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Miroslav Y. Syvyi, Sergey V. Hulyk

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About the functional typification of the Podilsk economic-geographical district mineral resources (Ternopil, Khmelnytskyi and Vinnytsia regions)

Miroslav Y. Syvyi, Sergey V. Hulyk

Ternopil Volodymyr Hnatiuk National Pedagogical University, Ternopil, Ukraine, syvyjm@ukr.net, ser_gul@ukr.net

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Abstracts. The article offers a functional typification of Podilsk economic and geographical area mineral resources (MR), based on taking into account their influence on the participation of certain industries in the territorial division of labor, complex-forming properties and the realized activity (degree of deposit development) of certain types of minerals and differs

from the general Ukrainian (Syvyi, 2011) with several features. Thus, three groups of mineral resources are determined in particular, according to the first feature: international, national and local; according to the second all types of mineral raw materials are grouped into three classes a, b, and c; three types of mineral deposits a, b and c are identified depending on the degree of development. Besides, the criteria are proposed for classification of some raw materials as strategic. In the presented variant of typification of mineral resources of the region, an attempt was also made to approximate geographical and geological positions in classifications, which will help to define clearly the role and place of mineral resources in the territorial and sectoral structures of the economy, to determine national priorities in the development of mineral and economic resources of the country-raw materials experience in geological practice. The first group (raw material of international importance) in Podillia includes valuable mineral waters such as Naftusia, radon, and sulfide waters, kaolins, graphite, facing stones from magmatic rocks, i.e. raw materials with significant (modern or potential) export potential. The second group (raw material of national importance) is the largest, with the vast majority of mineral resources explored in the region: most types of mineral waters, cement raw materials, construction stones, agrochemical raw materials, some types of technological raw materials and so on. Many of them are characterized by high realized activity, a large number is developed in insufficient quantities or generally not developed because of various reasons (lack of demand, environmental problems, depletion or insufficient exploration of stocks, etc.). The local raw materials include a small number of mineral types - ameliorant, construction sands, and others. Mineral resources with high complex-forming properties are almost absent in the region (except for Naftusia mineral waters, where large recreational complexes are formed). Class B (medium complex-forming properties) includes mineral resources, small mining sites, and centers that are formed based on them (cement raw materials, agrochemical raw materials, kaolins, mineral waters with specific components, etc.). However, the largest amount of mineral resources of the region is not marked by explicit complex-forming properties and is classified as class C. The article draws generalized conclusions about the functional structure of mineral resources of the region, which are revealed by their typification, the priority directions of investments in geological prospecting are offered, which should help to increase and optimize the mineral base of the region.

Keywords: *typification, mineral resources, strategic raw materials, classes of mineral resources, groups of mineral resources.*

Про функціональну типізацію мінерально-сировинних ресурсів Подільського економіко-географічного району (Тернопільська, Хмельницька, Вінницька області)

М. Сивий, С. Гулик

¹*Тернопільський національний педагогічний університет імені Володимира Гнатюка, Тернопіль, Україна, syvyjm@ukr.net, ser_gul@ukr.net*

Анотація. В статті запропоновано функціональну типізацію мінерально-сировинних ресурсів Подільського економіко-географічного району, яка ґрунтується на врахуванні їхнього впливу на участь певних галузей в територіальному поділі праці, комплексформувальних властивостях та реалізованій активності (ступені освоєння родовищ) окремих видів мінеральної сировини й відрізняється від загальноукраїнської (Syvyi, 2011) низкою особливостей. Так, зокрема за першою ознакою виокремлено три групи мінеральних ресурсів: міждержавного, загальнодержавного та місцевого значення; за другою усі види мінеральної сировини згруповано у три класи А, Б і В; залежно від ступеня освоєності виділено три типи покладів мінеральної сировини: а, б і в. Окрім того, запропоновано критерії віднесення деяких видів сировини до стратегічної. У поданому варіанті

типизації мінеральних ресурсів регіону здійснено також спробу зближення географічних і геологічних позицій у класифікаціях, які будуть сприяти чіткому визначенню ролі й місця мінеральних ресурсів в територіальній та галузевій структурах господарства, визначенню загальнодержавних пріоритетів у розвитку мінерально-сировинного комплексу країни, наближенню економіко-географічних напрацювань до геологічної практики. До першої групи (сировина міждержавного значення) на Поділлі віднесено цінні мінеральні води типу Нафтуся, радонові й сульфідні води, каоліни, графіт, облицювальне каміння з магматичних порід, тобто сировину з вагомим (сучасним чи потенційним) експортним потенціалом. Друга група (сировина загальнодержавного значення) – найчисельніша, сюди віднесено переважну більшість розвіданих у регіоні видів мінеральних ресурсів: більшість типів мінеральних вод, цементну сировину, будівельне каміння, агрохімічну сировину, деякі види технологічної сировини тощо. Багато з них характеризуються високою реалізованою активністю, значна кількість розробляється у недостатніх обсягах чи взагалом не розробляється з різних причин (відсутність попиту, екологічні проблеми, виснаженість чи недостатня розвіданість запасів та ін.). До місцевої сировини віднесено невелику кількість мінеральних видів – меліоранти, піски будівельні та ін. В регіоні майже відсутні мінеральні ресурси з високими комплексформівними властивостями (за виключенням мінеральних вод типу Нафтуся, на базі яких формуються великі рекреаційні комплекси). До класу Б (середні комплексформівні властивості) віднесено мінеральні ресурси на базі яких формуються невеликі гірничопромислові вузли та центри (цементна сировина, агрохімічна сировина, каоліни, мінеральні води зі специфічними компонентами та ін.). Однак найчисельніша кількість видів мінеральної сировини регіону не відзначається вираженими комплексформівними властивостями й віднесена до класу В. У статті зроблено узагальнені висновки щодо функціональної структури мінеральних ресурсів краю, які розкриваються їхньою типизацією, запропоновано першочергові напрямки інвестицій в геологорозвідувальні роботи, які повинні сприяти нарощуванню й оптимізації мінерально-сировинної бази регіону.

