

UDC 911.9:553.04

**Myroslav Yakovych Syvyi,**

Doctor of Science (Geography), Professor, Head of the Department of Geography and its Teaching Methods,  
Ternopil National Volodymyr Hnatyuk Pedagogical University,  
2 Maxyma Kryvonosa St., 46027, Ternopil, Ukraine,  
e-mail: [syvyjm@ukr.net](mailto:syvyjm@ukr.net), <https://orcid.org/0000-0002-3150-4848>;

**Serhij Wolodymyrowych Hulyk,**

PhD (Geography), Lecturer, Department of Geography and its Teaching Methods,  
Ternopil National Volodymyr Hnatyuk Pedagogical University,  
e-mail: [ser\\_gul@ukr.net](mailto:ser_gul@ukr.net), <https://orcid.org/0000-0001-8415-8304>;

**Petro Mychailovych Demyanchuk,**

PhD (Geography), Associate Professor, Department of Geography and its Teaching Methods,  
Ternopil National Volodymyr Hnatyuk Pedagogical University,  
e-mail: [dempetrom@gmail.com](mailto:dempetrom@gmail.com), <https://orcid.org/0000-0003-4860-7808>

## THE REGIONALIZATION OF PODILLYA TERRITORY (TERNOPIL, KHYMLNYTSKYI AND VINNYTSIA REGIONS) BY MINERAL RESOURCES

**М. Я. Сивий, С. В. Гулик, П. М. Дем'янчук. РАЙОНУВАННЯ ТЕРИТОРІЇ ПОДІЛЛЯ (ТЕРНОПІЛЬСЬКА, ХМЕЛЬНИЦЬКА І ВІННИЦЬКА ОБЛАСТІ) ЗА МІНЕРАЛЬНИМИ РЕСУРСАМИ.** В статті уперше охарактеризовано територіальну структуру мінерально-сировинних ресурсів Подільського макрорайону. Подано власне трактування мінерально-сировинного району, використане у даному дослідженні, та означено його внутрішню структуру. В межах макрорайону виокремлено шість мінерально-сировинних районів: Вінницький, Хмельницький, Товтровий, Чортківський, Західний та Подністрівський. Усі райони (окрім Чортківського та Подністрівського) відносяться до складного типу, тобто запаси мінеральної сировини зосереджуються в їх межах у вигляді макрокуців, куців та окремих родовищ. Установлено зокрема, що основними складниками компонентної структури мінерально-сировинних ресурсів Поділля є різні види будівельної сировини. Підпорядковане значення мають агрохімічна і технологічна сировина. Мінерально-сировинна база господарського комплексу подільських областей складається фактично із декількох видів будівельної сировини. Передовсім, це вапняки для виробництва вапна, цементна, цукрова сировина, камінь будівельний та сировина для будівельної кераміки. Для виокремлених мінерально-сировинних районів характерна чітко визначена сукупність основних та специфічних (властивих лише для даного району) видів мінеральної сировини і виразний генетичний зв'язок останніх як із окремими стратиграфічними, так і з структурно-геоморфологічними таксонами території. Усі виділені райони (за винятком Чортківського та Подністрівського) – змішаного типу. Більшість територіальних структур мінерально-сировинних ресурсів регіону є комплексними і лише декілька з них класифікуються як групові. У межах регіону переважають полікомпонентні зосередження родовищ і покладів мінеральної сировини, у яких найчастіше домінуючу роль відіграє сировина для будівельної промисловості. У майбутньому зростатиме значення специфічних корисних копалин, які зараз відіграють у районах підпорядковану роль. Це стосуються такої сировини як каолін, графіт, гранат, пеліканіт, флогопіт для Вінницького, крейда і зернисті фосфорити – для Хмельницького, флюсова та скляна сировина – для Західного, гіпси, ангідрити та фосфорити – для Подністрівського мінерально-сировинних районів.

**Ключові слова:** мінерально-сировинні ресурси, мінерально сировина, мінерально-сировинні райони, куці, макрокуці, родовища, гірничопромислові вузли, територіально-виробничі комплекси.

**М. Я. Сывий, С. В. Гулик, П. М. Демьянчук. РАЙОНИРОВАНИЕ ТЕРРИТОРИИ ПОДОЛЬЯ (ТЕРНОПОЛЬСКАЯ, ХМЕЛЬНИЦКАЯ И ВИННИЦКАЯ ОБЛАСТИ) ПО МИНЕРАЛЬНЫМ РЕСУРСАМ.** В статье впервые охарактеризована территориальная структура минерально-сырьевых ресурсов Подольского макрорайона. Приведено собственное понимание минерально-сырьевого района и означена его внутренняя структура. В пределах макрорайона выделено шесть минерально-сырьевых районов: Винницкий, Хмельницкий, Толтровый, Чертковский, Западный и Поднестровский. Все районы (кроме Чертковского и Поднестровского) относятся к сложному типу, то есть запасы минерального сырья концентрируются в их пределах в виде макрокустов, кустов и отдельных месторождений. Установлено, в частности, что основными составляющими компонентной структуры минерально-сырьевых ресурсов Подолья являются разные виды строительного сырья. Подчиненное значение имеют агрохимическое и технологическое сырье. Минерально-сырьевая база хозяйственного комплекса подольских областей состоит фактически из нескольких видов строительного сырья. Это прежде всего известняки для производства извести, цементное сырье, сырье для сахарных заводов, камень строительный и сырье для строительной керамики. Для выделенных минерально-сырьевых районов характерно четко определенное сочетание основных и специфических (свойственных только одному району) видов минерального сырья и отчетливая генетическая связь последних как с отдельными стратиграфическими, так и структурно-геоморфологическими таксонами территории. Все выделенные районы (за исключением Чертковского и Поднестровского) – смешанного типа. Большинство территориальных структур минерально-сырьевых ресурсов региона комплексные и только несколько из них классифицируются как групповые. В пределах региона преобладают поликомпонентные сосредоточения месторождений, в которых чаще доминирующую роль играет сырье для строительной промышленности. В будущем будет возрастать значение специфических полезных ископаемых, которые сейчас находятся в подчиненном положении. Это касается такого сырья как каолин, графит, гранат, пелликанит, флогопит для Винницкого, мел и зернистые фосфориты – для Хмельницкого, флюсовое и стеклянное сырье – Западного, гипсы, ангидриты и фосфориты – для Поднестровского минерально-сырьевых районов.

