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ECOLOGICAL AND GEOLOGICAL INVESTIGATION OF THE MINE INDUSTRIAL REGIONS IN LUHANSK DISTRICT IN CONNECTION WITH COAL-MINING INDUSTRY'S RESTRUCTURING

(Reviewed by the editorial board member M. Korjnev)

Goal. *A range of problems arisen in the process of coal-mining industry's restructuring in Luhansk district is analyzed.*

Methodology. *Main factors determining the possibility of unfavorable and dangerous processes related to the closure of coal mines are described and analyzed.*

The new data of the concentration of heavy metals and toxins in waters, soil, coal waste and rock dumps in industrial areas of closed mines in Luhansk district are obtained. In order to define the pollution level by several elements, a total index of concentration (TIC) has been applied. This index characterizes the overall geochemical load produced by all chemical elements with abnormal level of concentration.

Research results. *The data processing of lithographic sampling in Luhansk region has helped to define five large and more than 40 smaller areas of anthropogenic pollution. Within the main industrial areas, the more intensely polluted sites (2-32 km^2) were revealed. They are related to some plants or industrial units. TIC here is 16-50, and in some sites it reaches 150.*

Topicality. *It is revealed that the most contrasting (TIC 8 – 126) and extensive (410 km^2) anthropogenic area is located in Almazno-Mar`yvsk mine industrial region and stretches over 48 km in the northwest direction from the town of Perevalsk to the town of Zolotoye. Typical contaminants for this region are arsenic, lead, fluorine, mercury, barium, manganese. Within the region, large areas (15-25 km^2) with the maximum (TIC 16-77) pollution level of land were revealed. They are limited to industrial and intended for building landscapes of the towns of Alchevsk, Bryanka, and Stahanov. More local (1-4 km^2) but nevertheless more contrasting (TIC 16-126) abnormalities related to contamination are recorded near the coil mining plants of the towns of Teplohorsk, Zolotoye, and Horskoye.*

Conclusion. *The main pollutants of soils and bed deposits are revealed, they are the following: arsenic, lead, fluorine, mercury, phosphorus, zinc, and barium. Cadmium, thallium, antimony, manganese, lithium, copper and chromium are also found. In order to determine the level of land pollution by several elements, the total index of concentration was used. The specific features related to the occurrence of some microelements in industrial waste of Donbas are described, their probable sources and possible ways of use are suggested.*

Introduction. In the regions of coal industry development extremely unfavorable ecological circumstances have emerged. Anthropogenic changes in the geological environment that covers the area of more than 15000 km^2 within the limits of Donetsk, Luhansk and Dnepropetrovsk prove this fact. The situation took a dangerous turn due to the consecutive implementation of the program of removing from service unprofitable mines, chiefly by applying a method of "wet" conservation.

It is revealed that the main factors that precondition the unprofitable and dangerous processes associated with the closure of mines are the following:

- a fault-block structure of rock masses with a wavelike translation of blocks;
- monoclinique bedding of multilayer, lithologically heterogeneous and irregularly weathered mass of coal deposits;
- disturbance of the stressed state of rock masses in underworked areas, including the areas of abandoned shallow workings;
- a wide spread occurrence of fill-up grounds (rock dumps, dumps of domestic and industrial wastes);
- a large number of hydraulic engineering structures (tailing dumps, sludge dumps, settling basins, etc.);
- occurrence of soluble rocks and rocks that change their properties when soaked and rehydrated;
- imposition of depression cones in the areas related to mines;
- changes in chemical composition of surface and underground waters as a result of mines operation [1,2].

Taking into account the above listed, it is possible to suggest that Donbas represents a disturbed and very sensitive to exposure anthropogenic structure. The change in the state of the rock mass in the context of removal of mines from service will keep its magnitude but there will be the emergence and development of the whole complex of phenomena and processes quite undesirable in terms of ecological and geological safety. Among the particularly dangerous processes are the following:

- underflooding of territory and submersion of underground structures;
- rehydratation of soils, change of their physical and mechanical properties, activation of such processes as subsidence and hydration of ground base under various buildings, weakening of structure bonds in grounds that will induce the development of exogenic geological processes (sliding of slopes, ravines, etc.);
- activation of suffusion and erosion processes, irregular subsidence of the surface and, as a result, the deformation of buildings and structures;
- a hydrodynamic impact on the soil masses and buildings;
- intensification of gas release and gas accumulation in underground structures, cellars and basements, which is closely related to the issues of social safety;
- activation of underground water movement in the direction of operating mines, changes in the surface run-off;
- change in chemical composition of underground water, including the water of small artesian basins used for domestic and industrial water supply;
- increased corrosivity of groundwater and relevant processes of deterioration of metal, concrete and reinforced concrete structures.

