

## Northeastern part of the Bilanivske ferruginous quartzite quarry: Risks of mining allotment

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### Abstract

**Purpose.** Substantiation of the managerial decisions to minimize the risks of mining the Bilanivske ferruginous quartzite quarry on its northeastern margin.

**Methods.** The legislative, methodological, cartographic and literary materials on the topic, as well as the area of survey have been analyzed. The necessary cartographic plotting and calculations have been performed. An abstract-logical method is used to formulate conclusions and theoretical generalizations.

**Findings.** The ecological risks of the Bilanivske quarry northeastern margin have been substantiated: presence of uranium ore deposits and a radioactive anomaly; geochemical pollution of groundwater; a depression cone, large in area and in depth, can be formed in the region; a probability of using explosives when mining the field; use of the Bilanivske quarry eastern side for laying mine shafts and adits. The question is raised about the expected expansion of the Bilanivske quarry boundaries to the east during its mining, as well as falling into the sanitary protection zone boundaries of the northwestern residential community of the Nova Haleshchyna urban-type settlement. It is recommended, when mining the Bilanivske and Kremenchuk (Haleshchynske) iron ore deposits, to develop for them a unified draft Environmental Impact Assessment (EIA) and a unified draft of sanitary protection zone, taking into account the fact of their mutual influence on the environment.

**Originality.** For the first time, based on a combination of geological, mining, technological and spatial factors, a site (zone) of mutual risks has been identified in the Bilanivske and Kremenchuk (Haleshchynske) iron ore deposits development. The site has an area of 165 ha, bounded by the northeastern side of the Bilanivske quarry and the southern boundary of the planned Haleshchynske mine.

**Practical implications.** The research results can substantiate the need to resettle the residents from the northwestern residential community of the Nova Haleshchyna urban-type settlement, taking into account the Bilanivske field development by the open-pit method. In addition, they also can serve as a basis for resolving disputes between these residents and the administration of Ferrexpo Belanovo Mining LLC (Bilanivske Mining Plant).

**Keywords:** quarry, boundary, zone, risks, site, special permit, mining allotment

### 1. Introduction

The Bilanivske quarry was laid for mining the Bilanivske ferruginous quartzite field of the Kremenchuk magnetic anomaly (southwestern part of the Poltava region, Ukraine). According to the current in Ukraine “Regulations on the procedure for organizing and conducting pilot development of mineral deposits of national importance”, approved by order of the Ministry of Ecology and Natural Resources of Ukraine No. 34/m dated 03.03.2003, the quarry still operates as a pilot industrial facility. The execution of an act on granting a mining lease and land allotment for a quarry has been delayed, including due to the lack of a common public opinion on the deposit development, as well as due to the uncertainty of ecological and safety issues.

Ferrexpo industrial group (legal entity Poltava Mining and Processing Plant OJSC, a subsidiary of the Ferrexpo Poltava Mining group) received a special permit for subsoil use of the Bilanivske deposit for the extraction of ferruginous quartzites and associated minerals as early as on 20.12.2004. According to the Resolution of the Cabinet of Ministers of Ukraine No. 608 dated 17.06.2009, this special permit has been reissued to Ferrexpo Belanovo Mining LLC, a newly created division of the Ferrexpo group. An experimental industrial site was allocated in the southern part of the Bilanivske field. It was here that the stripping operations of the Bilanivske quarry and the study of the engineering-geological and hydrogeological conditions of the deposit development began.

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There is not an own ore mining and processing mills on the territory of Ferrexpo Belanovo Mining LLC and probably it will not appear in the near future (first of all, due to the delay in granting a mining lease and land allotment for the Bilanivske iron ore quarry). On the other hand, nearby (15 km to the south) there is a mining and processing mills of Ferrexpo Poltava Mining company with unutilized capacities, and the Bilanivske iron ore quarry is directly connected with Ferrexpo Poltava Mining company by a single transportation utility corridor.

Since the creation of Ferrexpo Belanovo Mining company, its activities have been criticized both from ordinary citizens (residents of nearby settlements) and from the Kremenchuk district administration, on the territory of which the Bilanivske field is located. The latter problem has already been resolved by merging the Bondarivka village council of the Kremenchuk district with the Nova Haleshchyna village council, as well as the administrative subordination of the newly created united territorial community of the Nova Haleshchyna to the Kozelschyna district. The unification of village councils with different administrative subordination became possible with the development of methodological approaches to the administrative-territorial reform in Ukraine [1]. There remains to establish mutually beneficial lease-economic and environmentally sustainable relationships between the territorial community and the mining enterprise [2], [3].

