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DIGEST



**ECOLOGICAL SAFETY
AND RECLAMATION OF DISTURBED LANDS
IN THE MINERAL RESOURCE COMPLEX:
FROM DAMAGE ASSESSMENT TO ECOSYSTEM RESTORATION**

№ 24 • 2026

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EMPRESS CATHERINE II
ST. PETERSBURG MINING UNIVERSITY

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Abstract

The digest brings together publications from Journal of Mining Institute spanning different years, devoted to environmental safety and the reclamation of disturbed lands in the mineral resource sector. The materials are arranged to follow the logic of the full cycle of technogenic impact: from the theoretical foundations of sustainable development and monitoring of anthropogenic load, through the mining and technical stage of reclamation and spoil heap management, bioremediation of oil-contaminated soils, and restoration of sludge ponds, tailings dumps, and disturbed landscapes, to the use of unconventional fertilizers, sewage sludge, and organic waste for the formation of artificial soil substrates. Both fundamental issues – economic assessment of reclamation, engineering-geological stability of technogenic masses, threshold concentrations of pollutants – and applied technologies are considered: protective coatings and bioactive foams for stabilizing dusting surfaces, bioremediation agents for oil degradation, phytoremediation combined with electrical treatment, and formulations of technogenic soils. The regional specificity of Kuzbass, the Kola Subarctic, the Urals, and the Northwest of Russia is reflected. The publication will be useful to researchers, environmental engineers, and specialists in the mining and oil refining industries.

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SECTION 1. Theoretical foundations of ecological safety and monitoring of anthropogenic load on ecosystems



Pashkevich M.A., Danilov A.S. Ecological security and sustainability // Journal of Mining Institute. 2023. Vol. 260. P. 153-154. <https://pmi.spmi.ru/pmi/article/view/16233>



Abstract. In 2015, UN Member States adopted the 2030 Agenda for Sustainable Development, aimed at balancing initiatives by the world community and individual countries in the environmental, social, and economic spheres. The global sustainable development goals are to promote the well-being of the world population, preserve the planet's resources, and maintain ecological security, which is vital in the age of the rapid industrial growth and ever-increasing anthropogenic pressure on the environment. For the successful achievement of sustainability goals in the manufacturing sector, integrated measures should be undertaken for monitoring and assessing the technogenic impact of industrial facilities. Additionally, it is necessary to develop environmentally-friendly technologies in the fields of gas and water treatment, land reclamation, and waste disposal. Therefore, fundamental and applied research in these related spheres is of particular importance. Currently, environmental monitoring of all components of the environment, along with anthropogenic objects and processes, receives considerable attention, which is determined by the vector of development in science and technology. In this regard, the latest innovations in green technology in this area are becoming increasingly significant.

Sinkov L.S., Martemyanova A.N. Impact analysis coal mining enterprises of Kuzbass on the environment // Journal of Mining Institute. 2014. Vol. 208. P. 65-69. <https://pmi.spmi.ru/pmi/article/view/5332>



Abstract. The article examines the impact of coal mining enterprises of Kuzbass on natural environment components. The possibilities of improving the environmental situation in the region by increasing the volume and quality of reclamation work taking into account possible changes of the legal framework and the financial mechanism for their support are analyzed.

Marinina O.A., Marinin M.A. Economic evaluation of reclamation an example Olimpiada GOK // Journal of Mining Institute. 2014. Vol. 208. P. 32-35. <https://pmi.spmi.ru/pmi/article/view/5326>



Abstract. Methodical features of calculation of cost-effectiveness evaluation of remediation, the accounting of capital and operating costs at various stages of recovery process of topsoil are considered. The example of calculation the cost of reclamation of Olimpiada GOK is given.

Fomin S.I., Faul A.A. The ecological negative influence reduction ways on mining regions // Journal of Mining Institute. 2013. Vol. 203. P. 215-219. <https://pmi.spmi.ru/pmi/article/view/5640>



Abstract. Coal mining can result in a number of adverse effects on the environment. Open cast coal mines leaves areas of land that are no longer usable and leaves a scarred landscape with no scenic value. Rehabilitation can mitigate some of these concerns.

Mine tailing dumps produce acid mine drainage which can seep into waterways and aquifers with consequences on ecological and human health. Subsidence of land surfaces due to collapse of mine tunnels can also occur. During the mining operation methane, a potent greenhouse gas and a constituent of fire damp, can be released. Wherever it occurs in the world, surface mining of coal completely eliminates existing vegetation, destroys the genetic soil profile, displaces or destroys wildlife and habitat, degrades air quality, alters current land uses, and to some extent permanently changes the general topography of the area mined.