Ключові слова: типизація, мінерально-сировинні ресурси, стратегічна сировина, класи мінеральних ресурсів, групи мінеральних ресурсів.

Introduction. The exploration and development of mineral resources are considered as one of the important factors in the formation of the structure of the social-territorial complex of Ukraine in general and the Podilsk region in particular. Historically, the exploration of mineral resources has been and is being done in several interrelated and independent ways. This is explained by the need for a comprehensive study of both the mineral itself concerning determining its future economic use and the processes involved in the prospecting, exploration, production, and processing of mineral resources. Today, there is a quite clear differentiation between such basic areas of study of the MR as geological-mineralogical, natural-geographical, economic-geographical, economic, environmental, historical and complex (structural-geographical). The last one is the basis of our studies (Syvyi, 2004; Syvyi, Paranko, Ivanov et al., 2013 and others). An important prerequisite for optimizing the areas of MR rational use is their economic and geographical studies as the part of structural and geographical ones. They allow establishing territorial geographical patterns of the location of mineral deposits, the degree of their exploration and development, the relationship between the enterprises of the mining industry, the structure of sectoral and regional consumption of mineral resources, the situation in raw material market, etc. The opportunities of mining- industrial combinations of the mineral resources direction on the basis of separate developed of deposits or their territorial groups are being explored. As noted by L. Rudenko, V. Palienko, L. Shevchenko and others (Rudenko et al., 2003), the formation of territorial-production complexes based on mineral resources de-

posits is extremely important for Ukraine, and their research should be a priority when choosing ways of optimization of the resources' use.

Mineral resources constitute a single natural-economic (geotechnical) system because they are characterized by all the features of any system: the integrity, relative autonomy of subsystems, certain stability of the structure, functionality or the presence of connections between subsystems, etc. (Syvyi, 2004). The system of "mineral resources" as a territorial object is characterized by a component, functional and territorial (geospatial) structure. Component and territorial structures of mineral resources of the Podilsk district with sufficient detail have been covered in our study (Syvyi, 2003, 2004, 2006).

Therefore, **the purpose of this work** was to analyze their functional structure, which would allow taking a holistic view of the specifics of mineral resources within the Podilsk economic and geographical area. The tasks, which were solved by this research, in general, were as follows: 1) to offer our variant of functional typification of mineral resources; 2) to classify the mineral resources of the region by the degree of their complex-forming ability; 3) to establish the nature of the impact of certain types of mineral resources of the region on the participation of the respective industries in the territorial division of labor; 4) to classify the types of mineral resources by the degree of development (realized activity); 5) to offer the main directions of exploration and investment in the region to increase reserves of strategic mineral resources, as well as resources with highly complex-forming and export potential, and raw material types scarce for region.

Materials and methods of research. Economic-geographical (as well as structural-geographical) studies of mineral resources in Ukraine are not among the priority ones for several reasons, so there has been relatively a few studies on these issues in the recent years. We can distinguish the studies which considered the problem from one or another sides (Horlenko, 1969; Palamarshuk M. et al., 1978; Mishchenko and Rjabokon, 1987; Palamarshuk M., 1987; Horlenko, 1990; Horlenko, 1995; Palamarshuk M., Palamarshuk O., 1998; Rudenko V., 1999; Mishchenko, 2001; Korzhnev et al., 2003; Rudenko L. et al., 2003, 2004; Syvyi, 2004; Kostachshuk, 2004; Hurskyj, 2008; Syvyi, 2009; Syvyi et al., 2013; Burka, 2015 and others).

Ukrainian researchers have proposed the classification of mineral resources according to their industrial use (Mishchenko and Rjabokon, 1987), a scheme of economic-geographical analysis of the MR with different variations (Horlenko, 1990; Palamarshuk M. et al., 1978; Palamarshuk M., Palamarshuk O., 1998; Syvyi, 2004), the territorial structure of mineral resources of Ukraine is analyzed (Palamarshuk M. et al., 1985; Palamarshuk M. and Palamarshuk O., 1998; Syvyi, 2003) and Podillia (Syvyi, 2004), the role of mineral resources information of industrial territorial complexes (Palamarshuk M. et al., 1978; Syvyi, 2004), the methodology for studying the potential of MR as an important component of the regional's natural resource potential has been worked out (Rudenko V., 1999; Syvyi, 2004), the problems of integrated use of the MR (Pedan and Mishchenko, 1981; Mishchenko, 1987; Syvyi, 2004, 2010) and others.

Concerning the economic and geographical typification of mineral resources of Ukraine, it was first proposed by M. Palamarchuk and O. Palamarchuk in 1998 (Palamarshuk M. and Palamarshuk O., 1998), a similar typification with slightly different approaches on the basis of the new factual material was also carried out later (Syvyi, 2011).

