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STABILITY OF GEOSYSTEMS UNDER THE IMPACT OF MINING OF NON-METALLIC MATERIALS IN THE TERRITORY OF SOUTHERN KYRGYZSTAN

Abstract. *The article examines the industry for the extraction of non-metallic materials in terms of assessing the extent of its negative impact on the environment of the adjacent territory, including atmospheric air, water and land resources. The factors associated with the activities of the enterprises of the industry and affecting the ecological state of land resources, violating the quality of water resources and the air environment, are determined. Aspects of rational use and protection of the geological environment are taken into account. At the same time, the results of scientific developments in the field of geoecological research of the extraction of non-metallic materials were taken as the basis, not only in the conditions of Kyrgyzstan, but also in the countries of near and far abroad. An assessment of the environmental safety of the development of deposits of various non-metallic materials in the southern regions of Kyrgyzstan is given. For this, the results of the analysis of the activities of 175 enterprises that develop non-metallic raw materials in the territory of Southern Kyrgyzstan were summarized. Studies were carried out on sampling from emissions from various enterprises for the development of quarries of non-metallic materials and an assessment was made of the resistance of geosystems to their impact.*

Key words: *geosystem, non-metallic raw materials, technology, construction industry, pollution, sustainability, assessment.*

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УСТОЙЧИВОСТЬ ГЕОСИСТЕМ ПОД ВОЗДЕЙСТВИЕМ ДОБЫЧИ НЕРУДНЫХ МАТЕРИАЛОВ НА ТЕРРИТОРИИ ЮЖНОГО КЫРГЫЗСТАНА

Аннотация. *В статье исследована промышленность по добыче нерудных материалов с точки зрения оценки масштабов её негативного воздействия на окружающую природную среду прилегающей территории, включая атмосферный воздух, водную среду и земельные ресурсы. Определены факторы, связанные с деятельностью предприятий отрасли и воздействующие на экологическое состояние земельных ресурсов, нарушающих качество водных ресурсов и воздушной среды. Приняты во внимание аспекты по рациональному использованию и охране геологической среды. При этом за основу приняты результаты научные разработки в сфере геоэкологического исследования добычи нерудных материалов не только в условиях Кыргызстана, но и в странах ближнего и дальнего зарубежья. Дана оценка экологической безопасности разработки месторождений различных нерудных материалов в южных регионах Кыргызстана. Для этого были обобщены результаты анализа деятельности 175 предприятий, ведущих разработку нерудного сырья на территории Южного Кыргызстана. Проведены исследования по отбору проб от выбросов от различных предприятий по разработке карьеров нерудных материалов и дана оценка устойчивости геосистем к их воздействию.*

Ключевые слова: *геосистема, нерудное сырье, технология, строительная индустрия, загрязнение, устойчивость, оценка.*

Introduction and problem statement. It is well know, that the development of non-metallic materials is the basis for the economic growth of any country. Sustainable economic growth depends on a complex of factors, which depend on the level of development of Mining companies, the level of development of the construction industry, the measures taken to protect the environment and sensible management of nature.

Research G.S. Kurchin, E.P. Volkova, E.V. Zeitseva, A.K. Kirsanova for the extraction of mineral resources show that the development of non-metallic materials is 62.9 % of the total reserve of extracted resources [12]. The development of these resources associated with an increase in the level of the construction industry in the region under study, which affects the ecological state of the environment in the surrounding areas.

In connection with the above data, the relevance of the topic associated with the development of non-metallic materials in the studied region of Kyrgyzstan.

Study of the problem. As noted in the scientific researches of A.B. Strelyaev, E.I.Andrianov, O.G. Burdziev, E.G. Ivanov, G.Kh. Ismayilov, G.S. Kurchin, I.S. Lomonosov, K.L. Wallwork, T.N. Furmanova the consequences of these activities are changes in the surface of the Earth's crust, concomitant pollution of abiotic components such as the atmospheric layer, water resources (rivers, lakes, glaciers), deterioration of the ecological state of coastal areas [1, 2, 5, 7 , 13, 14, 20, 21].

Some scientists, like Yu.A. Luzhkov, 2010; O.G. Burdzieva, 2011; G.G. Akhmanov notes that “in the geoecological study of the impact of mining on the environment, 2 methods are mainly used. In this direction, the environmental impact assessment of the territory, or rather, open-pit mining is one of the mandatory criteria in the comprehensive environmental assessment of the territory”. These issues well and comprehensively reflected in their scientific works “Environmental problems in the extraction of non-metallic building materials in Russia” [12].

