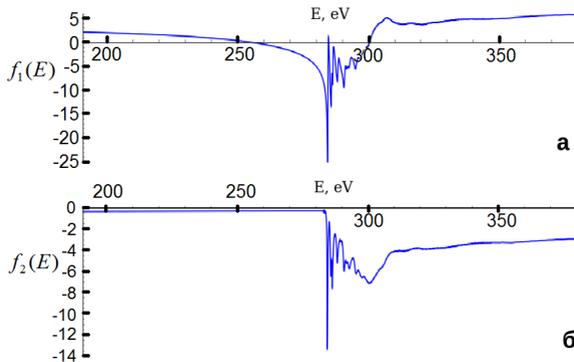


Fig.2. Spectral dependence of the real (a) and imaginary (b) parts of the atomic form factor in the C 1s region of the C_{60} fullerite edge.

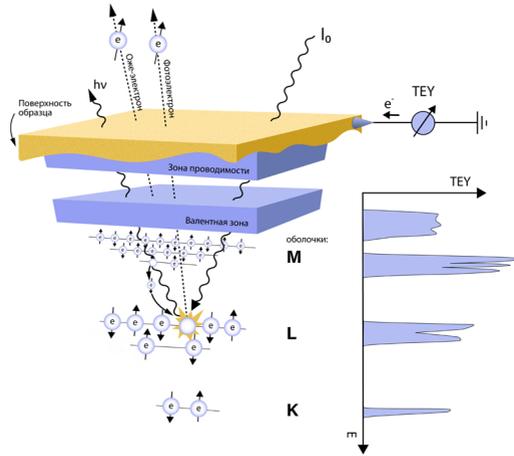


Fig.3. Absolute measurements with the TEY method: TEY — full electronic exit signal, σ is the absorption cross section, I_0 is the intensity of the incident radiation, φ is a monotonic function of energy.

$$TEY(E) \sim \sigma(E) \cdot I_0(E) \cdot E \cdot \varphi(E) \quad (2)$$

$$\sigma(E) \sim \frac{TEY(E)}{I_0(E) \cdot E \cdot \varphi(E)} \quad (3)$$

$$I_0(E) \cdot E \cdot \varphi_{Au}(E) \sim \frac{TEY_{Au}(E)}{\sigma_{Au}(E)} \quad (4)$$

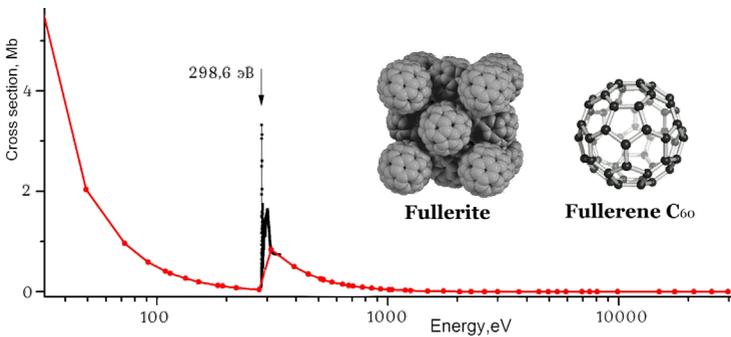


Fig.4. Spectral dependence of the absorption cross sections of the carbon atom (red line) [3] and fullerene C_{60} (black line).

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Chlorine dioxide: properties and applications

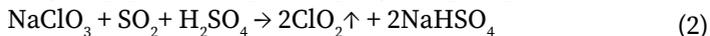
O.N. Grebyonkina

Institute of Chemistry, FRC Komi SC UB RAS, Syktyvkar

olya.grebyonkina@mail.ru

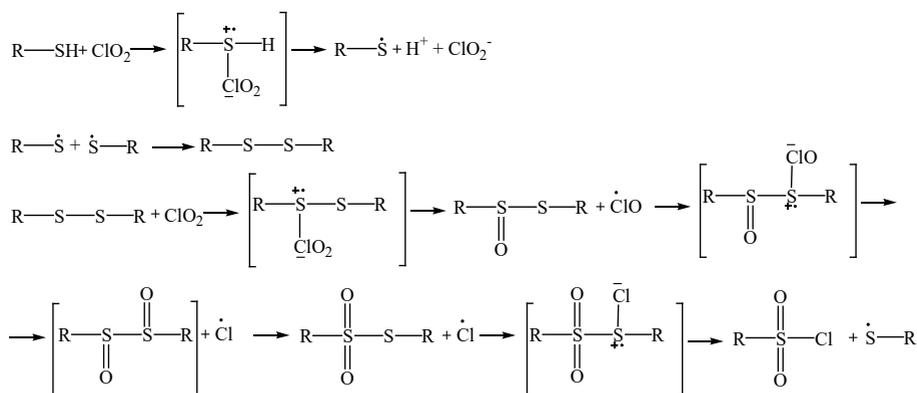
Chlorine dioxide (ClO₂) is a chemical compound consisting of one chlorine atom and two oxygen atoms. There are many facts about chlorine dioxide – they say it is a disinfectant, bleach, oxidizing agent, a miracle cure for all diseases. In this review, we will consider which of these facts are true and which are myths. For this, methods of preparation, physical and chemical properties, and applications will be considered.

Chlorine dioxide has unique physical and chemical properties [1]. It is a reddish to yellowish-green gas at room temperature that dissolves in water and in organic solvents. One of the most important qualities of chlorine dioxide is its high water solubility, especially in cold water. Chlorine dioxide does not hydrolyze when it enters water; it remains a dissolved gas in solution. Chlorine dioxide is approximately 10 times more soluble in water than chlorine. The best way to store chlorine dioxide is as a liquid at 4 °C. At this state it is fairly stable. Chlorine dioxide cannot be stored for too long, because it slowly dissociates into chlorine and oxygen. It is rarely stored as a gas, because it is explosive under pressure. When concentrations are higher than 10% chlorine dioxide in air, there is an explosion hazard. In a watery solution, chlorine dioxide remain stable and soluble. Watery solutions containing approximately 1% ClO₂ (10 g/L) can safely be stored, under the condition that they are protected from light and heat interference. Chlorine dioxide is rarely transported, because of its explosiveness and instability. It is usually manufactured on site from sodium chlorate.



In diluted, watery solutions chlorine dioxide is a free radical. At high concentrations it reacts strongly with reducing agents. There are literature data on the oxidation of organic compounds (alcohols, aldehydes, thiols, and disulfides) with chlorine dioxide [2]. For example, chlorine dioxide selectively oxidizes terpene thiols, the main reaction products, depending on the conditions, are disulfides, thiosulfates, thiosulfonates, sulfochlorides and sulfonic acids. The oxidation reaction proceeds according to the radical

mechanism (Scheme). Thus, the high oxidizing power of chlorine dioxide determines its antiviral and antibacterial activity. In order for a virus to multiply and thus cause an infection, it is necessary to penetrate into the cells of the host organism and begin to use the cellular material. To enter the cell, the surface proteins of the virus bind to specific cell surface proteins. Chlorine dioxide causes degradation of virus surface proteins by oxidizing aromatic amino acids, thereby causing loss of protein function. For example, for the influenza virus, chlorine dioxide oxidizes tryptophan 153, an amino acid that is important for the virus to bind to hosts, to N-formylkynurenine, causing loss of function. In addition, chlorine dioxide has been reported to have a direct effect on DNA or RNA nucleic acid modification [3].



Scheme

The physical and chemical properties of chlorine dioxide determine the areas of its application. Chlorine dioxide has many applications. It is used in the electronics industry to clean circuit boards, in the oil industry to treat sulfides and to bleach textile and candles. In World War II, chlorine became scarce and chlorine dioxide was used as a bleach. Nowadays chlorine dioxide is used most often to bleach paper [4]. It produces a clearer and stronger fiber than chlorine does. Chlorine dioxide has the advantage that it produces less harmful byproducts than chlorine. Chlorine dioxide gas is used to sterilize medical and laboratory equipment, surfaces, rooms and tools. Chlorine dioxide can be used as oxidizer or disinfectant [5]. It is a very strong oxidizer and it effectively kills pathogenic microorganisms such as fungi, bacteria and viruses. It also prevents and removes bio film. As a disinfectant and pesticide it is mainly used in liquid form. Chlorine dioxide can also be used against

anthrax, because it is effective against spore-forming bacteria. Some people use diluted solutions of chlorine dioxide for bad breath, tooth plaque, and wound healing, but there is no good scientific evidence to support these uses.

Chlorine dioxide is not a cure or treatment for medical ailments, including but not limited to autism, HIV, malaria, hepatitis viruses, influenza, common colds, and cancer. Claims that the ingestion of chlorine dioxide, often advertised as “Miracle Mineral Solution” or MMS, will cure these or other ailments are false. These products should not be consumed or given to someone to consume. The sale of these products as miracle cures is dangerous and has resulted in criminal convictions [3].

Thus, chlorine dioxide has unique physical and chemical properties. It is widely used in the chemical industry as a bleach, selective oxidizer, and disinfectant. In addition, chlorine dioxide has antibacterial and antiviral activity, however, it is not a drug, and its use is dangerous for human health.

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Features of the distribution of Zr and Hf in granites of the Nikolaishor Massif (the Subpolar Urals)

Yu.V. Denisova

Institute of Geology, FRC Komi SC UB RAS, Syktyvkar

yulden777@yandex.ru

The Nikolaishor Massif is located in the south-eastern part of the Subpolar Urals and is confined to the Nyartinsky block in the basin of the Nikolaishor and Igshor streams. This is a narrow conformable body elongated in the north-north-west direction with a length of 4 km and an average width of 1.5 km. The granitoid body located to the south also belongs to the Nikolaishor Massif. The rocks of this massif are represented by two main varieties: plagiogranites and normal K-feldspar granites. These granites mainly have a gneiss-like appearance and mutual transitions to gneiss and crystalline schists. According to A.M. Pystin [1], these rocks can be considered as plagiogranite-gneiss and granite-gneiss. Granite-gneisses develop mainly over plagiogranite-gneisses and are spatially closely related to them. In addition to the rocks of the granite series that make up the bulk of the Nikolaishor granite massif, it contains metamorphites of the Nyartinsky Complex granitized to varying degree [2,3]. The Nikolaishor Massif belongs to the S-type according to the Chappel's classification [4].

The new Zr-Hf geothermometer for magmatic zircons was developed by L.Y. Aranovich and N.S. Bortnikov in 2018 [5]. The main advantage of the proposed method is the ability to determine the temperature of formation of a single crystal. The method is based on the study of the distribution of zirconium and hafnium between zircon and the parent melt. According to the conclusions of these scientists, the crystallization temperature of zircon is inversely dependent on the coefficient characterizing the distribution of zirconium and hafnium between the mineral and the mineral-containing rock: $T(K) = 1531/(\ln(K_d) + 0.883)$, $K_d = (X_{Zr}^Z X_{Hf}^G)/(X_{Zr}^G X_{Hf}^Z)$, where K_d – distribution coefficient of Zr and Hf between zircon (Z) and granite (G), $T(K)$ – temperature, Kelvin, X_{Zr}^Z , X_{Hf}^Z – the content of Zr and Hf contents in zircon, ppm, X_{Zr}^G , X_{Hf}^G – the content of Zr and Hf in granite, ppm.

The study of the Nikolaishor Massif was carried out by the point method with the selection of five samples. Each sample consisted of pieces of unaltered rock with a total average weight of 10 kg [6]. Ten zircons were selected in each sample. The content of zirconium and hafnium in granite was obtained

using the ICP-MS method, in zircon it was determined using the microprobe analysis at the Research Center “Science” at the Institute of Geology (FRC Komi Science Centre, Syktyvkar, analyst A.S. Shuisyki). Using the Aranovich-Bortnikov geothermometer, the author determined the temperatures for each selected zircon (Table).

Table. Zr-Hf geothermometer for the Nikolaishor massif granites

№	Sample no.	The content of the element in zircon, wt. %		The content of the element in granite, wt. %		T, °C	№	Sample no.	The content of the element in zircon, wt. %		The content of the element in granite, wt. %		T, C°		
		Zr	Hf	Zr	Hf				Zr	Hf	Zr	Hf			
1	N-1	49.66	2.24	26.37	2.52	664	26	N-3	47.87	1.49	35.02	2.01	751		
2		47.37	2.12	26.37	2.52	659	27		47.27	1.67	35.02	2.01	846		
3		50.02	2.22	26.37	2.52	655	28		46.89	1.48	35.02	2.01	761		
4		48.29	2.25	26.37	2.52	683	29		46.81	1.68	35.02	2.01	859		
5		48.02	2.21	26.37	2.52	676	30		49.56	1.39	35.02	2.01	684		
6		46.70	2.12	26.37	2.52	668	31		47.55	1.77	35.75	2.11	866		
7		47.37	2.19	26.37	2.52	678	32		49.81	1.89	35.75	2.11	883		
8		49.88	2.21	26.37	2.52	654	33		47.52	1.78	35.75	2.11	871		
9		45.06	2.02	26.37	2.52	660	34		49.87	1.89	35.75	2.11	881		
10		48.97	2.33	26.37	2.52	696	35		47.56	1.32	35.75	2.11	662		
11	N-2	46.15	2.32	19.87	2.21	640	36	N-6	46.91	1.37	35.75	2.11	692		
12		48.22	2.45	19.87	2.21	646	37		49.88	1.44	35.75	2.11	683		
13		48.56	2.48	19.87	2.21	648	38		48.27	1.71	35.75	2.11	826		
14		48.55	2.42	19.87	2.21	635	39		49.65	1.45	35.75	2.11	693		
15		46.11	2.33	19.87	2.21	643	40		49.78	1.75	35.75	2.11	820		
16		46.25	2.35	19.87	2.21	646	41		47.80	1.16	39.78	2.01	672		
17		46.44	2.35	19.87	2.21	643	42		48.31	1.18	39.78	2.01	679		
18		50.12	2.55	19.87	2.21	646	43		48.19	1.55	39.78	2.01	874		
19		46.21	2.34	19.87	2.21	644	44		47.37	1.12	39.78	2.01	660		
20		46.15	2.34	19.87	2.21	644	45		47.06	1.43	39.78	2.01	826		
21		N-3	47.52	1.32	35.02	2.01	679		46	N-8	47.53	1.41	39.78	2.01	809
22			46.63	1.45	35.02	2.01	750		47		47.05	1.40	39.78	2.01	812
23			46.45	1.33	35.02	2.01	694		48		46.81	1.42	39.78	2.01	826
24			46.08	1.23	35.02	2.01	656		49		47.27	1.39	39.78	2.01	804
25			47.79	1.51	35.02	2.01	761		50		48.14	1.57	39.78	2.01	886

According to the data obtained, there was the same temperature regime for the zircons from samples N-1 and N-2. These minerals crystallized at

relatively low temperatures. Typical temperature ranges were from 654 °C to 696 °C and an average of 669 °C for sample No. 1 and from 635 °C to 648 °C and an average of 643 °C for sample No. 2. Two temperature conditions are observed for crystals from samples N-3, N-6 and N-8. For sample No. 3, the first thermal range is from 656 °C to 694 °C and an average of 682 °C, the second is from 751 °C to 859 °C and an average of 796 °C. Similar ranges are recorded for the N-6 sample (the first — from 662 °C to 693 °C and an average of 683 °C, the second — from 826 °C to 883 °C and an average of 858 °C) and N-8 (the first — from 660 °C to 679 °C and an average of 670 °C, the second — from 804 °C to 874 °C and an average of 825 °C). Thus, the rocks of the Nikolaishor Massif during their formation were exposed to two temperature regimes: from 635 °C to 696 °C and an average of 662 °C and from 751 °C to 883 °C and an average of 833 °C. Moreover, the studied massif was partially exposed to the second effect of high temperatures.

The study of the contents of zirconium and hafnium in granite-gneiss and zircons of the Nikolaishor Massif showed that the rocks are characterized by a high-temperature formation regime. Two temperature regimes were determined: from 635 °C to 696 °C (on average 662 °C) and from 751 °C to 883 °C (on average 833 °C) according to the Aranovich — Bortnikov geothermometer. The information received confirms the author's early conclusions [7,8].

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Structural features of the riphean framing of the nyarta complex in the northern part of the Subpolar Urals

K.S. Popvasev, I.L. Potapov

Institute of Geology, FRC Komi SC UB RAS, Syktyvkar

In the upper reaches of the Kozhim River the most complete precambrian-paleozoic sections were found. According to the schemes adopted by the Third and Fourth Ural Interdepartmental Conferences [1], the following stratigraphic units are distinguished in the precambrian section of the Subpolar Urals: the nyartin complex of the lower proterozoic, the man'hobey and shchokurya lower riphean suites framing it; the puiva formation, which includes the basal oshiz sequence of the middle riphean. The upper riphean includes the khobein and the sanaizskaya (moroya). The deposits of the sablegorskaya suite of late riphean-vednian age lie above. The precambrian section is crowned by the laptopai suite of vednian age.

In a number of works, including some with the participation of the authors [2-5 and etc.], the rocks of the man'hobey and shchokurya formations are shown to belong to the nyartin complex. Consequently, the framing of the above formations of the lower proterozoic begins with the metamorphic rocks of the puiva formation.

The presence of open and moderately compressed folds is a common structural element for all the subdivisions under consideration. These folds have steeply oriented axial surfaces and gently sloping hinges.

In the outcrops of the puiva formation, the primary structures are established here due to the presence of interlayers of metaporphyries among the monotonous shale sections. There is a system of closed asymmetric folds with hinges gently plunging to the northwest. The wings of the folds are cut by late schistosity. On steeply dipping wings, open almost symmetrical small folds are sometimes formed, with axial planes parallel to late schistosity.

For the rocks of the puiva formation, a geometric analysis of folding was performed. On the basis of the mass orientation of planar and linear structural elements, spherical diagrams were constructed (Fig.1a). The poles of planar inhomogeneities form a great circle arc ($F_n + 2$) with a strike azimuth of 34° and an angle of incidence of 75° in the southeast direction. The calculated fold hinge of the second generation ($F_n + 2$) is located in the center of the distribution area of the measured hinges and has a dip azimuth ($b_n + 2$) of 325° at a dip angle of 15° . The second arc ($F_n + 3$) is represented by the generation

of recumbent concentric folds parallel to the axial surfaces of late schistosity.

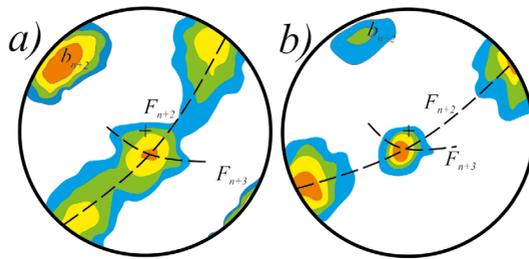


Fig. Spherical diagrams (lower hemisphere) of planar inhomogeneities, hinges. (The color indicates the isolines of the density of poles and hinges, in 1–2–4–6%): a) puiva formation, b) moroya formation.

Two systems of folds are identified in the deposits of the khobein and moroya suites. The early one is represented by closed asymmetric, similar folds. Short wings have a northwestern and southwestern fall. They are subvertical, and cut by late schistosity. Banding in rocks presumably develops parallel to the bedding. Where the dip is steeper, the schistosity cuts the bedding parallel to the axial planes of gently sloping or open asymmetric folds. Where the bedding dips gently, the schistosity is subparallel to the bedding. Stratification strikes south and west, schistosity — north and northeast. Such folds are similar to the folds found in the rocks of the puiva formation and the underlying formations of the nyarta Complex. The poles of planar and linear structural elements lie on a great circle arc (Fig.b). Striking azimuth (F_{n+2}) – 65° dip to the southeast at an angle of 80°. The average value of the azimuth immersion of the hinges (b_{n+2}) is 340°, the immersion angle is 10°. The reconstructed axial plane of the folds strikes northwest. The late folds (F_{n+3}) are recumbent, open, concentric, less often compressed, developing along the axial surfaces of the early folds with steep wings.

For the rocks of the sablegorsk formation, geometric analysis was not carried out, due to the insufficient number of measurements of planar and linear structural elements.

Based on the presented data, it can be concluded that there are two deformation stages in the precambrian setting of the nyartin complex. The first stage (F_{n+2}) led to the formation of direct folds of the first generation in the rocks that make up the middle-upper riphean section and the complication of previously formed structures in the lower proterozoic nyartin complex, in

which folds of the generation ($F_n + 1$) are represented. The second stage is associated with repeated dislocations in the Riphean and pre-Riphean rocks and the collapse of the lower paleozoic deposits.

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Der Einfluss der Befahrungszahl auf die Fahrspurtiefe und die Bodendichte

D.A. Severgina¹, V.V. Startsev¹, I.N. Kutyavin¹, N.M. Gorbach^{1,2}, A.A. Dymov¹

¹ Institut für Biologie FRC Komi Ural Branch der Russischen Akademie der Wissenschaftler, Syktywkar

severgina.darja@gmail.com

² SyktSU, Syktywkar

nikolay.tbo@gmail.com

Die durch die Harvester und Forwarder Paaren dargestellten Holzbeschaffungskomplexe wurden intensiv auf europäischem Nord Russlands bis 2006 eingesetzt. Heute wird das Holz etwa 95% durch die skandinavische Holzgewinnung beschafft. Es bringt weiterhin zu der Verdrängung der baumschaftlichen Holzgewinnung [1]. Es gibt ziemlich viele mechanische Störungen, die von Forwardern und Harvestern hinterlassen werden. Sie befinden sich hauptsächlich auf den Rollwegen, die 15 bis 30% der Holzschlagfläche einnehmen. Das Ziel dieser Forschungsarbeit ist die Einschätzung der Veränderungen physikalischer Bodeneigenschaften des Podsolbodens unter der Auswirkung der Holzbeschaffungskomplexen im bruchbeer-typischen Fichtenwald.