Korelskiy D.S., Chukaeva M.A. Estimation of the condition of the soil-vegetative complexes having stress at atmospheric impact // Journal of Mining Institute. 2013. Vol. 203. P. 174-177. <https://pmi.spmi.ru/pmi/article/view/5632>



Abstract. The main research objective was monitoring and assessment of terricolous and plant cover condition in forest ecosystems influenced by industrial pollution by the Severonickel Industrial Plant, which impact zone covers 1.4 thousand sq. km. During an expedition to the Murmansk Region samples of upper soil layers and plants were taken in areas directly affected by atmospheric impact from OAO Severonickel both at various distances from the plant and in background territories. This will help to determine the overall degree of soil contamination at various distances from the plant as well as distribution of heavy metals accumulated in various soil layers and a complex estimation of adverse impact on soil cover and various plant species.

Reshetnyak S.P., Fedotova Yu.V., Doroshenko V.V. Systematization of factors to be considered in mine abandonment design // Journal of Mining Institute. 2010. Vol. 188. P. 221-224. <https://pmi.spmi.ru/pmi/article/view/6614>



Abstract. Subsoil is not just a source of mineral resources; it also serves as a burial site of industrial and domestic wastes, a storage place for oil and gas, and an environment for constructing underground facilities and creating preservations and nature sanctuaries. Subsoil area development is intensified and diversified with each passing year, exerting great influence on ecological systems and all their components. Special attention should be paid to terrain as upper facet of lithosphere, submitted to maximal impact of anthropogenic processes. Activation and emergence of natural and anthropogenic processes causes changes manifested in various combinations of negative events. Most important events include deformations of rock mass and land surface: exhaustion and pollution of ground and surface water, waterflooding and swamping of tapped sites, soil dehydration and salinization, air pollution, land site withdrawal from commercial circulation etc.

Ivanov I.P., Nikolaeva T.N., Pospelkov G.B. Engineering geology and problems of disturbed land reclamation // Journal of Mining Institute. 2008. Vol. 176. P. 235-238. <https://pmi.spmi.ru/pmi/article/view/7323>



Abstract. Problems of reclamation the grounds broken as a result of development of deposits of minerals, borrow priority position in modern researches on rational use of natural resources. In clause the approach to the decision of the given problem from a position of engineering geology is considered.

Korelskiy D.S. Monitoring of soil and vegetation cover for reclamation of the ecological disaster zones of JSC Severonickel // Journal of Mining Institute. 2007. Vol. 170. Part 1. P. 114-118. <https://pmi.spmi.ru/pmi/article/view/7794>



Abstract. Severonickel Combine is one of the largest enterprises in the Kola Peninsula, processing Cu-Ni raw materials to produce non-ferrous metals and precious metal concentrates as end products. The industrial activities of the Severonickel Combine have a noticeable negative impact on the vast territory of the Murmansk Region, and the area characterized by a very high level of soil pollution occupies 1400 km². During the expedition to the Murmansk Region in summer 2005, control samples were collected from the upper soil horizons in the areas exposed to the direct atmospheric impact of JSC Severonickel, at various distances from the Combine and in the background areas. This will make it possible to determine the overall degree of soil contamination at different distances from the enterprise, as well as the distribution of accumulated heavy metals in different horizons. Sample areas of vegetation in the form of phytomass of woody, shrub-grass and moss-lichen circles were sampled. The conducted studies will allow to give a comprehensive assessment of the negative impact on soil cover and different types of vegetation.

Pospelkov G.B. Engineering and geological aspects of reclamation of territories disturbed by open mining operations // Journal of Mining Institute. 2007. Vol. 170. Part 1. P. 40-42. <https://pmi.spmi.ru/pmi/article/view/7777>



Abstract. Requirements for construction and mining works have always been taken into account in engineering geology. At present moment the most complicated tasks in mining practice are connected with reclamation of mined-out space. Operation of over two hundred coal mines and coal pits was stopped during the restructuring period in the Russian coal industry and they are currently go through different stages of the mine abandonment process. Land reclamation is a topical issue in open-cast mining, where the main task is to maintain stability during the reclamation period and subsequent use of the worked-out pits. Reliability of geomechanical calculation depends on the quality of geological data. Efficiency of activities to eliminate impact from mining works on surrounding environment is significantly decreasing when such data is incomplete or unavailable.

Pospelkov G.B. Engineering and geological surveys for reclamation of lands disturbed during field development (by the example of the SOBR) // Journal of Mining Institute. 2003. Vol. 155. Part 2. P. 43-44. <https://pmi.spmi.ru/pmi/article/view/9000>



Abstract. The role and types of engineering and geological research for quality reclamation work on land disturbed by field development are reviewed.

Kozlova N.V. On measures on protection of geologic environment during development of coal and shale deposits // Journal of Mining Institute. 1986. Vol. 109. P. 51-55. <https://pmi.spmi.ru/pmi/article/view/10502>



Abstract. The main factors determining the nature and scope of engineering measures for the rational use and protection of the geological environment are the engineering and geological conditions of the territory of the mining enterprise (the deposit and adjacent areas of its development), the method and system of mining operations and the technology of mineral processing.

SECTION 2.