The stock materials of the State Scientific Research Institute of Geoinform of Ukraine and its Podilsk branche, literary sources became the basis for carrying out this research and writing the article. The studies were carried out in the context of the budget theme of the Geography Department of TNPU named after V. Hnatiuk "Complex geographical studies of natural-economic geosystems of Podilsk region". Traditional methods have been used: gathering factual material to form a data bank for the mineral deposits of the region; analytical work related to the systematization and generalization of the collected stock materials, drawing conclusions, etc.

Research results. M. Palamarchuk and O. Palamarshuk O. (1998) depending on the influence of mineral resources on participation of the relevant branches in the territorial labor division, allocated the following groups of resources for Ukraine: international (I), nationwide (II), regional (III) and local (IV) importance. The first group includes resources with high-quality indicators and significant reserves that can successfully compete in the global mineral markets. Groups II and III include resources that are effectively utilized, respectively, within the country or a separate region. IV-th group includes minerals that do not affect the international labor division for various reasons: due to small reserves, unfavorable (or unprofitable) mining conditions, distribution throughout the country, locality (limited) use, etc. Specifically, the belonging of a mineral deposit to a particular group is determined by the effective area of consumption of raw materials or products of its processing. It depends to some extent on the level of development of productive forces. The grouping of Ukraine mineral resources into four groups has been suggested by the authors instead of the previous grouping (Palamarshuk et al., 1985) when union, zonal, republican, district and local groups were distinguished. It's clear that at that time it was a union division of labor.

According to the level of complex-forming activity, as in the previous classification, the authors distinguish three classes – A, B, C.

Thus, the typification of mineral resources of Ukraine provides the distinguishing of 12 main groups by the level of their complex-forming activity and the activity of their specialization development: A-I, A-II, A-III, A-IV, B-I, B-II, etc. (Palamarshuk M. and Palamarshuk O., 1998).

In addition, depending on the nature of development, there are three types of minerals (Palamarshuk M. et al., 1978): a — minerals of the realized activity, which retain their value for the future; b — minerals with low level of activity realization due to insufficient level of development or incompleteness of the last one c - minerals of unrealized activity (those which are not currently developed).

Practicing geologists, engaged in the exploration and preparation of mineral deposits for operation, distinguish national and local minerals. In Ukraine, the attribution of minerals to national and local importance is carried out by the Cabinet of Ministers of Ukraine upon the submission of the State Committee of Ukraine for Geology and Subsoil Use (PKMU, 2011).

It is also accepted in the world practice to allocate strategically important types of mineral raw materials for each country. The list and the volume of reserves of the last ones are determined by the level of economic development of the country, the structure of material production, the geopolitical situation, the state of foreign economic relations and other factors. For example, in the USA, there are 94 names of strategic types of mineral raw materials, in France - 13, in Russia - 29, etc. In Ukraine, the strategy of certain types of mineral raw materials is determined by different criteria. Thus, in the Program of Integrated Scientific Research of NAS of Ukraine "Strategic Mineral Resources of Ukraine" (Konceptia, 2012), the last ones are classified according to the industrial, economic and political aspects of their application and the importance of raw materials into six categories: 1) resources for strategic branches of energy and industrial sector: brown, black coal and coking coal, zirconium, titanium, iron, manganese, graphite, piezo quartz, hafnium; 2) resources for high-tech production areas: silica, tantalum and niobium, rare earth elements of yttrium and cerium groups, thorium, indium; 3) imported resources for domestic strategic industries: oil, natural gas, copper, lead, zinc, nickel, bauxite, apatite, gold, silver, diamonds, uranium (in fuel cells), fluor spar, pure quartz raw materials, etc.; 4) resources with significant export potential: iron, manganese, titanium, partly uranium; 5) resources for strategic sectors of Ukrainian economy that have been explored but are not being developed: apatite-titanium ores, nepheline, fluor spar, lithium ores, etc.; 6) non-ferrous metals, which are imported into Ukraine in the presence of domestic prospective deposits requiring studies: copper, phosphorites, apatites, chromium, molybdenum, nickel, gold, etc.

Even not a very thorough analysis of the classification reveals its cumbersomeness and inconsistency: the same mineral types fall into different categories (copper, gold, fluorine, apatite, phosphorites, titanium, iron, etc.), the categories are partially duplicated.

D. Gurskyj (2008) divides all strategically important minerals for Ukraine's economy into four categories (A, B, C, D), the division of which is based on such categories as degree of intensity of the exploitation of some types of the mineral resources, its export potential, explored reserves degree of exploration, the need of the raw materials for the country's economy: a) resources with significant export potential, significant reserves and highly realized activity; b) problematic resources which are extracted in limited quantities, with low

cost, environmental problems, scarce or depleted reserves, insufficiently explored newly discovered fields that need strategically important industries for the country's economy and are covered by imports; c) explored deposits, the raw materials of which are extracted in limited quantities or not extracted at all for various reasons, but the need for them may be renewed in the future; d) insufficiently explored and undeveloped fields, with the prospect of becoming strategically important for the country's economy in the near future. The author proposes a targeted exploration of 48 types of strategic mineral resources.

In the National Program for Development of the Mineral Resources Base of Ukraine until 2030 (Zahalnodierzhavna ..., 2011), all mineral resources are also divided into four categories, which are correlated with the categories proposed by D. Gurskyj for strategic raw materials.