The data of L.G. Balaev, L.D. Bely, F.V. Kotlov et al. on the diversity of geoecological processes resulting from the open mining of minerals, emphasize the need to classify mining factors that affect the environment of open mining [8].

A.N. Popov, V.A. Pochechun, A.I. Semyachkov [19] considere the formation of the quality of surface waters, which influence by economic activity through the discharge of wastewater, often untreated or insufficiently treated, scattered inflow of the flow of ingredients from a modified and polluted catchment area, and inflow by atmospheric. The issue of improving the state of water bodies solved by the formation of a biogeochemical barrier in the way of the flow of matter and energy. Given are Examples of the effective use of biogeochemical barriers for the protection of water bodies in mining areas.

Geoecological issues and peculiarities of open pit mining have not lost their relevance even in foreign studies. For example, in the work of K.L. Wallwork, in the UK and Australia can often find scientific literature on the environmental impact of quarries for the extraction of coal and mineral building materials, and in the Czech Republic - basalt [20].

The aim and objectives of the work. The aim of this work is to determine the stability of the geosystem of Southern part of Kyrgyzstan under the influence of the development of non-metallic materials. The objectives of the study included: 1) analysis of existing work on the development of non-metallic materials; 2) study the features of technological developments of non-metallic materials in the territory of Southern Kyrgyzstan; 3) to give an ecological assessment of loads by stages of the life cycle of materials. Study objects are activities for the development of non-metallic materials in the region of Southern part of Kyrgyzstan. Subject of the study is the stability of the geosystem under the influence of the activity of non-metallic materials.

Materials and research methods. The activity under study carried out on the territory of the Tien Shan, a large high-altitude mountain structure, consisting mainly of tectonic ridges and tectonic valleys. The mountains of the region connected by their orographic division with the Western (Fergana, Pskem, Chatkal, Kurama, etc.) and Southern Tien Shan (Alai, Turkestan, etc.).

The Pamir-Alai orographic region belongs to the Pamir mountain structure and includes the northern slope of the Chon-Alai Range and the Alai Valley in the territory of Kyrgyzstan.

The Ferghana Range separates the Ferghana Valley from Ala-Buka, Toguz-Toro and other small valleys on the Naryn side. Structurally, this is the western border of the Inner Tien Shan. The highest peak Uch-Seyit at the junction of Mount Torugart with the Alai Range reaches a height of 4940 m. The Fergana mountain range is the most important natural boundary: it is not only an orographic, but also a climatic, hydrological and landscape boundary that separates the Middle-Naryn and Fergana valleys. Its northeastern slope is short and steeply sloping, while the southwestern one is gentle and gradually passes into the plains of the Ferghana Valley.

The Chatkal mountain range surrounds the Fergana Valley from the north and extends from Sary-Chelek Lake to the Gava-Sai Valley in Kyrgyzstan. Its total length to the southeast is 225 km. Within KyrgyzstanIt is 165 km. The highest peak of the Chatkal Range is Mount Avletin with a height of 4503 m.

And the Alai-Turkstan orographic region surrounds the Ferghana Valley from the south and extends from the Tar River basin to the west of the Ak-Suu basin. Mount Chon-Alai stretches for 2500 km in the latitudinal direction, and the border between Kyrgyzstan and Tajikistan passes through it. The average height is 5500 m, the highest point is 7134 m (Lenin Peak).

The Alai Range starts from the Adyshev Range in the east and extends 350 km to the west. Its main axis diverges to the west in several branches, forming small separate ridges. Their absolute height increases further to the west. The Alai range ends in the Sokhtun basin. The orographic structure is the most complex. The highest peak is Tamdykul (5539 m).

The length of the Turkestan Range on the territory of Kyrgyzstan is 150 km (the southern side faces Tajikistan). The average height is 4300-4400 m. The highest peak is Rocky Mountain (5621 m). The northern foothills adjoin the plains of the Ferghana Valley.

The difference between deposits of non-metallic raw materials on the territory of the southern region of the Kyrgyz Republic is their confinement to densely populated areas, since their product used in the construction industry. Often, the contour of the development of the field located within the boundaries of settlements - cities, regional and rural agglomerations. However, studies of the impact of the development of these deposits on the components of the natural environment are episodic in nature and relate to certain issues of environmental protection.