Mining and technical stage of reclamation and tailings management

Fomin S.I., Vedrova D.A. Technology of overburden rock bench development by using a dragline with accommodation of waste rock in the goaf // Journal of Mining Institute. 2013. Vol. 205. P. 47-50. <https://pmi.spmi.ru/pmi/article/view/5490>



Abstract. Horizontal or gently dipping (less than 10), mineral deposits, to which the majority of sedimentary deposits, such as oil shale, coal, peat, clay, limestone etc. belongs to, with relatively thick sediment overburden advisable to practice using transtopless overburden removal technology, that is using a powerful stripping equipment – draglines. The main advantage of this technology is the placement of overburden directly into quarries goaf, significantly reducing the rented for the waste dumps disposing areas, and reduce the costs of mining-reclamation works.

Kuznetsov V.S., Kolosov O.Yu. Decrease in environmental pollution at work according to regeneration of dumps of dead rock // Journal of Mining Institute. 2013. Vol. 203. P. 137-141. <https://pmi.spmi.ru/pmi/article/view/5624>



Abstract. The questions of reclamation of debris dumps, which are the source of the negative impact on the environment, are considered in this article. The expediency of mine technical reclamation stage without drop off operation is analyzed and also foreign and Russian experience of this method practical realization is reviewed.



Opryshko D.S., Oblitsov A.Yu. Modern approaches to the landscaping reclamation // Journal of Mining Institute. 2013. Vol. 203. P. 142-145. <https://pmi.spmi.ru/pmi/article/view/5625>



Abstract. In given article modern technologies and materials, used for completion the tasks of land-scaping reclamation, are considered. Using new technical solutions, it is possible to decrease significantly the expenses on mining operations within the framework of reclamation.

Shuvalov Yu.V., Smirnov Yu.D. Reduction of dust load at technological processes of formation of dusty surfaces at quarries by foaming method // Journal of Mining Institute. 2007. Vol. 170. Part 1. P. 142-149. <https://pmi.spmi.ru/pmi/article/view/7802>



Abstract. The most promising and practically feasible is the method of applying a fertile layer based on sapropel on the surface. The project of reducing dustiness of mining waste dumps and increasing their bioproductivity is proposed. The economic efficiency of various methods of reclamation is analyzed.

Piskorz M. Problems of the protection of mining terrains in the mining industry of zinc and lead ores // Journal of Mining Institute. 2007. Vol. 170. Part 2. P. 246-249. <https://pmi.spmi.ru/pmi/article/view/7763>



Abstract. The article characterizes the peculiarities of underground mining of zinc and lead ores and its specific results on the relief surface. On the example of mining region of Poland, the problems of detection of rupture deformations, methods of prevention and elimination of these phenomena are presented. A special problem in this region is represented by old, historical mining operations. Negative results of the former mining practices are observed even nowadays. Depletion of zinc and lead ore deposits and partly economic reasons lead to the liquidation of some mining areas. In particular, such liquidation requires safety of underground parts of the mine, equalization of water relations and

reclamation of the ground surface. Mining operations within the boundaries of the region under consideration require coordination of tasks within the framework of ongoing operation and actions to establish appropriate infrastructure and management of the area.

Gasparyan N.A. Use of bioactive substances at reclamation of bulk dumps and technogenic formations // Journal of Mining Institute. 2006. Vol. 167. Part 2. P. 86-88. <https://pmi.spmi.ru/pmi/article/view/7966>



Abstract. One of the main sources of hazardous air pollution in the territories of mining, metallurgical and enrichment complexes and adjacent areas are dusty surfaces of bulk dumps. As a result of wind erosion fine-dispersed fractions are the most dangerous from the point of view of impact on respiratory organs, easily carried away from the surface for long distances. The method providing reduction of dust formation and dust transfer of fine-dispersed materials, increase of bioproductivity of bulk dumps and quick reclamation is offered. The results of tests of the protective coating for resistance to air flow and the results of bioproductivity of the treated surfaces of dumps are presented.

Ilchenkova S.A., Gasparyan N.A. Protection against wind erosion and improvement of bioproductivity of bulk dumps and reclaimed areas // Journal of Mining Institute. 2004. Vol. 159. Part 1. P. 43-46. <https://pmi.spmi.ru/pmi/article/view/8711>



Abstract. One of the main sources of hazardous air pollution of the territories of mining, metallurgical and enrichment complexes and adjacent areas is the dusty surfaces of bulk dumps. As a result of wind erosion fine fractions, the most dangerous in terms of respiratory hazards, are easily carried away from the surface over long distances. A method ensuring a decrease in dust formation and dust transfer of fine materials, an increase in the bioproductivity of bulk dumps and fast reclamation is proposed. The results of tests of the protective coating for resistance to air flow and the results of bioproductivity of the treated surfaces of the dumps are given.

Parakhonskii E.V. Development, research and implementation of environmental equipment // Journal of Mining Institute. 2004. Vol. 157. P. 194-196. <https://pmi.spmi.ru/pmi/article/view/8909>



Abstract. More than half of solid minerals are extracted in Russia by open pit mining. The development of large deposits is usually carried out by quarries of considerable depth, which is constantly increasing. Increasing the depth of quarries, as a rule, contributes to the deterioration of working conditions and atmospheric air pollution both in and around the quarries. A brief review of special quarry fans, designed for the organization of artificial ventilation of quarries by means of a brushless method, as well as installations for reclamation of slopes of rock dumps, is given.