Um die Veränderungen der Böden zu beurteilen, wurde das Feldexperiment organisiert, in dessen Rahmen eine Parzelle mit dem bruchbeer-typischen Fichtenwald, der sich auf podsolischen Böden entwickelte, durchgeführt wurde. In der Periode der Feldsaison 2020 wurden die ursprünglichen Podsolböden untersucht. Weiter, im Dezember 2020, wurde die Holzernte auf dem untersuchenden Sektor geschnitten. Ein vierachsiger Forwarder wurde als eine experimentelle Maschine eingesetzt. Zum Zeitpunkt der Holzernte gab es in der untersuchten Biogeozönose keine Schneedecke, und eine Woche vor dem Experiment herrschte eine negative Temperatur. Unter diesen Bedingungen wurden die Böden bis zu einer Tiefe von etwa 15 cm gefroren, wodurch ihre hohe Tragfähigkeit gewährleistet wurde. Zum Zeitpunkt des Experiments betrug die Lufttemperatur minus 3.2 °C. Die Temperatur der Einstreu betrug minus 0.5 °C. Die Bödendiagnostik wird mit der Hilfe von "Die Abstufungen der russische Böden" [2] und "Die Feldanhaengezahlböden" [3] mit der Empfehlungen zur Beurteilung der Eigenschaften von den Böden mit dem Turbohorizont durchgeführt [4,5]. Zur Bestimmung der Tiefe der Spurrillen wurden 162 Messungen für Böden nach

drei Gängen des Forwarders und 392 Messungen für Böden nach zehn Gängen des Forwarders durchgeführt. Die Bestimmung der Bodendichte der oberen genetischen Horizonte wird nach Wadyunina, Kortschagina [6] durchgeführt. In jedem Bodenprofil wurden die Proben von jedem genetischen Horizont 5 Mal genommen.

Um den Einfluss abhängig von der Anzahl der Holzbeschaffungskomplexe beurteilen zu können, wurden neun Rollwege etwa 50 Meter lang verlegt: drei Rollwege mit drei Gängen des Forwarders (3P), drei Rollwege mit zehn Gängen des Forwarders (10P) und drei Rollwege mit zehn Gängen des Forwarders und nachfolgender Rekultivierung (das Ausrichten von den Spurrillen, das Verschieben von der Einstreu, der Baumstümpfen, der Abholzungsrückständen) (10R). Drei Bodenprofile wurden auf den Rollwegen mit unterschiedlicher Gangzahl des Forwarders untersucht.

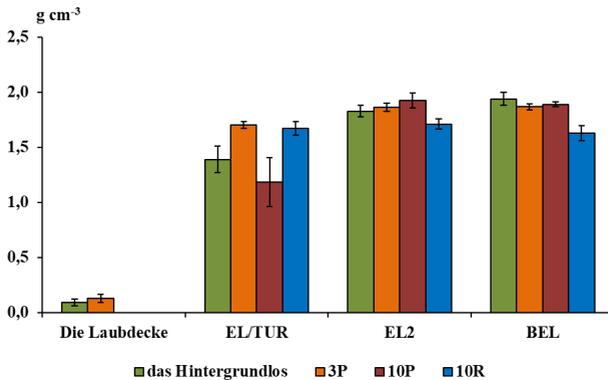
Alle veränderten Böden haben keine Bodenbedeckung. Es gibt auch viele Zweige und Nadeln auf der Bodenprofiloberfläche. Der Rollweg nach der dritten Fahrt des Forwarders wurde als Unterboden definiert, da die Horizonte des Bodenprofils nicht miteinander vermischt und zur Horizonten der ursprünglichen Podsolböden geglichen wurden. Die oberen Mineralhorizonte wurden überlastet. In dem Bodenprofil nach dem zehnten Gang des Forwarders wird der genetische TUR-Horizont beobachtet, der durch die Vermischung des organogenen und des oberen Mineralhorizonts gekennzeichnet ist. Diese Bodentypen wurden als die Böden mit dem Turbohorizont bezeichnet: das Rollweg nach dem zehnten Gang des Forwarders – der dentritische Boden mit dem Turbohorizont, das Rollweg nach dem zehnten Gang des Forwarders und nachfolgender Rekultivierung – der Boden mit dem Turbohorizont. Für die Böden mit dem Turbohorizont an einem rekultivierbaren (abgeflachten) Standort gibt es ein Mikrorelief mit dem Westen. Im Sommer bleibt das Wasser lange hier. In den unteren Horizonten aller Böden wird eine visuelle Überempfindlichkeit beobachtet.

Nach der Holzernte wurden die Messungen die Tiefen der Spurrillen gemacht. Die maximale Bodeneindringung wird auf den Rollwegen nach dem zehnten Gang des Forwarders beobachtet und beträgt 60 cm. Auf den Rollwegen nach dem dritten Gang des Forwarders beträgt die maximale Bodeneindringung 41 cm. Im Durchschnitt drücken die Holzbeschaffungskomplexe die Böden mit dem Turbohorizont etwa doppelt so stark durch.

Die Lagerungsdichte der oberen genetischen Horizonte der

untersuchten Böden ist viel höher als in ursprünglichen Boden (das Bild), außer der dendritischen Böden mit dem Turbohorizont.

Seine oberen Bodenhorizonte sind aufgrund der Lockerung des Bodens durch die Räder der Holzfällergeräte dichter. In unterliegenden Bodenhorizonte untersuchten Rollwege wird eine leichte Überbelegung beobachtet. Allerdings, die Lagerungsdichte des Bodens mit dem Turbohorizont ist wenig. Vermutlich ist es mit dem Ausrichten von den Spurrillen des Parzelles mit Hilfe von einem Bagger verbunden worden.



Das Bild. Die Dichte natürlichen Horizonte in untersuchten Böden. Die Bezeichnung: das Hintergrundlos – ursprünglicher Podsolboden; 3P – der Podsolboden, 10P – dendritische Böden mit dem Turbohorizont, 10R – der Boden mit dem Turbohorizont.

Daher kann nach den erhaltenen Informationen Folgendes festgestellt werden, dass das Stützbödenprofilen nach der Holzernte sich morphologisch erheblich von den ursprünglichen Hintergrundböden unterscheiden. Darin wird eine teilweise oder vollständige Zerstörung der oberen Horizonte und der Bildung neuer genetischer Horizonte zusätzlich zur allgemeinen Überbelegung der Böden beobachtet. Die Tiefe der Spurrillen auf den Rollwegen hängt natürlich von der Anzahl der Fahrten Holzbeschaffungskomplexe ab. Die Tiefe der Spurrillen der Rollwegen nach dem zehnten Gang des Forwarders ist 2–3 Mal höher als der Tiefe der Spurrillen der Rollwegen nach dem dritten Gang des Forwarders. Im Allgemeinen, die Bodendichte der genetischen Horizonte des Bodens mit dem Turbohorizont ist naturgemäß höher als die Bodendichte in den Horizonten typisches Podsolbodens.

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Behavior of structurally unstable grounds under vibrodynamic impact (Syktyvkar)

A.N. Vikhot

Institute of Geology, FRC Komi SC UB RAS, Syktyvkar

vikhot.anna@mail.ru

Static and dynamic impacts on grounds and rocks lead to a change of their conditions and physical and mechanical properties: Kporo, angle of internal friction, shear strength, etc. For example, the angle of internal friction decreases in half under the impact of elastic vibrations of 0.4g and tends to zero at 1g [1] *i.e.* the grounds are in a state of structural strain and lose impact resistance. Vibration impacts on grounds arise mainly from motor- vehicle traffic and machines work. It is generally assumed that they are considered weak compared to seismic impacts although vibrodynamic impacts up to 1.9 m/s^2 correspond to magnitudes up to 6.4. Irreversible properties changes of cohesive and non-cohesive grounds can occur during such long-term impact because the destruction rate exceeds the recovery rate.

The grounds have mainly a glacial origin (pechora horizon) and are complicated by alluvial sediments and a soil layer of plant remains near the day surface in the upper part of the geological section of Syktyvkar territory. [2,3]. Their diagenesis is not over yet so the study of the behavior of these structurally unstable grounds under vibrodynamic impacts is very relevant.

The experiment was carried out on a vibrodynamic installation consisting of an oscillator and a frequency converter. It allowed to control acceleration amplitudes from 0.022 to 0.819 m/s^2 . The results are presented in Table.

The critical exposure time was 5–7 s. Primary compaction occurred at vibration accelerations 0.069–0.254 m/s^2 in non-cohesive grounds. They begin to lose their stress-related properties starting from these values. The value was 0.069 m/s^2 for fine-grained damp sand. Medium-grained water-saturated sands were the most stable to the compaction at first thought (0.819 m/s^2). In fact, these sands springed into the liquefaction, passing a compaction. This is typical for grounds with high humidity. Thus, they are suitable for building only if their vibroflotation coefficient is known. The cohesion acceleration of the tested grounds was in the range of 0.561–0.819 m/s^2 . Structural bonds were preserved up to $a_{cr} = 0.009$ –0.162 m/s^2 in cohesive grounds. They were the most stable. Hard loams didn't decrease their strength to 0.516 m/s^2 . Complete

sandy loam liquefaction occurred when a critical vibration acceleration of 0.624 m/s^2 was given. Intense thixotropic grounds transformations occurred at higher frequency vibrations and vibration impact intensity values up to $1g$. The third stage was the softening stage of clays, loams and hard sandy loams and occurred at $a_{cr} = 0.561\text{--}0.624 \text{ m/s}^2$.

Table. Critical vibration accelerations during grounds impact

a, m/c ²	0.009	0.029	0.069	0.159	0.162	0.23	0.254	0.378	0.469	0.516	0.561	0.624	0.819
Dust sand													
$0.5 \leq S_r \leq 0.8$													
Very fine-grained sand													
$0.8 \leq S_r \leq 1$													
Fine-grained sand													
$0 \leq S_r \leq 0.5$													
$0.5 \leq S_r \leq 0.8$													
$0.8 \leq S_r \leq 1$													
Medium-grained sand													
$0 \leq S_r \leq 0.8$													
$0.8 \leq S_r \leq 1$													
Coarse-grained sand													
$0.8 \leq S_r \leq 1$													
Clay													
$0 \leq I_L \leq 0.25$													
$0.25 \leq I_L \leq 0.5$													
$0.5 \leq I_L \leq 0.75$													
$0.75 \leq I_L \leq 1$													
Loam													
$I_L < 0$													
$0 \leq I_L \leq 0.25$													
Sandy loam													
$I_L > 1$													
$I_L < 0$													

Note: coloured cells are the values of critical accelerations, gray gradation is the stages of the disturbance of the structural grounds stability.

In general this approach made it possible to discourse of the ground stability to vibrodynamic impacts in the first approximation. It is also necessary to take into account the nature of the vibration source, exposure duration - one-time, periodic or permanent, the sediment horizon depth, its thickness during a comprehensive assessment of the ground state because the vibroflotation coefficient and operating conditions depend on it.

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Conditions of formation of Upper Silurian carbonate deposits of the Gamburtsev shaft

I.L. Ulnyrov

Institute of Geology, FRC Komi SC UB RAS, Syktyvkar

ulnyrov_iv@mail.ru

Today, oil production on the Gamburtsev shaft is associated with deposits in the Lower Devonian sediments. However, the prospects of the Upper Silurian formations, from which oil inflows were obtained, have also been proved at the Khasyrey and Cherpayu fields. The study of the lithological composition of Upper Silurian rocks, the conditions of their formation and post-sedimentation transformations is an important aspect for the prediction of reservoir properties of rocks and the identification of the most productive horizons.

The Upper Silurian deposits of the Gerdyu and Greben horizons were studied in wells 1, 32, 35 — Khasyrey and 3, 13, 14 — Nyadeyu. According to the features of the lithological composition, structural and textural features and neutron (NGL) and gamma-ray logging (GL) data, 5 packs of rocks composing the studied interval of Silurian deposits were identified.

Within the Khasyrey area, according to the study of wells, four packs were marked from bottom to top along the section. In the lower part of the Gurdyu horizon, a carbonate pack of rocks (pack I) is traced, composed mainly of limestones and dolomites, from micro to fine-crystalline, massive, with rare clay interlayers. In the direction from south to north in the studied sections, the composition of the rocks composing the pack changes from dolomite to calcareous. The roof of the pack is dominated by rocks with abundant and diverse bioclasts: shells and sashes of ostracods, pelecypods and gastropods. From south to north, the incomplete capacity of the pack opened by different wells varies from 300 to 240 *meters*.

The second pack (pack II) composes the upper part of the Gurdyu horizon and is represented by clay-carbonate rocks. It is dominated by dolomites and clay limestones, multi-grained — from micro to fine-crystalline, massive, layered. The clay component concentrates in the intergranular space, and also enriches the interlayers, forming a layered texture. Organogenic residues in this pack are rare. Geophysical data indicate an increased clay content of rocks, which is confirmed by the core study. With an average power pack of ~ 140 *meters* in the central part of Khasyrey area, it decreases to 110 *meters*.

Two packs are also allocated as part of the Greben horizon. The lower carbonate-clay pack (pack III) is characterized by a core only in the 32-Khasyrey well. According to the GL and NGL, there is an increased clay content of rocks in the sole of the pack. According to the core study, the interval is composed mainly of clay limestones and dolomites, as well as dolomite-clay limestones, with the remains of brachiopods and pelecypods. The power of the pack increases from south to north from 90 to 140 *meters*.

Pack IV stands out in the upper part of the Greben horizon as carbonate. It is composed of alternating intervals of clay-carbonate and predominantly carbonate rocks. The limestones and dolomites composing the bundle have a lumpy structure with an abundance of recrystallized fragments of pelecypod and brachiopod shells. From south to north, there is a decrease in power from 150 to 110 *meters*.

In the sections of the Nyadeyu area, in addition to the listed four packs, there is a section of Upper Silurian rocks, which is increased by the fifth pack, which is absent in the Khasyrey area.

The Gerdyu horizon of the Nyadeyu area was characterized by a core only in the well Nyadeyu-3, so the bundles were allocated mainly according to logging curves. Pack I, composed of limestones with rare weakly clay intervals with a total thickness of ~ 70 *m*, stands out as carbonate. The clay-carbonate (pack II) logging and core is represented by silt-clay bioclastic limestones. The rocks have an increased (up to 20–30%) content of quartz grains of medium roundness. Detritus is represented by single fragments of tabulates, crinoids and recrystallized pelecypod shells. The power of the bundle is ~ 120 *meters*.

Pack III, composing the lower part of the Greben horizon, is represented mainly by clay limestones with rarely occurring quartz grains. Among the organic fragments, fragments of pelecypod shells and fragments of ostracod flaps, partially recrystallized, are noted. The power of the pack in the direction from south to north increases from 90 to 170 *meters*.

The carbonate-clay (pack IV) is characterized in the most detail by corn. In the lower part it is composed mainly of microcrystalline and bioclastic limestones with clay interlayers, and in the upper part of silt-clay limestones, fine-crystalline with rare undetectable detritus. The power of the pack decreases in the direction from south to north from 130 to 110 *meters*.

The section is completed by the fifth carbonate pack (pack V), represented mainly by microcrystalline, bioclastic limestones (partially recrystallized) with rare inclusions of pyrite. The power of the pack varies

from 50 to 20 *meters*.

In general, analyzing the lithological features of the described sections, it can be noted that on the territory of the shaft in the direction from south to north, there is a change in the capacities and material composition of the rocks composing the bundles. The section of the Upper Silurian deposits in the southern part of the Khasyrey area (well 35-Khasyrey) has a predominantly dolomitic composition. Dolomites and clay dolomites also form sections on the territory of the scooping area, which is located even further south. In the central and northern part of the Khasyrey structure (wells 1, 32 – Khasyrey), the dolomite composition is replaced by lime. Rocks in the sections of the Nyadeyu area are mainly represented by calcareous-clay rocks with siltstone mixing [1].

The lithological and facies characteristics of the studied sections allowed us to establish a cyclical change of sedimentation conditions in the Late Silurian period. The sediments of packs I and II composing the Gurdyu horizon are attributed to the sediments of the sublittoral zone with moderate dynamics of the aquatic environment, which are replaced by sediments of the littoral zone. In the upper part of the section, micro-grained dolomites are also noted, attributed to the deposits of coastal lagoons and temporary reservoirs. The section of the lower pack III of the Greben horizon records the preservation of littoral conditions. In subsequent packs IV and V, composed by intervals of clay-carbonate and predominantly carbonate rocks, a period of transgression with deeper water conditions was recorded. Pack V is allocated only on the territory of Nyadeyu area. The micro-lumpy limestones composing it are attributed to sublittoral environments with high dynamics of the aquatic environment [2].

Therefore, the lithological and facies characteristics of the Upper Silurian sediments indicate that the shallowing of the basin took place in the Gerdyu period, up to the formation of coastal lagoons and temporary reservoirs on the territory of the southern part of the shaft, probably located within the paleopodium. In the Greben period, deeper, sublittoral, shallow-shelf conditions prevailed in this area of the basin.

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The formation of boulder loam in the north of the Bolshezemelskaya tundra

N.N. Vorobev

Institute of Geology, FRC Komi SC UB RAS, Syktyvkar

v.nikita91@mail.ru

Quaternary deposits in the far north, in the Bolshezemelskaya tundra, have been poorly studied, and the identification of the boulder loams genesis is an important problem of the quaternary geology in this region. To establish the stratigraphic confinement of boulder loams, it is necessary to study the lithological features and location of the feeding glacier provinces.

In the northwestern and northeastern parts of the Bolshezemelskaya tundra in the basins of the Kuya and Padymeytyvis rivers, Quaternary sediments in coastal outcrops have been studied. In the Padymeytyvys river basin there are three exposures of boulder loams on the Sizimtseleyshor (Sz-1), Nadeytyvis (H-1) and Padymeytyvis (Pd-2) rivers (Fig.1).

Exposure Sz-1 is fully folded by dense boulder loam with inclusions of pebbles and rock boulders. In the outcrop N-1, several layers of different genesis with clear and even contacts are exposed. The section Pd-2 is characterized by a two-membered structure and consists of glacial (at the base of the section) and fluvial sediments.

In the valley of the Kuya River, boulder loam was exposed only in one outcrop – K-15 (Fig.1).

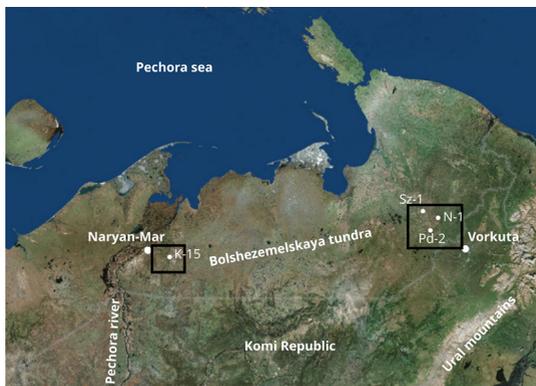


Fig.1. Locations of study areas.

In the northeast, boulder loams are characterized by a weak, sometimes

moderate degree of sorting of fine earths ($Sc = 0.15\text{--}0.41$). Microscopic examination of thin sections also confirms the poor sorting of the material (Fig.2).

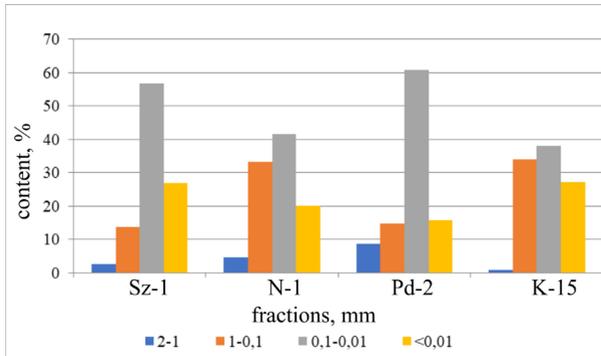


Fig.2. Granulometric composition of boulder loams in the Padymeityvis and Kui rivers basins.

The mineral composition was studied in outcrops N-1 and Pd-2. Epidote (19.9%) and siderite (21.2%), rather high contents of pomegranate (11.6%), pyrite (12.4%) and ilmenite (12.7%) dominate in the heavy fraction. Pyrite and siderite indicate a link between the glacier and the Triassic and Permian underlying rocks [1], and the ilmenite may be associated with the rocks of the Polar Urals [2].

According to the petrographic analysis, in the outcrops of N-1 and Pd-2, most of the coarse material is composed of fragments of carbonate rocks. Moreover, in the Pd-2 outcrop, their content is more than half of all fragments (58.8%), and they are represented mainly by dark-colored limestone and dolomite – 52.9%. The enrichment of boulder loams with Paleozoic dark gray and black limestones and dolomites is most likely due to the flow of material from the Chernov Rise and from Pai-Khoj, which is confirmed by the direction of orientation of elongated fragments from the north-east to south-west. In the Sz-1 outcrop, most of the petrographic material consists of igneous and metamorphic rocks (32.5%) and terrigenous rocks of the Permian and Triassic (30%). The sublatitudinal orientation of the long axes of the boulders in combination with the petrographic analysis data indicates a possible supply of material for the formation of this moraine from the Polar and Subpolar Urals.

In the explosive K-15 boulder loams are characterized by weak grading

of fine earths (Sc from 0.09 to 0.27). The heavy fraction is represented by siderite (13.1%) – amphibole (13.6%) – garnet (18%) – epidote (20.8%) mineral association with high pyrite content (7.7%), which may indicate a link of the glacier with rocks of Fennoskandiya. According to petrographic analysis data, most of the coarse clastic material is fragments of carbonate rocks. The enrichment of boulder loams with light gray and white limestone is apparently due to the flow of material from the Carboniferous Plateau, which is located in the north-west of the Russian Plain. This is confirmed by the orientation of elongated rock fragments in boulder loam from northwest to southeast in the sector of 305–325°.

Based on the results of particle size, mineralogical and petrographic analysis, there are two horizons of boulder loams in sections in the Padymeityvis river valley in the northeast of the Pechora Lowland. By analogy with the adjacent areas of the Bolshezemelskaya tundra [3], the formation of the lower moraine horizon of the moraines is associated with the Vychevodsky glacial cover (Q_{II}^{4v}), and the upper moraine horizon with the Polar one (Q_{III}^{4p}) (Fig.3). An indirect indication of this is the finer particle size distribution of the upper moraine as compared with the lower one, which was also noted by its predecessors.

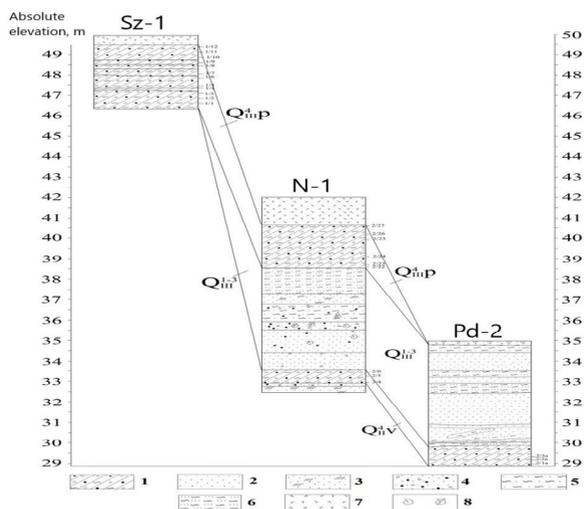


Fig.3. Correlation of sections of Quaternary sediments in the basin of the Padymeityvis river: 1 – boulder loam; 2 – gravel and pebbles; 3 – sand; 4 – sand with gravel and pebbles; 5 – loam; 6 – sandy loam; 7 – clay; 8 – shell clams.