### 1.1. Review of recent research and publications

For a long time, the main concerns of the local population were associated with the open-pit method of mining the Bilanivske field and the probability of radiation pollution of the territory caused by the uranium ore deposits occurring in this area. Since 2012, radio monitoring for the territory of Ferrexpo Belanovo Mining has been carried out. According to the data of field instrumental measurements and laboratory studies of soil samples, core samples, water, air dust [4], comparison of the radon emanation zones with fault structures [5], [6], assessment of soil radiation [7], it has been determined that the radiation level on the territory of Ferrexpo Belanovo Mining (before the quarry operation) is safe for the population, and the radioecological situation in general does not cause concern.

Our research [8] clarifies the position and radiation risks of uranium ore deposits, known as the Kremenchuk uranium deposit (or ore occurrence), as well as the presence of a radioactive anomaly revealed by the results of comprehensive profile radioecological studies [4]. A solution to the problem of radioactive zones in the northeastern part of the Bilanivske ferruginous quartzite field is proposed – development of the field without the use of explosives.

Certain radioactivity (in certain areas) is inherent only in separate iron ore deposits and is associated predominantly with their granitization. Uranium (and thorium) mineralization is an exception in such deposits, usually locally, accompanied by superimposed processes of secondary silicification, iron ore oxidation, alkaline and carbonate metasomatism [9], etc. In the Kryvyi Rih-Kremenchuk metallogenic zone of Ukraine, there are [10]-[12]: 2 uranium deposits (Pervomaiske and Zhovtorichenske – within the iron ore deposits with the same name), 3 uranium ore occurrences (Hannivsky, Kremenchuk, Krasnohvardiyskyi) and 11 occurrences of uranium mineralization.

In Ukraine, the instruction provides for radiological control within the Ukrainian Shield. The same work is carried out abroad. In particular, in recent years, the radiological impact assessment of natural radionuclides has been performed around the Itakpe iron ore mines (northern part of Central Nigeria) [13], [14].

The hydrochemical state of underground-water levels and the quarry protection from the groundwater inflow have also been assessed in the vicinity of the Bilanivske quarry construction. According to the data in [15], all groundwater found within the Bilanivske field is unsuitable for both drinking and fishery use. This water discharge from the quarry into surface water bodies is possible only with proper preliminary treatment (desalinization). The Bilanivske quarry protection model proposed by the authors of [16] provides for advanced groundwater pumping by a powerful system of 63 wells located mainly along the quarry contour and a system of eight in-pit drainage trenches. Potential water inflows into the Bilanivske quarry can reach 2460 m<sup>3</sup> per hour (as at the Yerystivske quarry, adjacent from the south) [17]).

From the point of view of Ferrexpo Belanovo Mining organization, it has almost all the necessary permits, conclusions, approvals, solutions for mining the Bilanivske ferruginous quartzite field [18]. But the final project documentation revision is possible only with the registration of a mining lease. Perhaps the latter is the reason for the delay in the development of a full-fledged Environmental Impact Assessment (EIA) draft for Ferrexpo Belanovo Mining. So far, there is only EIA draft developed for the first phase of the Bilanivske field mining, in fact, for the southern part.

In Slovakia, for example, in addition to the EIA, a *Model for environmental impact assessment of mining project* is also developed [19]. And first of all, the possibility of a negative impact of the mining industry on the population is assessed.

Moreover, the European Union has introduced a social license for mining operations. The local population participates at all stages of the EIA development, including the discussion of issues of geology and mining technology, preliminary discussion, as well as the stages of determining the factors for assessment and development of the project [20].

In Sub-Saharan Africa (Ghana, Namibia, South Africa, Tanzania), a social license for subsoil use and the mineral rights provision is just being introduced. The distinction between the concepts of “mineral rights” and “land rights” exacerbates social tensions, since there are practically no obstacles to obtaining mineral rights (from the state) for multinational mining companies. The relationship between government and society is also tense given Africa’s colonial past [21].

In Latin America, the so-called corporate social responsibility takes place in relation to the mining industry, when enterprises take an active social position, including in solving problems of society [22], [23].

Against the background of a constructive dialogue between the population and mining companies, there are cases of tenacious opposition from the government and the public, leading to the denial of a license and the spontaneous decay of the territory. An example is the former mining region Rosia Montana in the Apuseni Mountains (the so-called Golden Quadrangle of Romania) [24]. On the other hand, in some countries, supporting the mining industry is a priority. For example, in Sweden, the state is responsible for the consequences of mining operations, and partly the state shows a significant tolerance to environmental violations [25].