The total reserves of sand and gravel deposits of Kojoyar, Khattakhat and Akterek are 117.2 million m^3.

More than 10 % of more than 500 deposits of clays and clayey rocks, represented by loess and loess-like loams, have been explored in detail, their reserves amount to 247 million tons. During the development of these deposits, manifestations of georisks of water genesis are high.

The data of the Ministry of Industry indicate that in recent years, in the extraction of minerals, deposits of building materials developed in Kyrgyzstan, called "SGM" - sand and gravel mixtures, have taken the first place. The intensive development of the SGM has a huge impact on the change in the terrain and becomes a field for the development of geo-risks, including water character.

Raw materials in the deposits of the southern region of Kyrgyzstan mined by open-cast mining, therefore they are subject to geo-risks of water genesis in the form of seasonal

precipitation of abnormal precipitation, the effects of flooding and flooding by surface and ground waters.

The group of natural and anthropogenic impact included the following factors:

1. The degree of soil erosion, which characterizes the loss of soil nutrients, which, in turn, affects the rate of vegetation regeneration. The criterion is the degree of soil damage.

2. The ecological framework of a territory or a combination of natural and anthropogenic areas, that characterizes its functional structure and reflects the level of anthropogenic load.

The main criterion is the area of the geosystem under anthropogenic use. In this case, we tried to get the percentage of areas allocated for agriculture, forests and aquatic ecosystems to the total area of the region. Such indicators were obtained on the basis of national statistics and with the help of space photography.

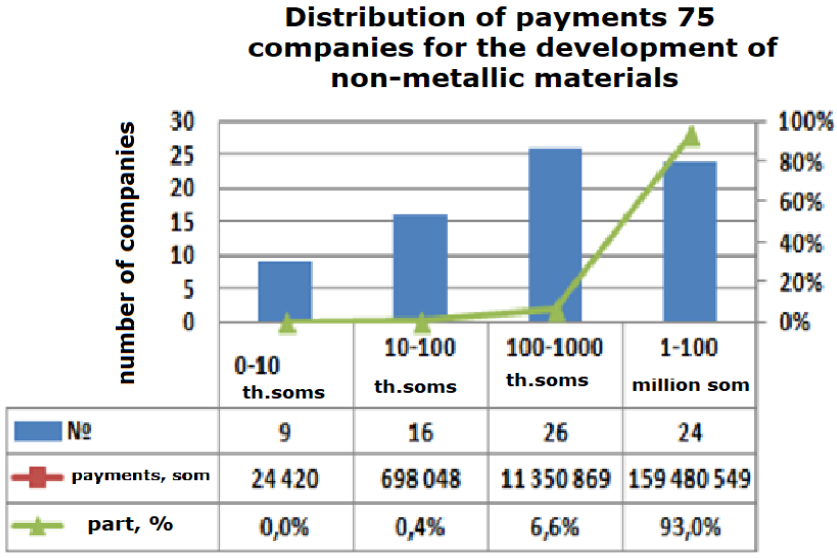


Figure 1. Distribution of non-metallic materials processing fees by companies

Modern reality shows that the economic impact of mining is insufficient to ensure sustainable development of the region (see Fig. 1) [18]. The principles of sustainable development assume that the ecological stability of the area contributes to a good social life. Open pit mining fundamentally alters the most stable rocks of the geological system, soil strata and natural vegetation, altering the hydrogeological conditions of the area, causing air pollution and destroying the living conditions of native animals. Therefore, surface light inevitably has a negative effect on all natural components [9, 16, 17].

Technologies for the production of non-metallic building materials include the extraction of mineral raw materials, their mechanical processing. The industry of non-metallic building materials brings together enterprises producing (mining) crushed stone, gravel, sand, sand and gravel mixtures as the main products. The extraction of non-metallic materials takes place in opencast mining from rock strata close to the surface. The main elements of quarries are ditches, ledges and heaps [3, 10, 16, 17, 21].

Nonmetallic rocks typically underlie a 1 m to several meter thick layer of waste rock. The depth of the quarries is usually 15-20 m, in some cases 80–100 m. The development of the subsoil plot envisaged in two stages - stripping operations; excavation of sand and gravel mixtures (SGC) to a depth of 0.5-1 m above the water level.