Based on the lithological study of boulder loams – low grade of fine earth, sustained orientation of detrital material, abrupt excretory contacts with underlying sediments, in the northwest of the Pechora Lowland they are formations of glacial genesis – moraines (tills). By analogy with the adjacent areas of the Bolshezemelskaya tundra [3], the formation of the moraine is associated with the Polar ice cover (Q_{III}^{4p}) (Fig.4).

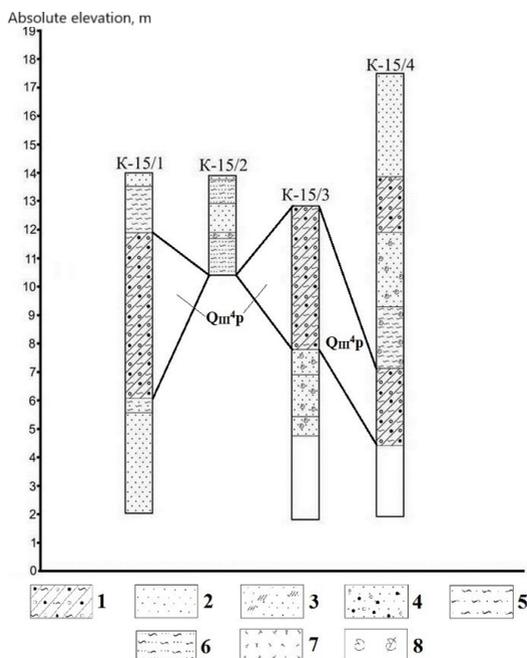


Fig.4. Correlation of sections of the Quaternary sediments in the Kuya river valley: 1 – boulder loam; 2 – gravel and pebbles; 3 – sand; 4 – sand with gravel and pebbles; 5 – loam; 6 – sandy loam; 7 – clay; 8 – shell clams.

A comprehensive lithological study of moraine deposits in the far north of the Pechora Lowland is very promising for the purposes of lithostratigraphy. The results are useful for conducting geological mapping of the territory.

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Sections 2
“Humanities”

Scientific contacts of radioecologists of the Komi Republic with R.M. Aleksakhin

T.A. Sokerin

FRC Komi SC UB RAS, Syktyvkar

tima.cok@mail.ru

Scientific contacts are a mechanism for the development of science, which allows individuals and research teams to exchange knowledge and ideas. These contacts play an important role for the development of such a science as radioecology, various aspects of which are investigated in many scientific institutions of Russia. In this article I will show the development of scientific contacts by the example of professional relations between radioecologists of the Komi Science Center and R.M. Aleksakhin, one of the most famous radioecologists in the world. The evolution of these ties is advisable to consider in three stages: 1) late 1950s, 2) late 1960s – early 1970s, 3) after 1986.

The late 1950s was the time of rapid development of radioecology as a scientific discipline. This period coincides with the start of R. Aleksakhin's research activity and the formation of separate division of radiobiologists in the Komi Branch of the USSR Academy of Sciences. In 1959, Aleksakhin initiated his career as a specialist in the field of radioecology [1]. In the same year, a special radiobiological laboratory was established in the Komi Branch of the Soviet Academy of Sciences [2, p. 29].

The period of the late 1960s – early 1970s was marked by a series of joint scientific events, in which both the outstanding radioecologist and scientists of the Komi Autonomous Soviet Socialist Republic (ASSR) took part. In 1966, a large symposium was held in Stockholm on the issues of radiation ecology. R.M. Aleksakhin and the first Head of the Department of radiobiology of the Komi Branch of the USSR Academy of Sciences V.I. Maslov were among the Russian lecturers who participated in this event [3, p. 367]. A year later, R. Aleksakhin took part in a field meeting of the Academic Council of the Academy of Sciences on the problems of radiobiology in Syktyvkar [4, p. 134]. Two more events occurred in the early 1970s. In 1972, a special commission, consisting of eight people, including R. Aleksakhin, inspected the Komi Branch of the Soviet Academy of Sciences. The members of the commission concluded that radioecological studies of biogeocenoses with an increased level of natural radioactive elements in this center were carried out most comprehensively in the USSR [5]. The following year, R. Aleksakhin attended a major symposium

on radiation biology, which was held in Syktyvkar [4, p. 135]. All these events played a significant role in deepening scientific connections between radioecologists.

The most important milestone in the development of radioecology in Russia was the accident at the Chernobyl nuclear power plant in 1986. This event intensified the scientific collaboration between the two Heads of the scientific institutions. R.M. Aleksakhin was the Head of the All-Russian Research Institute of Agricultural Radiology and Agroecology (1989–2015), and his follower A.I. Taskaev headed the Institute of Biology of the Komi Science Center (1988–2010). R. Aleksakhin emphasized that radioecologists of the Komi Republic made an important contribution to the assessment and elimination of the consequences of the Chernobyl accident [6, p. 91].

The sharp growth of interest in radioecology after this nuclear accident actualized the problem of training specialists. An important role in this process was played by R. Aleksakhin, 46 of whose students have got scientific degrees [1]. He was the PhD supervisor of three scientists of the Institute of Biology (Kochan I.G., Shuktomova I.I., Taskaev A.I.) [7]. A. Taskaev in his turn ensured scientific continuity by preparing candidates and doctors of sciences [8, p. 44]. According to R. Aleksakhin, A. Taskaev created an effective team of specialists in Komi [6, p. 90]. Today these scientists ensure the further development of Russian radioecology.

Thus, scientific contacts between R. Aleksakhin and radioecologists of the Komi Republic can be characterized as long-term and stable ties. These relations influence the high level of radioecological research in the Komi Republic in the modern period.

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The establishment of the archaeological collections in national museum of the Komi Republic in the 1920s–1930s

S.A. Rodov

Institute of Language, Literature and History, FRC Komi SC UB RAS, Syktyvkar

s.a.rodov@yandex.ru

Archaeological collections are the largest component of the collections at the Komi region's major centers of historical heritage study. These collections were formed over a period of more than 100 years. The study of the components of this heritage broadens scientific understanding of the history of the formation of archaeological collections in the Komi Republic. This, in turn, allows researchers to more accurately reconstruct the main stages of the ancient and medieval history of the region. In this article we examine the history of formation of the first archaeological collections of the National Museum of the Komi Republic in 1920s–1930s.

The National Museum of the Komi Republic (hereinafter, the NMRK), one of the first scientific, cultural and educational institutions in Komi, was founded in 1911. The museum's archaeological collection contains over 96,000 items. There are artifacts from more than 250 archaeological monuments from the Paleolithic Age to the Middle Ages. The collection is divided into items found during special works (excavations, survey) and occasional finds.

The beginning of the acquisition of archaeological collections dates back to the 1920s, when the collections of the Museum received finds of the Iron Age and the Middle Ages from the excavations of the members of the Society for the Study of the Komi Territory (hereinafter, SSKT) A.S. Sidorov and A.N. Gren and the expedition of the «Glavnauka» headed by A.P. Smirnov. The collections of the 1930s are represented by the materials of the excavations and explorations of P.D. Stepanov, an employee of the Republican Museum of History and Regional Studies (hereafter, RMHRS). Through the study of archaeological collections, researchers reconstruct the main stages of the region's ancient and medieval history. To solve these tasks it is important to understand who and under what conditions these collections formed. This article briefly describes the history of the archeological collections of the National Museum of the Komi Republic, which were obtained both during scientific expeditions and by local historians, and provides statistical data on these collections. The source base of the research was formed by the documents and archaeological collections of the period under study from the funds of the NMRK.

In the early 1920s in Soviet Russia there was a close connection between local history and museology: they complemented each other. Museum collections began to form under the local history societies and new museum collections were created [1]. During this period, archaeological research on the territory of the Komi Autonomous Region (hereinafter, the Komi AR) was carried out by A.S. Sidorov, a member of SSKT. In the early 1920s, the scientist initiated archaeological research in the Komi AR and regularly excavated in the basins of the Vym, Lower Vycheгда, Vashka and Mezen rivers. He compiled an archaeological map of the Komi AR with a descriptive text attached, where for the first time he summarized both literary data and materials of his own research on the ancient past of Komi [2].

A.S. Sidorov's scientific activity became more active after the establishment of the SSKT in May 1922, which greatly contributed to the development of science and culture in the Komi. A.S. Sidorov was one of the organizers and leaders of this society [3]. The archaeological collections of the NMRK formed by A.S. Sidorov contain 147 items obtained from the excavations of the Vanvizdino site, the Pozheg site, and collections in the Sysolsky, Ust-Vymsky and Knyazhpogostsky districts of the Komi Republic (Tabel 1).

Since 1924, A.N. Gren, a teacher at the Ust-Sysolsk institute of public education, who was also a member of the SSKT, had been conducting his research on the territory of the Komi AR. He headed the anthropological section of the Society and carried out archaeological field research. In 1924, A.N. Gren conducted excavations in the settlement near Vanvizdino, excavated the Karybjiv ancient settlement, the Dzhibjag and White moss burial grounds (later named Klyanysh-Lasta) on the Vycheгда River [4]. The archaeological collection formed by A.N. Gren contains 35 items (Tabel 1).

In the second half of the 1920s, the archaeologist V.A. Gorodtsov commissioned an expedition to the Komi AR, led by A.P. Smirnov. In 1925, the expedition had conducted excavations at the Karymlyk ancient settlement, the Klyanysh-Lasta and Gidsayag burial grounds. Subsequently, the expedition published a detailed report on the excavations. On the basis of the materials available at that time A.P. Smirnov made a brief summary of medieval archaeological monuments of the Vycheгда region and reveals their specificity. At the same time, A.P. Smirnov excavated the Vanvizdino site, previously investigated by A.S. Sidorov [5]. The archaeological collection formed by the Glavnauka expedition headed by A.P. Smirnov contains 1407 items (Tabel 1).

In 1939, P.D. Stepanov, an employee of the RIKM, carried out exploratory archaeological works on the Sysola river and excavations of the Votchinsky settlement. The archaeological collections formed by P.D. Stepanov contain 294 items (Tabel 1).

To summarize the above, by the beginning of 1940, 10 archaeological collections from different eras had been formed, which enabled scientists to draw further conclusions about the region's ancient population and its cultural background. Archeological excavations on the territory of the Komi Republic were carried out until the end of the 50s by enthusiastic local historians, as well as by professional expeditions, such as the expedition of the Glavnauka. However, these works were sporadic and covered a small territory - mainly the basins of the Vym, Vychegda and Sysola rivers.

The 1920–1930 collections of the National Museum of the Komi Republic represent only a small part of this heritage. At the same time, there is no systematized catalogue of museum collections of archaeological objects in the Komi Republic as of today. This discussion works under the assumption that further systematization of information about the region's museum collections will expand scientific understanding of the ancient and medieval history of the Komi Republic.

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Recovery of local traditional dyeing recipes according to ethnographic data: process, theoretical and practical significance

L.M. Kostareva

Institute of Language, Literature and History, FRC Komi SC UB RAS, Syktyvkar

plm4991@mail.ru

Dyeing craft is textile materials dyeing with natural organic dyes. Natural dyes are extracted from fresh or dried natural raw materials (bark, roots and leaves). It was the only possible way to change the color of textile for a long time before the advent of artificial dyes.

The Komi (Zyryans) are known to be famous for their rich tradition of wool pattern knitting. Various colors are needed for the pattern knitting technique to create the ornamentation. Komi (Zyryans) developed different recipes for natural dyeing of wool yarn. Wool as a fiber of animal origin is dyed easier and more intensively than fibers of plant origin (linen, cotton, hemp, and nettle). The type of fiber determined the natural dyes and the dyeing formula. Therefore, the largest number of described recipes is associated with dyeing of wool.

At the beginning of the 19th century, the search for new dyes became necessary for the development of textile industry to dye various materials. Active experiments began on the creation of artificial analogues of natural dyes. The experiments were successful. In the second half of 19 century, artificial dyes began to be actively used. New bright colors and a simple method of application forced out natural dyes not only from industrial, but also from hand-crafted dyeing of fabrics and yarn. Craftsmans began using artificial dyes, so many local dyeing recipes were lost.

Few historical and ethnographic works were devoted to this topic. These include the works of researchers of the late 19th and early 20th centuries (Nikolay Golitsin [1], Georgiy Startsev [2]) and the works of ethnographic scientists of the second half of the 20th century (Lubov Gribova [3], Galina Romanova [4] and Glaphira Shipunova [5]).

There are two methods of recovery of traditional dyeing recipes: the method of analysis and generalization of historical and ethnographic sources, and experimental methods of verification of dyeing recipes. Using these methods, I have developed a process plan for the recovery of local traditional dyeing recipes. This plan consists of a number of steps:

The first step is data collection. Recipes found in the sources were analyzed for the presence or absence of the following information:

1. Dye raw material preparation. Dye raw materials were mainly used fresh, with some part of them being dried for dyeing in winter. Some recipes contained information about collection time and description of the dyeing plant.
2. Preparation of fabric for dyeing: type of material and methods of washing / bleaching.
3. Equipment and accommodation. Data on the place where the dyeing was carried out and on the tools that were used in the process.
4. Dyeing method. The dyeing method using excipients is known to be mordant. Mordants are found to affect color stability and saturation. Three types of mordant dyeing can be applied: with a preliminary mordant, simultaneously with a mordant and with a subsequent mordant. Dyeing method without the use of excipients is known to be non-mordant.
5. Preparation of a dye decoction: information about the raw material boiling time and the ratio of ingredients.
6. Preparation of the mordant solution: type of mordant, source of mordant.
7. Dyeing time. Duration of dyeing affects not only the color but also the fiber structure.
8. Fixing and color correction: fixers and compositions that were used to fix or change color (formic acid, salt, brine, lye, alkali, etc.). Acids have been considered to brighten the color. Alkalis have been considered to darken the color.
9. Other factors: for example, the use of fermentation processes, pickling, etc.

The second step of the recovery process is an experimental recipe test. Checking the recipe, all parameters are observed as much as possible.

Most of collected recipes presented good results during the experimental testing.

The third step is recipe adjustment. During the experiment, some recipe details were clarified.

During the process of recovery of dyeing recipes according to ethnographic data a number of problems arise. For example, a problem with dyeing plant definition. The source most often indicates the local name of the

plant, sometimes in the local language. Sometimes not a plant is described. According to the description of the dyeing plant location, it is possible to find out that it is a mushroom or lichen. Specialists in the field of botany, ethnobotany, mycology and lichenology were involved as consultants to solve a similar problem.

Recovered dyeing recipes have theoretical and practical applications. The recovery of local traditional dyeing recipes is important for studying the traditional culture of Komi (Zyryan). It allows to restore all stages of the traditional technology of creating textiles. Dyeing recipes can tell us a lot about the traditions and life of peoples of a particular area. The colors, which they had received from local plants, influenced their clothing, household items, and overall color perception.

Today recovered recipes can be used both in the reconstruction of traditional clothing and in the creation of modern textiles: clothes, accessories, home textiles. Natural dyeing has several advantages, including the availability of dye raw materials, the possibility of home use, hypoallergenicity, biodegradability of waste. In some countries, serious work is already underway to return natural dyes to practical dyeing technology.

Natural dyeing is the possibility to dye textile materials without using artificial dyes, with all ingredients “growing under our feet”.

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Technology of application of methods of active learning in English classes

E.V. Serdyuk¹, I.A. Kuznetsova²

¹ Department of English at the Institute of Foreign Languages, SyktSU, Syktyvkar

² Institute of Foreign Languages, SyktSU, Syktyvkar

Kuznetsovy.irinaimarya@yandex.ru

Listening is a part of oral communication activity and is used in any oral communication. A person faces listening every day, whether it is communicating with people, watching TV shows, listening to music or talking on the phone. When teaching foreign languages through listening, the lexical composition of the language and its grammatical structure are assimilated, it facilitates the mastery of speaking, reading and writing, at the same time, being the most difficult process in teaching a foreign language. In the domestic methodology, listening is considered to be a passive skill, but currently some authors note the active nature of listening, since in the process of listening there is an active work of mental processes that allow us to perceive the sounding information, process it, correlate it with the standard stored in long-term memory, learn and understand the meaning.

In order to reveal students' attitude towards listening, we conducted a survey among school graduates asking them the following questions:

1. Do you like English classes? Why?
2. What do you like to do most in English classes?
3. Do you have any difficulties listening to the recordings?
4. What is the most difficult for you while listening to the recordings?
5. How many times do you need to listen to the recordings to understand it well?

The majority of students answered that they liked English classes providing the following arguments:

- Yes, because it's interesting.
- I like the way English sounds.
- Yes, because I can communicate with foreigners.
- Yes, because I like learning languages in general.
- I can communicate on the Internet with ease.
- Yes, because I can learn about new cultures.
- Yes, because I can improve my knowledge of English.

The responses to the second question revealed that the most favorite activities are reading and translating texts (38.5%) and doing grammar exercises (30.8%). The least appealing activities are listening and doing tests (7.7% both).

When it comes to difficulties while working on listening, 76.9% of students have problems, while only 23.1 % do not.

The most challenging aspects of listening are the speed of speaker's speech and pronunciation and accent (38.5% both). 15.4% of students noted that they understand nothing.

As for the number of playing the recording for a better understanding, 53.8% of students need to listen to the recording three and more times, while 46.2% need to do that twice. There were no students for whom listening one time is enough.

After analyzing the results of the entrance questionnaire, we determined that listening is not the preferred activity in the classroom, students experience significant difficulties when working with it, their level of motivation is low. Thus, it was decided to apply active learning methods to increase the motivation of students and further develop listening skills.

Learning becomes effective when its participants are actively involved in the educational process. In this regard, it is advisable to apply methods and techniques that activate students in the classroom. It should be noted that the methods of active learning are a continuation of the concept of problem-based learning, which appeared in the 1920–30 years. Before proceeding to the consideration of active teaching methods, it is necessary to find out what “problem-based learning” is.

By problem-based learning, G.M. Kojaspirova understands «learning in which knowledge is not communicated to students in a ready-made form. Knowledge is acquired only in the process of solving problematic situations» [1]. That is, students face situations that are new to them and cause some difficulty, a contradiction, for which they use the knowledge accumulated over the years of study. According to the teacher, active teaching methods are “methods that stimulate the cognitive activity of students, involving each participant in mental and behavioral activity”.

E.V. Zarukina highlights the following features of active learning technology: [2]

- activation of students' thinking;
- long-term involvement of students in the learning process (during

- the entire lesson, not sporadically);
- increasing the degree of motivation of students, independent search for creative solutions;
 - interactivity, that is, constant interaction of subjects of educational activity.

Let us consider the most popular methods of active learning:

1) Problematic situations

This technique is based on a contradiction that does not have an unambiguous solution. This is due either to the students' lack of knowledge on this issue, or to the fact that their knowledge on this problem is insufficient to solve this particular problem. With the help of a question or a controversial statement, the teacher creates a problematic situation, to solve which students resort to finding a new, more non-standard approach. Inclusion in the process of finding a solution contributes to a more stable memorization of information. This technique allows you to motivate students before listening to an audio recording, since the answer to the problematic question will be contained directly in the audio text.

2) Discussions

The discussion (or round table) implies the division of the class into groups to express and defend their opinions on a problematic issue. At the same time, the process is regulated by the moderator, and the participants follow the rules that are determined in advance. The technique is suitable for working on listening after listening to the text. Students express two opposing opinions about the topic of the text, and then give arguments in defense of their point of view and refutation of the point of view of rivals.

3) Brainstorming

The purpose of this technique is to trigger students' mental activity to solve a problem task. Students' task is to offer as many solutions as possible (including unrealistic ones) in a short period of time. Ideas are written on the board, and then the most successful ones are selected. Using the technique allows you to prepare students to listen to the audio text, assume what it will be about, and then compare the answer with the content of the text.

4) Mental map

The technique allows you to structure the available data on the problem, as well as its solutions. In the center of the sheet of paper there is a topic, from which branches with aspects of the problem depart. Next, it is necessary to draw branches of the second level, on which more detailed information is indicated. With the help of a mental map, you can fix ideas about what the audio text will be about, what thematic topics will be used, how events will develop, etc.

5) Basket of ideas

The method is similar to the intellectual map, but the nuance is that it implies only collecting and fixation of students' knowledge on the topic. This technique is most effective before listening to audio text, as it allows you to update the material.

6) The method of control questions

A list of specially compiled leading questions that introduce students to the problem is used. In this case, keywords are used, and questions are asked sequentially. The students' task is to answer and give arguments. When working on listening, it is often used to summarize the topic of listening or at the stage of understanding control.

Thus, the use of active teaching methods makes it possible to make students active participants in the educational process, which in turn solves a number of tasks, such as: increasing motivation to learn, in this case to listening, developing creative abilities and critical thinking, revealing the abilities of each student.

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Linguoculturological potential of the zoonym cock in french phraseology

A.Y. Motorina, Y.S. Sukhorukova

SyktSU, Syktyvkar

alexandra.motorina@mail.ru

Nowadays, the description of the linguoculturological potential of somatisms, phytonyms, coloratives, zoonyms, etc. is an object of cross-cultural description. The analysis of the phraseological world-picture is an essential element of research.

The relevance of this work puts emphasis on the diversity of semantics of phraseological units (henceforth — PhU) with a component-zoonym. This diversity is explained by the figurative and situational motivation of the PhU, associated with the worldview of the native-speaking people. The object of this study is French phraseological units with the component-zoonym *coq*. The subject is the specificity of semantics and culturologically conditioned connotative coloring of the component-zoonym *coq* in the French phraseological area.

The goal of this study is to analyze the associative meanings of the component-zoonym *coq* in the French phraseological context and to identify the linguocultural specificity of understanding the image of a cock in the French language consciousness.

It is known that PhU have a great linguoculturological potential. “The phraseological layer of the language is a mirror, where a linguocultural community identifies its national self-consciousness” [1]. Model, stereotypical, symbolic figurative basis of PhU determines their cultural and national specificity. Phraseology does not borrow abstract images, but touches on those spheres of human life that are part of everyday interaction with the outer world. Therefore, one of the phraseologically frequent components is zoonym.

Zoonyms are lexemes that have the component ‘animal name’ in the semantic structure of the primary direct meaning. It is the zoonyms, reinterpreted within PhU, that can reflect differences in the national, mental, social and psychological spheres of the linguistic community and culture as a whole.