Despite the different approaches to the organization of the mining activity, in all cases it is necessary to talk about the social risks. In Canada, to assess the level of social risk, the *social risk indices* are used, which determine the *social-geological potential of the territory* [26]. Scientists proceed from the fact that the mine construction in a particular area is possible only if the social aspects of this area are understood and taken into account.

In parallel, the possibility of assessing the environment “fragility” of the mining zone, according to the *criteria of the vulnerability of the territory* [27].

### 1.2. Unresolved aspects of the problem

The absence of final project documentation for the Bilanivske quarry creates uncertainty in the issue of sanitary protection zone of this enterprise, especially in view of human settlements that remain outside the projected evacuation zone. In particular, it is a long-standing need to substantiate the managerial decisions for minimizing the risks of mining the Bilanivske ferruginous quartzite quarry on its northeastern margin.

### 1.3. Setting purpose and objectives

The purpose of the paper is to substantiate the managerial decisions for minimizing the risks of mining the Bilanivske ferruginous quartzite quarry on its northeastern margin. In this case, the following individual tasks are solved: study of regulatory documents governing the issues of mining allotments; analysis of global experience in mining the deposits by the method of deep open pits; analysis of the projected solutions for the Bilanivske quarry construction and its impact on the environment; analysis of the sanitary protection zone boundaries in the northeastern part of the quarry.

## 2. Methods

The basic research material includes the legislative, methodological, cartographic (Figs. 1 and 2) and literary sources on the issues of radioecology, hydrogeology, population density of the area, designing the side slopes and boundaries, planning the methods of mining the quarries, as well as regulation of mining allotments and sanitary protection zones of mining enterprises.

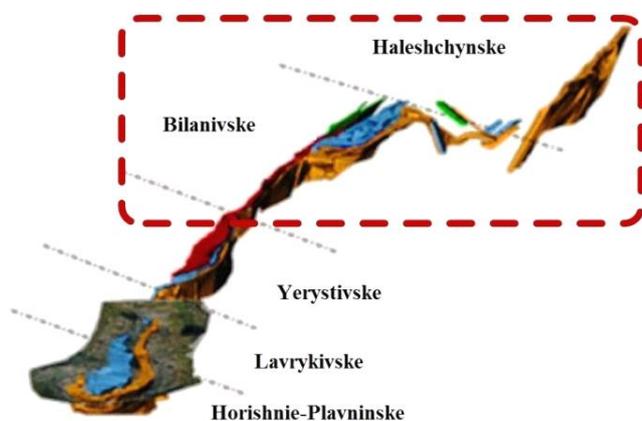


Figure 1. Scheme of deposits in the southern part of the Kremenchuk iron ore district (according to the scheme of Ferrexpo, <http://ferrexpobelanovomine.com/en/pro-nas/>); the dotted line outlines the surveyed area

Based on the results of these materials analysis, the necessary cartographic plotting and calculations have been performed. An abstract-logical method is used to formulate conclusions and theoretical generalizations.

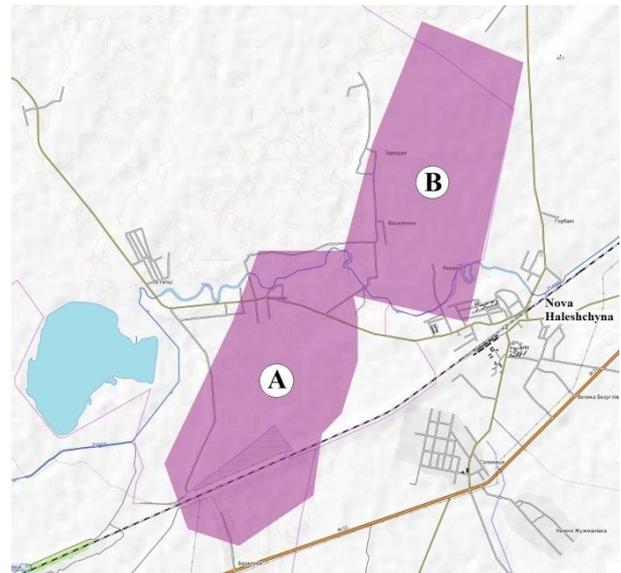


Figure 2. Layout scheme of the surveyed area (according to the Public cadastral map of Ukraine dated 15.08.2020): A, B – licensed sites for subsoil use (A – Bilanivske; B – Kremenchuk (Haleshchynske) fields)