Determining the list of strategic types of mineral raw materials involves the calculation of their current and prospective needs, ensuring reliable import of scarce types, as well as the priority budget financing for the creation and development of their base, identifying priority objects for investment, etc. In today's difficult economic environment, such measures cannot, of course, cover such a wide range of minerals and it is imperative to set national priorities. Therefore, we believe that the strategic types of mineral resources in Ukraine (as well as in the region) should be attributed primarily to a) energy resources that are extracted in insufficient quantities and are largely imported (oil and condensate, natural gas, uranium in fuel elements, coking coal); b) a group of non-ferrous metals imported (lead, zinc, nickel, aluminium, etc.) and raw materials for high-tech industries (rare earth metals of yttrium and cerium groups, tantalum and niobium); c) a group of mineral species with high export potential, as a reliable source of foreign exchange earnings (iron, titanium, manganese, zirconium, kaolin, refractories, facing stones from magmatic rocks, etc.); d) some non-ferrous and precious metals (gold, copper, lithium) and non-metals (titanium-apatite ores, apatites, phosphorites, feldspar), which are currently imported, but there are significant reserves and prospective resources in the country (Syvyi, 2011).

The list of strategic mineral raw materials will vary depending on the needs of industrial consumption, the global market for mineral resources and other factors. Now, for example, the highest growth in the world is increasing production and consumption of energy resources, alloying metals, certain types of non-ferrous and precious metals, rare earth raw materials, diamonds, agrochemical raw materials.

We present our own variant of functional typification of mineral resources of the Podilsk region below, which generally preserves the approaches proposed by (Palamarshuk M. and Palamarshuk O., 1998), but attempted to converge geographical and geological positions in classifications (for example, reducing the number of groups), which will contribute to a clearer definition of the role and place of mineral resources in the regional and sectoral structures of the economy, setting priorities in the development of the mineral resources of the region (Fig. 1, Table 1).

mineral resources of international importance, which will allow management structures of the regional and local level to approach the planning of development of their economic complexes more rationally and effectively, to use the available mineral raw materials, especially in the present conditions of the local government reform.

The *second group* includes the resources that are currently being effectively utilized, or that can be used in the long run within the state or in individual regions.

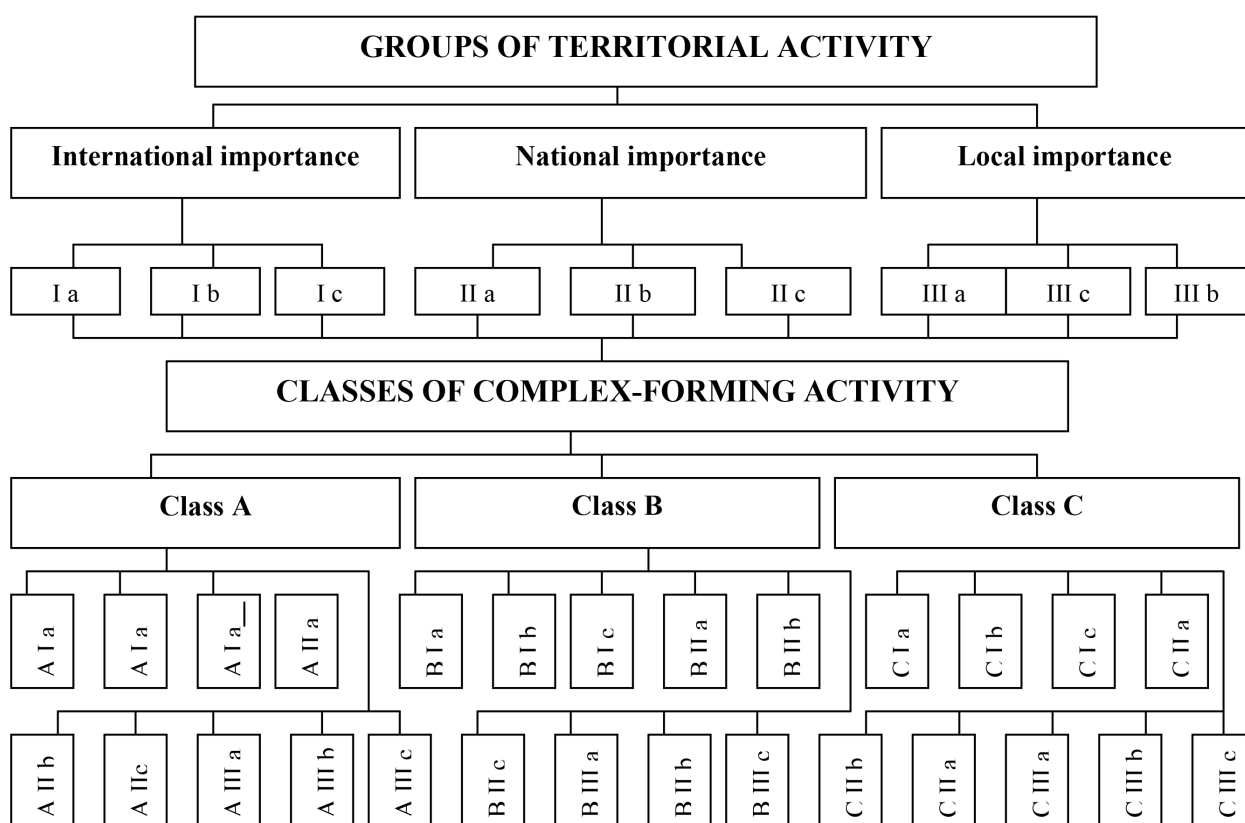


Fig. 1. Functional structure of the mineral resources typification of Ukraine (Syvyi, 2011)

We distinguish three groups of minerals, depending on their influence on the participation of the respective branches in the territorial division of labor (territorial activity): of international, national and local importance (Syvyi, 2011).