**Ключевые слова:** минерально-сырьевые ресурсы, минеральное сырье, минерально-сырьевые районы, кусты, макрокусты, месторождения, горнопромышленные узлы, территориально-производственные комплексы.

**Problem formulation.** At present, in Ukraine the list of questions, related to the systematic study of the problems of the mineral resource base of the country and the mineral resource complex, formed on its basis, and which are within the competence of the sciences of structural and geographical direction, are scarce and limited by geo-ecological problems [1, 6, 15, 16, 17, 18]. At the same time an integrated approach to the study of mineral raw material resources of the separate regions, areas and districts became important long time ago and is important now [13, 14, 19, 27, 28, 29]. Topical issues are those, related to a thorough analysis of the state of mineral raw material resources of the separate regions, to optimize the functioning of mining and processing industries, creating reliable and effective models of balanced and important territory, rational use of mineral resources and environmental protection problems of mining industry regions. This is a range of issues, addressed by structural geography as a science, one of the key tasks of which is the scientific substantiation of rational nature management in the regions to optimize, which includes comprehensive study and consideration of zonal-provincial and local natural resources and the conditions of the use of nature [19, 20, 21].

**The aim** of the economic and geographical regionalization of the Podillya region performed in article was to identify the spatial and time-dynamic patterns of concentration of mineral deposits, distinguishing their place and role in the economic complex of the region; substantiation of proposals for optimization of its structure and functioning efficiency, refinement of the nature use in the whole region.

**Analysis of the latest research and publications.** A systematic study of the Podillya region's mineral raw material resources from a structural and geographical point of view was not practically conducted until the early 2000's. The works that are characterized by mineral resource base of a particular state [2, 3, 4, 5, 7, 9, 10, 11, 12, 13, 14] pay too little attention to this region, apparently, because of the lack of significant deposits of raw materials of

national or international importance. Podillya really stands out mainly for construction raw materials. However, taking into account the notable growth rates of production in recent years, it is in the construction industry that will require the development of new raw materials in the near term, and also considering the fact that the mineral specialization of the region is transforming because of the materials of new large reserves agrochemical and technological raw materials, there is a need to reconsider the perspectives of the mineral resource base of the region. In recent decades, several publications [19, 22, 23, etc.], some of them of a system character, have been devoted to the region's mineral raw material because of specialization materials of related problems to this sphere [19]. This paper proposes the regionalization of the Podillya territory by mineral resources, which should help optimize several structures of mining materials because of specialization of Podillya region, ensure the rational use of their mineral base, determine the prospects and directions of development of mineral resources deposit of the region.

**The methodology of research.** The regionalization of the territory of the Podilsk region by mineral resources within three administrative regions was carried out by us based on the methodology proposed in [11, 12] and used by us in a somewhat modernized way [19], taking into account local specificity. The territory of Podillya in our work [21] was singled out as a macrodistrict. Hence, elements of the territorial structure of its mineral raw material resources are the bunches, macrobunches, deposits and individual deposits. The structure of the district in our understanding can be shown on the scheme (Fig. 1).

It should be noted that the term *district* in this work refers to territorial structures that cover an area of approximately 2000-3000 km<sup>2</sup> or slightly larger than in traditional bunches, with a significant number of deposits that are related to the confluence with certain stratigraphic horizons (often up to 1-2, rarely-several) and are located within separate structural-geomorphological units, which are separated

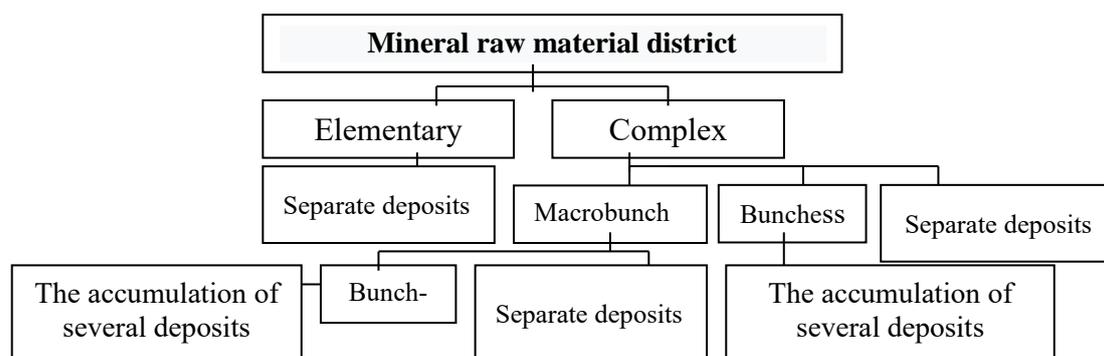


Fig. 1. The structure of mineral raw materials of Podillya districts

by [26]. For example, the Khmelnytskyi district is almost identical to the Khmelnytskyi structural-denudation height, and the dominant types of mineral resources here are clay, sand and peat quaternary and neogene ages. Thus, the main allocation of mineral resources in the work is based on two basic principles: historical-geological and territorial (territorial integrity). Somewhat larger than in the traditional territories of the Podillya districts are explained by the fact that the isolation of such structures within Ukraine [12, 21, 24] was based on the concentration of a certain number of compactly located, as a rule, large and significant industrially significant deposits. Selection of the Podillya districts was carried out mainly with the consideration of many predominantly small stocks of construction material deposits, which are, however, genetically linked and localized in large territories. The district can combine macrobunches, bunches and separate deposits. The definition of the latter is given in the work [19].