Mining allotment issues are regulated in Ukraine by the following main documents: The Code of Ukraine about Subsoil (No. 132/94-VR dated 27.07.1994, edition of 16.10.2020), Mining Law of Ukraine No. 1127-XIV dated 06.10.1999, edition of 16.10.2020), Land Code of Ukraine (No. 2768-III dated 25.10.2001, edition of 24.07.2021), Law of Ukraine On Land Lease (No. 161-XIV dated 06.10.1998, edition of 06.07.2021), Regulations on the procedure for granting mining allotments (approved by the Resolution of the Cabinet of Ministers of Ukraine No. 59 dated 27.01.1995, edition of 19.05.2020) [28].

According to Ukrainian legislation, the granting of mining leases should ensure not only the introduction of rational, environmentally friendly mining technologies, but also prevent danger to people, property and the environment (Articles 17 and 53 of the Code of Ukraine about Subsoil). One of the main environmental requirements in the sphere of mining operations is the organization of a sanitary protection zone between the mining enterprise and residential buildings (Article 34 of the Mining Law of Ukraine). The bounds of the mining allotment are determined by the boundaries of a mining facility specified in a special permit for the use of subsoil, as well as by the contours of mineral reserves assessed by the State Commission of Ukraine on mineral reserves (including reserves of C<sub>2</sub> category), taking into account the rock displacement zones or flattening the sides of the quarry (Article 12, 18 of the Regulations on the procedure for granting mining allotments).

The Bilanivske quarry boundaries were adjusted several times, mainly in the northeastern part, while the eastern boundary was shifted to the west (due to an increase in the angle of gradient of the quarry eastern side).

Such an approach to the construction of quarries is substantiated by international practice [29]-[31].

In Canada and the USA, in particular, steep slopes of quarry sides have been used for a long time. Thus, the side of the Flintkote asbestos quarry (Pontbriand, Quebec, Canada), composed of granites, was built at an angle of 70°, and the side of the iron ore quarry Empire of Cleveland-Cliffs Inc. (Marquette, Michigan, United States) – at an angle of 80°. In Central Kazakhstan, at the Kounrad and Akzhal quarries, mining the copper ore in granodiorite-porphyrite, the slopes of the sides are 60-70° [32]. The deep kimberlite deposits of the Aikhal Mining and Processing Division (Yakutia) are mined with the side slope angles of 70-80°. When mining the copper-uranium-zircon-apatite-vermiculite deposits in Palabora Mining Company Ltd. (Phalaborwa, Limpopo Province, South Africa), alongside with general angles of the side slopes up to 58°, the vertical benches with a height of 30 m are used. The Zhelezny Open Pit of baddeleyite-apatite-magnetite deposits at the Kovdor GOK (Kola Peninsula), 600 m deep, is also designed with general angles of the side slopes up to 60° and vertical benches with a height of 30 m [31].

The steep eastern side of the Bilanivske quarry is a necessary measure conditioned by the proximity of the located uranium deposits. It is possible to further narrow the quarry using a compound (open pit-underground) method of mining the Bilanivske field. It is important to determine the optimal depth for the transition from open pit mining to underground mining [33], as well as to improve the environmental safety [34]-[36]. At the Chah-Gaz iron ore deposit (Iran), 450 m is substantiated for the transition to underground mining of the deposit [33]; at the Bilanivske ferruginous quartzite field, depths of 400 and 500 m are taken for similar purposes.

### 3. Results and discussion

Despite Ferrexpo Belanovo Mining’s attempts to locate the quarry further to the west, the future shafts of the Bilanivske field, if developed by underground method, should be designed on the eastern side (footwall) of the quarry. This is confirmed by the relevant experience at the fields with similar geological structure [37], [38], as well as the problematic construction of mine shafts in the western side of the Bilanivske quarry, given the presence there of a large evaporation pond of an oil-processing plant.