In France, the symbol of the cock appeared in the period of the Roman conquest. Originally, the nickname “cocks”, given by the Romans to the

Gauls, was used ironically. It was based on the etymological homonymy of the latinism *gallus* – 1) Gaul, 2) cock. For the Gauls themselves, *coq gaulois* became a symbol of valour and bravery. Gradually, the cock becomes the emblem of the French people, the national symbol and the defender of France [2]. After the Great French Bourgeois Revolution of 1789–1799, the cock is associated with the image of the wrathful people. It symbolizes vigilance and is an “unmasker” in the press, caricatures, etc. [2].

In the course of the work, 22 PhU with the component *coq* were studied, extracted by continuous sampling method from a bilingual French-Russian phraseological dictionary, edited by V. G. Gak and from the electronic resources.

The analysis was carried out according to the following algorithm: 1) study of the structure of PhU with the component-zoonym *coq*; 2) consideration of phraseological dyads with the component *coq* from the point of view of the thematic correlation of the partner; 3) study of the semantics of the component *coq* in French phraseology; 4) consideration of the mechanisms of transformation of meanings *coq* in the phraseological context and emerging additional connotations; 5) detection of the cultural and historical basis for rethinking the images of the cock in the French language consciousness. As a result of the analysis, 2 semantic fields were identified, including PhU with the component *coq*: personal and social role-playing characteristics of a person. The field “Personal characteristics” is divided into the following semantic groups: “Appearance” (5 PhU), “Intellectual characteristics” (1 PhU), “Emotions” (3 PhU), “Character traits” (6 PhU), “Everyday habits” (2 PhU). The field “Social role-playing characteristics of a person” includes the groups: “Marital status” (2 PhU), “Economic status” (1 PhU) and “Interpersonal relations” (2 PhU).

As an example of the analysis, we have chosen the semantic group “Character traits”, which includes 6 PhU. In this group, the associative features, associated with the image of a cock in the French consciousness, are the following:

1) amorous: *courtiser les femmes comme un coq* (lit. to court women like a cock) ‘to chase every skirt’. Lexeme *coq* acquires a metaphorically conditioned meaning and is used to nominate a man who is confident in his success with women, by similarity with the behavior of a cock that is the only male in the henhouse and, accordingly, has no rivals.

2) pugnacious: *se battre (se comporter) comme un petit coq* (lit. to fight /

behave like a little cock) ‘to be a teaser’ – the meaning appeared by association with the behavior of fighting cocks, who are aggressive and quickly get into a fight.

3) bully: être hardi comme un coq sur son fumier (lit. to be bold as a cock on his manure) ‘to be bold as a rooster on his dunghill’. Lexeme coq acquires a metaphorically conditioned meaning due to observing the behavior of a cock in the henhouse. It is brave because it is at home, on its own territory, where it is the only owner and where nothing threatens his safety.

4) proud: fier comme un coq (lit. proud as a cock) ‘proud as a cock, arrogant’. The associative meaning of coq is conditioned by the proud gait of these birds, the observation of which provoked this comparison.

5) weak-willed, traitor: renier au chant du coq (lit. to renounce at the first crowing of the cock) ‘break down on the first test’. This phraseology is an allusion to the biblical story of the Apostle Peter’s threefold renunciation of Christ before the first crowing of the cock proclaiming the dawn.

6) chaotic, incoherent: passer du coq à l’âne (lit. to go from cock to donkey) ‘quickly change the subject’. At the moment, the etymology of this PhU is obscured. But one of the versions makes a reference to a literary work. In the fairy tale of the Brothers Grimm “Town Musicians of Bremen”, published in 1815, “musicians” are four animals: a donkey, a dog, a cat and a cock. To frighten and confuse the robbers, they ride each other, the donkey is at the bottom, and the cock is at the top, which creates a motley pyramid. Perhaps, the associative meaning ‘confusion, chaos’ appeared in this way.

The theoretical and practical analysis allows us to make the following conclusions.

The term “zoonym” in the most general sense is interpreted as a lexeme, which has the archiseme ‘animal name’ in the semantic structure of its primary meaning. Zoonyms have significant semantic potential and, when used metaphorically, refer to different spheres of human life. The reason for the linguocultural value of research on PhU with the component-zoonym is the importance of a person’s understanding of itself in the context and interaction with the surrounding nature. Moreover, the PhU with the component-zoonym allows to trace culturally and historically conditioned associations connected with the images from the animal world in different ethnic communities, and to establish the causes of their emergence.

Our analysis of 22 PhU with the component-zoonym coq allowed us to divide them into 8 semantic groups. The largest group “Character traits”

includes 6 PhU, the smallest groups “Intellectual characteristics” and “Economic situation” include 1 PhU each. The associative semantic features, revealed in the component coq by metaphorization in the phraseological context, were analyzed. Their appearance depends on the historical and cultural experience of observation and interaction of the French with this domestic bird, and the ethnospecific features of the verbalization of this experience.

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Graphical features of the modern french short story

P.V. Poroshkina, Yu.Yu. Baryshnikova

Institute of Foreign Languages, SyktSU, Syktyvkar

paulina.poroshkina@gmail.com

A short story is a small narrative genre, similar in volume to the tale. As you know, these genres belong to the belle-letters style, and, therefore, have their own distinctive features. Anna Gavalda is a master of modern French literature. Her short stories have the aim to create an emotional impression and immerse the reader in a realistic story world. To create this effect, the author employs various means at all levels of the language, and graphical features play a big role in creating the emotional effect. This idea is emphasized by I.V. Arnold. In her opinion, since the perception of literary works occurs mainly through reading, and not through hearing, their graphical presentation turns out to be of a great importance. In this case, the change of fonts, the division into paragraphs and the arrangement of lines, capital letters and punctuation marks matter [1, p. 296].

The graphical features of the short story add expressiveness to the literary text and perform an aesthetic function. Graphics play an important role in the texts of French short stories. V.S. Sladkova believes that the tension inherent in this genre is expressed through punctuation and graphical presentation of the text. Besides, V.S. Sladkova thinks that graphics and punctuation are the active artistic techniques that are clearly available at the first acquaintance with the text (not while reading, but even while viewing) [2, p. 100]. Thus, the graphical means are used in a literary text so that the reader can reveal the hidden meaning, subtext, as well as feelings that were implied by the author.

Question marks and exclamation marks convey the greatest emotionality. A distinctive feature of the texts of modern short stories is the use of several exclamation marks at the end of a sentence, as well as a combination of exclamation marks with question marks. Doubling or tripling of the exclamation mark enhances the expressiveness of speech, emphasizes a feeling or emotion, for example:

(déjà avec Sagan tout à l'heure, vous aurez compris que j'ai ce qu'on appelle des références littéraires!!!) / (What with that reference to Sagan earlier, by now you must have realized I'm what they call the literary type!!!) [3, p. 6].

Je rêve!!! C'est TOI qui écoutes France Info toute la journée!!! / You can't be

serious!!! You're the ONE who listens to France Info all day!!! [3, p. 65].

In short stories, the reader may also notice a combination of question and exclamation marks. According to A.A. Kalinina, the question mark is indicative of negative emotions and negative attitude to the subject of speech, and the meaning of the emotional evaluation is expressed by means of the interrogative structure itself, without the participation of lexical means [4, p. 207]. Thus, in this combination, the exclamation mark enhances the negative emotion and gives the statement expressiveness. This combination can also be used in rhetorical questions, enhancing their emotional coloring. For example:

Attends? Mais qu'est-ce que tu crois? Que je te raconte des craques bien mélo pour avoir une raison de t'appeler?! / What? What do you think? You think I'd make up some over-the-top sob story just to have a reason to call you?! [3, p. 93].

De quoi te préoccupais-tu donc quand mes épaules étaient si rondes, si tièdes et ta main si proche!? / What could possibly have distracted you when my shoulders were so round and warm and your hand was so close!? [3, p. 13].

Emotionality can also be expressed with the help of pauses marked in the text with a dash or marks of omission, which convey the indecision, uncertainty and embarrassment of the character, as well as the inability of the character to complete the sentence due to the rush of feelings [1, p. 297]. According to N.S. Valgina, marks of omission is a sign that is meaningful and full of emotions, it is an indicator of hidden meaning, subtext, understatement, emotional and psychological tension, difficulty and discontinuity of speech [5, p. 131]. For example:

Mais... on va se revoir, n'est-ce pas? Je ne sais même pas où vous habitez... Laissez-moi quelque chose, une adresse, un numéro de téléphone... / But ...we'll see each other again, won't we? I don't even know where you live... Give me something, an address, a phone number... [3, p. 13].

Ecoute, je ne pensais pas que tu allais le prendre comme ça, je vais raccrocher. Je suis désolée. Je... / Listen, I didn't think you'd take it like this – I'm going to let you go. I'm sorry. I... [3, p. 92].

Another graphical feature is the font. T.V. Gorshkova thinks that the change of the font is the most expressive mean of graphics, namely the italics [6, p. 34]. I.V. Arnold also notes this graphical feature and claims that epigraphs, poetic inserts, prose, quotations, words of another language, the names of the literary works and everything that seems extraordinary in the text or requires emphasis is written in italics [1, p. 310]. Thus, the font is changed to italics for

a more accurate disclosure of the character or to emphasize the significance of a single word or a sentence.

In A. Gavalda's short stories, the reader can find words in italics. The writer changes the font in order to highlight the title of the book (*J'attends un enfant*), the name of the magazine (*Paris Match*), as well as to emphasize the significance of the word, to strengthen it. For example:

Pendant des années j'ai cru que cette femme était en dehors de ma vie, pas très loin peut-être mais en dehors / For years I believed that this woman was outside my life – not very far maybe, but outside [3, p. 87].

The font change is also observed in the use of capital letters. As I.V. Arnold notes, whole words can be written in capital letters and are distinguished as pronounced with a special emphasis or especially loudly [1, p. 309]. For example: *Je rêve!!! C'est TOI qui écoutes France Info toute la journée!!! / You can't be serious!!! You're the ONE who listens to France Info all day!!!* [3, p. 65].

The writer can also employ capital letters to highlight newspaper headlines in order to immerse the reader in the story. For example: *A la page 3 du Figaro du mardi 30 septembre: UNE FAUSSE MANŒUVRE SUSPECTÉE / Today, I bought all the papers. On page 3 of the Figaro dated Tuesday, September 30: DRIVER ERROR SUSPECTED* [3, p. 66].

Therefore, the modern French short story is characterized by the following graphical features: punctuation (question marks, exclamation marks, dashes, marks of omission); font change (italics, capital letters). These features add expressiveness to the narrative, contribute to a more accurate transfer of the character's feelings, and also express the author's attitude to what is happening.

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Teaching listening comprehension in german with the use of podcasts as an alternative method

N.A. Polyakov, M.V. Bart

Institut of Foreign Languages, SyktSU, Syktyvkar

npolyakov000@gmail.com

Educational process in its current concept requires a foreign language teacher to possess flexibility in applying modern approaches and methods of education. Computers and their impact on our lives have changed the society completely. Teachers should also realize and accept this fact since the concept of a modern lesson has been changing as well. The problem is that today the lessons should be conducted in such a way to make it easier to get students interested in them. The way to get students motivated in their work is becoming more and more difficult. The trivial method of using only a textbook does not justify the expected results anymore. That is why teachers are turning towards interactive multimedia platforms for assistance to bring diversity into their lessons. No doubt, multimedia is beneficial in teaching foreign languages, however it cannot be a perfect solution to every problem. Teachers tend to use presentations, videos and interactive platforms, but very few educators dare to apply podcasts as an alternative to classical audio texts. However, teaching practice shows that the use of podcasts can improve efficiency of the educational process.

According to Cambridge Dictionary, a podcast is a broadcast that is placed on the Internet for anyone who wants to listen to it or watch it [1]. “Unlike conventional television or radio, podcasts allow listening to audio files and viewing video transmissions not live, but at any time convenient for the user”. We can distinguish between authentic podcasts, which are created for native speakers, and educational podcasts, which serve, obviously, for educational purposes [2]. The modern educational standards oblige teachers to apply authentic material when teaching. In terms of listening comprehension, of course, the students should listen not only to their teacher, but to people who consider the students’ target language their mother tongue. But practically it is not applicable with a student who hasn’t reached the B1 level yet. That’s why the audios and/or podcasts that are created for educational purposes prevail in schools. The most effective way to find a podcast is to reach a directory of podcasts. One of the most popular directories is Apple Podcasts, which has been used by the author of this article.

The aim of the research was to find out whether teaching listening comprehension with the use of podcasts can be effective and if so to create guidelines for teachers to help them avoid implicit difficulties. A number of tasks were determined as follows: to analyze the textbook recommended by the school curriculum, to find the most suitable podcast using a directory, to elaborate a set of exercises based on the selected podcast, to teach listening using this set of exercises, to analyze the results and provide methodological recommendations for using podcasts in teaching German.

The study was conducted on the basis of grade 7 “b” of the ‘Pushkin Gymnasium’ (Syktyvkar, Komi, Russia). According to the curriculum, it is assumed that students learn German as a second foreign language from the fifth grade. However, a good third of the students had never studied German before as the children joined the class from other public schools. Consequently, it was also necessary to help the beginners to integrate into learning German and to create a pleasant image of the second foreign language. At the same time, it was necessary to adapt the material so that it would be useful not only to beginners, but also to students who have had some experience in learning German. At the beginning children were afraid to give answers to questions even in Russian, they were shy, passive and lacked initiative. The average grade of the class barely exceeded two points (an F-level).

The study was practically based on the podcast «Deutsch-Podcast» (ger. German-Podcast) as a means of teaching listening comprehension. This podcast was chosen for several reasons. Firstly, this podcast is created by German teachers for educational purposes. Secondly, the hosts provide listeners with plausible communication situations: they talk about shopping, learning languages, everyday life. Besides, the authors divide the episodes into three levels of difficulty (A1-A2, B1-B2, C1-C2) and use appropriate vocabulary and grammatical constructions for a specific level. The slow pace of conversation makes it easy to edit each episode via any audio editor.

At the initial stage a plan was made on how to incorporate the podcast into the curriculum. Some segments of podcasts were identified which could be used to cover different topics. The basic means of teaching German as a second foreign language in the gymnasium is provided by the textbook ‘Horizonte’ (ger. “Horizons”), in which listening materials are represented by classical audio recordings. We analyzed the textbook and the podcast and chose a few episodes, cut them into several parts and then used them as an auxiliary means to teach one grammatical topic (the German Past Tense) and

two lexical topics (Mood; the Weather).

Thus, in the end of the experimental teaching students expressed a positive desire to continue working with the podcast in the future and rated the effectiveness of listening to podcast episodes in learning German an average of three out of five points (data obtained by a questionnaire). When asked “Was it interesting for you to listen to the podcast in German and learn new material with its aid?” seven out of thirteen students gave a positive answer. We can conclude that systematic work with the podcast and competent performance of exercises based on it showed good results. In the end of the work with the podcast the students were more active and tried to answer the questions despite the fact that their answers were often wrong. Students, who had possessed some knowledge in German by that time, got a chance to improve their listening skills and the beginners were able to learn the basics of it.

In order to achieve positive practical results, a foreign language teacher should follow some guidelines. The following recommendations are tips on how to plan the work and conduct a lesson using a podcast.

At the preparatory and planning stage it is recommended to:

1. Match the topic/section from the textbook with the episode of the podcast.
2. Select a suitable piece of podcast that is as close to the topic as possible and is appropriate to the level of language skills of the majority of students.
3. Edit the selected episode using an available audio editor (e.g. Audacity): add pauses, increase the volume of the track, remove unnecessary parts.
4. Make handouts for work, as well as presentations using modern platforms (e.g. Canva).

When working with podcasts it is reasonable to:

1. Explain what a podcast is, introduce the hosts, show a picture of the speakers, present their website, so that you can establish personal contact between the listeners and the speakers.
2. Explain to children how to work with handouts since many teenagers due to their age may be careless with them.
3. Clearly explain to schoolchildren their task and prepare them

psychologically for the work.

Remember that:

1. It is unacceptable to make a situation possible when the learning process becomes entertainment rather than studying.
2. The assignments should be appropriate to every child's level of knowledge and shouldn't be too much facilitated for beginners because the students with some language experience could be simply demotivated.

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Teaching students to engage in dialogue in a foreign language: opinion exchange

A.E. Arteeva, N.V. Chuprova

SyktSU, Syktyvkar

anch5shawnmendes@mail.ru

Communication skills are considered to be vital nowadays. The ability to work in a team, ask questions, reach a compromise are regarded as crucial. So people have to be good at making arrangements, listening to other people and expressing their opinion. As the English language is becoming an international language, uniting people from all over the world, communicating only in the native language is not enough. The more languages a person speaks – the better.

Many Russian companies start cooperating with foreign ones. That is why employees who speak English are more likely to get a promotion or a raise in the salary.

People communicate a lot every day and the main form of oral communication is the dialogic speech [1, p. 155].

As it is stated, dialogic speech is a process where two or more people are exchanging their lines within a certain topic [2, p. 204]. Dialogic speech has a number of features: reactivity, ellipticity, turn-taking, fast pace, etc. A teacher must take into consideration all these peculiarities to organize the teaching process successfully.

Depending on the situation people communicate using different types of dialogue:

1. Dialogue – information exchange – one-sided dialogue.
2. Dialogue – action planning [3, p. 378].
3. Dialogue-opinion exchange .
4. Dialogue-interview – the first person is asking questions and the second one is answering the given questions [4, p. 70].

Teaching students to lead a dialogue starts in the secondary school because teenagers at the age of twelve – fifteen are eager to speak their mind, share their views and beliefs with the peers and grownups. Teenagers are flexible and they are likely to change their opinion while they do not have a firm opinion yet. So they listen to other people's opinions. That is why dialogue-opinion exchange is the best type of dialogue for secondary school learners. Moreover, at that age students are experienced enough to argue and defend their point of view.

In my opinion, dialogue-opinion exchange is one of the most important types of dialogue for developing dialogical skills as it involves both speakers in the situation and lets them express their feelings and thoughts. A dialogue-opinion exchange is a free-flowing dialogue, which is why students are likely to face difficulties while leading this kind of dialogue. While leading a dialogue-opinion exchange students should know how to:

- express an opinion and then agree or disagree with the opinion of the speaking partner;
- approve or disapprove of the idea;
- show doubt;
- give the partner an emotional feedback (show sadness, sorrow, happiness);
- to support the partner, paying him/her a compliment [2, p. 208].

A teacher of foreign languages must take into consideration that due to various reasons students might not be ready to speak their mind. Two main reasons for that are: lack of experience in the topic they are discussing; refusal to speak because they are afraid to be criticized by a teacher or the classmates. That all prevents students from successful learning.

To avoid these problems a teacher should prepare debatable topics for discussions that are interesting for students. For example, such topics as school uniform, hobbies, travelling, the best way to entertain yourself etc. are highly debatable and imply different opinions.

Also a trusting environment in the class is of great importance as it helps to avoid the fear of public speaking or mockery. No doubt, language barrier prevents students from taking part in the discussion. Students think it is better to keep calm rather than make mistakes. That is why teachers must pay special attention to preparatory work. Preliminary work should include agreement (I agree/I think you are right) and disagreement (I disagree/I don't think so/I am afraid you are mistaken) clichés and opinion expressing clichés (I think/In my opinion).

Preliminary work involves a group of exercises that help students express their own opinion, agree or disagree with partner's opinion. The next set of exercises can be used on the preliminary stage.

1. Agree with me. Use the clichés.

Teacher: *When I go backpacking in Italy, I can meet the locals.*

Student: *I agree with you. When I go backpacking in Italy, I can meet the locals.*

2. Disagree with me. Use the clichés.

Teacher: *When I go camping I can visit museums.*

Student: *I'm afraid you're mistaken. I can't visit museums when I go camping.*

3. Say if you like backpacking, why or why not. Use the clichés.

Student: *I personally think that backpacking is a great kind of holiday because it's cheap and you can learn to organize yourself.*

4. Work in groups. Say what you can do:

- on a backpacking tour around Europe;
- on a package holiday;
- on a cruise around the Mediterranean;
- when you go camping in Russia.

5. Ask your friend if he:

- likes travelling;
- would like to go on a package tour, why;
- would like to go backpacking, why;
- would like to go on a cruise with you

Productive speech stage

1. You are organizing a summer holiday with your friend. Discuss the following types of holiday and choose which one you'll both enjoy the most.

- backpacking around Europe;
- a package holiday in Italy;
- a cruise around the Mediterranean;
- camping in Russia [5, p. 99].

When sticking to this set of exercises, teaching students to lead a dialogue-opinion exchange can be productive. One more important aspect is teaching students to start, lead and finish the dialogue. So the preparatory stage should include both work on one dialogical unity and making up mini-dialogues consisting of two or three dialogical units. A student should explain why he or she sticks to this or that opinion so one short sentence is not enough for leading a dialogue-opinion exchange. Despite the fact that students may face a number of difficulties while learning to lead a dialog-opinion exchange, these difficulties may be avoided if the teacher's approach is competent.

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Impact of competition ideas on the poverty situation in Russia

M.M. Styrov^{1,2}, R.L. Zahariev³

¹Institute of Socio-Economic and Energy Problems of the North of FRC Komi SC UB RAS, Syktyvkar

²SyktSU, Syktyvkar

³Institute of Socio-Economic and Energy Problems of the North of FRC Komi SC UB RAS, Syktyvkar

zahariev@iespn.komisc.ru

The problem of poverty is one of the eternal ones. Today, it also worries rulers, scientists, and ordinary citizens. Usually, poverty is understood as a lack of material resources, an absolute or relative inability to meet basic everyday needs. We intend to consider this concept more broadly. We consider it expedient to interpret this concept more broadly and also mean by it the underdevelopment of a person's inner abilities, the scarcity of his social ties, the limited possibilities of labor, creative and spiritual self-realization.

Mistakes of state policy, imperfection of the social organization of society, low wages in certain industries, etc. are usually indicated as the main causes of poverty.

Agreeing in general with these points and proceeding from personal observations, however, we must admit: most often the main culprit of poverty is directly or indirectly personal social deviations, in other words, sins: drunkenness, drug addiction, fornication, the commission of crimes, the arbitrary rupture of a person's kinship and other relationships, the concentration of vital interests mainly in material sphere, etc.

Moreover, we undertake to assert that the shortcomings of the social order ultimately arise from the accumulation of individual private errors, crystallizing into ugly forms of laws and other institutions [1]. A prime example of this is the legalization of abortion in Russia in 1920.