Kryachko O.Yu., Norvatov Yu.A., Godlevskaya G.I. Conditions of stability and reclamation of hydraulic dumps taking into account consolidation of reclaimed rocks // Journal of Mining Institute. 1976. Vol. 70. Part 2. P. 33-35. <https://pmi.spmi.ru/pmi/article/view/11263>



Abstract. The production of surface mining in some areas is accompanied by the reclamation of hydraulic dumps, which are often located on fertile land. The return of the territories to agriculture is connected with the duration of consolidation of the reclaimed rocks to a state that allows the movement of equipment on them.

SECTION 3. Remediation of hydrocarbon contamination consequences. Soil bioremediation



Danilov A.S., Sosnina I.D., Serdyukova E.A. Development of a composition and evaluation of the effectiveness of a bio-based product for cleaning oil-contaminated soils // Journal of Mining Institute. 2026. Vol. 277. P. 3-12. <https://pmi.spmi.ru/pmi/article/view/16687>



Abstract. Soil pollution by oil and petroleum products is a serious environmental problem, especially relevant for industrialized regions. Microbiological remediation based on the use of oil-oxidizing microorganisms is a promising method of restoring polluted soils. The aims of the study are to develop a composition and assess the effectiveness of a specialized bio-based product adapted to the climatic conditions of northwest Russia. Bacterial strains capable of utilizing petroleum products as the only carbon source have been selected and cultivated. Based on laboratory tests, a consortium of microorganisms was selected, including strains of *Acinetobacter* sp. (VKM B-3202), *Rhodococcus erythropolis* (VKM Ac-858 T) and *Pseudomonas alcaligenes* (VKM B-1295), and their growth activity was evaluated. Three biologics compositions have been developed, differing in the proportions of bacterial suspensions by volume, and the technology of their application to oil-contaminated soils has been determined. The effectiveness of cleaning soils contaminated with oil and petroleum products (gasoline, diesel fuel, oil products from a spill at the Tammsu railway station (Vyborg) at temperatures of 10-20 °C, typical for the climate of the region, was studied in laboratory conditions. At a temperature regime of 20±1 °C and natural soil moisture, after 60 days of the experiment, the maximum concentration reduction rates reached 75.59 % for crude oil, 71.97 % for oil products from the spill, 90.53 % for diesel fuel, 75.81 % for gasoline. At a temperature of 10±1 °C – 40.62 % for crude oil, 49.58 % for oil products from the spill, 69.06 % for diesel fuel, 68.10 % for gasoline. The results of the study confirm the effectiveness of the developed bio-based product for oil-contaminated soil purification in the climatic conditions of northwestern Russia.

Minnikova T.V., Kolesnikov S.I. Environmental assessment of biochar application for remediation of oil-contaminated soils under various economic uses // Journal of Mining Institute. 2025. Vol. 271. P. 84-94. <https://pmi.spmi.ru/pmi/article/view/16293>



Abstract. Remediation is an important area of oil-contaminated soil restoration in Russia, since oil refining industry is the major one for Russia and neighbouring countries, and the issues of environmentally effective and economically profitable remediation of oil contamination have not yet been solved. Soils under various economic uses have different surface areas and degrees of soil particles envelopment with oil due to the presence or absence of cultivation, the amount of precipitation and plant litter. The introduction of various substances for remediation into oil-contaminated soils of steppes (arable land), forests, and semi-deserts, considering their differences, gives different results. Biochar is coal obtained by pyrolysis at high temperatures and in the absence of oxygen. The uniqueness of this coal lies in the combination of biostimulating and adsorbing properties. The purpose of the study is to conduct an environmental assessment of biochar application for remediation of oil-contaminated soils under various economic uses. The article compares the environmental assessments of biochar application in oil-contaminated soils with different particle size fraction. The following indicators of soil bioactivity were determined: enzymes, indicators of initial growth and development intensity of radish, microbiological indicators. We found that the most informative bioindicator correlating with residual oil content is the total bacteria count, and the most sensitive ones are the roots length (ordinary chernozem and brown forest soil) and the shoots length (brown semi-desert soil). The use of biochar on arable land and in forest soil (ordinary chernozem and brown forest soil) is less environmentally efficient than in semi-desert soil (brown semi-desert soil). The study results can serve to develop measures and managerial and technical solutions for remediation of oil-contaminated soils under various economic uses.