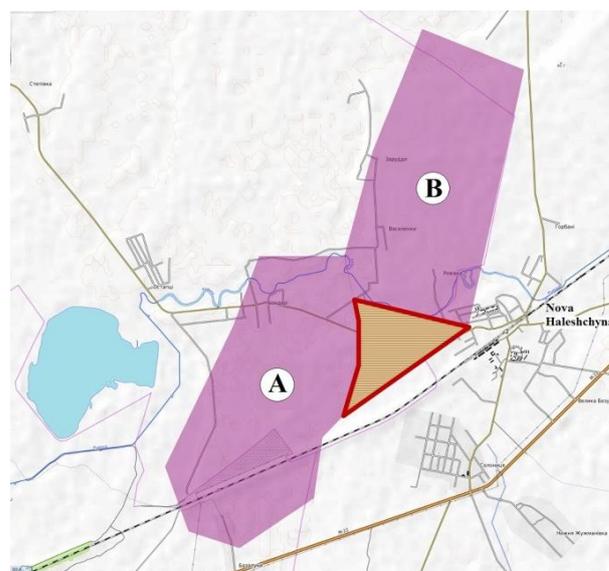
Mining enterprises are separate entities, and therefore their impact on the environment is usually considered separately. In the case of the Bilanivske quarry, it is advisable to adhere to the principle of interdependence, since the northeastern part of the Bilanivske ferruginous quartzite field adjoins the southern part of the Kremenchuk (Haleshchynske) high-grade iron ore deposit (Fig. 1). At the same time, the northeastern side of the Bilanivske quarry is the southern side of the future Haleshchynske mine (Fig. 2).

The Kremenchuk (Haleshchynske) high-grade iron ore deposit will also be mined in the near future. This is evidenced by a special permit for subsoil use, by the way, granted simultaneously with a special permit for the use of the Bilanivske field, and to the same owner (Table 1). Moreover, according to the plans of Ferrexpo Belanovo Mining, the Kremenchuk (Haleshchynske) iron ore deposit development is envisaged by the shaft method of mining, with the laying of the first shaft and an inclined adit from the eastern side of the Bilanivske quarry (a domestic variety of industrial symbiosis [39]).

**Table 1. Characteristics of special permits for subsoil use of the Bilanivske and Kremenchuk (Haleshchynske) fields**

Special permit data	Field	
	Bilanivske	Kremenchuk (Haleshchynske)
Registration number	3572	3571
Date of issue	20.12.2004	20.12.2004
Duration of action	20 years	32 years
Validity	to 20.12.2024	to 20.12.2036
Object area, ha	989.80	936.40
Reserves balance category A + B + C <sub>1</sub> + C <sub>2</sub> :		
Ferruginous quartzite, ths. tons	1664141	775840
Ores rich in iron, ths. tons	–	239877
Migmatite, plagiogranite, thous. m <sup>3</sup>	445954	–
Permit holder	Ferrexpo Belanovo Mining LLC	

The territory of the mutual influence zone of mining enterprises for the development of the Bilanivske and Kremenchuk (Haleshchynske) fields (Fig. 3) is described by five turning points of the licensed site boundaries of Ferrexpo Belanovo Mining (Table 2). According to calculations, it is 165 ha (or 8.5% of the total area of both licensed sites of Ferrexpo Belanovo Mining).



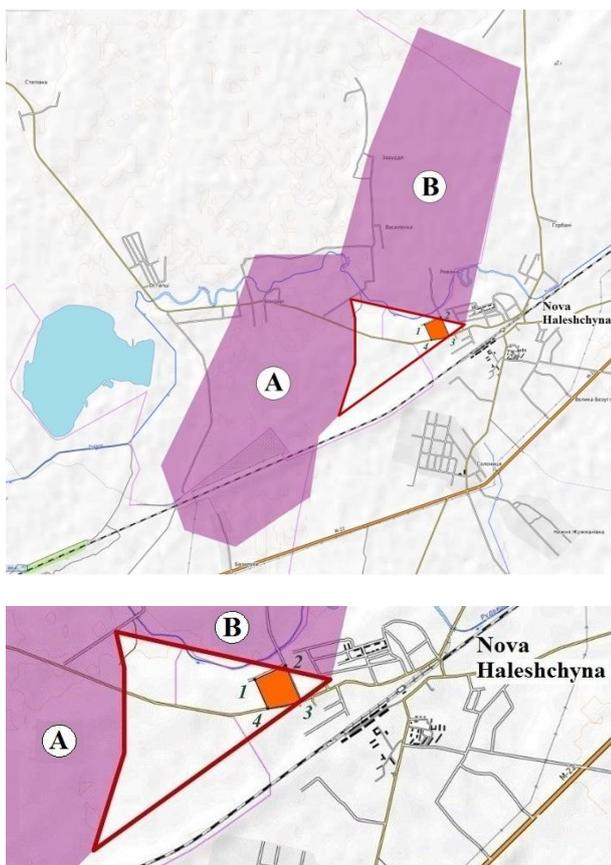
**Figure 3. Mutual influence zone of mining enterprises for the development of the Bilanivske (A) and Kremenchuk (Haleshchynske) (B) fields**