All elements of the territorial structure of the mineral raw material resources are divided into groups (not a very successful term in our opinion) and complex [12]. The development of group elements does not lead to the development of interconnected industries. The exploitation of complex ones – causes the formation of industrial territorial complexes. In other words, the forms of concentration of complexes of mineral resources are called the complex forms. Therefore, the analysis of the resource composition, the concentration of reserves, mining conditions of development, the scale of industrial development and participation in the territorial division of labor of such mineral raw material resources makes it possible to determine the feasibility of formation on their basis of mining units of mineral resources.

**Presenting main material.** We have identified six mineral resources districts within the Podilsk macrodistrict: Vinnytsia, Khmelnytskyi, Tovtry, Chortkiv, Western and Podnistrovskyi. Each of them is characterized by a certain complex of mineral resources, basic and subordinate their specificity in their location, genetic connection with certain stratigraphic horizons and structural-geomorphological units, which can be used both in the planning of prospecting for certain types of raw materials, and to address the optimization of the region's mining infrastructure. All districts (except Chortkiv and Podnistrovskyi) are of a complex type, that is, mineral resources are concentrated within their limits in the form of macrobunches, bunches and separate deposits. Their short characteristics is given below.

Vinnytsia (Northeast) mineral raw material district (I) covers the northeastern regions of Khmelnytskyi and the central, northern and eastern regions of

the Vinnytsia region (Fig. 2). The district is located on the southwestern outskirts of the Ukrainian Shield (West Dnieper reservoir-denudation altitude on Precambrian rocks and Gaysyn accumulative-denudation plain), which determines the species composition of the mineral resources of the territory. The main raw materials here are mainly granitoids of the Archean-Proterozoic complex (granites, granodiorites, migmatites, blackheads), which are used as rubble and roll. The share of construction stone dominates the mineral balance of almost all administrative districts of the territory. In addition to the building stone, clay rocks are distributed in the northeast mineral resources bunch as raw materials for building ceramics, construction sand, facing stone, peat, and brown coal. Specific types of raw materials, typical only for the bunch, are primary kaolins formed on granites, and graphite, garnet, pelicanite, phlogopite, mineral radon water. They are all also related to the foundations of the platform.

Within the area there are two bunches: Kozyatyn-Illintsi and Zhmerynka-Kalynivka and Shepetivka bunch.

*The Kozyatyn-Illintsi macrobunch* covers the northeastern regions of Vinnytsia region: Kozyatyn, Pogrebyshe, Lipovets, Illintsi and northern Kalynivka. The extreme northern part of the bunch (north of Kozyatyn district) is occupied by *Kozyatyn bunch*. The decisive role here is played by compactly located deposits of primary kaolins. It focuses on the largest kaolin deposits of Podillya: Velyki Gadomyntsi, Glukhivets and others of interstate importance. High quality of kaolin raw materials, large reserves, compact location of deposits, favorable conditions of the domestic and foreign markets make it necessary to specialize the region for its extraction, enrichment and processing. Kaolin deposits are classified as class B (raw materials with average complex forming ability). Within the scale, a large deposit of interstate cladding granites (Zhezheliv) is being exploited, and a large deposit of silicon mineral water (Kozyatyn), classified as class A.

On the territory of bunches there are also perspective deposits of pelicanites (in the north of the Kalynivka district) and opal awaiting development, many granitoid deposits (especially in the Kalynivka district), which are being developed for rubble and roll. In the Lypivtsi district, the Turbiv kaolin deposit has been developing for a long time. Thus, due to its mineral-specialization, the Kozyatin-Illintsi complex macroscale can be considered as one of the most promising in the region. Mineral raw material resources serve as the basis for the functioning of a small Glukhiv-Turbiv mining hub with a distinct mineral-mineral orientation. The deposits of the Glukhiv-Turbiv kaolin bunch are basic (by geologi-



cal regionalization), which have been the object of intensive exploitation for a long time. The mining hub specification is the extraction and processing of kaolin raw materials. There are such powerful enterprises as Turbiv Kaolin Plant, which supplies kaolin concentrate for filling rubber, artificial leather and for pesticide production and one of the most powerful in Ukraine - Glukhiv kaolin mill (extraction of kaolin for porcelain, chemical, light and ceramic) production of cable, rubber, ultramarine, refractories, perfumes); in addition, a shortage-sparse concentrate is produced at the plant from the main production screenings. Within the boundaries of the mining hub, the only quarry of facing granite is being exploited in Vinnytsia, which is being developed by Zhezheliv deposit, as well as a number of quarries that produce crushed stone and rubble stone from granitoid rocks in the Kalynivka district.

In the near future, the share of enterprises, focused on mineral raw materials in the structure of mining hub may increase, and its bunch will significantly expand because of the commissioning of certain deposits of pelicanites (decorative stones, raw materials for the production of low-temperature high-speed glass-fiber cement, crushed stone, cement) in Pohrebyshche, Kozyatyn, Khmilnyk districts as well as a positive solution to the issue of extraction associated with the pelicanites of highly decorative opal of the Talalaiv deposit.