The removal of mines from service affords ground to consider ecological and hydrogeological factors and wastes accumulated during the long-term mining (for instance, waste dumps, slurry sumps and wastes of coal dressing placed on industrial areas) as a source of impor-

tant influence on ecological and geological characteristics of natural and anthropogenic systems. It is known that in Stakhanov mining industry region there is approximately a hundred of waste dumps; these waste dumps are the sources of air pollution. Moreover, they have a negative effect on the surface run-off, soil cover, and underground waters. Therefore, the new data acquisition on the concentration of heavy metals and toxic components in waste dumps will improve the ecology of the area. Hence, the research on the effect waste dumps and waste coal have on the environment is extremely topical [3,4].

Goal. *The goal of investigation* is to reveal a mechanism of toxic and "small" elements distribution both in the rocks containing coals and the waste produced by coil industry plants. This will help to solve ecological and geochemical problems concerning further storage or use of products coming from coal conversion.

Methodology. In order to realize these goals, it is necessary to solve the following tasks:

- to study the geological structure and hydrogeological conditions within the locations of industrial enterprises;
- to study the special aspects of the waste storage;
- to carry out an investigation of potentially dangerous objects of industrial plants: industrial area, waste dumps, production waste, refuse dumps, mine water settling basins, slime tanks, etc.;
- to define and map investigated anomalies.

Anthropogenic anomalies are characterized by a complex of elements-impurities, therefore, in order to estimate a level of land pollution by several elements, a total index of concentration is used (TIC). This index characterizes the geochemical load produced by all chemical elements with abnormal content. According to the standards GOST 17.4.02-83 "Classification of chemical substances for land pollution control", 24 elements of 1-st, 2-nd and 3-d classes of danger were defined.

In some samples only selective components were determined. In order to define the TIC, the value of their concentration was taken on the basis of related samples or, otherwise, baseline value was used. This applies primarily to arsenic [5].

Research results. In the result of data processing of lithographic sampling in the limits of Luhansk region five large and more than 40 local polluted areas were revealed. Within the main anthropogenic site, the more intensely contaminated plots (2-32 km^2) were determined. All of them are related to some plants or industrial units. TIC here is 16-50, and in some plots it reaches 150.

It is found that configuration of anthropogenic anomalies is very complicated and preconditioned by irregular distribution of pollution sources (mines, plants, industrial dumps). Besides, complex air flows in urban area also add to the problem. The main impurities of subsoil are: arsenic, lead, fluorine, phosphorus, mercury, zinc, and barium; while cadmium, antimony, molybdenum, chromium, manganese, copper, lithium, and thallium are of less importance.

The determination of natural geochemical background plays a key part in defining the intensity of anthropogenic pollution of subsoil. The assessment of geochemical background was carried out on the basis of characteristical samples in the areas located far away from a source of pollution. Local background was defined for each of the three sites, as well as for the whole investigated area. The coefficient of variation characterizing the diversity of background content ranges from 12 to 67.

Comparative characteristic of local background values shows the certain (6-30%) increase in the content of lead, phosphorus, cobalt from the west to the east. Higher concentration of magnesium, chromium, barium, lithium was found in the central part of the investigated area.

It was revealed that geochemical background in the south of Luhansk region practically doesn't differ from clarkes and regional geochemical background of the soils in Donetsk region [3,4].

Selected samples (n=1797) helped to define mean contents of chemical elements. All the elements except vanadium and niobium showed an increase in mean contents in relation to background concentration.

Topicality. It is revealed that the more contrasting (TIC 8 – 126) and extensive (410 km^2) anthropogenic site is located in Almazno-Mar`yvsk mine industrial region. It stretches over 48 km in the northwest direction from the town of Perevalsk to the town of Zolotoye. Arsenic, lead, fluorine, mercury, barium, manganese are typical contaminants for this region. Within the site large plots (15-25 km^2) with maximum (TIC 16-77) subsoil pollution were detected. They are limited to industrial and intended for building landscapes of the towns of Alchevsk, Bryanka, and Stahanov. More local (1-4 km^2) but nevertheless more contrasting (TIC 16-126) abnormalities related to contamination are recorded near the coal mining plants of the towns of Teplohorsk, Zolotoye, and Horskoye.