**Table 2. Coordinates of turning points of the problem area boundaries on the northeastern margin of the Bilanivske quarry (according to special permits for subsoil use)**

Field/special permit registration number	Point number (corresponds to a special permit)	Geographical coordinates	
		north latitude	east longitude
Bilanivske 3572	8	49° 09' 29"	33° 43' 08"
	7	49° 09' 57"	33° 43' 21"
	6	49° 10' 21"	33° 43' 21"
Kremenchuk (Haleshchynske) 3571	2	49° 10' 32"	33° 43' 18"
	1	49° 10' 18"	33° 44' 50"

It will be appropriate to note that this particular area is characterized by the known deposits of uranium ores and the presence of radioactive anomalies [4], [5], [8].

But the most important thing is that the northwestern residential community of the Nova Haleshchyna urban-type settlement falls within the boundaries of this site (“zone of mutual influence” or “zone of mutual risks”) (Fig. 4). Its total area (with houses, household plots, roads within the residential community and along the perimeter) is 8.6 ha (this is 5.2% of the “mutual risk zone” area or 0.45% of the total area of both licensed sites of Ferrexpo Belanovo Mining).



**Figure 4. Geographical location of the northwestern residential community of the Nova Haleshchyna urban-type settlement: (a) general plan; (b) on an enlarged scale, relative to the problem area boundaries (1, 2, 3, 4 – points of residential community contour boundaries)**

Almost the entire residential community is located in a zone of 1500 m from the eastern boundary of the Bilanivske licensed site and in a zone of 300 m from the southern boundary of the Kremenchuk (Haleshchynske) site (Table 3) (distances are obtained from the Public Cadastral Map of Ukraine as of 15.08.2020).

According to the norms of State sanitary rules for the planning and development of human settlements, approved by order of the Ministry of Health of Ukraine CH-173-96 No. 173-96 dated 19.06.1996, edition of 07.03.2019), residents of the northwestern residential community of the Nova Haleshchyna urban-type settlement are subject to compulsory resettlement. This requirement is valid both for the open pit mining of the Bilanivske field using explosives, and for the underground mining of the Kremenchuk (Haleshchynske) field using the technology of hydraulic mining (hydromonitors [40]-[43], most likely).

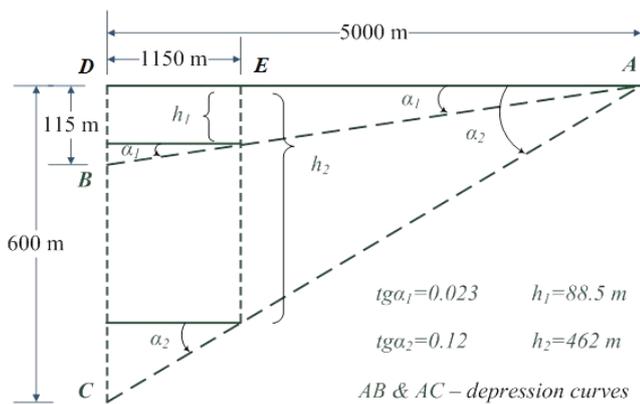
**Table 3. Location of the northwestern residential community of the Nova Haleshchyna urban-type settlement relatively the boundaries of the licensed sites for subsoil use of the Bilanivske and Kremenchuk (Haleshchynske) fields**

Point number on the scheme (Fig. 2)	Point description	The shortest distance to the boundary of licensed sites for subsoil use	
		Bilanivske field	Kremenchuk (Haleshchynske) field
1	northwest corner of the residential community	1150 m	135 m
2	northeast corner of the residential community	1390 m	within the field boundaries
3	south-east corner of the residential community	1530 m	240 m
4	southwest corner of the residential community	1250 m	355 m
		min = 1150 m	min = 0

Where to get water for hydraulic mining of Haleshchynske high-grade ores? Of course, from the quarry waters of the Bilanivske field. But this is also a negative aspect for the adjacent territories. Thus, according to the work [16], in the eighth year after the start of stripping operations at the Yerystivske ferruginous quartzite field (adjacent to the Bilanivske field from the south), the radius of the depression cone of the Yerystivske quarry (due to the quarry drainage and the system of dewatering wells of the drainage contour) has reached 5000 m. And the Bilanivske quarry in terms of mining depth (600 m) surpasses the Yerystivske quarry. What does this mean for the residents of the northwestern residential community of the Nova Haleshchyna urban-type settlement, if to provide such a scenario of dewatering activities for the Bilanivske quarry?