The capacity of the kaolin-mining industry can be significantly increased in the near future after the commissioning of the large Velyki Hadomyntsi deposit, which is fully prepared for development and is characterized by high quality of raw materials, suitable mainly for the production of expensive chalk paper. There is also a powerful reserve of explored kaolin deposits. In general, the future expanded mining hub has virtually unlimited capacity to replenish the kaolin concentrate of the domestic market and its export. It may also include operating companies located in the neighborhood in the Kalynivka district of the only explored in Ukraine deposits of garnet stone (valuable abrasive raw materials) - Slobidka and Ivanivka.

*Zhmerynka-Kalynivka macrobunch* occupies the territory of Zhmerynka, Vinnytsia, northern part of the Tyvriv and southern part of Kalynivka districts. Within its limits it's possible to distinguish three small bunches: Zhmerynka, Vinnytsia and Kalynivka.

Granite rocks of Demydiv, Volodymyrivka, Brailiv and other deposits, suitable for production of rubble, are compactly located in *Zhmerynka bunch*. Only the large Demydiv field is being developed. The Riv limestone is also being exploited field for lime nearby. Also known are the few deposits of limestone-ameliorants and deposits of raw materials for building ceramics.

A similar specialization of raw materials is typical of the *Kalynivka bunch*: it is dominated by compactly concentrated granitoid deposits with significant reserves, suitable for the production of rubble (Ivaniv, Pysarivka, Cherepashyntsi, etc.). Most of them are being operated. Numerous deposits of forest loam are among the building materials. In addition, there is the only known in Ukraine exploited deposit is Slobidka, which is rich in garnet (class B according to the complex forming ability [23]); garnet is also found in the neighbouring Ivaniv garnet deposit, which is being exploited for rubble.

*Vinnytsia bunch* is characterized by numerous deposits of migmatites, gneisses and charnokites, suitable for the production of rubble, clay raw materials for building ceramics and sandy raw materials, located near the regional center. Much of the field is being developed.

The Lukashivka deposit and the Tyazhyliv deposit of silicon mineral waters near Vinnitsia (both fields are of national importance) can be considered as promising. Kalynivka and Vinnytsia bunches are complex territorial mineral resources structures. The high level of territorial concentration of the same types of fields in the bunches opens favorable prospects for their joint exploitation, use of common access roads, sources of energy and water supply, use of waste, etc. The Vitava deposit is somewhat separated within this macrobunch of granitoids (Tyvriv district), which is being developed by Gniyan Quarry.

*Shepetivka (or Shepetivka-Polonne) complex bunch* covers the eponymous districts and is characterized by significant concentration of deposits of granitoids (granites, granodiorites, gneisses) here, the share of which sharply prevails over other types of raw materials (Klymentovyshi, Sudylykiv, Polonne etc.). The deposits are characterized by a high degree of development and they are mainly developed for rubble. Deposits of highly decorative defects for facing needs have not yet been identified (except, perhaps, the Sudylykiv deposit, whose granodiorites are recognized as suitable for the production of facing blocks).

A group of very densely concentrated deposits of primary kaolins (Maidan-Villa deposits, Polonne, etc.) is a specific mineral raw material of the bunch. Deposits are not characterized by high levels of development and are of local importance. Burtyn graphite deposit and refractory clay deposit of the same name have been discovered within the bunch. The first of these has an interstate value and good prospects for exploitation in the near future. There are also known deposits of raw materials for building ceramics, peat, as well as two deposits of radon water (Polonne and Shepetivka), which are not being developed and can have complex-forming sig-

nificance. Other types of raw materials of the bunch are of local importance.

On the basis of the complex Shepetivka-Polonne bunch, the mining hub of the same name was formed and operates now. Its specialization is defined by the kaolin raw materials extraction and processing enterprises. There is a whole network of diversified businesses enterprises, focused on the production and consumption of primary kaolins. Operations of the Maidan-Willa group of deposits are undertaken by such enterprises as Maidan-Willa Combine of Refractories Ltd and state enterprise Burtyn Refractory Plant, state enterprise Polonne Mayak Plant, whose products are refractory bricks and fireclay powder, as well as commercial structures, Polonne Porcelain Factory Ltd, etc. The kaolin concentrate is used by the Poninkiv Cardboard and Paper Factory and until recently by the Polonne Factory of Artistic Ceramics. In addition, it should be said that a number of primary kaolin deposits are included in the neighborhood of Zhytomyr region, which are included in the kaolin district described in the Dubrivka-Khmelivka district. Baranivka Porcelain Factory has been functioning on its basis, until recently several porcelain and earthenware enterprises in Baranivka district of Zhytomyr region were operating, which should be considered (together with Khmelnytskyi) as a part of a single mining hub of mineral - raw material orientation.

In the future, after the completion of the Glukhiv-Turbiv mining hub, a large multi-sectoral complex may be formed that will unite the two characterized structures (Glukhiv-Turbiv and Shepetivka-Polonne mining hubs), as well as the neighboring Slavuta mining hub. Thus, in the northern regions of the Khmelnytskyi and Vinnytsia regions, a large territorial-industrial association with a distinct mineral-raw orientation is being formed.