Shulaev N.S., Kadyrov R.R., Pryanichnikova V.V. Combined method of phytoremediation and electrical treatment for cleaning contaminated areas of the oil complex // Journal of Mining Institute. 2024. Vol. 265. P. 147-155. <https://pmi.spmi.ru/pmi/article/view/16040>



Abstract. The scale of land pollution with oil waste necessitates the use of economical and effective methods of recultivation. Phytoremediation is one of the simplest methods, but it has a number of limitations, so additional preparation of the territory is often required before it is carried out. Preliminary electrical preparation and subsequent seeding of special phytoremediants are of interest. Passing a constant electric current through the soil volume under a low voltage removes toxicants from deep soil layers even with flooding. In addition, it reduces pollutant content in the upper layer, where the plants root system is located, which creates more favorable conditions for phytoremediants. Adequately selected types of plants will ensure additional soil cleaning, improve its structure and air exchange. The results of two research directions are presented. Experiments on the study of plant resistance to oil-contaminated soil substrate allowed establishing contamination thresholds at which it is advisable to sow a particular species, and to choose optimal phytoremediants. The study of the oil-containing soil cleaning in a monocathodic electrochemical installation with the fixation of main characteristics (oil products concentration, soil temperature, volt-ampere characteristics) allows us to develop technical measures to prepare territories for phytoremediation taking into account the relief features.

Sozina I.D., Danilov A.S. Microbiological remediation of oil-contaminated soils // Journal of Mining Institute. 2023. Vol. 260. P. 297-312. DOI: 10.31897/PMI.2023.8. <https://pmi.spmi.ru/pmi/article/view/15837>



Abstract. Microbiological remediation is a promising technology for the elimination of environmental contamination by oil and petroleum products, based on the use of the metabolic potential of microorganisms. The issue of environmental contamination by crude oil and its refined products is relevant in the Russian Federation since the oil industry is one of the leading sectors of the country. Mechanical and physico-chemical methods of treatment are widely used to clean oil-contaminated soils. However, the methods belonging to these groups have a number of significant drawbacks, which actualizes the development of new methods (mainly biological), since they are more environmentally friendly, cost-effective, less labor-intensive, and do not require the use of technical capacities. Various bio-based products based on strains and consortia of microorganisms have been developed that have proven effectiveness. They include certain genera of bacteria, microscopic fungi, and microalgae, substances or materials acting as sorbents of biological agents and designed to retain them in the soil and increase the efficiency of bioremediation, as well as some nutrients. Statistical data, the most effective methods, and technologies, as well as cases of using microorganisms to restore oil-contaminated soils in various climatic conditions are presented.

Buzmakov S.A. Soil restoration under oil pollution of different levels // Journal of Mining Institute. 2013. Vol. 203. P. 128-132. <https://pmi.spmi.ru/pmi/article/view/5622>



Abstract. There are some levels of soil pollution under oil products. The author introduces reclamation things according to this levels. There are main parameters of practical works of territory environmental assessment, soil restoration, utilization of wastes with oil products.

Reshnyak V.I., Zhigulskiy V.A. Complex of measures on restoration of quality of natural environment on industrial object // Journal of Mining Institute. 2009. Vol. 180. P. 51-53. <https://pmi.spmi.ru/pmi/article/view/7091>



Abstract. The results of the researches of soil pollution on the territory of artificial site (bunkering base) have been presented. A recultivation measures to ameliorate the soil quality have been suggested. The main idea of recultivation includes: eliminations of pollution course; remediation of the soil by artificial aeration and regulation of humidity by the drainage system of petrocontaining waters with its subsequent treatment.

Bogdanov V.L., Mukhina L.B., Dmitrieva E.Yu., Shmeleva I.V. Biological reclamation of land contaminated by oil products // Journal of Mining Institute. 2003. Vol. 154. P. 231-234. <https://pmi.spmi.ru/pmi/article/view/9214>



Abstract. In the biological method of land reclamation the period of restoration of anthropogenic-disturbed territory depends on the degree of soil contamination by hydrocarbons, ecological conditions of plants and microorganisms-destructors of oil-hydrocarbons. The threshold concentration of oil products in sod-podzolic soils (3 l/m^2) was established for meadow phytocenoses, exceeding which leads to disruption of plant life. In areas with this degree of soil contamination plant cover begins to form in the second year after the anthropogenic disturbance of the territory. The presence of oil products in the soil at a concentration of $4-5 \text{ l/m}^2$ causes the death of up to 95-100% of the natural flora. Based on the reaction of meadow plants we can distinguish three degrees of soil pollution by oil products: weak ($1-2 \text{ l/m}^2$), medium (3 l/m^2) and strong (more than 4 l/m^2). Introduction of oil-hydrocarbon destructor microorganisms into the contaminated soil increases the germination of cultivated plants by 40-50%. It is advisable to use the biopreparation "Auros" and peat compost on the contaminated plots and sow meadow clover, white clover, common clover, awnless brome, meadow fescue, meadow tymofeevka.