This means that the residents of the northwestern residential community of the Nova Haleshchyna urban-type settlement, located 1150 m from the Bilanivske quarry, will not have any groundwater resources at all, even for technical purposes. A variant of the regime of full hydraulic protection of the quarry, at which such lowering of the groundwater level in the northwestern residential community of the Nova Haleshchyna urban-type settlement is expected, may be unfavorable (Fig. 5): at the beginning of mining the ferruginous quartzites (exposure of the sedimentary strata) – up to an elevation of -88.5 m from the daylight surface, and at the time of completion of mining the Bilanivske quarry – to an elevation of -462 m. The rule of a right-angled triangle is used for calculations, since, due to the significant intensity of water-lowering measures, the depression curves are close in shape to straight lines [44] (Fig. 6).

Intensive drainage from the eastern side of the quarry is a compulsory measure to compensate for the less efficient drainage on the western side, which is inevitable due to the presence of a large evaporation pond there and the need to protect it. The use of surface water (the Rudko River) by local residents is also questionable, due to the inevitable loss of underground water supply for the river. Thus, the only reservoir for residents of the northwestern residential community of the Nova Haleshchyna urban-type settlement could be the underground water of the crystalline basement, but its use is impossible – due to the presence of uranium and radium in this water [45].



**Figure 5.** Scheme for calculating the lowering of the groundwater level in the northwestern residential community of the Nova Haleshchyna urban-type settlement with the variant of full hydraulic protection of mining the Bilanivske ferruginous quartzite quarry

The risks of the northwestern residential community of the Nova Haleshchyna urban-type settlement are increased due to the possibility of using explosives when mining the Bilanivske quarry. The eastern side of the quarry is composed mainly of ferruginous quartzites and granites, which are known to have the highest values of uniaxial compression strength – up to 350 and 276 MPa, respectively [46] (Table 2). Massive explosions can cause the disintegration of the ore bodies at the Kremenchuk uranium field with negative consequences for the residents of the northwestern residential community. It is to be recalled that the uranium deposit is located on the western boundary of this residential community.

During the operation of quarries, their boundaries are usually changed [29]. At the Bilanivske quarry, with its steep eastern side, it should be probably expected the expansion of its boundaries, moreover, in an eastern direction. The management of Ferrexpo Belanovo Mining LLC should foresee this possibility already now, while defining the boundaries of the mining allotment. And since the sanitary protection zone is designed depending on the actual boundaries of the quarry, it is also necessary to provide for the expansion (eastward) of the compulsory evacuation zone.

Given the complex of ecological risks on the northeastern margin of the Bilanivske quarry, it is impossible to hope for mining the Bilanivske field in the conditions of a “narrowed sanitary protection zone” [47]. According to the State sanitary rules for the planning and development of human settlements No. 173-96, the dimensions of the sanitary protection zone in relation to residential and public buildings are determined taking into account all factors of negative impact.

#### 4. Conclusions and recommendations

The territory of the northeastern margin of the Bilanivske quarry (165 ha), limited by its northeastern side and the southern boundary of the licensed site for subsoil use of the Kremenchuk (Haleshchynske) iron ore deposit, should be regarded as an area of ecological risks. The factors for this are:

- 1) existing uranium ore deposits and radioactive anomaly;
- 2) geochemical pollution of groundwater;
- 3) the probability of the depression cone formation, large in area and in depth, as a result of drainage measures taken at the superdeep Bilanivske quarry;

4) resulting effect of this drainage is a critical lowering of the groundwater level;

5) the possibility of mining the Bilanivske field using explosives (due to monolithic strata of crystalline rocks);

6) the priority of using the Bilanivske quarry eastern side for laying its own mine shafts, as well as a mine shaft and an inclined adit for the adjacent Haleshchynske mine;

7) the entry of this territory into the boundaries of the sanitary protection zones, provided that explosives are used when mining the Bilanivske and Kremenchuk (Haleshchynske) fields and the technology of hydraulic mining, respectively.

Given the fact of mutual influence on the environment, it is recommended, when mining the Bilanivske and Kremenchuk (Haleshchynske) iron ore deposits, to develop for them a unified draft of Environmental Impact Assessment (EIA) and a unified draft of sanitary protection zone.

In the context of the previous paragraph, it is recommended to additionally adjust the design boundaries of the mining allotment for the Bilanivske quarry.