**The Khmelnytskyi mineral resources district (II)** covers the northern regions of Ternopil and the central and northwestern of Khmelnytskyi Region and corresponds to the Khmelnytskyi structural and denudation heights, the Kremenets gorgory and Slavuta alluvial-glacial glacier. The main mineral resources here are raw materials for construction and coarse ceramics and expanded clay, represented by quaternary loam and neogene clays, as well as construction sands and peatlands of quaternary age. The specific raw materials of the area are construction chalk, saponites, glaukonite and granular phosphorites, which have been intensively explored in recent years. Small deposits of limestone-ameliorants and mineral waters of sodium chloride type are also known. We distinguish Shumsk-Kremenets macrobunch and Slavuta bunch within the district.

*The Shumsk-Kremenets macrobunch* covers the Kremenets, Shumsk, northern Lanivtsi districts of Ternopil and Bilogiria districts of Khmelnytskyi regions. The decisive specificity of macrobunch is the increased concentration of peat fields, which occupy large bunches and are often interconnected. Deposits of brown coal and construction chalk are typical for this bunch. Construction sands are widespread (especially in the Bilogiria district). Mainly peat deposits, periodically - small sand deposits and the only cretaceous deposit (Pidlissti) are used. Mineral resources of the macrobunch are locally relevant and not complex forming. The prospects for the newly discovered granular phosphorite deposits in the northern regions of Ternopil and Khmelnytskyi regions are being evaluated.

The peculiarity of the *Slavuta bunch* (Slavuta and northern Izyaslav districts) is that there are almost no deposits of crystalline shield rocks used as a building stone and are crucial for the neighboring Shepetivka bunch. The only Mukhariv deposit of pink granites suitable for cladding is known. The characteristic mineral resources of the Slavuta bunch are, above all, numerous deposits of construction sands, which are very compactly concentrated in the southwestern part of the Slavuta and adjacent bunches of Izyaslav districts. Sand fields are characterized by considerable reserves and various purposes (for building mixtures, silicate bricks, concrete, road pavements, etc.) and are being intensively exploited. Specific raw material for the bunch is the recently discovered deposits of *saponites* - valuable agrochemical raw materials (code B-IIb according to [23]). In addition, within the bunch a few deposits of raw materials for construction ceramics and a large deposit of clay (Kryvyn) are being explored, suitable for cement production. Agrochemical and cement raw materials of the Slavuta bunch have average complex-forming properties, so the bunch can be considered complex.

On the basis of the fields of Slavuta bunch, a small mining hub was formed, mainly of a construction direction. Large reserves of sandy raw materials of various purposes, and very tightly concentrated, which contributes to their efficient operation, have become the basis for the functioning of a number of enterprises focused on the production of construction profile products: Slavuta plant "Budfarfor", Slavuta plant of reinforced concrete products, factory glassware (the last two are not currently working). In addition, there are several brick factories operating within the Slavuta mining hub, the Slavuta saponite raw materials workshop. In the future, it is expected to expand the extraction of mineral raw materials primarily agrochemical purposes (saponites, granular phosphorites) with average complex-forming activity and nationwide value, so it is pos-

sible to predict the increase of industrial potential of mining hub by investing funds in the construction of new products and development and phosphoric flour, production of mineral fertilizers, compound feeds, etc.). Certain perspectives of the district are associated with the development of the Kryvyi Rih clay deposit for the cement industry and the Mukhariv deposit of facing granites, which, after further exploration, may be of national or even interstate importance.

**The Zbarazh-Pischanka (Tovtry) mineral resource district (III)** extends as a stripe from the northwest to the southeast through all Podillya district (Fig. 2). The bunch completely covers Tovtry ridge within the Ternopil and Khmelnytsky regions (Podilski Tovtry) and from Kamianets-Podilskyi continues in the east, then in southeastern directions all the way to Pischanka and Chechelnik districts of Vinnytsia region (Murafski Tovtry). The main raw materials within the bunch are miocene limestone, mainly sarmatian tier: oolitic, detrital, reef, often recrystallized. Limestone is primarily used as saw stone, raw materials for calcining lime, sugar mills, cement, construction (rubble and rubble) industry. Types of raw materials that are of subordinate importance in the bunch are construction sands, clay rocks for building ceramics, limestone ameliorants. Within the bunch there are such specific resources as mineral waters Zbruchansk Naftusia, sodium chloride and others, which have complex-forming significance. On the territory of the district we distinguish three macrobunches: Zbarazh-Pidvolochysk, Kamianets-Podilsky-Chemerivtsi and Sharгород-Pischanka.

*Zbarazh-Pidvolochysk polycomponent macrobunch* is located on the territory of the eponymous districts, also covers the northern part of the Ternopil district. Within it, two bunches are clearly distinguished: 1) Ternopil, mainly monocomponent, group, represented by numerous miocene deposits of construction sands, very compactly located, some of which are operated; 2) Galushchyntsi-Maksymivka, also mainly monocomponent and group, located in Zbarazh and Pidvolochysk districts. Several large deposits of miocene age limestone are concentrated here, which are used as building stone, raw materials for lime, flux raw materials (Galushchyntsi and Maksymivka), raw materials for sugar mills (Polupanivka, Novosilka), liming of acid soils.

*Kamianets-Podilsky-Chemerivtsi polycomponent macrobunch* is also quite clearly differentiated into two bunches: 1) *Kamianets-Podilskyi*, which occupies mainly the northern part of the eponymous and adjacent section of Chemerivtsi districts. The main mineral raw material here is miocene age limestone, suitable for use in cement production (Humentsi deposit) - class B in complex-forming

capacity, for calcining lime (Nigyn-Verbka, etc.), sugar mills (Verbka, Nigyn-Verbka etc.) as ameliorants, raw materials for the production of rubble (Kyzhelivka, etc.). Limestone deposits are mainly large and medium-sized, well-developed; 2) *Chemerivtsi*, located in the northern part of the district and represented by compactly concentrated deposits of limestone for sugar mills (Lysogirka, Karachivtsi, etc.), lime production (Zakupne, Kovalivka, etc.), limestone-ameliorants, sawdust and limestone. Nearby - in Husyatyn and Gorodok districts there are unique Novozbruchansk and Zbruchansk mineral water deposits of the type Zbruchansk Naftusia, which have complex-forming significance.