And in this article we would like to consider the impact on the problem of poverty of one of the ideas generated by destructive human pride, but extremely deeply embedded in the flesh and blood of mankind — the idea of competition.

This category has been known since ancient times, it is rooted in the initially dualistic understanding of the world as a “constant struggle”. Heraclitus, Thomas Hobbes and many other authors wrote about it, but Adam Smith really sang it and introduced it as the basis of the economic structure

[2]. Now, under the influence of the “economism of our era” (S.N. Bulgakov [3]), the ideology of competition penetrates from the purely industrial into the public sphere — education, healthcare, law enforcement, culture, social protection.

Our hypothesis is as follows: the paradigm of competition contributes to an increase or, at least, consolidation of the level of poverty of the population, especially in its spiritual aspect. How can this manifest itself?

First, competition sets up all economic actors — from the individual to supranational unions — for general competition. Of course, in every competition there are not only winners, but also losers [4] who are pushed to the margins of life. In addition, due to economic benefits, many workers have to work without registration of labor guarantees and benefits. V.Y. Katasonov writes: “Capitalism inevitably activates the processes of redistribution of the “social pie” not only vertically (taking away part of the “pie” from the worker by different capitalists), but also horizontally. Since capitalism breeds unemployment, poverty, and misery, crime among the poor and poor inevitably rises as a means of survival” [5].

Secondly, the competitive spirit puts material goods in the first place in the system of values, belittling the importance of spiritual ones — faith, hope and love. Accordingly, a person in the process of growth and education pays more attention to health, knowledge and skills — more as tools of “success”, rather than the potential for serving people. And he pays less attention to the development of mental qualities, which leads to a gradual impoverishment of the heart, the destruction of the family, and in the long term — to physical poverty due to disappointment with life and harmful inclinations, for example, alcohol abuse. “In order to arouse activity in a person, do not knock him off his feet and, most importantly, confuse and out of fear of industrial stagnation, do not drive him into industrial delirium tremens, which is also a source of activity, but exhausting, not supporting force ... It may be so: industrial activity will boil over, but with this boiling water only a part of the rural population will have time to settle down somehow, the rest will die in an evil lot, will become vagabond, go on robbery, overflow the cities to staff the pathetic urban proletariat, will become a round homeless, as it was everywhere where the peasant was freed without land and settlement” — K.D. Kavelin wrote in the XIX century [6].

Thirdly, the ideas of rivalry divide people from each other, placing the care of the needy mainly on the shoulders of the state and charitable

foundations. This is facilitated by numerous scammers, who also act on the principle: “Everyone survives as best as they can”. However, the state system of social protection is initially scarce and cannot provide for all life situations, and most importantly, due to its impersonality, it does not enrich a person from the inside, does not cause gratitude and awakening of his own labor reserves, often leads to dependency. However, it must be recognized that volunteering and charity do not completely give up their positions and in some respects even show growth dynamics.

Thus, the ideas of competition, which promise a universal “awakening” in the pursuit of material well-being, in reality lead to a deep stratification of society by income level, but even more so to the loss by a person of the true meaning of life. This is evidenced by the high level of formal poverty in some countries, and no less high rates of suicide and mental ill-health in others. Detailed empirical studies on these issues have yet to be carried out. But the results can be predicted now: the progress of the economy in itself is not in itself the progress of humanity, and therefore does not solve the problem of poverty. Approximately such conclusions were reached a century and a half ago by Henry George [7]. Therefore, a new economic paradigm is needed, focused on cooperation, mutual assistance, and the collection of treasures not on “earth” but in “heaven” (Matt. 6:19-20).

What might this new paradigm consist of? First, in the return of value, priorities of personal and social development from sensual to idealistic, spiritual [8]. In this case, poverty will no longer look like a life tragedy, but can really be a voluntary, conscious way of being for the sake of saving the heart from vanity and serving God and neighbors. Secondly, it is not necessary to artificially heat up competition, but to more tune the economy to cooperation, unity, mutual assistance. And as incentives to bet on the intangible: conscience, responsibility, love. Finally, increasing the level of real, rather than ostentatious, charity could greatly help those in need and reduce the level of social tension in the world. Of course, the most valuable is the good that is done not by compulsion, but by conviction.

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From the history of scientific and technical policy of the USSR

K.I. Chuprova

FRC Komi SC UB RAS

kshelginskaya@mail.ru

At the present stage, Russia is undergoing a radical transformation in all spheres of society, including science. The ongoing large-scale reforms to develop the scientific sphere are changing the direction and priorities of research, and the very model of development of the scientific community is being transformed. Under these conditions, the study of the experience of interaction between the state and science at various stages of history acquires great interest and practical significance.

In this report, based on the analysis of various approaches to the assessment of scientific and technological policy, and the study of state regulations, we will consider the formation and main directions of state management of scientific research and technical development at different stages of the history of Russia and their role in the functioning of the state.

With the advent of the Soviet power, attention to the functioning of the scientific sphere of the country increased. Already in 1917, a document that regulated scientific and technical activities was issued. So the decree of the All-Russian Central Executive Committee and the Council of People's Commissars of the RSFSR (Russian Soviet Federative Socialist Republic) of November 9 (22), 1917 established the State Commission for Education. Further, a number of documents on the organization of science were adopted, which also determined the main tasks of science [1].

The foundations of the scientific and technical policy of the Soviet government were laid at the VIII Congress of the Russian Communist Party (Bolsheviks) in 1919, when the Program for Building Socialism was adopted. For the first time, science faced questions related to the development of scientific research, technical developments and their introduction into the national economy. In the 1920s–1930s scientific institutions were created (X-ray and Radiological Institute, State Optical Institute, Institute of Applied Chemistry, etc.), aiming at developing the country's industrial sector. During this period, research institutes were also created in various areas (aviation, chemical, instrument-making, machine-building, metallurgical, etc.). Research trends in these institutes were associated, first of all, with the development of the military-industrial complex of the country. It should be noted that in the

1930s, special attention was paid to the promotion of scientific and technical knowledge among the population. This task was carried out through an increase in the number of special scientific and technical literature. Thus, according to a number of researchers, in the period 1918–1930, the foundation was laid for the management system of the scientific and technical sphere of the state.

The intensive development of the scientific and technical sphere is observed in the pre-war and war period in the history of the USSR, when the tasks of developing the military-industrial complex, due to the emerging external threat, came to the fore in state policy. But at the same time, the totalitarian system that was formed in the country and repression dealt a serious blow to the development of science and technology. The scientific and technical potential (training of professional personnel, development of science-intensive industries, etc.), formed in the pre-war period, provided the needs of the army at the initial stage of the war [2].

With the beginning of the Great Patriotic War, scientific work in all areas was subordinated to the needs of the country's defense. It was the efforts of the Soviet scientists that ensured the growth in the creation of powerful weapons, which undoubtedly predetermined the most important condition for the victory of the Soviet people in the war. The successful development of science during the war continued largely due to the evacuation of scientific institutions to the eastern regions of the country. Researchers of the scientific and technical policy of the USSR assess the period of the Great Patriotic War as one of the most important periods in the development of science and technology, when one of factors contributing to the victory was the development of the military-industrial complex.

According to many researchers, the golden age of the scientific and technological policy of the USSR falls precisely on the 1950s–1970s [3]. Its distinctive features included the expansion of the scope of scientific research, the use of major technological improvements in the economy, and meeting the needs of the military scientific industrial complex. The scientific activity in the post-war period resulted in the leading role of the USSR in nuclear energy, space exploration and automation by the 1960s.

Crisis moments in the implementation of the management of scientific and technological policy in the USSR appear at the final stage of the functioning of the USSR, at the end of 1970s — early 1980s. During this period, the country lost its leading position in the world in terms of the level of development of

the scientific and technical complex, and difficulties arose in introducing the results of scientific and technological revolution into the country's economy [4]. The defining moment was the recognition of the auxiliary role of science in the economic development of the country, which meant a significant turning point in the implementation of scientific and technological policy [5].

Summing up, we note that with the advent of the Soviet power, special attention was paid to scientific and technical progress. Throughout the history of the USSR, the state paid special attention to the development of science. And, as a rule, the development of scientific and technological policy was conditioned.

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Komi-zyrjänische geographische Namen: Probleme der Kodifizierung der schriftlichen Norm in Komi und Russisch

G.V. Fedyuneva, S.F. Mamontova

Institut für Sprache, Literatur und Geschichte, FRC Komi National Center, Syktyvkar

1s-mamontova@agiks.ru

Einführender Teil

Geografische Namen werden geografischen Merkmalen zugeordnet und dienen zu ihrer Identifizierung. Sie spielen eine wichtige Rolle im Leben der modernen Gesellschaft, auch im Prozess der Regierungsentscheidungen, sie sind ein notwendiges Instrument und eine Voraussetzung für den Zugang zu anderen Informationsquellen.

Die Namen geografischer Objekte sind Teil des historischen und kulturellen Erbes der Völker der Russischen Föderation und unterliegen der Registrierung und Rechnungslegung. Um die einheitliche und nachhaltige Verwendung von Namen und deren Erhaltung zu gewährleisten, wird der Staatliche Katalog der geografischen Namen (im Folgenden SCGN genannt) geführt. Die Bedeutung des SCGN besteht darin, dass die Register normalisierte Namen für alle Subjekte der Russischen Föderation enthalten, die für die Verwendung durch staatliche und lokale Behörden, verschiedene Organisationen, die Medien und normale Bürger bestimmt sind. 13377 Toponyme sind im Register auf dem Territorium der Republik Komi registriert, aber dieser Katalog enthält nicht alle existierenden Toponyme. Darüber hinaus erfordern viele von ihnen eine Vereinheitlichung in Bezug auf ihre Rechtschreibung und Verwendung.

Darstellung des Problems, Relevanz

Die Vereinheitlichung geografischer Namen ist ein wichtiges Thema in der russischen Gesetzgebung. Viele Namen geografischer Objekte entsprechen jedoch nicht den orthografischen Normen und Traditionen ihrer Verwendung auf Russisch. Die Komi-Toponymie ist sehr variabel und erfordert eine Standardisierung in den beiden Staatssprachen der Republik Komi. Derzeit gibt es keine speziellen theoretischen Studien zur Vereinheitlichung geografischer Namen im Bereich der Komi-Toponymie. Eine aktuelle Aufgabe ist auch die Schaffung eines modernen Wörterbuchs geografischer Namen in Komi und Russisch. Heute verfügbare Wörterbücher und Nachschlagewerke (Afanasiev 1996; Turkin 1986; Reference book 2016) enthalten nur einen kleinen Teil

der Toponyme, zudem bedürfen sie einer Normalisierung hinsichtlich ihrer Rechtschreibung. Es ist notwendig, Arbeiten an topografischen Karten verschiedener Maßstäbe und Referenzpublikationen, statistischen Daten und Rechtsdokumenten durchzuführen, um alle Namen auf Russisch zu identifizieren und die nationale Form der Komi-Toponyme festzulegen.

Ziele und Aufgaben der Forschung

Das Problem der Kodifizierung der schriftlichen Norm der Toponymie auf dem Territorium der Republik Komi in der Komi- und russischen Sprache ist das Hauptziel dieser Forschungsarbeit. Um dies zu erreichen, ist die Lösung der folgenden Aufgaben erforderlich: 1) Sammlung und Systematisierung von Toponymen der Republik Komi aus verschiedenen Quellen; 2) Untersuchung der Struktur und Methode der Bildung der geografischen Namen von Komi; 3) Klassifizierung von Toponymen; 4) Analyse von Namensvarianten von geografischen Objekten; 5) Entwicklung von Prinzipien für die Übertragung von Komi-Syryansk-Ortsnamen in russischen Quellen und russischen Ortsnamen auf dem Territorium der Republik Komi – in Komi-Quellen; 6) Entwicklung von Grundlagen für die Katalogisierung geografischer Namen der Republik Komi.

Die wissenschaftliche Bedeutung der Studie hängt eng mit ihrer Relevanz zusammen. Die Arbeit wird neues, bisher nicht untersuchtes Material zur Toponymie der Komi-Republik enthalten, das die Grundlage für die Erstellung eines modernen zweisprachigen Wörterbuchs bilden kann. Ein neuer Ansatz für die einheitliche Schreibweise von Toponymen der Republik Komi wird ebenfalls vorgeschlagen.

Die Arbeit verwendet allgemeine linguistische **Forschungsmethoden**: vergleichende, kontrastive und beschreibende sowie spezielle Methoden und Techniken der toponymischen Forschung, insbesondere kartografische und statistische Methoden, eine Methode der vergleichenden Analyse von Varianten geografischer Namen, die im Staatskomitee für registriert sind Staatliche Besteuerung mit inoffiziellen Namen auf topografischen Karten.

Das Material für unsere Studie sind topografische Karten in mehreren Maßstäben verschiedener Erscheinungsjahre, Wörterbücher und Nachschlagewerke der Republik Komi.

Im Rahmen der Arbeiten wurden im Zeitraum von 1970 bis 2000 topografische Karten der Maßstäbe 1:100 000, 1:200 000, 1:1 000 000

ausgewertet. Durch die Analyse des kartografischen Materials und des SCGN wurden auf dem Territorium der Republik Komi mehr als 14.000 geografische Namen identifiziert: mehr als 7.000 Namen von Hydronymen, mehr als 2.000 Namen von Limnonymen (Namen von Seen) und Mikrotoponymen (Namen von Orten, Weiden, Wiesen), Gelonyme (Namen von Sümpfen) – 1090, Oronyme (Namen von Reliefobjekten) – 392. Rechtlich bestehende Namen von Siedlungen – 756. Ehemalige Siedlungen – 745.

Derzeit wird an topografischen Karten im Maßstab 1:50 000 gearbeitet, analysiert wurden die südlichen und zentralen Regionen der Republik Komi. Die nördlichen müssen noch ausgearbeitet werden – dies sind Ust-Tsilemsky, Pechora, Usinsk, Inta und Workuta.

Ergebnisse

Die Analyse und Systematisierung einer möglichst großen Anzahl geografischer Namen wird es ermöglichen, Wege zur Lösung vieler Probleme der Normalisierung der Verwendung geografischer Objekte der Republik Komi zu finden, um solche negativen Tatsachen für die staatliche und öffentliche Verwendung von Toponymen als Verzerrung auszuschließen Sprache und Schreibweise nationaler Namen geografischer Objekte, willkürliches Ersetzen einiger Toponyme durch andere, unterschiedliche Wiedergabe derselben Namen in verschiedenen Quellen und so weiter. Die Studie wird die theoretische Grundlage für die Erstellung eines vollständigen Wörterbuchs der Toponyme der Republik Komi in der Komi- und russischen Sprache sowie die Grundlage für die offizielle Registrierung einer standardisierten Form geografischer Namen im SCGN.

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Sections 3
“Biology and Physiology”

J-wave incidence in a porcine model of acute ischemia

A.S. Poselyaninov^{1,2}, P.V. Khomenko^{1,2}, M.E. Grubbe^{1,2}

¹Institute of Physiology, FRC Komi SC UB RAS, Syktyvkar

²Institute of Medicine, SyktSU, Syktyvkar.

a.poselyaninov@gmail.com

Introduction. Activation slowing predisposes to ischemic ventricular tachyarrhythmias including ventricular fibrillation (VF). It can be expressed as a prolongation of QRS complex and J-wave generation in the body surface electrocardiogram (ECG) [1,2]. However, the relationship between the two ECG markers of prolonged ventricular depolarization is unclear thus far. The aim of our study was to analyze an association of J-wave occurrence with QRS prolongation and VF development in a model of acute myocardial ischemia in pigs.

Methods

Experimental protocol. Experiments were performed in 46 domestic pigs (30–45 kg body weight). The study conformed to the Guide for the Care and Use of Laboratory Animals, 8th Edition published by the National Academies Press (United States) 2011, the guidelines from Directive 2010/63/EU of the European Parliament on the protection of animals used for scientific purposes and was approved by the Ethical Committee of the Institute of Physiology of the Komi Science Centre, Ural Branch of Russian Academy of Sciences. The animals were anesthetized with zoletil (Virbac S.A., Carros, France, 10–15 mg/kg, *i.m.*), xylazine (Interchemie, Castenray, Netherlands, 0.5 mg/kg, *i.m.*), and propofol (Norbrook Laboratories Ltd., UK, 1 mg/kg, *i.v.*), intubated and mechanically ventilated. The heart was accessed via a midsternal incision.

A model of myocardial infarction in pigs was induced by ligation of the left anterior descending coronary artery (LAD). After the ligature placement, the chest was reclosed, and the heart was allowed to stabilize for 30 *min*. 12 standard ECG leads were recorded continuously from the baseline to the end of ischemia using INCART software (“Kardiotechnica-04-8m,” St. Petersburg, Russia).

Data processing. The maximal QRS duration regardless of the presence of a J-wave was determined throughout 12 standard ECG leads at baseline and at 1, 2.5, 5, 10, 15, 20, 25, 30, 35, and 40 *min* of coronary occlusion. The appearance of the J-wave was defined as a positive or negative wave at the end of the QRS complex or the appearance of slurring at the end of the complex

with respect to the ECG baseline [3].

Data are expressed as medians and interquartile ranges (IQR). The Wilcoxon test was used for paired comparisons between study groups. Univariate logistic regression analysis was used to test for a possible association between measured ECG parameters. The differences were considered to be significant at $p < 0.05$. Statistical analyses were performed using SPSS 19.0 (SPSS Inc, Chicago, IL).

Results. VF episodes occurred in 26 (56.5%) out of 46 pigs, and clustered in early (1–10 *min*, 16 cases) and delayed (17–40 *min*, 10 cases) periods of occlusion, which are referred to 1A and 1B phases, respectively. The dynamics of QRS duration changes corresponded to VF distribution and was characterized by two peaks of QRS prolongation with the first peak observed immediately after the beginning of LAD occlusion at the 5th minute [72 (IQR 68–88) vs. 68 (IQR 60–71) ms at baseline, $p = 0.001$] and the second peak at the 25th minute [68 (IQR 64–78) vs. 68 (IQR 60–71) ms at baseline, $p = 0.056$] of ischemic exposure. However, in the univariate logistic regression analysis the association of the maximal QRS duration and VF occurrence was demonstrated for 1B (OR 1.060 95% CI 1.007–1.117; $p = 0.027$), but not 1A phase of ischemia.

The J-wave incidence showed the transitory character during the whole period of ischemic exposure. In the univariate logistic regression analysis, the association of the maximal QRS prolongation and J-wave appearance was shown during the whole period of ischemia (OR 1.040 95% CI 1.020–1.060; $p < 0.001$), phase 1A (OR 1.028 95% CI 1.005–1.051; $p = 0.015$) and 1B (OR 1.097 95% CI 1.032–1.166; $p = 0.003$). No significant associations (OR 0.641 95% CI 0.263–1.562; $p = 0.328$) between the appearance of the J-wave and the development VF during were observed in our myocardial ischemia model.

Conclusion. During myocardial ischemia, J-wave generation was associated with QRS prolongation but did not predict VF development.

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Tpeak–tend interval as a vf marker in ischemia

P.V. Khomenko^{1,2}, A.S. Poselyaninov^{1,2}, M.E. Grubbe^{1,2}

¹Institute of Physiology, FRC Komi SC UB RAS, Syktyvkar

²Institute of Medicine, SyktSU, Syktyvkar

dok-rk@yandex.ru

Background. Because the QT interval reflects the overall duration of depolarization and repolarization of the ventricular myocardium, Tpeak–Tend interval is thought to reflect the dispersion of ventricular repolarization [1,2]. In recent years, increasing attention has been paid to Tpeak–Tend interval as a marker of the risk of cardiac arrhythmias and cardiovascular mortality, since it reflects dispersion of repolarization. The purpose of this study was to investigate whether Tpeak–Tend on surface electrocardiogram predicts ventricular fibrillation (VF) in experimental myocardial ischemia in pigs.

Methods. Experiments were performed in 42 domestic pigs (30–45 kg body weight). The study conformed to the Guide for the Care and Use of Laboratory Animals, 8th Edition published by the National Academies Press (United States) 2011, the guidelines from Directive 2010/63/EU of the European Parliament on the protection of animals used for scientific purposes and was approved by the Ethical Committee of the Institute of Physiology of the Komi Science Centre, Ural Branch of Russian Academy of Sciences. The animals were anesthetized with zoletil (Virbac S.A., Carros, France, 10–15 mg/kg, *i.m.*), xylazine (Interchemie, Castenray, Netherlands, 0.5 mg/kg, *i.m.*), and propofol (Norbork Laboratories Ltd., UK, 1 mg/kg, *i.v.*), intubated and mechanically ventilated.

The myocardial ischemia was induced by the left anterior descending coronary (LAD) artery occlusion. After ligature placement, the chest was reclosed, and the heart was allowed to stabilize for 30 min. Continuous recordings of 12 standard ECG leads were done at the baseline and during the 40-minutes of coronary occlusion by the INCART software (“Kardiotechnica-04-8m”, St. Petersburg, Russia).

The peak and end of T-waves were determined and Tpeak–Tend intervals were calculated in each ECG lead at baseline, and at the 1st, 3rd, 5th, and then every 5 minutes until the end of experiment. Then, the maximal Tpeak–Tend interval was calculated. Data are expressed as medians and interquartile ranges. The Wilcoxon test was used for paired comparisons between study groups. Univariate logistic regression analysis was used to test associations

between the maximal Tpeak–Tend and VF development. The differences were considered significant at $p < 0.05$. Statistical analyses were performed using SPSS 19.0 (SPSS Inc, Chicago, IL).

Results. 24 out of 42 pigs experienced VF. Distribution of the VF occurrence had two peaks at 1–5 minutes and 17–40 minutes (referred to as 1A and 1B phases, respectively) of coronary occlusion. Maximal Tpeak–Tend prolonged progressively during occlusion (Fig.). In respect to the baseline value [64 (IQR 52–72) ms], it became greater starting from the 5th minute of occlusion 76 (IQR 67–92) ms, $p = 0.001$] with a maximum at the 25th minute [98 (IQR 79–116) ms, $p < 0.001$]. In the univariate logistic regression analysis, maximal Tpeak–Tend was associated with VF development during the whole period of ischemia (OR 1.016 95% CI 1.004–1.028; $p = 0.007$) and separately in phase 1B (OR 1.028 95% CI 1.005–1.051; $p = 0.017$), but not in phase 1A (OR 1.016 95% CI 0.995–1.037; $p = 0.137$) [3].