Excavators, trucks, loaders, truck manipulators as well as crushing and screening plants operated in the open-cast mines of the SGC mining companies, which not only serve to develop these resources, but also partly represent sources of pollution to the environment (PE).

The processing of mined rocks ensures their crushing, screening, hydraulic classification, washing, dewatering, concentration, storage and shipment of the products to the consumer. The processes listed classified as factors affecting the lithosphere.

When crushing rocks to obtain crushed stone and sand in the desired fractions, depending on their physical and mechanical properties (strength, the presence of weak inclusions, pieces of limestone, etc.), inorganic dust released during crushing in jaw, cone crushers.

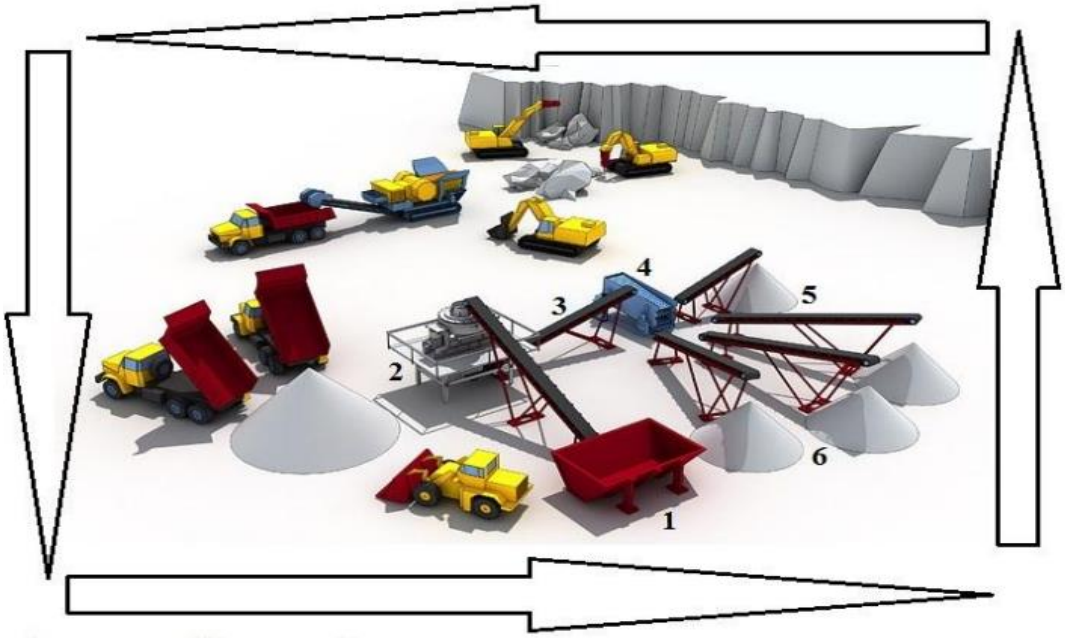


Figure 2. Technological scheme for the development of non-metallic materials
1 - Receiving hopper of the vibrating chute; 2 - Crusher; 3 - Unloading conveyor; 4 - Inclined inertial screen; 5.6 - sand, crushed stone of various fractions.

Existing crushers do not allow crushing the material to the required size in one pass of the stone through the crusher; therefore, it crushed in several stages in successive crushers (see Fig. 2).

Using long-term data, the critical values of the parameter that determine the level of air pollution were calculated. For this purpose, the statistical processing of the entire series of calculated values of the parameter P carried out separately by graduations for all seasons. The following gradations of the values of the parameter P distinguished by:

- reduced (0.35);
- extremely high (> 0.45).

Periods of high air pollution conditionally include those when the value of the parameter P > 0.35 observed continuously for three days or more. The value of the parameter P considered as a predictor and, based on statistical processing, associated with predictors: wind speed, atmospheric stability, etc. Of particular importance is taking into account synoptic processes in the analysis and forecast of long periods (3 days or more) with high air pollution.

Results and its discussion.

Analysis of methods for instrumental determination of the pollutant content in industrial exhaust gases.

The process of instrumental determination of the pollutant content in emissions can divided into the following stages:

(a) sampling from the flue;
(b) sample transport;
(c) preparing samples for analysis;

(d) measurement of gas flow parameters in gas channels;

(e) Measurement of pollutant concentrations.