On the basis of macrobunch, the same-named mining hub is formed, the basis of which is a series of mining enterprises producing products for the construction industry and several enterprises consuming mineral resources (Ukrtsukoramkin Association, Podilsky Tovtry, Zakupnyansky quarry, Nigynskyi quarry, Zubrivsk quarry, which produces crushed stone for the Kamenets-Podilsky plant of building materials, etc.).

Several mining enterprises in the Borshchiv district of the Ternopil region, which develop silurian limestones for road-building needs, should be included in the structure of the mining hub described. The Ternopil quarry here exploits the Brodok Right Bank deposit, the Burdyakiv special career - the Brodok Left Bank, and Skala-Podilsk - the deposit of the same name. Quarry products are crushed stone and rubble stone. Gipsovik produces sawstone at Teremtsiv field of limestone, and also develops gypsum deposits of Kudryntsi deposit for the needs of cement production. Within the mining hub there is a powerful cement plant (Closed Jointed-Stock Company Podilsky Cement), which uses the raw materials of a large complex of the Gumentsi deposit (limestones, clays). In addition, there are several sugar mills within the borders of the mining hub, about a dozen small brick mills, Commercial Firm Zakupnyansky inter-farm feed mill (the latter is a potential consumer of limestone for feed additives that are not being developed), Kamianets-Podilskyi bitumen plant operates within the described territorial association.

Expansion of the mining enterprises' network in this territory by putting into operation the explored reserves of carbonate raw materials is kept by the need to preserve the unique landscapes of Podillya Tovtry, where almost all quarries or deposits of raw materials for the sugar, cement and other industries are located. In addition, the opening of new mining enterprises will worsen the ecological status of the Sataniv-Makiv territorial recreation complex, whose territory overlaps with the area described by the

mining hub. Therefore, to consider the prospects of expanding the mineral base of mining hub, in our view, is inappropriate, and the planning of prospecting for the identification of new sources of raw materials for the sugar and cement industries should be carried out in other areas [19].

A small bunch, represented by several large deposits of saw limestones, limestones for lime production and limestones of the sarmatian age, stands to the east of Dunaivtsi town. Deposits are not being developed. Minor travertine deposits are also known here.

*Shargorod-Pischanka macrobunch* covers the territory of Shargorod, Tomashpil, Kryzhopil and Pischanka districts of Vinnytsia region. Within it, two deposits are clearly distinguished: Shargorod and Pischanka.

A feature of the *Shargorod bunch* is the sharp predominance of sarmatian limestone (sawdust) limestone deposits on its territory (Derebchyn, Sapezhanka, etc.). Most of the fields are developed underground, but there are opportunities for the introduction of separate fields and open mode of operation. All fields are concentrated very compactly, which creates favorable conditions for their joint development. Along with the deposits of the tess limestones, there are insignificant reserves of limestone deposits for lime, limestone-ameliorants, for sugar mills, limestones and granites for the production of rubble. The bunch is classified as a group bunch.

Within the *Pishchanka bunch*, the sarmatian tier limestone deposits, which are intensively exploited (Dmytrashkivka, Dmytrashkivka-Trudove, etc.) also prevail. However, unlike the Shargorod bunch, there are large reserves of limestone for sugarmaking (Studenivka deposit). Small deposits of limestone for lime and land reclamation, as well as small deposits of building sand and clay raw materials for building ceramics have also been explored. All deposits of the bunch are classified as class B [23].

In the future, it is likely that a small polycomponent bunch will be formed in the Tomashpil district, where two large Tesso deposits (Stina-Rusava and Stina) are now explored in detail; next to the previously explored Vyla field of limestone for sugar mills, there are also known insufficiently studied deposits of sandy raw materials, small deposits of limestone for reclamation and rubble. All deposits are compactly located in the western part of the district, and refer to class C [23].

***Chortkiv mineral resources district (IV)*** is similar to Khmelnytskyi and is located west of Tovtry strand. The area covers the watershed sections of the river basins of the Zolota Lypa, Koropets, Strypa, Seret and generally coincides with the Ternopil structural-denudation height. Typical

rocks for this area are loam and clay quaternary and neogene age, which are used as raw materials for construction and rough ceramics, expanded clay and agglomerate raw materials. Quaternary peat deposits, which are widespread mainly in Zboriv, Ternopil, Terebovlya and Kozova districts, are also characteristic. In the district there are also common building sands, facing stone, marls of cretaceous age. Sulfide and other types of mineral waters, which are complex-shaped and explored in the Terebovlya district, Konopkivka sulfur manifestation in the same area, phosphorites in the Buchach district may be considered as specific raw materials for the area. The deposits of loam and other raw materials are distributed over the territory of the district more or less evenly and do not form significant clusters, that is, the area according to the internal structure can be considered as elementary, in the presence of complex-shaped mineral resources deposits-complex.