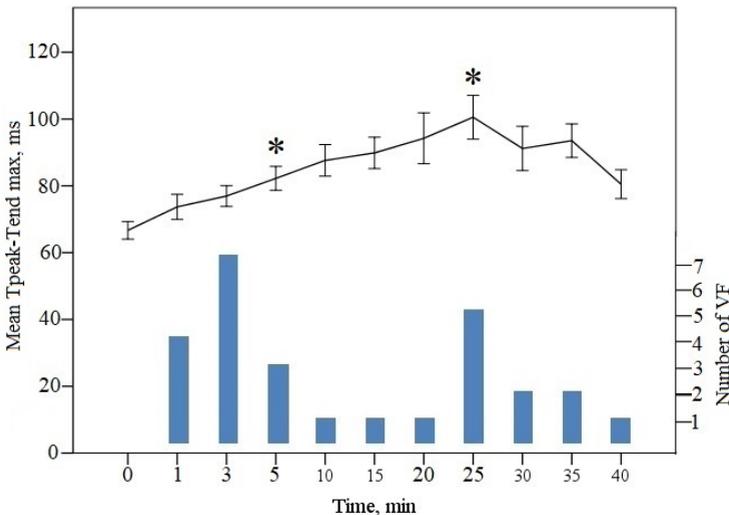


Fig. Distribution of the frequency of occurrence of VF between phase 1A and 1B. The amount of VF is shown with respect to the change in the average value of Tpeak–Tend max in different time intervals. * – $p < 0.05$ compared to the control condition.

Conclusion. Prolonged Tpeak–Tend predicts 1B ventricular fibrillation during the experimental ischemia in pigs.

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T-wave amplitude dynamics in the bicycle exercise test “to exhaustion” in cross country skiers at the beginning of the preparatory period

A.K. Kudinova

Institute of Physiology, FRC Komi SC UB RAS, Syktyvkar

unbelievably88@gmail.com

Introduction. Constant high-intensity physical activity leads to changes in the athlete’s ECG. In particular, this concerns the process of repolarization of the heart ventricles [1–4]. At the same time, repolarization changes are known to intensify with an increase in years of training and be more prominent in males and endurance athletes [4]. ECG assessment, including its repolarization complex, is an element of pre-competitive screening of an athlete’s functional state. It is known that ECG parameters of an athlete are affected by the stage of the annual training cycle and by the climatic annual cycle [5]. At the beginning of the preparatory period of the training cycle, the functional capabilities of athletes are expected to be high. At the same time, in this period the low temperature factor is not expressed, so athletes are expected to have an adequate myocardial response to the exercise test. In the exercise testing the occurrence of such repolarization modifications as the inversion of the ECG T-wave may serve as a marker of ventricular myocardial overwork and exhaustion [6]. Therefore, the observation of repolarization changes in different periods of the annual cycle is important for the diagnosis of the functional state of athletes.

The purpose of the study: To study the dynamics of the ECG T-wave in elite athletes in the exercise test “to exhaustion” at the beginning of the preparatory period.

Materials and methods. The sample group in our research is composed of male members of the Komi Republic national cross-country skiing team, who have the title of Master of Sports ($n = 16$). Prior to the testing, an informed consent for the experimentation was signed by all participants; the protocol of the experiment was approved by the local Ethics Committee. The experiments were conducted at the beginning of the preparatory period of the yearlong training cycle (June). Before the testing the athletes’ height and body mass were measured. Athletes performed a bicycle cardiopulmonary exercise test “to exhaustion” with use of the ergospirometry system “Oxycon Pro” (Erich Jaeger, Germany) with an ECG recording in 12 conventional leads. The

amplitude and polarity of the ECG T-wave at rest in sitting position and at the peak testing load were studied. PQ-segment was taken as an isoline. Statistical analysis of the results was performed in the program Statistica 8.0 (StatSoft Inc., 2007) and Microsoft Excel, 2010. The Shapiro-Wilk criterion was used to assess the normality of the distribution of indicators. The Mann-Whitney criterion was used to evaluate changes in the amplitude of the T wave in the test “to failure”, and the Pearson Chi-squared criterion — of the polarity of the T-wave. The differences were recognized as significant at $p < 0.05$.

Results. The height, body weight, age and main test results (M±SD) of the athletes are presented in Table 1. The mean height of the athletes was 179.5 ± 5.0 cm, body weight — 72.7 ± 5.0 kg, age — 25.1 ± 4.7 years. The mean peak load was 345 ± 41 W, the mean VO₂max reached 4474 ± 403 ml/min. Sinus rhythm on the ECG was registered among all athletes. Sinus bradycardia (heart rate is less than 60 beats/min) at rest supine position was found in 80% of athletes. The transition zone was marked in leads V2–V5. The Sokolov-Lyon index (RV5/6 + SV1/2) [7] exceeded the norm in 53% of the athletes, and the Cornell Index (RaVL + SV3) [7] — in 7% of the athletes. The presence of a J-wave (j-point rise of more than 0.1 mV along with ST-segment elevation) at rest was noted among 68.8% of athletes in anterior leads (V1–V4).

Table 1. T-wave amplitude changes in sitting position at rest and at the peak load of the bicycle exercise test “to exhaustion” in cross country skiers (Me [25;75]%, n)

ECG lead/ Test phase	Sitting position at rest	Peak load
I	0.20 [0.14; 0.23], 14	0.15 [0.15; 0.20], 16
II	0.50 [0.29; 0.60], 14 *	0.27 [0.23; 0.38], 15 *
III	0.30 [0.21; 0.35], 14	0.20 [0.16; 0.31], 12
aVR	-0.35 [-0.39; -0.16], 14 *	-0.25 [-0.30; -0.16], 15 *
aVL	-0.07 [-0.10; 0.05], 13	0.05 [-0.00; 0.10], 11
aVF	0.42 [0.25; 0.50], 14 *	0.20 [0.05; 0.30], 12 *
V1	-0.20 [-0.25; -0.10], 13	-0.23 [-0.30; -0.18], 14
V2	0.15 [-0.07; 0.24], 14	0.15 [0.12; 0.23], 14
V3	0.90 [0.80; 1.15], 14 *	0.65 [0.53; 0.80], 16 *
V4	1.00 [0.74; 1.14], 14	1.00 [0.83; 1.20], 16
V5	0.70 [0.53; 0.94], 14	0.50 [0.45; 0.80], 15
V6	0.60 [0.33; 0.85], 14	0.33 [0.25; 0.50], 15

Note: (*) – $p < 0.05$ – Mann-Whitney criteria.

There was a significant decrease in the T-wave amplitude at the peak load compared with the sitting position at rest (Table 1) in II, aVR, aVF, V3 leads.

During the test the T-wave polarity remained positive in I, II, III, aVR, V5, V6 leads (Table 2). Reaching the peak load the number of inverted T-waves decreased in aVL leads by 8.3%, in V1 by 14.3%, in V2 by 23.1%, V3 by 7.1%, V4 by 7.1%. Only in the aVF lead there was an increase in the number of T-wave inversion by 16.7%. All changes were statistically insignificant.

Table 2. The polarity of the ECG T-wave at rest and at the peak load in exercise test “to failure” in cross country skiers at the preparatory period

Test phase ECG lead/ T-wave polarity	Sitting at rest		Peak load	
	-	+	-	+
I		100%		100%
II		100%		100%
III		100%		100%
aVR	100%		100%	
aVL	75%	25%	66.7%	33.3%
aVF		100%	16.7%	83.3%
V1	100%		85.7%	14.3%
V2	57.1%	42.9%	28.57%	71.43%
V3	7.1%	92.9%		100%
V4	7.1%	92.9%		100%
V5		100%		100%
V6		100%		100%

Note: “-” is for the negative T-wave, “+” is for the positive T-wave.

Discussion. It is a well-known fact that T-wave decreases with increasing physical load as vagal myocardium regulation shifts to sympathetic [1–3]. The presence of inverted T-waves in the anterior leads (V1–V4) at rest with the presence of a J-point or ST-segment elevation in athletes is associated with high vagal tone and is attributed to a variant of the normal ECG among athletes. In general, the detection of T-wave inversion and J-wave presence is associated with regular intensive physical activity. Indeed, this sign requires close attention, as it can also demonstrate pathological changes [1,8]. It is also suggested that alteration of T-wave could happen due to metabolic changes in the cardiomyocytes [4,6]. It is noted that an increase in the occurrence of

repolarization changes is registered with the intensification of training, and an improvement in this process is seen with its reduction [1-3]. During physical exercise a decrease in the registration of the J-wave and negative T-waves is registered, which is assumed to associate with a decrease in the influence of the parasympathetic nervous system with the onset of exercise [1,2,6].

Thus, the dynamics of the ECG T-wave in the exercise test «to failure» in the Komi Republic national cross country skiing male team at the beginning of the preparatory period showed the absence of any significant changes in the mechanism of T-wave formation in the maximum physical load test. This can serve as an indicator of the good condition of the myocardium, a sign of the absence of its overstrain at the beginning of preparatory stage of the training cycle. To form a complete picture of the impact of training activities on the processes of ventricular repolarization, further analysis of indicators at all stages of the load test and the annual training cycle should be performed.

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Flow cytometric analysis of *Eisenia fetida* coelomocytes after radiation exposure

A.V. Rybak, T.A. Maystrenko

Institute of Biology, FRC Komi SC UB RAS, Syktyvkar

canewa.anuta@yandex.ru

Introduction. The coelomic fluid of earthworms contains coelomocytes — immunocompetent cells responsible for immunity, homeostasis and detoxification of substances. Two main types of coelomocytes are distinguished: amoebocytes and eleocytes [1]. Eleocytes, as opposed to amoebocytes, are characterized by a high level of autofluorescence derived from riboflavin stored in chloragosomes. This is exactly why these cells are easily discernible by flow cytometry. It is known that contamination of soil by heavy metals affects earthworm coelomocytes including their differential counts, riboflavin content [2], and also causes their morphofunctional damages [3]. Therefore, changes in coelomocytes can be used as a biomarker of immune response to environmental stress [2,4]. Currently there is a lack of investigations on the differentiation of coelomocytes exposed to ionizing radiation. Therefore, the aim of the study was analysis of the differentiation of *E. fetida* coelomocytes after chronic and acute radiation exposure.

Materials and methods. The laboratory culture of *Eisenia fetida* earthworms was used for experiments. All earthworms were maintained in a constant temperature (23–25 °C) in soil substrate containing peat, sand and neutralized with CaCO₃ to pH 6.2. Invertebrates were exposed to acute γ -radiation at dose 10 Gy (137Cs gamma irradiation chamber “Issledovatel”, $P\gamma = 0.75 \text{ Gy/min}$) and chronic exposure (2 months) of radioactive soil substrate contained 100, 70 and 50% of soil with increased concentrations of technologically enhanced concentrations of naturally occurring radionuclides (RS_100, RS_70, RS_50): 238U, 226Ra and their decay products (Vodny settlement, Komi Republic).

Earthworms were stimulated with buffer (95% PBS, pH 7.4; 5% absolute ethanol; 2.5 mg/ml EDTA) for 2 min to expel coelomic fluid containing coelomocytes through the dorsal pores according to procedure [5]. Then coelomocytes suspensions were centrifuged twice (500 g, 7 min; 400 g, 10 min) to separate the cells from the buffer using PBS. The cell density was adjusted to 1–1.5 x 10⁵ cells/ml cell suspension for all samples.

The autofluorescence of coelomocytes was measured using flow

cytometer CytoFLEX (Beckman Coulter, USA). During analysis 10000 cells per sample were analyzed based on their forward scatter (FSC) and sideward scatter (SSC). Fluorescence FITC (excitation – 488 nm, emission – 525/40 nm) was also recorded. The results were analyzed using CytExpert 2.4 software.

Statistical analysis was performed using GraphPad Prism 8 software. Differences between values were determined using Mann-Whitney test.

Results. Certain new data results were obtained to assess the effect of ionizing radiation to earthworm coelomocytes by means of flow cytometric analysis. The trend to decrease the proportion of autofluorescent cells (AC, %) in coelomic fluid of *E. fetida* exposed to soil contaminated with naturally occurring radionuclides during two months (Fig.1a) as well as after acute γ -irradiation at 10 Gy was shown (Fig.1b).

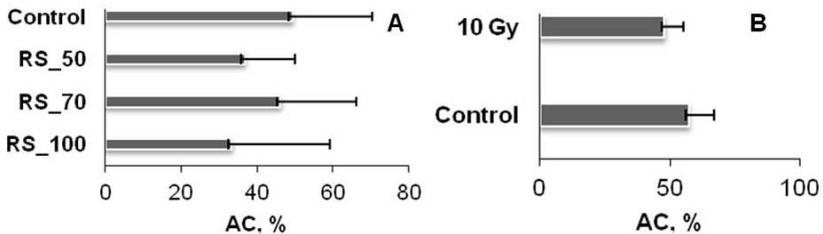


Fig.1. The proportion of autofluorescent cells (AC, %) of *E. fetida* coelomocytes after chronic (A) and acute (B) radiation exposure.

Analysis of the results by the quadrant method, taking into account the changes of cellular morphology of coelomocytes, revealed the trend to expressed differentiation of *E. fetida* immunocompetent cells after chronic radiation exposure, especially in the RP_100 (Fig.2).

It should be noted that metal and radiation impact induces different types of morphological changes in cells: membrane damage, vacuolation, membrane blebbing, binucleation and micronucleation. For example, Gautam and colleagues (2022) [3] showed that coelomocytes of earthworms *Metaphire posthuma* from industrially contaminated soil of Calcutta (Cd, Pb, Cr, Hg) were characterized by all types of cellular damage indicated above. We suggest that membrane damage can cause the loss of riboflavin granules by eleocytes, and, accordingly, a decrease in the count of autofluorescent cells. Definitely, this assumption requires further study.

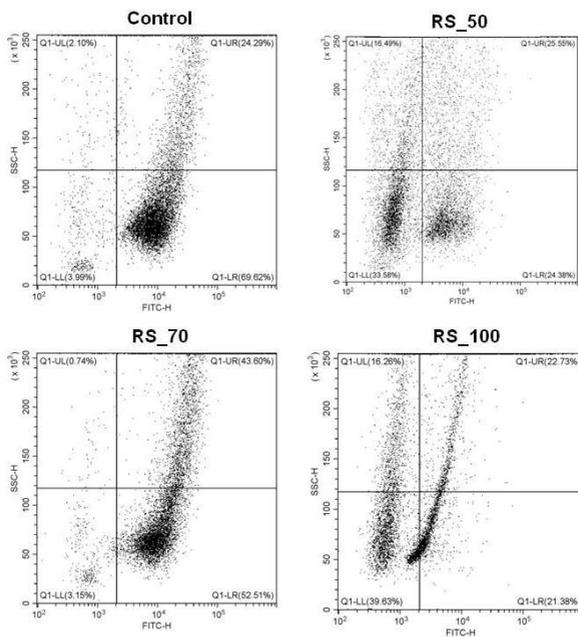


Fig.2. The flow cytometric dot plots of *E. fetida* coelomocytes (one earthworm) after chronic radiation exposure.

Thus, in order to confirm the trends identified during preliminary experiments, it is necessary to increase the sample size and synchronize the laboratory culture of *E. fetida* to reduce the contribution of ontogenetic differences to the biological response. The flow cytometric analysis of coelomocytes in combination with the quantitative determination of the riboflavin content in eleocytes for *E. fetida* can expand the range of recorded parameters and supplement traditional methods for assessing the state of biological systems.

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Efficiency assessment of oil polluted soil recultivation methods in the high north based on soil metabarcoding

E.E. Rasova, E.S. Belykh, E.N. Melekhina, I.O. Velegzhaninov, D.V. Tarabukin, A.N. Zinovieva, M.Yu. Markarova, A.A. Taskaeva

Institute of Biology, FRC Komi SC UB RAS, Syktyvkar

elrasova@mail.ru

Oil spills pose a great threat to the ecosystems of the High North, therefore, the search for methods of effective remediation of contaminated areas is an urgent task of present [1,2]. The aim of this study was assessment of the soil cleanup degree from petroleum products and restoration of the diversity and structure of soil bacteria and fungi communities at sites with different recultivation conditions.

Material and methods. The study was carried out in 2019 at the Verkhnevozeyskoye oil field (Usinsk district, the Komi Republic, 66°37'40" N., 57°07'56" E.) where several oil spills occurred between 1989 and 1996. The contaminated area of about 2 hectares was located on a high peatland with a peat deposit thickness up to 1.5–2.0 m, in which oil penetrated to a depth of 1.0–1.5 m. The remediation experiment was initiated in 2002, 13 years after the oil spill. In the first instance, the area was prepared for recultivation by removing oil and excess moisture from the soil surface. Plowing to a depth of 25–30 cm was carried out. Afterwards the area was divided into sites, on which different methods of remediation were tested. A description of the methods to be utilized is given extensively in [3]. Briefly, a control site was without remediation procedures, sites 1–4 were distinguished by biopreparations, grass seeds and fertilizers, and a background site was located in similar edaphotopic conditions to the other study sites, but was not exposed to oil contamination (Table 1). A dwarf willow birch sedge-horsetail bog was selected as the background site.

For metabarcoding, soil samples (39 in total) were collected from each site and total DNA was isolated with the DNeasy Power Soil Kit (Quagen, USA) in the Center of Collective Usage “Molecular Biology” of the IB FRC Komi SC UB RAS (Syktyvkar, Russia). Amplification of 16S rRNA and ITS gene sites and the amplicon library sequenation on a MiSeq sequencer (Illumina, USA) were performed in the SB RAS Genomics Core Facility (ICBFM SB RAS, Novosibirsk, Russia). The determination of oil products in soil was carried out in the “Ecoanalit” laboratory of the IB FRC Komi SC UB RAS. Statistical data analysis

was performed using Microsoft Office Excel and R (R Core Team) programs with the Mann-Whitney test. Multiple comparisons were made with False Discovery Rate correction.

Table 1. Brief description of remediation methods used at the experimental sites of the Verkhnevozeyskoye oil field in 2002

Test site	Biopreparations	Plant seeds	Fertilizers	Number of soil samples for metagenomic analysis
Background	—	—	—	6
Control	—	—	—	9
1	“Universal” ¹	<i>Phleum pratense</i> , <i>Agrostis gigantea</i> , <i>Avena sativa</i>	Mineral fertilizers	8
2	“Universal”, lignin sorbents ² , BAG ³	<i>Deschampsia cespitosa</i>	Compost Mineral fertilizers	6
3	—	<i>Avena sativa</i> , <i>Phleum pratense</i>	Mineral fertilizers Dolomitic meal	5
4	“Roder” ⁴	<i>Phalaris arundinacea</i> , <i>Phleum pratense</i> , <i>Avena sativa</i>	Mineral fertilizers Lime	6

1 — Design: yeasts *Rhodotorula glutinis* and bacteria *Rhodococcus egvi*, *Rhodococcus erythropolis*, *Pseudomonas fluorescens*. 2 — Dried and crushed compost with embedded oil-destructing microorganisms isolated from the oil-contaminated soils of the study area. 3 — Biologically active fertilizer-seeding granules on the compost basis with fertilizers and seeds of perennial herbs. 4 — Bacteria *Rhodococcus ruber* and *Rhodococcus erythropolis*.

Results. As a result of this analysis, a total of 1385659 16S rRNA gene fragment reads and 2023453 ITS gene fragment reads were obtained. Based on the received reads, we analyzed common and unique taxonomic units, as well as assessed the abundance of representatives from various divisions of bacterial and fungal communities of the experimental sites (data not presented). As the Shannon diversity indexes’ values evidenced (Fig.1), the most significant decrease in biodiversity among the contaminated sites as compared to the background site was observed at site 1. Site 4 turned out to be the closest to the background site in terms of biodiversity value.

The Bray-Curtis distance-based ordination of the bacterial community’s composition indicates that the samples of the background area are isolated in a separate cluster, almost not overlapping with the samples of the oil-

contaminated areas (Fig.2A). At the same time, in the fungal community, both the background and control sites are isolated from the other areas, and all the recultivated sites are similar to each other (Fig.2B).

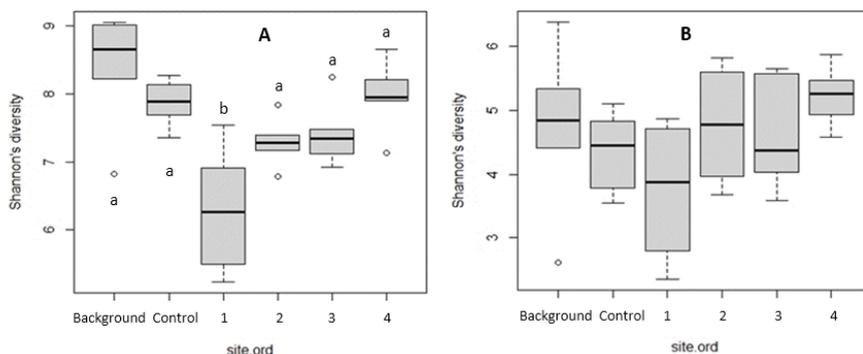


Fig.1. Shannon biodiversity indexes of bacteria (A) and fungi (B) in the sites studied.

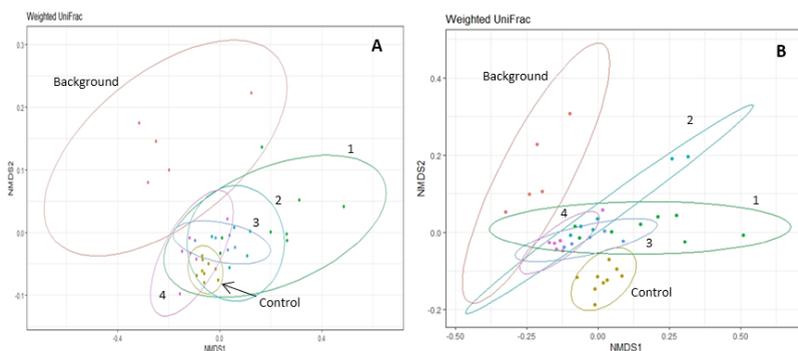


Fig.2. Non-metric multidimensional scaling (NMDS) ordination of bacterial (A) and fungal (B) communities' composition of the sites studied based on the Bray-Curtis distance.

We were also concerned with determining the total petroleum hydrocarbon (TPH) content of the soil at sites studied (Table 2). The level of soil contamination with petroleum products at sites 1–4 remained extremely high at the moment of sampling. However, during the observation period (since the moment of spill) the level of TPH in the surface layer decreased on average 3–7 times. The most significant (up to 33 times) decrease was observed at site 2, reclamation of which was performed using seeds of plants and biopreparations in the form of special pellets.