The *first group* includes resources with high-quality indicators and a significant level of territorial concentration of reserves and, accordingly, significant realized and potential export potential. Mineral deposits in this group may or may not be distinguished by powerful reserves, the last feature is quite capable of offsetting their rarity and uniqueness. Following Palamarchuk M. we believe that (Palamarchuk M., Palamarchuk O., 1998), it is useful to allocate the

The *third group* includes mineral resources with a low impact on the interdistrict division of labor due to: 1) high prevalence; 2) small reserves, low-quality indicators or unfavorable development conditions. At the same time, there are several types of mineral resources that are of local importance, but, given their prevalence, they may be important for the development of individual administrative districts or integrated territorial communities, especially in the absence of deposits with significant reserves of high-quality indicators. Also, expanding the list of locally sourced raw materials would help local communities to invest in mining, as it greatly simplifies the process of putting the fields into operation.

Each group is divided into three subgroups: a, b and c. The sub-group “a” includes mineral deposits, which are being intensively developed now and will retain their importance for the future; sub-group “b” includes deposits with insufficient level of mineral exploration, limited production volumes due to environmental problems, high cost, low reserves, insufficient exploration, lack of technological schemes for raw material processing, etc; The sub-group “c” refers to mineral resources that are not currently being developed for various reasons, but retain their importance for the economy of a country or region and may become exploited in the near future.

Mishchenko (Michshenko, 2006), in some cases for the production of certain complex products, in other cases - for the creation of cascade-type enterprises, when waste or by-products of one of them are used as raw materials for others, etc. Class B covers minerals that provide complex formation mainly at the local level — small territorial-industrial complexes and centers are developed on their basis. Class B includes minerals that are not complex-forming. In the Table 1, the main mineral resources of the Podilsk region are classified according to the principles outlined above.

Thus, each type of mineral resources explored in the Podillia (Fig. 1, Table 1) can be designated by a

Table 1. Functional typification of mineral resources of Podillia

CLASSES/ GROUPS	GROUPS ACCORDING TO THE TERRITORIAL ACTIVITY						
	INTERNATIONAL (I)		NATIONAL (II)			LOCAL (III)	
	A	C	A	B	C	A	C
A	Mineral waters of Zbruchansk Naftusia type						
B	Mineral water: radon, sulfide Kaolin *		Cement raw materials: marls, limestones, clays, gypsum; gypsum for the production of plasterboard, binder mixes	Glaucanite, saponite; mineral waters of Myrgorod type, silicic, Regina type, bromine water, sodium chloride brines, medical muds	Minerals water without specific components, brown coal, mica (phlogopite), garnet, opal, fluorspar* , apatite* , phosphorite*		
C	Facing stones made of magmatic rocks *: granites, granodiorites etc.	Graphite; abrasive raw materials, layer silicic	Dolomites, building stones made of igneous rocks: granites, granodiorites, enderbites, blacks, limestone for sugar-plants, building stones of the sedimentary rocks, brick and tile raw materials (mudstones, fusible clays, forest, shales), facing stones (sandstone)	Silicate sands, concrete; natural drinking water, saw stones (limestone), buikding chalk	Expanded clay, abrasive (garnet), field-sparrow raw, bentonite clays, sulfur, trembling, pelicanite, marble onyx; peat, glass sands; facing stones (travertines, plaster), sand-gravel mixtures (pebbles, gravel), refractory clays	Sands for construction, raw materials for production lime, gypsum (limestone, chalk, gypsum), raw materials brick-tile (loam)	Raw materials for soil reclamation (limestone, gypsum, sapropel)

*Resources, defined by the author as the strategic

By the level of complex-forming activity, there are three classes: A, B, C. Class A combines minerals, which development leads to the formation of territorial-production complexes of mineral resources or modern clusters built on the benefits of the territorial combination of mineral deposits as noted by

specific code characterizing the degree of its complex-forming and territorial activity (for example, A-Ia — mineral waters of the type Naftusia, i.e. raw material with high complex-forming properties, international importance, which is being intensively developed now and will retain its value for the future; B-IIb

— claydite raw material (mudstone) — raw material without pronounced complexing properties, national importance, growth known reserves which are not currently being developed, etc.).

Thus, the most valuable mineral raw material of the region is Naftusia mineral waters, which are assigned to the group I (Class A). These waters are exploited quite intensively for both balneological purposes and for bottling. They are of international importance, because of their vast reserves and unique balneological properties in the same time they are complex-forming - based on Sataniv-Makiv recreation unit in the Khmelnytskyi region, focused mainly on the use of waters such as Zbruchansk Naftusia, waters with other components for example – bromine and others. Unique combination of landscape and climatic conditions of Podilsk Tovtry, therapeutic properties of several types of mineral waters, ecologically clean territory and other favorable factors (creation of Tovtry resort with special investment regime) allow to predict further expansion and branching of functional structure, functional transformation of one of Ukraine leading resort areas and gaining international status in the near future. It's also worth mentioning that on the basis of the mineral waters of Naftusia type (similar to Zbruchansk Naftusia) in Truskavets and Skhidnytsia there are resorts of international importance, where citizens from different EU countries are being healed, i.e. these waters are classified by us (Syvyi, 2011) as resources of international importance. For these reasons, we believe that the mineral water is unique in its reserves and its therapeutic properties of the Podilsk region (Zbruchansk Naftusia, sulfide and radon) can also be classified as the first group resources but needs adequate infrastructure in the region and involvement of necessary investments. Moreover, the resort in Konopkivka (sulfide waters) used to have an international status in the 19th century.