Bogdanov V.L., Shmeleva I.V., Yakovitskaya A.P. Bioremediation of soil cover contaminated with oil products // Journal of Mining Institute. 2001. Vol. 149. P. 248-250. <https://pmi.spmi.ru/pmi/article/view/9644>



Abstract. Studies of meadow phytocenoses have established a threshold concentration of oil products in sod-podzolic soils (3 p/m^2), the excess of which leads to disruption of plant life. In areas with such degree of soil contamination vegetation cover is formed in the second year after technogenic disturbance of the territory. The presence of oil products in the soil in the concentration of $4-5 \text{ p/m}^2$ causes the death of up to 95-100 % of natural flora. Analysis of research results allows us to distinguish three degrees of soil contamination with oil products based on the reaction of meadow plants: weak ($1-2 \text{ l/m}^2$), medium (3 l/m^2) and strong (more than 4 l/m^2). For bioremediation of contaminated soils, it is advisable to cultivate meadow and creeping clover, hedgehog, meadow fescue, meadow timothy. Organic compost based on peat proved to be the best biostimulant for activation of soil microflora – oil-hydrocarbons destructors – under conditions of optimal soil humidity.

SECTION 4.

Reclamation of industrial sludge ponds, tailings dams and disturbed landscapes



Guman O.M., Antonova I.A. Potential use of water treatment sludge for the reclamation of small-capacity sludge collectors // Journal of Mining Institute. 2024. Vol. 267. P. 466–476. <https://pmi.spmi.ru/pmi/article/view/16421>



Abstract. In small settlements, collectors for the sludge produced during water treatment processes are small-sized and located in the vicinity of drinking water storage reservoirs or in coastal areas. Sludge removal is not economical. Besides, the relief depressions formed after sludge disposal are required to be reclaimed. In ore mining regions, where the main settlements of the Urals are located, sludge produced in water treatment has high contents of heavy metals typical of ore mining provinces. Consequently, places of sludge accumulation are potential sources of water pollution. The article discusses the possibility to mix sludge with slaked lime and local overburden with the help of special equipment. So far water treatment sludge in the region has been used to reclaim the surface of solid waste landfills by creating anaerobic conditions for waste decomposition. When placed inside the embankment dams as an independent object, sludge needs to be improved for the increase of its bearing capacity and the ability to bind heavy metals. The article aims at the substantiation of the composition and properties of the reclamation material made of the water treatment sludge mixed with local overburden and slaked lime (technosoil). For this reason the paper describes the composition of the sludge in a sludge collector, the composition and properties of the overburden rocks as a component of the mixtures with water treatment sludge, the composition and properties of the mixtures of water treatment sludge with overburden rocks and $\text{Ca}(\text{OH})_2$ as a component dewatering sludge and neutralizing toxicants. Furthermore, the research work provides the technology created for the optimal processing of the water treatment sludge in the process of the reclamation of a sludge collector. The research results and the experience obtained in reclamation of disturbed lands in the region have confirmed the possible use of technosoil for the reclamation of small-capacity sludge collectors. The analysis of the chemical composition and physical and mechanical properties of the mixtures under study has shown that the most economical and environmentally sound reclamation material is a mixture of water treatment sludge, loose overburden dump soils and $\text{Ca}(\text{OH})_2$ in a ratio of 60 : 30 : 10 %.

Mitrakova N.V., Khayrulina E.A., Blinov S.M., Perevoshchikova A.A. *Efficiency of acid sulphate soils reclamation in coal mining areas // Journal of Mining Institute. 2023. Vol. 260. P. 266-278. DOI: 10.31897/PMI.2023.31. <https://pmi.spmi.ru/pmi/article/view/16057>*



Abstract. During the development of coal deposits, acid mine waters flowing to the surface cause the formation of acid sulphate soils. We study the effectiveness of soil reclamation by agrochemical and geochemical methods at the site of acid mine water discharge in the Kizel Coal

Basin, carried out in 2005 using alkaline waste from soda production and activated sludge. A technosol with a stable phytocenosis was detected on the reclaimed site, and soddy-podzolic soil buried under the technogenic soil layer with no vegetation on the non-reclaimed site. The buried soddy-podzolic soil retains a strong acid pH concentration $H_2O = 3$. A high content of organic matter (8-1.5 %) is caused by carbonaceous particles; the presence of sulphide minerals reaches a depth of 40 cm. Technosol has a slightly acid pH reaction $H_2O = 5.5$, the content of organic matter due to the use of activated sludge is 19-65 %, the presence of sulphide minerals reaches a depth of 20-40 cm. The total iron content in the upper layers of the technosol did not change (190-200 g/kg), the excess over the background reaches 15 times. There is no contamination with heavy metals and trace elements, single elevated concentrations of Li, Se, B and V are found.

Kovshov V.P., Yakubovskii M.M., Kovshov S.V. *Water economic reclamation of sandy opencasts in Leningrad region as the complex way of decision of region's environmental problems // Journal of Mining Institute. 2013. Vol. 203. P. 133-136. <https://pmi.spmi.ru/pmi/article/view/5623>*



Abstract. One of the most perspective reclamation directions of the fulfilled sandy open-cast mines is water economic. Thereof working out of new more simple and economic projects water economic reclamation is required, thus capable in a complex to solve various

geoenvironmental problems. The short review of the basic existing reclamation directions the fulfilled sandy open-cast mines is given. The water economic direction in which the special accent becomes on designing of fire reservoirs is in more details analyzed.