***Berezhany-Monastyrysk (V) (Western mineral raw-material district)*** is only partially located in the Ternopil region and covers its extreme western part and generally corresponds to the western part of the Opillia structural-denudation height. In the area, the dominant minerals are limestones and marls, mainly badenian, rarely turonian. They serve as raw materials for the cement, sugar and lime industries. Loams (raw materials for building ceramics), small limestone deposits for the production of rubble are also widespread within the district. Jurassic dolomites - raw materials for the glass and metallurgical industry of national importance (code C-IIa) and sand for glass production (C-IIc) can be considered as specific raw material of the area [23]. The area can only be considered relatively complex - fossils with medium complex-forming properties are small reserve deposits of cement raw materials, the industrial prospects of which are not defined. Two large mineral-bearing bunches stand out: Berezhany and Monastyrysk.

*Berezhany bunch* is located on the territory of the eponymous district. It is characterized by a dense concentration of deposits of carbonate raw materials - limestones and marls for burning lime (Pidvysoke, Berezhany, Volytsia, etc.), cement (Verbiv, Lapshyn, Posukhiv) and sugar (Potutory). With the exception of Pidvysoke, not all fields are currently being developed. Within the bunch, significant deposits of construction sands (Berezhany, Volytsia, etc.) and a small Rogachyn deposit of glass sands of national importance are also discovered, and other mineral resources of Berezhany bunch are of local importance.

The main mineral raw materials of the *Monastyrysk bunch* are also rocks suitable for the needs of the cement industry - the only one, taken into ac-

count by the State Balance, the Bertnyky limestone deposit and the previously explored complex Grygoriv deposit. Nearby are limestone deposits suitable for lime production, reclamation, large Goncharivka and other deposits of raw materials for building ceramics, small, poorly studied deposits of construction sand. In addition, a large dolomite deposit of Korzhiv suitable for the glass and metallurgical industries is being developed here. Dolomites are exported outside the area and identified by the code (C-IIa) [23].

**Borshchiv-Yampil (Podnistrovskiy) mineral-raw material district (VI)** stretches as a stripe along the left bank of Dniester river from Monastyrsk district in Ternopil region till Yampil in Vinnytsia and in general coincides with Prydnistrovska structure – denudation and Mohyliv-Podilskiy denudation highs. Northern boundary lies approximately on the line Buchach – Borshchiv. The characteristic mineral resources of the region are ancient proterozoic and paleozoic rocks (sandstones, limestones, granites, blacks, etc.), which are deposited in deep-cut valleys of the Dniester and its left tributaries and used as building stones (mainly rubble and roll). These include deposits of red-colored devonian sandstones in Buchach district, vendian sandstones in Mohyliv-Podilskiy, Murovani-Kurylivtsi and Yampil districts, silurian limestones in Borshchiv and Kamyanets-Podilskiy, crystalline rocks in Mohyliv-Podilskiy, Chernivtsi and Yampil districts. There are also known sarmant limestones for lime, building sands, raw materials for building ceramics. Specific to the area are primarily rich deposits of baden gypsum and anhydrite in Borshchiv and Kamyanets-Podilskiy areas, deposits of sand-gravel mixtures from alluvial deposits of the Dniester in Zalishchyky, Kamyanets-Podilskiy and Yampil districts, abrasite and abrasite deposits raw materials (formation flakes) - Grynchuk deposit in Kamyanets-Podilskiy district. Complexes forming deposits should be considered to be the deposits of sodium chloride-mineral waters of the Mirgorod type, explored in the Mohyliv-Podilskiy district and bromine chloride-sodium waters, the deposit of which is known near Kamyanets-Podilskiy, and its manifestations – in Buchach district.

No clear deposits and macro-deposits were found within the area. Deposits of mainly construction materials are spread over the area more or less evenly. Some of their accumulations can be noted in the northern part of Borshchiv district, where several deposits of silurian limestones, suitable for rubble and roll, are compactly located; numerous manifestations of trembling in the Mohyliv-Podilskiy district are tightly concentrated; there are several small granitoid deposits in Chernivtsi district of Vinnytsia region and a number of other small deposits of con-

struction materials. Mineral waters of Mirgorod type and bromine chloride-sodium are identified by the code (B-IIb) [23]. Crystalline rock deposits for construction purposes can be of national (with significant reserves) value. Other types of minerals in the area (except for the small Grynchuk field of flint deposits that are being exported) are of local importance.

In the neighboring districts of the Khmelnytskyi and Vinnytsia regions, the *polycomponent macrobunch (Nova Ushytsia)*, which occupies the territory of Nova Ushytsia, Murovani-Kurylivtsi, part of Kamyanets-Podilskiy, Vinkivtsi, and Mohyliv-Podilskiy districts, and partially occupies the territory of Podnistrovsk, Tovtry and Khmelnytskyi area. The peculiarity of macro-bunch is the presence of numerous deposits and manifestations of phosphorites - specific and granular. Within the macrobunch, glauconite and apatite deposits are also known, that is, the specificity of the territory lies in the accumulation of mainly agrochemical raw materials here, which is not currently being developed, but which we have referred to as strategic (apatites, phosphorites) [23, 25] and in the future, after a detailed assessment can get a nationwide importance.

On the basis of the resources of the agrochemical raw materials of the Nova Ushytsia macrobunch, it is possible to predict the formation of a mineral-raw material orientation in the future mining hub especially since the Bakhtyn deposit of the fluvial spar – strategic raw material is explored in the areas of the macrobunch in the Murovano-Kurilivets region. Formation of a small mining hub here may begin in the near term with the introduction of this scarce raw material deposit (code C-IIc) into operation in Ukraine. A comprehensive approach to the extraction and processing of fluorite raw materials involves the construction of a mining and processing plant that will produce fluorite, feldspar and quartz concentrates. For recycling quartz concentrate can also be built factories of glass and silicate brick.