The group I (Class B) includes radon and sulfide mineral waters. The Konopkivka Territorial and Recreation Center was formed in the Ternopil region and was based on sulfide (hydrogen sulfide) waters. There is “Medobory” sanatorium in the village of Konopkivka, a health complex for agricultural workers in the Nastasiv village and Mykulyntsi Water Treatment Hospital (based on therapeutic mud deposits, near Mykulyntsi village). There are also several water displays located near Mykulyntsi (Sorotsk, Kozivka etc.). The significant forecasted resources of hydrogen sulfide water and favorable environmental conditions make it possible to evaluate the prospects for the development of the recreation center. Another small recreational center (Khmelnytskyi) was

formed on the basis of two radon water deposits in the Khmelnytskyi district of the Vinnytsia region - Khmilnytskyi and Novokhmilnytskyi. The waters of the fields are used by the “Khmilnyk” health resort of the “Ukrprofzodorovnytsia”, the Central military clinical sanatorium “Khmilnyk”, the inter-economic sanatorium “Podillia”, the road clinical hospital №2, the medical rehabilitation center of the Ministry of Internal Affairs of Ukraine, the regional physiological hospital of the regional state administration. There are also opportunities to increase the production of radon water for balneological purposes.

Formation of small recreational complexes is possible in the future on the basis of the Nemyriv radon water deposit in the Vinnytsia region, the operation of which has recently started by the “Avangard” sanatorium, as well as in Shepetivsk and Polonsk districts of the Khmelnytskyi region after commissioning of the same deposits.

This group includes very rich deposits of primary kaolins of international importance, classified by us as strategic raw materials. Some of them have been explored and developed, some are ready for exploitation. Ukrainian deposits account for 95% of European reserves of this raw material. Ukrainian enterprises consume 20-25% of enriched kaolin (Korpan et al., 2018). Therefore, exporting it to the countries of Europe, the USA or even Africa is a very urgent issue. In contrast to some individual researchers (Palamarshuk M. and Palamarshuk O., 1998), we attribute kaolin to raw materials with medium complex-forming properties, because its extraction causes the emergence and functioning of several industrial enterprises for which the raw material is the main or auxiliary. Currently, 8 kaolin deposits are being developed in the Khmelnytskyi and Vinnytsia regions. Thus, based on the complex Shepetivka-Polonne area, an industrial site of the mineral orientation of the same name was formed and operates (Syvyi, 2004). It focuses on a whole network of diversified businesses oriented on the production and consumption of primary kaolins. Operations of the Maidan-Willa Group of Fields are undertaken by such enterprises as the Maidan-Willa Group of Refractories and the Burtyn Refractory Plant, municipal enterprise “Polonne Mayak Plant”, Polonne Porcelain Factory and others. Kaolin concentrate is also used by the LLC “Poninkovka Paper and Cardboard Factory-Ukraine”. Besides, some primary kaolin deposits, which are included in the Volyn sub-province (Dubrivka-Khmilivka kaolin district), are also operated in the vicinity of the Zhytomyr region. They are based on the Dubrivka Refractory Brick Factory and several

porcelain and faience enterprises in the Baranivka district of the Zhytomyr region. These enterprises, in our opinion, should be considered as a part of a single industrial unit of mineral resources, which covers the Shepetivka, Polonne districts of Khmelnytskyi region and Baranivka district of the Zhytomyr region. Also, in the Vinnytsia region, the mineral resources of the Kozyatyn- Illinetskyi Macroscale are the basis for the functioning of a small Glukhivetsky-Turbivsky Mining Site with a distinct mineral-raw orientation (Syvyi, 2004). The base is the deposits of the Glukhivetsky-Turbivsky kaolin district, which have been the objects of intensive exploitation for a long time. Such powerful enterprises as Turbivsky Kaolin Plant, which supplies kaolin concentrate for filling rubber, artificial skins and for pesticide production and one of the most powerful in Ukraine - Glukhivetsky kaolin factory (extraction of kaolin for porcelain, chemical, radio and ceramics) as well as for the production of cable, rubber, ultramarine, refractories, perfumes); in addition, a short-spattered concentrate is produced at the plant from the main production screenings. AKW Ukrainian Kaolin Company has started the development of the Velikogadomynetsky deposit, which is characterized by the high quality of raw materials, suitable mainly for the production of expensive chalk paper. SOKA Ukraine LLC, which belongs to the French group of companies SOKA and was opened in 2014, is developing, in particular, the Zhezheliv deposit near Kozyatyn. The uniqueness of the enterprise lies in the fact that the plant produces kaolin from raw materials obtained from more than one field, using the method of selective production and combination of different types of raw materials. It's production is 40,000 tons of enriched kaolin per year, 80% of which is exported to different countries of the world. The plant's products are used as raw materials for the production of plumbing, ceramic tile, porcelain, mineral fillers, facing bricks and mixes for construction.

Class B Group I is represented in the Podillia first of all by deposits of rocks facing from magmatic rocks: granites, granodiorites, labradorites, gabbro, etc., which are not marked by complexing properties, but have the high quality of raw materials and significant export potential. In total, 5 deposits of facing stones from magmatic rocks have been explored in Podillia, 4 deposits of which are being developed in the Vinnytsia region. Here, as facing stones, reserves of gray, biotite-cordierite, medium- and coarse-grained, porphyry-shaped grenades, medium in granite decorative qualities are used. The largest deposit is Zhezheliv.