A close connection between maximum concentration of elements and industrial and urbanized landscapes is particularly noticeable in a geological profile Zoinsk-Mikhaylovka that runs across the town of Alchevsk. Here one can detect positive abnormalities of lead, barium, manganese, chromium, copper and negative abnormalities of phosphorus and vanadium, and the latter two are not characteristic for industrial landscapes.

The revealed anthropogenic site comes second in terms of size and pollution level. It is a location (5 km wide and 80 km long) of sublatitudinal extension within the limits of Bokovo-Khrustalny and Dolzhano-Rovenetsky mining regions. Here arsenic, lead, mercury, barium, and molybdenum have the most profound effect on the structure of contamination. Maximal contamination level (TIC 16-149) is recorded on the territory of industrial and urbanized landscapes of the towns of Vakhrushevo, Krasnyi Lukh, Antratzit, Sverdlovsk, Chervonopartizansk, and a village Dzerzhinsky.

Peculiarities of chemical elements distribution in the direction Krasniy Luch-Rovenki, Sverdlovsk-Krasnodon allow to associate their maximal concentration with urban agglomeration and certain plants (a mine "Centrosoyuz", a plant "Titan", Krasnidon industrial and domestic waste).

Characteristic feature of anthropogenic site (TIC 8-120), which was found in the area subjected to the influence of enterprises of Luhansk (80 km^2), is the presence of such elements as cadmium, antimony, lead, zinc which are the main land pollutants.

Besides, large anthropogenic sites of pollution (100-120 km^2) were detected near the towns of Lisichansk and Krasnodon.

Waste dumps and waste coal may be used as a secondary source of natural resources and building material, for instance, as back filling in road construction. This will guarantee the complex effective use of coal dumps and lead to the improvement of ecological situation in coal mining regions.

Taking into account a range of modern ecological problems in coal regions, the view on rock dumps as mere recultivation objects seems to be somewhat narrow. According to the results of geological exploration, the majority of mining waste should be considered as prospective deposits of ferrous, non-ferrous and rare-earth metals [4,6].

Available operational experience in processing such anthropogenic deposits shows that the better they are explored, the more valuable they may become .

Conclusions. Special features of geological structure and hydrogeologic conditions of investigated territories are studied. It is defined that mining enterprises are the main sources of pollution of land, bed deposits, surface and underground waters. Environmental pollution by harmful and toxic elements has integrated nature due to a vast variety of sources of pollution, specific features of migration and accumulation.

The main pollutants of soils and bed deposits are explored, and they are the following: arsenic, lead, fluorine, mercury, phosphorus, zinc, barium. Cadmium, thallium, antimony, manganese, lithium, copper and chromium also occur. Dangerous concentrations of these elements are found on industrial sites of coal mining enterprises and coking plants, where the total index of pollution ranges from 16 to 32 units, and in some enterprises it reaches 130 units.

Implementation of a complex approach to a coal-mining industry's restructuring requires a change of attitude to rock dumps, their estimation as a raw stock and adoption of new management solutions concerning their diversified usage, particularly on the state level.

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ЕКОЛОГО-ГЕОЛОГІЧНІ ДОСЛІДЖЕННЯ ГІРНИЧОПРОМИСЛОВИХ РАЙОНІВ ЛУГАНСЬКОЇ ОБЛАСТІ В ЗВ'ЯЗКУ З РЕСТРУКТУРИЗАЦІЄЮ ВУГІЛЬНОЇ ПРОМИСЛОВОСТІ

Мета. *Проаналізовано комплекс проблем що виникли при реструктуризації вугільної промисловості Луганської області.*

Методика. *Описано та систематизовано основні фактори які визначають можливість виникнення несприятливих і небезпечних процесів при закритті вугільних шахт.*

Отримані нові дані за вмістом важких металів і токсичних компонентів у ґрунтах, відходах вуглезбагачення і породних відвалах на проммайданчиках ліквідованих шахт Луганської області. Для визначення величини забруднення ґрунтів кількома елементами застосований сумарний показник концентрації (СПК). Характеризує він загальну геохімічну навантаження, створювану усіма хімічними елементами з аномальними змістами.