Fomin S.I., Ubugunov E.L., Shevelev V.A. *Features land reclamation, disturbed as a result of activities of dzhidinsky mining treatment complex // Journal of Mining Institute. 2012. Vol. 195. P. 174-176. <https://pmi.spmi.ru/pmi/article/view/6130>*



Abstract. Converting disturbed as a result of industrial activity land in a state in-suitable for use in the national economy, to prevent their negative impacts on the surrounding landscape complexes, the protection of these complexes, optimization of the combination of man-made and natural landscapes is achieved revegetation. Reclamation of the tailings left behind after work Dzhidinsky mining treatment complex will ensure reduction of negative impacts on the environment and human health.

Pashkevich M.A., Korelskiy D.S. *Development of effective methods of reclamation of highly toxic technogenic massifs of enterprises of mineral and raw materials complex // Journal of Mining Institute. 2009. Vol. 180. P. 43-46. <https://pmi.spmi.ru/pmi/article/view/7089>*



Abstract. The paper presents result of monitoring toxic technogenic massifs of the OJSC «Mikhaolovskiy GOK» Company and the LLC «Severonickel» Company. Their technogenic influence on various environmental components is assessed. New reliable environmentally-safe and economically efficient ways of technogenic massif reclamation are suggested based on formation of protective screens made of polymer materials sintered with the massif rocks. An optimal screen formation technology is selected as the result of research carried out in test areas.

Malyshkin M.M. Increase of efficiency of methods of sludge pits reclamation // Journal of Mining Institute. 2009. Vol. 181. P. 220-222. <https://pmi.spmi.ru/pmi/article/view/7078>



Abstract. One of the most critical environmental problems of the oil industry in Russia is contamination with drilling waste that has a negative impact on the living conditions of people, animals and plants. The paper offers techniques to reclaim drilling mud sumps and enhancing their efficiency. Drilling mud sumps are pits dug on the territory of drilling sites and filled with drilling waste. The problem with reclamation of drilling mud sumps can be solved through forest recultivation, i.e. planting trees over the sumps. In order to further enhance recultivation it is offered to use carboxymethyl cellulose, which will create a protective coating on the seed surface, and to perform engineering recultivation before planting seeds.

Malyshkin M.M., Pashkevich M.A. Monitoring and development of methods of oil sludge pits reclamation // Journal of Mining Institute. 2008. Vol. 174. P. 236-238. <https://pmi.spmi.ru/pmi/article/view/7538>



Abstract. One of the largest environmental problems of the oil industry in Russia is drilling waste contamination, that has negative impact on the living conditions of the people, animals and plants. Drill return sumps are pits on the territory of drilling sites, filled with drilling waste. The problem of drill return sumps recultivation can be solved using the local tree crops and drilling wastage skillfully employed as growth-stimulating substance alongside with drill return sumps amelioration. This gives us a possibility of developing of a conceptually new scientific and methodical base of forest recultivation on the disturbed lands.

Malyshkin M.M. Recultivation of sludge pits by planting with plants // Journal of Mining Institute. 2007. Vol. 170. Part 1. P. 119-120. <https://pmi.spmi.ru/pmi/article/view/7795>



Abstract. One of the most serious environmental problems in the Russian oil industry is environmental pollution by drilling waste, which has a negative impact on the living conditions of people, animals and plants. Drilling sumps are pits on the territory of drilling sites filled with drilling waste. The problem of reclamation of drilling sumps can be solved using, along with reclamation of sumps, local tree crops and drilling wastes skillfully applied as growth-stimulating substances. This makes it possible to develop fundamentally new scientific and methodological bases for reclamation of forests on disturbed lands.

SECTION 5.

Use of non-conventional fertilizers, sludge and organic waste for the formation of artificial soil-grounds



Ivanova L.A., Slukovskaya M.V., Krasavtseva E.A. Assessing the effectiveness of sewage sludge in the reclamation of disturbed areas in the Kola subarctic zone (a case study of a sand quarry) // Journal of Mining Institute. 2024. Vol. 267. P. 444-452. <https://pmi.spmi.ru/pmi/article/view/16418>



Abstract. An assessment was made of the effectiveness of reclamation using sewage sludge for the accelerated formation of a stable erosion-proof vegetation cover on the unproductive anthropogenic soil of a sand quarry in the context of the Kola North.

The experiment, launched in 2017, included three treatments: control – no treatment, experiment 1 – fragmentary (50 %) application of sewage sludge, experiment 2 – continuous application. In the sixth growing season, anthropogenic soil samples were examined, and measurements of CO₂ emissions were carried out. It was shown that the application of sewage sludge had a positive effect on the physicochemical and agrochemical properties of the soils: in situ pH and density decreased, hygroscopicity increased, available phosphorus and potassium increased. Significant differences ($p < 0.05$) were found between CO₂ emissions in the control and experimental treatments. The content of organic carbon in the control treatment was lower than in the experimental ones; under fragmentary application of sewage sludge, it was three times lower, and under continuous application, it was nine times lower. Significant ($p < 0.05$) differences in the content of carbon and nitrogen in cold and hot water extracts between control and treatment samples were found under continuous application of sewage sludge. At the same time, by calculating the C/N ratio, a very low level of nitrogen was found in the humus. The main factors behind the variability of the estimated parameters were identified – the treatment itself and the method of its application, the contribution of the treatment alone was 60 %, the contribution of the application method was 14 %. Taking into account the economic factors, fragmentary application of sewage sludge onto the anthropogenic sand quarry soil is recommended to support the establishment of a stable erosion-proof phytocenosis.