The same class includes the large Burtyn deposit of graphite (Khmelnytskyi region), which is not being developed. Approved ore reserves amount to 113390 thousand tons (Korpan et al., 2018). The content of graphite in the ore is close to similar indicators in the Zavalla deposit and makes 6,3%. According to the geological-industrial estimation, the Burtyn deposit is considered to be a real raw material base of a new cost-effective enterprise.

Podnistrovsky seam flints (Grinchutsk deposit) belong to the first group because of their uniqueness. In chemical composition and physical and mechanical properties, it is a valuable natural raw material for the production of grinding balls and lining plates, which are widely used in porcelain and earthenware and other industries. Till the present time, they were the only natural supplier of raw materials to the UIC countries. Reserves of flints are quite considerable (2800 thousand tons), now they are not being developed.

The second group includes several types of minerals with realized activity (Table 1). Thus, cement b (limestone, clay, gypsum), which is extracted only in the Khmelnytskyi region, is included in Class B, but the balance of raw materials is also known in the Ternopil and Vinnytsia regions. Based on these deposits, Kamianets-Podilsk- Chemerovetsky Mining Unit (Syvyi, 2004) was formed, which is based on some mining enterprises producing products for the construction industry and several enterprises consuming mineral resources. Within the industrial site, there is a powerful cement plant (OJSC Podilsky Cement), which uses the raw materials of a large complex of the Gumenets deposit (limestones, clays). Besides, several sugar plants about a dozen small brick plants the Zakypnyansky Compound Feed Factory (the latter being a potential consumer of limestone for feed applications not currently under development), and Kamyans-Podilsk Asphalt Concrete Plant operates here.

Recently, the Portuguese firm "C + PA - Cimentos e Produtos Associados, S.A." has expressed interest in the construction of a cement plant with an annual capacity of 1 million tons in Vinnytsia region. It was planned to use Riv and Tartak deposits as raw materials.

"Knauf Gypsum Rock" LLC extracts gypsum stone in the Shyshkivtsi quarry near Borshchiv, Ternopil region. Now a mining plant, a crushing and sorting section, a warehouse and a section for loading wagons with raw materials have been built based on the quarry. Products (gypsum and anhydrite) are shipped to the Knauf Gypsum Kyiv enterprise, partly exported to Belarus, Lithuania, Moldova. The explored volumes

of gypsum in the Shyshkivtsi deposit amount to more than 10 million tons, estimated resources — 70–80 million tons. The design capacity of the mining enterprise is 500 thousand tons of gypsum stone per year. In the Khmelnytskyi region Kudrynetske-1— the only field is being developed. Raw materials deposit is being developed. It is a single deposit suitable for obtaining gypsum of the first grade. The reserves amount to 1146,1 thousand tons. Gypsum stone is used by the porcelain and faience and cement industry, and also is going to produce gypsum blocks and gypsum boards.

The second group includes the fields, which are now actively exploited. First of all, it is mainly construction materials: stones made of magmatic and sedimentary rocks, brick-tile raw materials, dolomites, etc. Construction stone deposits (granites, granodiorites, chemokines, sandstones, limestones) are used for production of rubble stone and scree are widespread throughout the Podolsk region (187 deposits, 85 of which are now under development (Korpan et al., 2018)). This class also includes dolomites of the Korzhiv deposit in the Ternopil region, which are developed not only for the needs of the local construction and glass industry but also as flux raw material for metallurgy (after the loss of flux dolomite deposits in the occupied territory of Donbas). For the same reasons, the limestone of Novosilkivka and Maksymivka fields is shipped to metallurgy, which is listed on the balance sheet as raw materials for sugar-making and lime.

Different types of mineral waters, brought by us to group II (Class B) are characterized by the insufficient level of development of specific components (bromine, sodium chloride brines, siliceous, etc.), some types of agrochemical raw materials (Table 1). For example, in Khmelnytskyi, bromine waters are installed at two fields together with the Naftusia waters (Zbruchansk and Zaichykyv), they also form a separate field - Kamianets-Podilsk, which were met at the Naftusia water type in the Ternopil region. They are used in small quantities. The Mirgorod-type waters are used in the Makiv and Bronnytsky deposits for healing and at Theophilipil — as drinking bottled water. Several mineral water deposits of various types (Naftusia, Krainsk, Kyshyniv, Makhachkala, Regina, Moscow, Izhevsk, etc.) are recommended by specialists for the establishment of drinking resorts and bottled water plants on their basis but are currently in operation.

A small mining site (Slavuta) was formed in the northern regions of Khmelnytskyi based on very densely concentrated sand deposits for silicate products, deposits of cement raw materials (Kryvyn deposit of clays) and deposits of saponites, agrochemi-

cal raw materials. Sand fields are being developed quite intensively here, saponites are exploited in small quantities.

Gluconate-raw material deposits for complex mineral fertilizers, feed additives and ameliorates are also distinguished by the average complex-forming properties. Significant reserves of Adamiv and Karachyivsk deposits have been explored in the Vinkovets district of the Khmelnytskyi region, fully prepared for operation, placed compactly and may become the basis of a small mining center shortly.

The Class B of the second group (subgroup «b») includes deposits of mineral resources, which are currently characterized by a certain unrealized potential (drinking water, saw stones, etc.). So, for example, deposits of saw limestones, which are concentrated mainly in Vinnytsia region and are characterized by significant industrial reserves (more than 12 million tons), are operated in very small volumes (2,3 thousand tons - production at 3 fields, which are currently being developed) (Korpan et al., 2018). Sands for silicate products are developed only at 3 fields with 9 explored with industrial reserves and scarcity of raw materials in the region. The same applies to sands, which are used as lightweight concrete fillers.