It is recommended to admit the zone of ecological risks, allocated on the northeastern margin of the Bilanivske quarry, as the compulsory evacuation zone. It is advisable to resettle the residents of the northwestern residential community of the Nova Haleshchyna urban-type settlement as early as at the stage of the Bilanivske field exposure.

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## **Північно-східна частина Біланівського кар'єру залізистих кварцитів: ризиків гірничого відводу**

С. Лашко

**Мета.** Обґрунтування управлінських рішень щодо мінімізації ризиків розробки Біланівського кар'єру залізистих кварцитів на його північно-східній околиці.

**Методика.** Проаналізовані законодавчі, методичні, картографічні та літературні матеріали по темі та району досліджень. Виконані необхідні картографічні побудови та розрахунки. Для формулювання висновків і теоретичних узагальнень використано абстрактно-логічний метод.

**Результати.** Обґрунтовані екологічні ризики північно-східної околиці Біланівського кар'єру: наявність покладів уранових руд і радіоактивної аномалії; геохімічне забруднення підземних вод; вірогідність утворення в районі великої за площею та на глибину депресійної воронки; ймовірність застосування вибухових засобів при розробці родовища; використання східного борту Біланівського кар'єру для закладення шахтних стволів і штольні. Поставлене питання про очікуване розширення меж Біланівського кар'єру на схід у процесі його експлуатації та попадання північно-західного мікрорайону селища Нова Галещина в межі санітарно-захисної зони. Рекомендовано при експлуатації Біланівського та Кременчуцького (Галещинського) залізрудних родовищ розробити для них єдиний проєкт ОВНС і єдиний проєкт санітарно-захисної зони, враховуючи факт їх взаємного впливу на оточуюче середовище.

**Наукова новизна.** За сукупністю геологічних, гірничо-технологічних і просторового чинників уперше виділена ділянка (зона) взаємних ризиків розробки Біланівського та Кременчуцького (Галещинського) залізрудних родовищ. Ділянка має площу 165 га, обмежена північно-східним бортом Біланівського кар'єру та південною межею запланованого Галещинського рудника.

**Практична значимість.** Результати досліджень можуть слугувати обґрунтуванням необхідності переселення мешканців північно-західного мікрорайону селища Нова Галещина з огляду розробки Біланівського родовища кар'єрним способом, а також бути підставою для вирішення спорів між цими мешканцями та адміністрацією Біланівського гірничо-збагачувального комбінату.

**Ключові слова:** кар'єр, межа, зона, ризики, ділянка, спеціальний дозвіл, гірничий відвід

## **Северо-восточная часть Белановского карьера железистых кварцитов: риски горного отвода**

С. Лашко

**Цель.** Обоснование управленческих решений относительно минимизации рисков разработки Белановского карьера железистых кварцитов на его северо-восточной окраине.

**Методика.** Проанализированы законодательные, методические, картографические и литературные материалы по теме и району исследований. Выполнены необходимые картографические построения и расчеты. Для формулировки выводов и теоретических обобщений использован абстрактно-логический метод.

**Результаты.** Обоснованы экологические риски северо-восточной окраины Белановского карьера: наличие залежей урановых руд и радиоактивной аномалии; геохимическое загрязнение подземных вод; вероятность образования в районе большой по площади и на глубину депрессионной воронки; вероятность применения взрывчатых средств при разработке месторождения; использование восточного борта Белановского карьера для закладки шахтных стволов и штольні. Поставлен вопрос о возможном расширении границ Белановского карьера на восток в процессе его эксплуатации и попадания северо-западного микрорайона поселка Новая Галещина в пределы санитарно-защитной зоны. Рекомендуется при эксплуатации Белановского и Кременчугского (Галещинского) железорудных месторождений разработать для них единый проєкт ОВОС и единый проєкт санитарно-защитной зоны, учитывая факт их взаимного влияния на окружающую среду.

**Научная новизна.** По совокупности геологических, горно-технологических и пространственных факторов впервые выделен участок (зона) взаимных рисков разработки Белановского и Кременчугского (Галещинского) железорудных месторождений. Площадь участка – 165 га, он ограничен северо-восточным бортом Белановского карьера и южной границей запланированного Галещинского рудника.

**Практическая значимость.** Результаты исследований могут служить обоснованием необходимости переселения жителей северо-западного микрорайона поселка Новая Галещина в связи с разработкой Белановского месторождения карьерным способом, а также быть основанием для разрешения споров между этими жителями и администрацией Белановского горно-обогатительного комбината.

**Ключевые слова:** карьер, граница, зона, риски, участок, специальное разрешение, горный отвод