Khordan M.M., Bek Dzh., Garsiya-Sanches E., Garsiya-Orenes F. Bulk density and aggregate stability assays in percolation columns // *Journal of Mining Institute*. 2016. Vol. 222. P. 877-881. DOI: 10.18454/PMI.2016.6.877. <https://pmi.spmi.ru/pmi/article/view/6935>



Abstract. The restoration technologies in areas degraded by extractive activities require the use of their own mine spoils. Reducing deficiencies in physical properties, organic matter, and nutrients with a contribution of treated sewage sludge is proposed.

This experiment was based on a controlled study using columns. The work was done with two mine spoils, both very rich in calcium carbonate. Two sewage sludge doses were undertaken (30,000 and 90,000 kg/ha of sewage sludge) in addition to a different mine spoils used as restoration substrates. The water contribution was provided by a device that simulated short duration rain. The leached water was collected 24 hours after the last application. The experiment saw the bulk density decrease and the aggregate stability increase, thereby improving the structure. The improved soil structure decreases its vulnerability to degradation processes such as erosion and compaction.

Petrova T.A., Rudzisha E. Utilization of sewage sludge as an ameliorant for reclamation of technogenically disturbed lands // *Journal of Mining Institute*. 2021. Vol. 251. P. 767-776. DOI: 10.31897/PMI.2021.5.16. <https://pmi.spmi.ru/pmi/article/view/14721>



Abstract. When rehabilitating technogenically disturbed lands of mining facilities, fertilizers and ameliorants are to be applied due to the lack of organic matter and nutrients required for the restoration of the soil and vegetation layer. The use of unconventional fertilizers (ameliorants) based on sewage sludge is one of the actual directions of land reclamation at mining sites. The purpose of the

work is to summarize and analyze up-to-date information on the effectiveness of the use of sewage sludge for the reclamation of technogenically disturbed lands of mining and processing industries. The analysis is based on a review of recent studies aimed at assessing the impact of introduced sediment on soils, plant communities, and rehabilitated areas. The introduction of sewage sludge has a positive effect on the physical and chemical parameters of the soil (optimizes density and aggregation), saturates it with nutrients, i.e. N, P, K, Ca, Mg, and Na, thus improving plant growth indicators. However, it may contain a number of heavy metals and pathogens; therefore, studies of each sediment and conditions of reclaimed areas are necessary.

Pashkevich M.A., Petrova T.A., Rudzisha E. Lignin sludge application for for-est land reclamation: feasibility assessment // *Journal of Mining Institute*. 2019. Vol. 235. P. 106-112. DOI: 10.31897/PMI.2019.1.106. <https://pmi.spmi.ru/pmi/article/view/13172>



Abstract. The article analyses waste generation of pulp and paper industry in North-Western Russia. The environmental impact of waste storage facilities of the pulp and paper mill was assessed, the need for utilization of lignin sludge was justified. In North-Western Russia, 1.21 million hectares of disturbed areas are in need for reclamation; they are abandoned quarries and lands alienated for pipeline and road construction. The suitability of lignin sludge for preparation of artificial fertile soils for reclamation purposes is estimated. For this purpose, experiments were carried out to create an artificial mixture with different ratios of lignin sludge and soil, to detect the maldevelopment of several plant species grown on various compositions of lignin sludge and soils. It was revealed that lignin sludge as an organic additive to soils is not toxic to vegetation and living organisms, allowing improving fertility of artificial soils.

*Smirnov Yu.D. Rational ways of protection of recultivated soils
// Journal of Mining Institute. 2006. Vol. 167. Part 1. P. 109-112.
<https://pmi.spmi.ru/pmi/article/view/8079>*



Abstract. An important problem of anthropogenic massifs is the slowdown in the natural formation of vegetation cover on dumps and tailings dumps of mining enterprises, which is explained by the impoverishment of rocks with nutrients. In this regard, of particular importance are the studies aimed at developing economically feasible ways to reduce dust emissions into the atmosphere and restore the biological productivity of disturbed areas, excluding the performance of labor-intensive operations to apply a traditional soil layer during reclamation. Based on the study of properties of various biologically active substances, the use of a new environmentally friendly bioactive foam is proposed, which fulfills the main tasks of biological reclamation: return of disturbed lands to the agricultural fund and fixation of dusty surfaces (soils, dumps, tailings).

Scientific edition

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FROM DAMAGE ASSESSMENT TO ECOSYSTEM RESTORATION**

Digest

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