Table 2. Total petroleum hydrocarbon (TPH) content in the soil of sites studied (mg/kg of soil)

Site	Control	1	2	3	4	Background
TPH × 10 ³ / Ratio of decrease compared to 2002. ¹	62.4 ± 29.2* / 3.3	71.2 ± 93.8* / 4.1	9.8 ± 3.1* / 33.0	72.3 ± 28.6* / 3.1	42.3 ± 46.4* / 7.2	0.9 ± 0.7 / 3.3

* Differences with the background site are significant at $p < 0.05$. 1 – TPH ratio between averages for 2002 (based on Novakovskiy et al., 2021) and 2019.

Discussion and Conclusions. The effectiveness of the microbiome recovery of oil-contaminated soils at the High North after utilizing of different remediation methods was investigated.

The bacterial communities' structure of the oil-contaminated sites, regardless of the remediation method, had similar features. At the same time, there were differences in the fungal communities' structure between the control site and the remediated sites. The background area held an isolated position in terms of diversity and ratio of both bacterial and fungal species.

Site 2, where “Universal”, BAG, and lignin sorbents were applied, was characterized by the highest rate of oil decomposition. However, this site differed little from other contaminated areas in terms of bacterial and fungal diversity. At site 4, where “Roder” biopreparation was applied, the intensity of oil destruction was significantly lower than at site 2, but at the same time the highest bacterial and fungal biodiversity was observed compared with other contaminated areas. In terms of the bacterial community structure, site 4 had the greatest similarity with the background area. Site 1, where the “Universal” preparation was applied without the use of other biopreparations, had the lowest bacterial and fungal biodiversity. It can be assumed that the most effective bioremediation methods for this area are complex preparations based on compost and bioactive pellets, which in our study were BAG and lignin sorbents.

In conclusion, it should be noted that the choice of an effective soil remediation method promotes accelerated decomposition of oil and soil settlement by bacteria and fungi. However, in the process of remediation, the soil microbiome acquires new features, distinct from the original state.

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Electrical activity of the human heart during ventricular depolarization under hypoxic exposure

E.V. Zamenina, I.M. Roshchevskaya

FRC Komi SC UB RAS, Syktyvkar

e.mateva@mail.ru

Introduction. The study of the functioning of the human organism in conditions of oxygen deficiency is an urgent medical and biological problem. The functioning of the cardiovascular system in conditions of oxygen deficiency leads to a change in the work of the heart and is reflected in its electrical activity [1,2]. Body Surface Potential Mapping (BSPM) – registration of cardioelectric potentials from multiple unipolar leads on the torso – is an informative method for studying the functional state of the heart under the influence of various genesis [3,4] which makes it relevant to use this method in conditions of exogenous hypoxia.

The purpose of this study is to investigate the electrical activity of the human heart on the chest surface during the period of ventricular depolarization under hypoxic exposure.

Materials and methods. 14 subjects (19.7 ± 0.9 yrs, 74.4 ± 9.8 kg, 177.2 ± 6.4 cm) were investigated by the methods of BSPM. They were previously informed about the purpose of the study, possible subjective feelings and gave written voluntary consent before participating. The study was conducted in accordance with ethical principles of the WMA Declaration of Helsinki and approved by the Ethics Committee of the Federal Research Centre “Komi Science Centre of the Ural Branch of the Russian Academy of Sciences”.

During the study the subjects were in a semi-sitting position. Hypoxic exposure was carried out exogenously through a face mask for 15 minutes under normal atmospheric pressure using a hypoxic gas mixture (oxygen content 12.3%) obtained at a Kröber O₂ oxygen concentrator (Germany).

In the initial state at every minute of hypoxic exposure and recovery period (5 minutes of breathing with atmospheric air), the heart electrical activity was studied in the examined patients using BSPM: unipolar ECGs were recorded in the limb leads from 64 electrodes evenly located on the torso using an automated system for synchronous multi-channel registration. Oxygen saturation with blood hemoglobin (SpO₂) and heart rate (HR) were also recorded using a pulse oximeter “Nonin 8500” (USA).

On the ECG in the second lead from the limbs, the average duration

of the QRSII complex and R-RII interval were determined for three cardiac cycles.

When analyzing the electric field of the heart on the body surface of the subjects during the period of ventricular depolarization, the following were determined: the amplitude characteristics of the positive and negative extremes (the amplitude of the maximum and the minimum, respectively); the spatio-temporal changes in the parameters of the electric field of the heart on the body surface during the period of ventricular depolarization (the beginning and the end of the formation of the electric field of the heart, the beginning and the end of the first inversion of the relative position of the zones of positive and negative cardiopotentials; the duration of depolarization and the first inversion).

Statistical analysis was performed using the statistical software SPSS version 22.0 (SPSS for Windows, SPSS Inc., Chicago). The normality of the distribution of values was determined by the Shapiro-Wilk test. Since the data had a normal distribution, the results were represented as means \pm standard deviations. Statistical examinations were performed using the paired Student's t-test. The differences were considered significant at $P < 0.05$.

Results. During the period of hypoxic exposure a statistically significant decrease in SpO₂ and an increase in HR were revealed compared with the initial state ($p < 0.05$). During the recovery period SpO₂ and HR recovered to their original state.

During all the hypoxic exposure and the recovery period the duration of QRSII did not change compared to the initial state. From 1 to 10 *minutes* of acute normobaric hypoxia a statistically significant decrease in the duration of the R-RII interval was noted compared with the initial state ($p < 0.05$). From 12 *minutes* to the end of hypoxic exposure the duration of the R-RII interval increased. During the recovery period a increase in the duration of the R-RII interval relative to the initial value was maintained.

At the first minute of hypoxic exposure there was a increase in the maximum amplitude of the positive extremum. Further and until the end of exposure to acute normobaric hypoxia a decrease in the amplitude of the maximum was noted. During the period of breathing with atmospheric air the maximum amplitude of the positive extremum did not recover to the initial level. During the hypoxic exposure period the amplitude of the minimum decreased. A statistically significant decrease in the maximum amplitude of

the negative extremum was found at the third, seventh, 10th and 15th minute of hypoxic exposure and the entire recovery period ($p < 0.05$).

During the period of ventricular depolarization, the duration of the beginning and the end of the formation of the electric field of the heart, the first inversion of the relative position of the zones of positive and negative cardiopotentials, and the entire period of ventricular depolarization did not change during hypoxic exposure compared with the initial state.

Conclusions. The study of BSPM during the period of ventricular depolarization under hypoxic exposure showed differences in the amplitude of the maximum negative extremum. The temporal characteristics of the electric field of the heart during hypoxic exposure did not change.

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In silico exploration of porcine ventricular action potential response to $I_{K(ATP)}$ activator and I_{NaL} blocker in arrhythmogenic myocardium

I.A. Komarov

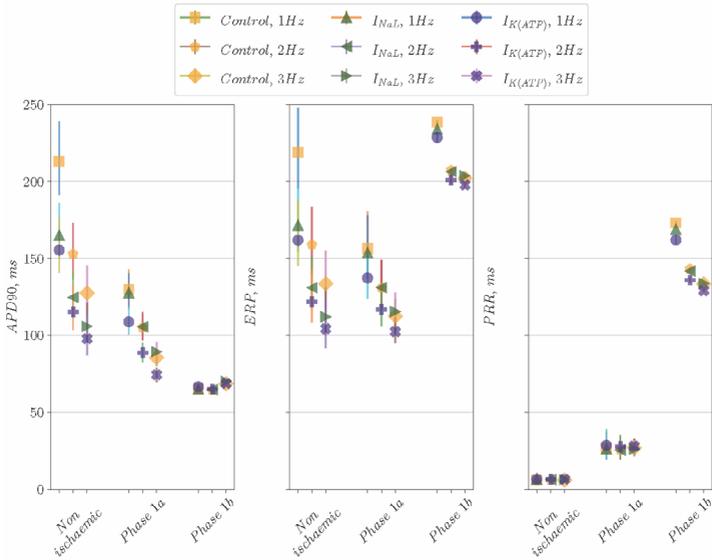
Institute of Physiology, FRC Komi SC UB RAS, Syktyvkar

Ilyakomarovn@yandex.ru

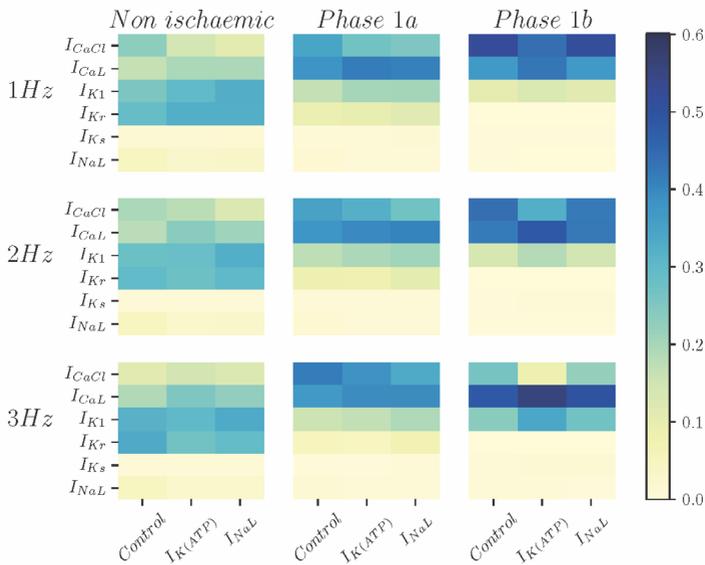
Myocardium is utterly vulnerable to arrhythmias under ischaemic conditions. It is assumed that an arrhythmic risk can be controlled with therapeutic interventions in the myocardial border zone by modifying the characteristics of ionic channels. It was previously suggested [1] that the action potential durations (APDs) in the perfused zone were a superior arrhythmogenic factor in the ischaemia-reperfusion model as they modulate ventricular tachycardia/fibrillation (VT/VF) incidence. In the latest *In Silico* study the APD-shortening pharmacological agents were considered and $I_{K(ATP)}$ activator as well as I_{NaL} blocker appeared to be the most promising ones for further research. The aim of the present study is to explore the intervention of $I_{K(ATP)}$ activator and I_{NaL} blocker in porcine ventricular cardiac cells population under ischaemic conditions.

The effect of the considered agents was simulated by increasing/decreasing the conductance and using a shift in inactivation gate voltage of half-maximal inactivation of the affected ionic channels in accordance with experimental data [2,3]. Two doses of each agent were applied: an injection of the activator would increase the respective ionic stream by 30% and 100% and an injection of the blocker would inhibit the respective ionic stream by 30% and 50%. The doses were based on the known values of half-maximal effective concentration (EC_{50}) and half-maximal inhibitory concentration (IC_{50}) for the activator and the blocker respectively. Action potential (AP) generation was performed with pacing frequencies set to 1 Hz, 2 Hz and 3 Hz. The cellular dynamics was governed by the previously developed biophysically-detailed model.

As Fig. (panel (a)) displays, I_{NaL} blocker has a peculiar effect on APD90 (APD at 90% repolarisation) as well as on effective refractory period (ERR): being comparably less efficacious it also occurs a slight incensement of both metrics at 3 Hz pacing and makes the correlation between APD90 and ERP decline under ischaemic conditions. $I_{K(ATP)}$ activator, however, serves to increase the correlation in presumably $[K^+]_o$ -dependable manner.



(a) Relationship and rate dependence: PRR, APD₉₀ and ERP



(b) Impact on ionic currents distribution

Fig. Panel (a) reveals the relationship and rate dependence of APD₉₀, ERP, PRR of porcine cardiac cells being under influence of I_{NaL} blocker and $I_{K(ATP)}$ activator and control conditions. Mean values and their deviations are presented. Panel (b) shows a distribution of normalised ionic currents as a function of pacing frequency and environmental condition.

There is an undistinguished variability in post-repolarisation refractoriness (PRR), which only tends to extend with the severity of ischaemia. At the same time, the relation between APD90 and ERP is strongly ischaemic-related and it is under conditions of relatively severe ischaemia the correlation between them breaks down. The considered pharmacological agents do not seem to demonstrate high quality changes in the dynamics of APD90/ERP relationship. These statements point out that the exact relation between APD90 and ERP is mostly determined by the environment. Calcium overload and rapid activation rates both increase the probability of early afterdepolarisation (EAD) and induce arise of delayed afterdepolarisation (DAD). As it is shown on the Fig. (panel (b)), I_{NaL} blocker appears to be EAD/DAD-preventive at higher pacing rates compared to $I_{K(ATP)}$ activator. The latter, nevertheless, suppresses I_{CaCl} which is known, for instance, to contribute to DAD in calcium overloaded cells, in all Phase 1b cases. The response of non-ischaemic tissue is controversial at higher pacing frequencies.

The results of this study suggest that the relationship between APD90 and ERP preserves in all cases under considered conditions and is supposed to be mostly determined by environment (e.g. $[K^+]_o$); $I_{K(ATP)}$ activator has a greater impact on APD compared to I_{NaL} blocker, however, the anti-arrhythmogenic properties of the latter cannot be disregarded based on that fact; a pacing rate in conjunction with a given ischaemic condition may be a modulator of agents activity.

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Prospects for biotechnological production of mycelium and mycelial-substrate complexes of xylotrophic basidiomycetes as sources of biologically active compounds

V.V. Martynov

Institute of Biology, FRC Komi SC UB RAS, Syktyvkar

mar7inov.v@yandex.ru

Fungi are one of the most important elements of ecosystems, both in terms of species diversity and biomass and functional load. Representatives of this kingdom of living organisms have been a valuable food resource for humans since ancient times. There are numerous examples of the use of mushrooms in folk and scientific medicine. At the present, studies to create new adaptogenic agents that increase immune status and resistance of body to stress in adverse conditions of natural and industrial environment are of great interest for regenerative medicine. Xylotrophic fungi *Pleurotus ostreatus* (Jacq.) P. Kumm. as well as representatives of genera *Trametes*, *Grifola*, *Ganoderma*, *Polyporus*, etc. can serve as sources of biologically active compounds with expected adaptogenic activity [1–4].

With the development of biotechnology, it has become possible to obtain mycelium of fungi and extracts or purified substances based on them in quantities sufficient for the needs of the pharmaceutical industry.

The aim of this work was to study the growth characteristics, activity of lignolytic enzymes in some species of xylotrophic fungi, selection of the fastest growing strains, selection of substrates and the most optimal conditions of cultivation to obtain mycelium and mycelial-substrate complexes as raw material for isolation of biologically active compounds.

Research objectives:

- comparative study of wood component degradation by different species of xylotrophic fungi;
- determination of the activity of lignolytic enzymes of wood-destroying fungi during deep and solid-phase cultivation on various wood wastes;
- selection of fast-growing strains of xylotrophic fungi and selection of conditions for their cultivation on a lignocellulosic substrate.

The activity of lignin-destroying enzymes of two strains, *Trametes hirsuta* (Wulfen) Lloyd., 24.24 and 17.24, and the corresponding enzymatic activity of the fungus *Fomitopsis pinicola* (Sw.) P. Karst. 5.21 (Table) were

investigated. It was shown that *F. pinicola* 5.21 has high lignin peroxidase activity, and both strains of *T. hirsuta*, 24.24 and 17.24, have both high lignin peroxidase and high laccase activity. The combined action of the enzymes of lignin peroxidase with high oxidative capacity and low specificity of action and laccase participating in the key reactions of lignin biodegradation makes the studied *T. hirsuta* fungus strains effective lignin destructors.

Table. Maximum activities of extracellular fungal ligninases depending on the type of substrate and method of cultivation

Substrate	Method of cultivation	Laccase units/ml×min	Manganese peroxidase, units/ml×min	Lignin peroxidase, units/ml×min
<i>Trametes hirsuta</i> strain 24.24				
Spruce sawdust	SF	16.65 (14)	4.55 (14)	14.83 (14)
	SSF	12.52 (21)	11.79 (21)	25.18 (21)
Birch sawdust	SF	9.76 (14)	3.80 (14)	13.47 (14)
	SSF	10.27 (21)	11.25 (21)	23.42 (21)
<i>Trametes hirsuta</i> strain 17.24				
Spruce sawdust	SF	10.20 (14)	3.32 (14)	13.53 (14)
	SSF	9.19 (21)	10.47 (21)	28.33 (21)
Birch sawdust	SF	9.85 (14)	3.15 (14)	11.49 (14)
	SSF	7.01 (21)	9.28 (21)	24.32 (21)
<i>Fomitopsis pinicola</i> strain 5.21				
Spruce sawdust	SF	6.68 (14)	3.36 (14)	12.35 (14)
	SSF	3.87 (21)	8.66 (21)	17.32 (21)
Birch sawdust	SF	1.98 (14)	3.02 (14)	10.36 (14)
	SSF	3.05 (21)	8.35 (21)	16.48 (21)

It was shown that the fastest growing strain is the fungus *T. hirsuta*, which destroys lignin to a greater extent during bioconversion of wood. For solid-phase fermentation, it is preferable to use sawdust of coniferous trees.

An extended experiment on solid-phase fermentation of spruce sawdust by the fungus *T. hirsuta* has been carried out recently to work out the mycelial-substrate complex in order to determine the antioxidant activity of the extract obtained from it and to determine the contribution of purified individual compounds into this activity.

The work was performed under the scientific supervision of Doctor of science in Biology, Professor Vladimir Vitalievich Volodin.

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Influence of substances that stimulate DNA repair on the lifespan of *Drosophila melanogaster*

N.S. Ulyasheva¹, N.R. Pakshina¹, E.N. Proshkina¹, A.A. Moskalev^{1,2}

¹Institute of Biology, FRC Komi SC UB RAS, Syktyvkar

²Institute of Molecular Biology, V.A. Engelhardt RAS, Moscow

Ulyasheva-1309@yandex.ru

Violation of the mechanisms for maintaining the integrity of the genome is one of the causes and central characteristics of aging. Therefore, possible ways to increase longevity and slow down the rate of aging is to prevent DNA damage, improve the response to DNA damage, and repair this damage (DNA repair), as well as to remove cells with damage. The implementation of these pathways is possible with the help of pharmacological preparations and biologically active substances.

We turned our attention to substances that stimulate DNA repair. A previous analysis of the literature revealed the presence of such substances, some of which are already evidence-based geroprotectors. Most of them are substances of natural origin with a non-specific mechanism of action. According to bioinformatics analysis, among synthetic substances there are more specific ones that stimulate DNA repair without direct damage [1].

The purpose of this work was to investigate the effect of retinoic acid, enoxacin, KN-93, and UNC-0646 on the lifespan of *Drosophila melanogaster*.

We studied the effect of these drugs on the lifespan of male and female fruit flies of the wild-type *Canton-S* line. The experiment was carried out in four biological replicates.

In our study, the expected positive effect is mainly observed in females. In males, life expectancy decreased or did not have a statistically significant effect on the survival of individuals. The antibiotic enoxacin concentrations of 1 μM and 100 μM increased the median lifespan of females by 2–5% ($p < 0.001$), and the age of 90% mortality (maximum lifespan) — by 4–6% ($p < 0.001$). Retinoic acid had a positive effect in females at all concentrations tested. The increase in maximum lifespan was 1–6% ($p < 0.001$), the increase in the median lifespan when using the substance at concentrations of 10 μM , 100 μM and 500 μM — by 2–5% ($p < 0.001$). In males, the compounds enoxacin and retinoic acid had no statistically significant effect on male survival.

It is likely that both compounds stimulate response to DNA damage and DNA repair by influencing epigenetic regulation. Recent studies have shown

that retinoic acid controls gene expression through several interrelated mechanisms. Retinoic acid promotes epigenetic changes, in particular, it affects the level of DNA methylation, histone modifications, the formation of complexes with Polycomb proteins, and the activity of transcription factors. It can enhance the repressive structure of heterochromatin, providing protection for genetic material [1].

Enoxacin is a regulator of microRNA biogenesis and a potential stimulator of DNA repair. It has been previously reported that this antibiotic is able to increase the lifespan of *Caenorhabditis elegans* [2]. One of its targets is the RNA-binding protein ADAR, which interacts directly with mechanisms of biogenesis and functioning of miRNAs. One of its targets is the RNA-binding protein ADAR, which interacts directly with mechanisms of biogenesis and functioning of miRNAs. Moreover, in the mouse preadipocyte cell line, enoxacin suppresses the evolutionarily conserved miR-34a, which increases expression during aging and affects the level of DNA repair [2]. It has also been shown that, in human cells, OPD and DNA repair can be pharmacologically enhanced by enoxacin due to its ability to stimulate the biogenesis of non-coding RNAs associated with response to DNA damage by targeting the TRBP protein and activating DICER. Enhanced production of these non-coding RNAs promotes 53BP1 recruitment to damage sites, accelerating DNA repair through non-homologous end reunion and, ultimately, increasing cell survival after genotoxic exposure [3]. We assume that similar mechanisms may operate in *Drosophila*, since miRNA biogenesis pathways are evolutionarily conserved.

Previously obtained data indicate a potential geroprotective effect of compounds KN-93 and UNC-0646. At the same time, compounds KN-93 and UNK-0646 did not have a pronounced geroprotective effect on *Drosophila* males. KN-93 increased the median lifespan of females by 2–3% ($p < 0.001$) at a concentration of 0.1 μM , 1 μM and 100 μM , and the maximum lifespan by 1–4% ($p < 0.001$) at a concentration of 0.1 μM , 1 μM . Substance UNC-0646 at all concentrations increased the median and maximum lifespan. The compounds did not have a statistically significant effect on the lifespan of male fruit flies.

KN-93 is a new membrane-permeable synthetic inhibitor of purified neuronal calmodulin-dependent protein kinase 2 (CaMK-II) [4]. An earlier study revealed the effect of KN-93 on the expression of two cell cycle regulators and important OPD proteins p53 and p21 [5].

UNC-0646 is a potent selective G9a methyltransferase inhibitor [6]. G9a is recruited to DNA damage sites in an ATM dose-dependent manner, in

which G9a is phosphorylated to serine 569 ATM. It can also promote efficient localization of DNA breaks and induce local histone methylation at H3K9 and H3K56 [7]. There are studies showing that G9a is a transcriptional repressor that promotes p53-dependent activation of PUMA, triggering cell apoptosis [8].

Thus, enoxacin and retinoic acid at concentrations of 100 μM and 500 μM had the most effective geroprotective effect on the lifespan of *Drosophila melanogaster* specimens. Their further study opens prospects for development of approaches to increase lifespan and slow down aging by stimulating protective mechanisms aimed at maintaining genome stability.