Результати. *У результаті обробки даних літохімічного опробування території Луганської області виявлено п'ять великих площинних техногенних ореолів забруднення і більше 40 локальних. Всередині основних техногенних ореолів виділяються ділянки (2-32 км^2) з більш інтенсивним забрудненням ґрунтів. Вони приурочені до окремих підприємств або промислових вузлів. СПК тут 16-50, а в окремих місцях досягає 150.*

Наукова новизна. *Визначено, що найбільш контрастний (СПК 8 – 126) і великий (410 км^2) техногенний ореол розташований в Алмазно-Мар'ївському гірничопромисловому районі і простягається на 48 км в ПЗ напрямку від м. Перевальськ до м. Золоте. Характерними забруднювачами для нього є миш'як, свинець, фтор, ртуть, барій, марганець. Усередині ореолу виявлені великі (15 25 км^2) ділянки з максимальним (СПК 16 – 77) забрудненням почвогрунтів. Приурочені вони до промислово-селитебних ландшафтів міст Алчевськ, Брянка, Стаханів. Більш локальні (1-4 км^2) , але контрастні (СПК 16 – 126) аномалії з забрудненням ґрунтів відзначені поблизу вугледобувних підприємств рр. Теплогірськ, Золоте, Гірське.*

Практичне значення. *Виявлено основні елементи – забруднювачі почвогрунтов і донних відкладень , ними є: миш'як, свинець, фтор, ртуть, фосфор, цинк, барій. Зустрічаються кадмій, талій, сурма, марганець, літій, мідь і хром. Описано особливості поширення деяких мікроелементів в промислових відходах Донбасу, наведені можливі джерела їх надходження і варіанти використання.*

Ключові слова. *Вугільна промисловість, еколого-геологічні дослідження, грунти, підземні води, забруднення, сумарний показник концентрації (СПК), Луганська область.*

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ЭКОЛОГО-ГЕОЛОГИЧЕСКИЕ ИССЛЕДОВАНИЯ ГОРНОПРОМЫШЛЕННЫХ РАЙОНОВ ЛУГАНСКОЙ ОБЛАСТИ В СВЯЗИ С РЕСТРУКТУРИЗАЦИЕЙ УГОЛЬНОЙ ОТРЯСЛИ

Цель. *Проанализирован комплекс проблем возникших при реструктуризации угольной промышленности Луганской области.*

Методика. *Описаны и систематизированы основные факторы определяющие возможность возникновения неблагоприятных и опасных процессов при закрытии угольных шахт.*

Получены новые данные по содержанию тяжелых металлов и токсичных компонентов в грунтах, отходах углеобогащения и породных отвалах на промплощадках ликвидированных шахт Луганской области. Для определения величины загрязнения грунтов несколькими элементами применен суммарный показатель концентрации (СПК). Характеризует он общую геохимическую нагрузку, создаваемую всеми химическими элементами с аномальными содержаниями.

Результаты. *В результате обработки данных литохимического опробования территории Луганской области выявлено пять крупных площадных техногенных ореолов загрязнения и более 40 локальных. Внутри основных техногенных ореолов выделяются участки (2-32 км^2) с более интенсивным загрязнением почв. Они приурочены к отдельным предприятиям или промышленным узлам. СПК здесь 16-50, а в отдельных местах достигает 150.*

Научная новизна. *Определено, что наиболее контрастный (СПК 8-126) и обширный (410 км^2) техногенный ореол расположен в Алмазно-Марьевском горнопромышленном районе и простирается на 48 км в СЗ направлении от г. Перевальск до г. Золотое. Характерными загрязнителями для него являются мышьяк, свинец, фтор, ртуть, барий, марганец. Внутри ореола выявлены крупные (15–25 км^2) участки с максимальным (СПК 16-77) загрязнением почвогрунтов. Приурочены они к промышленно-селитебным ландшафтам городов Алчевск, Брянка, Стаханов. Более локальные (1–4 км^2), но контрастные (СПК 16-126) аномалии с загрязнением почв отмечены вблизи угледобывающих предприятий гг. Теплогорск, Золотое, Горское.*

Практическое значение. *Выявлены основные элементы-загрязнители почвогрунтов и донных отложений, ими являются: мышьяк, свинец, фтор, ртуть, фосфор, цинк, барий. Встречаются кадмий, таллий, сурьма, марганец, литий, медь и хром. Описаны особенности распространения некоторых микроэлементов в промышленных отходах Донбасса, приведены возможные источники их поступления и варианты использования.*