Flue gases typically sampled in streams of high temperature, humidity, dust and chemical aggressiveness.

Table 1

Ecological assessment of the pressures by stages of the life cycle of materials

Types of building materials	Adverse effects of exposure to building materials by life cycle stages						Degree
	Ecosystem damage	Lack of raw materials	Emissions	Energy	Human health	Waste	Total points
Wood materials	1	1	1	1	1	1	6
Natural stone	3	2	1	2	1	1	10
Ceramic materials	2	1	1	3	1	1	9
Glass materials and other mineral melts	3	1	2	3	1	1	11
Metallic materials	3	2	3	3	2	1	14
Materials based on mineral binders	3	1	2	3	2	2	13
Polymer based materials	3	3	3	3	3	3	18

According to the authors of the works [1, 4, 6, 8, 11, 13-15, 21], each environmental factor has a negative impact on the biosphere and can be rated on a scale from 1 to 3:

– maximum negative impact - 3 points;
– average negative impact - 2 points;
– minimal negative impact - 1 point.

Authors Kurchin G.S., Volkov E.P., Zaitseva E.V., Kirsanov A.K. [13] proposed an environmental assessment for the main stages of the life cycle of various building materials.

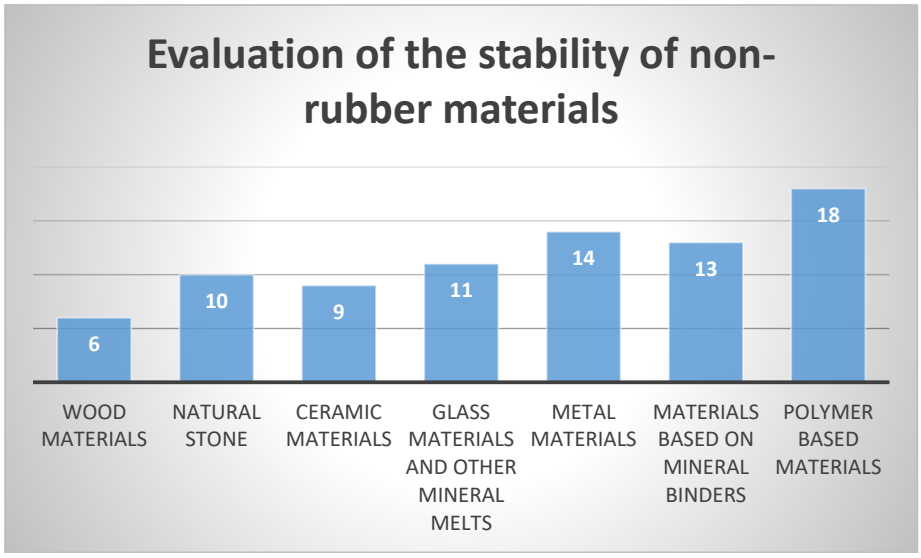


Figure 3. Sustainability of Geosystems from the development of non-metallic materials

As can be seen in Figure 3, wood has the minimum negative impact (6 points), while polymer-based materials have the maximum value (18 points).

An approximate scoring of environmental factors and developed their negative impact on the ecosystem. The authors of [13] distribute the scale of the total loads as follows:

- no more than 6 points - low load;
- from 7 to 12 points - average load;
- from 13 to 18 points - high load on the ecosystem.

Conclusion. The results of the analyzes show that natural materials and their use have the least impact on the environmental ecosystem and, accordingly, on the state of human health, while materials of more complex structure created by man have a greater impact, taking into account his transformation.

Given that under the geosystem's stability to the impact of mining, we considered its ability to withstand mining impact, as well as the ability to restore its former properties, which were disturbed by this impact, then when determining the stability levels we took into account the state of the properties of the geosystem.

Geosystems with low resilience to mining impacts are subject to rapid and intensive changes even with low mining loads. At the same time, there is a deep violation of self-regulation, recovery processes is extremely slow. In order to maintain the ecologically safe state of these geosystems in the shortest possible time, it is necessary to carry out a series of measures to optimize disturbed areas.

Medium stability geosystems indicates the ability to withstand longer and more extensive impacts while maintaining the ability to self-heal, subject to separate reclamation work.

Geosystems have a high stability and withstand permanent and intensive loads. They are characterized by being active the formation of artificial inheritance, which does not exclude the implementation of additional reclamation measures, in addition to those provided for in the article.

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