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Geroprotective effects of dicer activation in *Drosophila melanogaster*

N.R. Pakshina¹, D.V. Yakovleva¹, E.N. Proshkina¹, A.A. Moskalev^{1,2}

¹Institute of Biology, FRC Komi SC UB RAS, Syktyvkar

²Institute of Molecular Biology, V.A. Engelhardt RAS, Moscow

pakshina.n.r@ib.komisc.ru

The key role in the coordination of cellular processes necessary for the regulation of gene expression belongs to small RNAs and proteins of their biogenesis. They regulate gene expression at the post-transcriptional level, split their target RNAs or inhibit their translation. Among the proteins that ensure the biogenesis and functioning of small RNAs are proteins of the *Dicer* family [1,2]. They play an important role in the regulation of stress resistance and lifespan of model organisms [3]. Dicer proteins are involved in the repair of DNA double-strand breaks. A decrease in their activity leads to a disruption in response to DNA damage and provokes an accelerated aging phenotype [4,5]. At the same time, overexpression of genes of the *Dicer* family prolongs life and increases resistance to stressors [6]. In *Drosophila*, *Dicer-1* is involved in miRNA biogenesis, while *Dicer-2* is involved in short interfering RNA biogenesis [1].

In previous studies, it was found that the pharmacological drug enoxacin is able to activate Dicer in human cells. It is effective in restoring global miRNA expression and inhibits the growth of tumor cells by enhancing the production of microRNA. Enoxacin promotes RNA interference and microRNA biogenesis through *Dicer* activation.

The aim of this work is to study the geroprotective effects of genetic and pharmacological activation of *Dicer* genes in *Drosophila melanogaster*.

The tasks of the study include:

1. To study the effect of RNA interference of *Dicer* genes on the lifespan of *Drosophila melanogaster* in experiments with enoxacin.
2. To study the effect of conditional overexpression of the *Dicer* gene on the lifespan of *Drosophila melanogaster*.

To study the effects of genetic activation of the *Dicer* genes and RNA interference of the *Dicer* genes in experiments with enoxacin, the GAL4/UAS system was used. In the case of overactivation, the UAS line carried an additional copy of the gene under study under the control of UAS. In the case of RNA interference, the UAS line contained dsRNA, which specifically

represses one of the studied genes, under the control of the UAS promoter. The GAL4-elav driver was used as a GAL4 component: a conditioned mifepristone-inducible in the experiment with overexpression and a constitutive one for RNA interference [7].

Drosophila was kept in climatic chambers with constantly maintained conditions.

To study the effect of the RNA interference inducer, enoxacin at concentrations of 1, 5, 10, 50, 100, 500 $\mu\text{g/ml}$ is applied to the surface of the *Drosophila* nutrient medium. 30 μl of NaOH solution is applied to the medium of the control group of animals. This treatment is carried out for flies of the wild line *Canton-S*, *Drosophila* type with constitutive RNA interference of the *Dicer* genes and without RNA interference.

Overactivation of the *Dicer-1* and *Dicer-2* genes in the nervous system of females (but not males) had a geroprotective effect and led to the calculation of the median by 8–10% ($p < 0.001$, Gehan-Breslow-Wilcoxon test) and life expectancy index, age of 90% mortality by 5–7% ($p < 0.05$, Wang-Allison method). It was also previously found that increased activity of *Dicer-2* in the nervous system and throughout the body of *Drosophila* increases lifespan.

We studied a wide range of concentrations. A positive effect of enoxacin on median lifespan was observed in *Canton-S* males at a concentration of 50 $\mu\text{g/ml}$ by 2% ($p < 0.05$) and in females at a concentration of 10 $\mu\text{g/ml}$ by 5% ($p < 0.05$), but at a concentration of 1 $\mu\text{g/ml}$ in females decreased the mean duration by 2% ($p < 0.05$). Thus, in *Drosophila*, enoxacin exhibited a geroprotective effect at concentrations of 10 and 50 $\mu\text{g/mL}$; therefore, we used only them for further work.

In order to test the contribution of *Dicer* activation to the geroprotective effect of enoxacin, we tested whether this effect would persist in flies with RNA interference of the *Dicer-1* and *Dicer-2* genes in the nervous system.

Males with the elav driver but without the UAS construct (i.e., without the RNA interference of the *Dicer* genes) were used as controls. Males treated with the elav driver at concentrations of 10 and 50 $\mu\text{g/mL}$ showed an increase in median lifespan by 5% ($p < 0.0001$) and 2% ($p < 0.05$), respectively, and a maximum lifespan by 4% ($p < 0.05$) at concentration 10 $\mu\text{g/ml}$. In females, enoxacin did not lead to statistically significant changes in lifespan.

At the same time, this effect of enoxacin was not preserved during RNA interference of the *Dicer-1* and *Dicer-2* genes, as in males. Thus, *Dicer* activation is a likely pathway for the geroprotective action of enoxacin.

Thus, the following conclusions can be drawn:

1. Overexpression of the *Dicer-1* and *Dicer-2* genes in the nervous system caused an increase in the lifespan of *Drosophila melanogaster* by 8–10% ($p < 0.001$).
2. Treatment with the RNA interference activator enoxacin at concentrations of 10 and 50 $\mu\text{g}/\text{mL}$ was less effective and increased the lifespan of *Drosophila* by 2–5% ($p < 0.05$).
3. The geroprotective effect of enoxacin was absent in *Drosophila* with knockdown of the *Dicer-1* and *Dicer-2* genes. It is likely mediated by the activation of these genes.

Investigation of performance within the framework of the state task on the topic “Genetic and functional studies of the effects of geroprotective interventions on *Drosophila melanogaster* model” no. 1021062211102-1-1.6.8.

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Influence of abiotic environmental factors on growth, development and functional state of buds of woody perennial plants in the North

M.S. Atoyan

Institute of Biology, FRC Komi SC UB RAS, Syktyvkar

Marinka140895@mail.ru

Under the influence of global climatic factors and local impacts on ecosystems, there is a disruption of the natural carbon cycle and balance, a change in vegetation.

It is assumed that ecosystems of the North will react to climatic changes earlier than others. A more pronounced increase in air temperature, an increase in the growing season, etc. is predicted, which will affect the functional components and intensity of plant metabolic processes.

The seasonal rhythm of growth and development processes is the most important adaptive trait that emerged in plant evolution as an adaptation to tolerate unfavorable periods of the year.

Many receptor systems that perceive changes in the external environment are localized in meristems. Anatomorphological and morphological transformations of renewal buds are associated with significant changes in activity and direction of physiological and biochemical processes necessary for preservation of plant organism vital activity.

Despite great progress in elucidating the patterns of plant survival at low temperatures and the related understanding of the peculiarities of the geographical distribution of plants in different climatic zones, many key questions have not been sufficiently developed.

Renewal buds are a good model to study the processes of growth, metabolism and bioenergetics under the influence of environmental factors (light, temperature). Such studies can provide new information on physiological-biochemical and molecular mechanisms of shoot growth at the stage of intrarenal growth under the influence of exogenous and endogenous factors.

The purpose of this work is to study the complex influence of abiotic factors on the structural and functional organization and dynamics of the development of tree plant buds in the conditions of the North.

The tasks included:

- to determine the crystallization temperature and the proportion of

frozen water in the buds of *Larix sibirica* renewal in connection with the seasonal adaptation of plants to low temperatures.

- to determine the amount of tissue water content and free and bound water content in *Larix sibirica* kidneys.

The object of the study was *Larix sibirica*.

Buds were sampled in late October, early November, late March and early April. The method of differential scanning calorimetry was used. Crystallization temperature and the proportion of frozen water in the buds were measured on a DSC-60 Shimadzu (Japan) calorimeter. The main causes of cell death at low negative temperatures are ice formation resulting in dehydration and mechanical damage of cell structures by ice crystals. Consequences of exposure to low negative temperatures largely depend on the water content of plant tissues, free and bound water content. *Larix sibirica* buds were least watery in October and November (0.9 g H₂O/g dry weight), in mid-spring the water content was slightly higher (1.6 g H₂O/g dry weight). The proportion of bound (not frozen) water was about 25% of the total water content in buds in October and March. Preservation of plant viability under the action of low temperatures is associated with changes in intracellular water content and biochemical transformations in meristems. Estimation of water freezing temperature showed that the free water fraction underwent phase transition: in October, water was freezing at about -8.0 ± 0.3 °C, while in March, the value of this parameter did not change and was about -8.7 ± 1.5 °C. To prevent water freezing in plant cells, a considerable amount of cryoprotective compounds (amino acids, sugars, soluble proteins, etc.) which are able to bind free water thereby preventing ice crystals formation are synthesized.

Based on the data obtained, it can be assumed that the increase in cryoresistance of *Larix sibirica* buds by the beginning of winter is largely due to a decrease in tissue water content. With the onset of sap mobilization, the water content of *Larix sibirica* buds naturally increased, and the amount of bound water also increased, which was apparently caused by the increased concentration of hydrophilic molecules, soluble carbohydrates, and proteins. An increase in the amount of bound water in the buds during the spring period reduces the risk of intracellular ice formation.

Dark and photoinduced cytotoxicity of iodine containing chlorophyll *a* derivatives

N.D. Belykh¹, D.A. Serova², E.I. Pushkareva³, G.V. Ermolina¹,
I.O. Velegzhaninov⁴, D.V. Belykh³

¹SyktSU, Syktyvkar

²Technopark “Quantorium”, Syktyvkar

³Institute of Chemistry, FRC Komi SC UB RAS, Syktyvkar

⁴Institute of Biology, FRC Komi SC UB RAS, Syktyvkar

Photodynamic therapy is currently one of the intensively developing methods of treating oncological diseases, increasingly being introduced into clinical practice [1]. The method is based on the ability of compounds called photosensitizers (PS) to generate reactive oxygen species when irradiated with light of a certain wavelength, resulting in damage of irradiated tissues only. Selective accumulation by malignant neoplasms to some extent is also an important property of photosensitizers. The combination of these properties makes a selective destruction of cancer cells possible. Ideally, the use of this method should ensure the destruction of the tumor, with no adverse effects in surrounding health tissues. Also, the photodynamic effect is also used for the deactivation of pathogenic microorganisms and therapy of corresponding pathologies [2]. A promising direction for improving medical PS is to improve the reactive oxygen species (ROS) generation ability and to increase difference between effective concentrations of dark and photoinduced toxicity. It is known that the introduction of halogen atoms into the PS molecule enhances their ability to generate singlet oxygen when exposed to light. At the same time, the presence of a halogen atom in the molecule can lead to dark toxicity increase [3,4]. The effect is undesirable, if the compound is planned to be used as a PS. However, it would be justified if the photoinduced cytotoxic activity were enhanced to a greater extent. Besides, the increase in the dark cytotoxicity of porphyrin allows to use these compounds as selective antitumor agents, taking into account their affinities to malignant neoplasms.

The purpose of this study is to evaluate new chlorophyll *a* derivatives containing an iodine atom in the molecule (Fig.1) as potential photosensitizers for medical purposes and as antitumor cytostatics. To achieve the aim the ability of chlorophyll *a* derivatives containing an iodine atom in the molecule to produce photoinduced cytotoxic effect was determined. Uptake and ROS production intensity was studied for compounds with the most pronounced effects.

Human cervix carcinoma *HeLa* (BioloT, Russia) was used to study the dark and photoinduced toxicity of chlorophyll *a* iodine derivatives in accordance with [5]. Cells were maintained on DMEM/F12 medium (PAA Laboratories GmbH, Austria) containing 10% bovine serum (FBS) (HyClone, USA), without antibiotics at 37 °C and 5% CO₂. Cell viability was determined through cytotoxicity tests using fluorometric microculture cytotoxicity assay (FMCA) [6]. Studies were carried out in six biological replications. Cell survival and IC50 (concentration of semi-maximal inhibition of cell growth) were used as a quantitative measure of dark and photoinduced toxicity. The ability of the compound to penetrate the cell was evaluated using fluorescence microscopy [5]. The photodynamic effect of the compounds under study was evaluated at 3 concentrations (0.1; 1; 10 μM in the growth medium), while cell survival was compared with dark and photo-induced exposure to PS, at the same concentration. A decrease in the proportion of surviving cells under the combined action of the compound and light means the presence of photosensitization. The greater the difference between cell survival under the photoinduced and the dark exposure, the stronger photosensitization is. The lower the concentration induces pronounced photosensitizing effect, the higher PS effectivity is. Results of FMCA toxicity test of nine compounds studied are presented in Table 1. Chlorins 1, 2 and 4 demonstrated the greatest photosensitizing activity, at 0.1 μM, and were investigated in more detail.

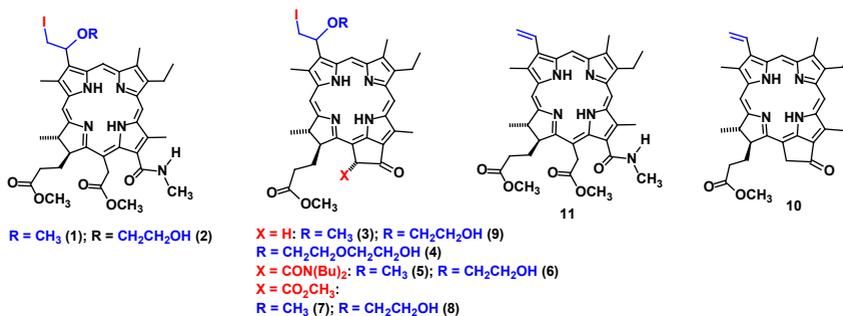


Fig. 1. Structures of the chlorophyll *a* 1-alkoxy-2-iodineethyl derivatives studied.

Fluorescent microscopy of HeLa cells exposed to compounds 1, 2 and 4 for 1 hour shows accumulation of porphyrins in cells (Fig.2) that allows interactions with internal cell structures. To evaluate compounds 1, 2 and 4 as potential antitumor PS half maximal inhibitory concentration (IC50) values were determined for dark and photoinduced exposure. The values obtained

were compared with similar compounds already studied [7] that do not contain an iodine atom *10* and *11* (Table 2), but manifest both photoinduced and intrinsic cytotoxicity. The dark toxicity of compounds *1* and *2* was shown to be significantly lower than that for compound *11* containing no iodine atom in the molecule. The photoinduced toxicity of the compound *1* and *2* comparable to the compound *11* makes it possible to consider these compounds as potential PS. Similarly, inclusion of the iodine atom to the methyl pyropheophorbide, a derivative number *10*, resulted in a noticeable increase in photoinduced toxicity of compound number *4* (Table 2). The rise in photoinduced toxicity may be caused by an increase in the quantum yield of singlet oxygen photogeneration. With comparable dark toxicity of *4* and *10*, compound *4* along with *1* and *2* could be considered as a potential PS.

Table 1. Survival rate of HeLa cells (mean±SE) after dark and photoinduced exposure to 1-alkoxy-2-iodoethyl derivatives at concentrations of 0.1, 1.0 and 10 μM. (Concentrations with a difference of 10 or more times between dark and photoinduced exposure are highlighted bold).

Compounds	Survival rate, %					
	0.1 μM		1 μM		10 μM	
	dark	photoinduced	dark	photoinduced	dark	photoinduced
1	99.1 ± 7.1	8.4 ± 2.6	97.4 ± 8.9	6.19 ± 0.35	62.3 ± 5.5	5.97 ± 0.33
2	93.1 ± 6.3	3.44 ± 0.19	97.9 ± 6.8	3.61 ± 0.23	57.0 ± 6.7	3.51 ± 0.33
3	95.0 ± 5.8	99.4 ± 9.3	93.6 ± 5.6	98.5 ± 6.8	90.2 ± 4.9	34 ± 10
4	98.3 ± 2.3	9.66 ± 0.37	103.5 ± 1.3	8.86 ± 0.66	73.6 ± 2.5	9.17 ± 0.50
5	99.9 ± 2.2	91.6 ± 2.6	90.8 ± 1.6	77.8 ± 1.3	92.7 ± 6.0	3.42 ± 0.14
6	81 ± 12	88.8 ± 6.4	77 ± 12	73.6 ± 7.6	72.3 ± 6.3	72.9 ± 9.3
7	112.9 ± 2.2	109.1 ± 2.9	106.0 ± 1.8	4.20 ± 0.28	99.5 ± 2.0	4.04 ± 0.20
8	105.5 ± 5.8	89.4 ± 3.8	90.9 ± 2.2	21.4 ± 8.2	88.1 ± 2.0	11.68 ± 0.58
9	101.7 ± 6.7	97.1 ± 4.6	86.4 ± 6.3	5.01 ± 0.26	78.7 ± 4.5	4.72 ± 0.17

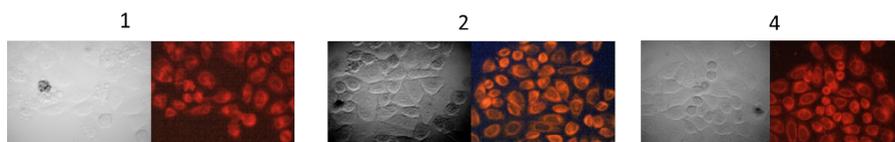


Fig.2. Microscopic study of interaction of compounds with HeLa cells during incubation for 1 hour.

So, the introduction of iodine atom into the periphery of chlorin macrocycle increases the difference between the dark and the photoinduced toxicity. Based on the data obtained/presented compounds *1*, *2* and *4* could be further investigated as perspective PS.

Table 2. Values of IC50 (dark) standard error (SE) (μM) for dark and photoinduced

exposure on HeLa cells of compounds 1, 2 and 4 in comparison with compounds 10 and 11. (At IC₅₀ > 100 μ M the percentage of surviving cells (%) at a compound concentration of 100 μ M is indicated in parentheses).

Compound	IC ₅₀ (dark) \pm SE, μ M	IC ₅₀ (photoinduced) \pm SE, μ M	IC ₅₀ (dark)/IC ₅₀ (photoinduced), μ M
1	10.46 \pm 0.22	0.0497 \pm 0.0040	210
2	62 \pm 11	0.0480 \pm 0.0014	1292
11	4.01 \pm 0.80	0.025 \pm 0.003	160
4	> 100 (63 \pm 14 %)	0.021 \pm 0.013	> 4762
10	> 100 (58.86 \pm 2.01 %)	1.42 \pm 0.16	> 70

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Volume of ischemic myocardial damage in lad occlusion in pigs

M.E. Grubbe^{1,2}, A.S. Poselyaninov^{1,2}, P.V. Khomenko^{1,2}

¹Institute of Physiology, FRC Komi SC UB RAS, Syktyvkar

²Medical Institute, SyktSU, Syktyvkar

grubbe.me@gmail.com

Introduction. Ventricular arrhythmias are often observed in patients with coronary heart disease due to heterogeneous changes in the electrophysiological properties of cardiomyocytes [1]. Under experimental conditions, it was found that occurrence of ventricular fibrillation (VF) on the background of acute ischemia in experimental myocardial infarction is associated with the volume of myocardial damage [2]. The purpose of the work was to evaluate the capability of the method of visualization of the ischemic heart damage area to test its association with VF incidence.

Methods. The experiments were performed in 18 pigs. The animals were anesthetized with zoletil (Virbac S.A., Carros, France, 10–15 mg/kg, i.m.) and propofol (Norbrook Laboratories Ltd., UK, 1 mg/kg, i.v.), intubated and mechanically ventilated. The heart was accessed via a midsternal incision. A ligature was placed around the left anterior descending artery (LAD) just distal to the first diagonal branch origin. Three flexible plunge electrodes were drawn transmurally through the anterior portion of the left ventricle, interventricular septum and right ventricle at the apical, middle and basal levels. To register epicardial electrograms, a multielectrode grid was applied to the anterior surface. Coronary occlusion was maintained for 40 min, during which electrophysiological recordings were done. After the experiment, animals were euthanized under deep anesthesia by the intravenous potassium chloride injection either at the end of ischemic episode or immediately after VF development [3].

Data are expressed as mean and standard deviation. The Student's t-test was used for paired comparisons between study groups. Univariate logistic regression analysis was used to test for a possible association between measured ECG parameters. The differences were considered significant at $p < 0.05$. Statistical analyses were performed using SPSS 19.0 (SPSS Inc, Chicago, IL).

Results. The hearts were quickly excised. Coronary arteries were cannulated and perfused with 1% Evans Blue dye. The hearts were placed for 1 *hour* in the freezer. Then, 10-mm-thick slices were made in apex-to-base direction. The normal myocardium was stained blue and the ischemic zone remained pale.

Then, the slices were photographed, and the size of the ischemic zone was determined as a ratio of the area of the ischemic zone to the total cut-off area in each slice using open-source Fiji ImageJ software (Fig.). Areas of normal myocardium were manually allocated and their area was calculated. Then, the area of the ischemic zone was calculated (cavities were excluded from the calculation).

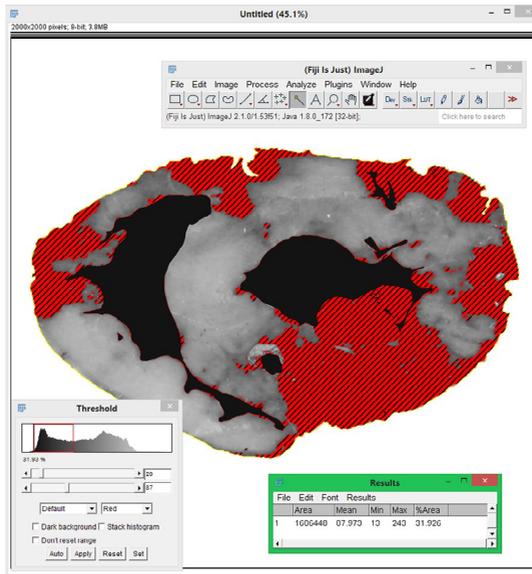


Fig. The slice of the pig's heart in processing using the program Fiji ImageJ. The areas of ischemia are light gray, the perfused areas of the normal myocardium are shading, the cavities of the right and left ventricles are black in the figure.

18 pigs were divided into two groups: those who had VF during the experiment (15 out of 18 animals) and those who did not have it (3 out of 18 animals). No significant differences were observed in the ischemic damage size between VF and noVF groups ($56 \pm 19\%$ and $72 \pm 9\%$, respectively, $p = 0.163$). In the univariate logistic regression analysis, the association between the area of the ischemic zone and VF appearance was insignificant (OR 0.921 95% CI 0.800–1.010; $p = 0.199$).

Conclusion. Preliminary results showed no differences in the area of ischemic damage in animals with and without ventricular fibrillation occurrence. This method is time-consuming, but successful for identifying the area of ischemic myocardial damage.

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