Class B of the same group includes deposits of several minerals that are not currently being developed (Table 1). These include the balance reserves of such strategic, in our view, minerals as fluorine, apatite, and phosphorites. The only Bakhtin deposit of Podolia of the fine spar is prepared for the exploitation with industrial supply of more than 4 million tons of ore. The total content of useful components (35–38%) and indicators of the cost of extraction and enrichment of Bakhtin ore are not inferior to fluorite ores, which are being developed in the USA, France and other countries of the world. The deposit is considered to be complex (except for fluorite, two feldspar and quartz concentrates are expected to be produced). The feasibility conditions for the possible development of the deposit can be improved by bringing into operation promising forecast resources of categories P_1 and P_2 (several tens of million tons with CaF_2 content of 11,9–17,0%) estimated at sites near Bakhtin deposit (Syvyi et al., 2013). It should be noted that all Ukrainian enterprises - consumers of smelter (metallurgical plants, shipbuilding, and aluminum enterprises) work on imported raw materials.

Apatite ores in the Podillia are represented only by ore manifestations. In particular, in the Letychivsk district of the Khmelnytsky region, prospective manifestations of apatite ores with estimated resources of 30 million tons of P_2O_5 were identified

within the limits of the Goloskivsky apatitinous area. Projections of ore resources in the Vinnytsia region are estimated at tens of million tons. Phosphate ores have been thoroughly developed only in two deposits - Zhvanivsk and Verbsk, in the middle of Zozulynske and Faschiivka deposits in the Khmelnytskyi region with the forecasted resources of over 93 million tons of ore (Korpan et al., 2018). Chalk-like phosphate limestones of the Khmelnytskyi and Vinnytsia Podnistrov region may be perspective for the use as a complex agro-ore (phosphorite and limestone flour) with estimated resources of about 16 million tons.

The region's deficiencies are claydite, abrasive raw materials (garnets), bentonite clays (Class C), reserves of which are detected in the region but are not being developed. The situation is similar to peat deposits, which total balance reserves in the Podillia exceed 200 million tons, and production is actually stopped at all the deposits. The Slobidka deposit of garnet with reserves of 673 thousand tons with an average mineral content in granites – 15-18% is, which is explored in detail is another example in the Kalynivka district of Vinnytsia region. A large Ivaniv deposit of garnet-biotite granites is being developed for rubble near the Slobidka deposit in the same area. The content of garnet in the granites of the deposit is about 27%, the reserves of rocks are estimated at 25 million tons (for example, in the USA, the garnet is extracted from rocks with a content of more than 8-10%). Garnet of both fields is homogeneous pyrop-almandine. The micro hardness of the garnets is 1400-1500 kg / mm², the full abrasive ability against monocorundum is 45-52%, the initial one is 81-87%. At the Ivaniv deposit, garnet is present mainly in 2-5 mm grains, and the content rocks (granites) are composed of feldspar and quartz with a small admixture of other minerals, which facilitates the extraction of garnet concentrate and allows most of the waste after enrichment to be used as quartz-feldspar glass industry. It has also been found that garnet concentrate from the Ivanovo deposit is not inferior in quality to foreign analogs (Syvyi, 2004). Some types of raw materials have not yet been explored for various reasons: minor reserves (native sulfur, bentonite clays); lack of consumers (trembling, etc.); lack of investment (pelicanites, onyx marble, etc.), environmental problems (sand and gravel mixtures).

Local raw materials (Group III) are represented mainly in the region by construction materials and ameliorates, with the former (sands for construction, loam, sandy loam, etc.) being intensively exploited, while the last one is not being developed due to lack of demand.

Conclusions. Thus, functional typification of mineral resources of Podillia reveals their following features: a) in Podillia mineral species with low complex-forming properties predominate; b) there are some minerals (mainly mineral waters) where on their basis the large recreational complexes are formed. The last ones are currently formed and have great prospects for expanding and complicating the functional structure in the future; c) there is a number of types of raw materials that can serve (and serve) as a basis for the formation of small territorial-industrial complexes belonging to the mineral raw field of activity (kaoline, mineral waters of certain types, cement raw materials, brown coal, agrochemical raw materials); d) the region as a whole has a small amount of mineral resource of international importance with significant export potential. First of all, they are the rich deposits of primary kaoline, graphite, mineral waters, facing stones; e) most types of mineral resources of the region are of national importance; f) the realized activity (or degree of development) of the existing mineral resources (including raw materials of strategic, international and national importance) is generally insufficient - the whole number of deposits of scarce types of raw materials are not currently being developed or exploited for minor reasons. (insufficient study, inventory depletion, lack of investment, environmental factors, etc.); g) development in perspective of valuable raw materials explored in the region, especially agrochemical and technological ones, makes it possible to expect the formation of small mining centers and units of mineral resources at their base, which will positively affect the overall structure of the industrial complex of the region, provide localities and job creation; h) investments in geological prospecting in the territory of the region should help to identify and increase reserves of raw materials with high complex-forming properties, which are almost completely devoid of land, prospecting and exploration of fuel and energy raw materials, new valuable deposits of mineral ornamental materials, agrochemical stones and technological raw materials; i) the expansion of the list of local mineral resources, where the exploitation was being performed under the simplified permitting procedures, would encourage the interest of local communities to make investments into their development.

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