The basis for the formation of the three resort and recreation hub allocated by us within the Podillya region were first of all the rich mineral and mineral waters discovered here, as well as other favorable factors – climatic, ecological-geomorphological, landscape, cultural-historic, etc.

For example, a small Konopkivka mining hub was formed on the basis of the Konopkivka sulfide water deposit in the Terebovlya district of Ternopil region. Here there is a sanatorium "Medobory" in the village Konopkivka, a health complex for agricultural workers in the village. Nastasiv and Mykulyntsi water treatment hospital (on the basis of therapeutic mud deposits near Mykulyntsi village). All health resorts specialize in the treatment of diseases of the muscle skeletal system, peripheral

nervous system, skin. There are also several water displays located near Mykulyntsi (Sorotske, Kozivka, etc.). Significant predicted sulfide water resources and favorable environmental conditions make it possible to positively evaluate the prospects for the development of resort and recreation hub.

The great resort and recreation hub (Sataniv-Makiv) Formation is based on the development of the unique mineral healing waters of the Zbruchansk Naftusia type of healing mineral water. The deposits are located in the Zbruch River basin in the Ternopil and Khmelnytsky regions and in the valley of the Muksha Dunavtsi and Kamianets-Podilskyi districts of the Khmelnytskyi region. The deposits are mainly complex and also contain waters with specific components: bromine chloride-calcium-sodium and mirgorod type. The latter are either currently unused or underused. Therefore, resort and recreation hub health resorts are generally focused on the use of Naftusia waters. On their basis, the preventive office of the Volochysk Machine building Plant (Volochysk field), sanatoriums in the village of Sataniv - "Tovtry", "Zbruch", "Berizka" (Zbruchansk field), sanatorium "Zbruch" in Husiatyn (Novozbruchanska), "Ukraine" in the village Makiv (Makivske field), sanatorium "Forest song" in the village Privorittia (Mukshyn field). On the basis of bromine waters of high mineralization of Kamianets-Podilskyi field there is a sanatorium "Podillya" and a health center in Kamianets-Podilskyi.

There are also plants working here for industrial bottling of medicinal and table mineral waters "Novozbruchanska", "Zbruchanska", "Tovtry", "Pearl of Podillya", table waters "Vilhivchanka", "Podolianochka", "Kamianets-Podilskyi", "Dariya" and others.

There are real opportunities in the area for expanding the wellness network primarily by making full use of the explored reserves of exploited fields and putting into operation reserve explored fields (Kamianka, Zaychykiv, etc.).

There is also an opportunity for expanding the range and enlarging the production capacity of industrial bottling plants for medical and natural water. Unique combination of landscape and climatic conditions of Podilski Tovtry, therapeutic properties of several types of mineral waters, ecologically clean territory and other favorable factors (creation of Tovtry resort with special investment regime) allows to predict further expansion and branching of functional structure, functional transformation of the leading resort areas in Ukraine and gaining international status in perspective.

The third small resort and recreation hub (Khmilnyk) was formed on the basis of two radon water deposits in Khmilnyk district of Vinnytsia region - Khmilnyk and Novokhmilnyk. The waters

of the fields are used by the Khmilnyk sanatorium, the Central Khmilnyk Military Clinical Sanatorium, the Podillya inter-economic sanatorium, the Road Clinical Hospital No. 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 is possible in the future on the basis of the Nemyriv radon water field in Vinnytsia region, the operation of which has recently started by the "Avangard" sanatorium (the field is characterized by high reserves - more than 400 m<sup>3</sup>/day [8]), as well as in Shepetivka and Polonne districts of Khmelnytskyi region after commissioning of the same name deposits. At present, the radon waters of the Shepetivka field are being used in a small amount by the Shepetivka City Hospital.

### **Conclusions.**

1. The main constituents of the component structure of the Podillya mineral raw material resources are the various types of construction materials. Agrochemical and technological raw materials are of subordinate importance.

2. Mineral raw material base of Chortkiv, Tovtry and Western mineral resource districts are made up of virtually several types of construction materials (except for valuable mineral deposits). First of all, it is limestone for the production of lime, cement, sugar, construction stone and raw materials for building ceramics. In the Khmelnytskyi district, several types of mineral resources are also sharply dominated: raw materials for building ceramics and expanded clay, building sands and peat. In the five administrative districts, 1-2 types of mineral raw materials were explored. The Vinnytsia district is characterized by the predominance of granitoids used as rubble stone and roll. The share of construction stone dominates the mineral balance of almost all administrative districts of the territory. Loam as raw material for building ceramics, building sand, facing stone, peat, brown coal are also common. Thus, the area's resources are characterized by a very narrow spectrum of explored mineral raw materials, especially with significant reserves. Only four administrative districts differ in the availability of several (4 - 8) types of mineral raw materials.

3. In general, in the structure of the mineral raw material resources of the region, the most significant is the proportion of construction stone, which is three times larger than the share of such raw materials as cement, limestone for lime, brick-tile.

4. Distinctive mineral resources regions are characterized by a well-defined set of basic and specific (characteristic only for this area) types of mineral resources and a distinct genetic connection of

the latter with individual stratigraphic units (groups, systems, divisions, tiers) and structurally - geomorphological taxaones of the territory. All selected areas (except Chortkiv and Podnistrovskiyi) are of mixed type.

5. Most of the territorial structures of the mineral raw material resources in the region are complex and only a few are classified as grouped.

6. Within the region, multicomponent concentrations of mineral deposits and deposits dominate, in which raw materials for the construction industry most often play a dominant role.

7. In the future, the importance of specific mineral resources, which now play a subordinate role in the districts, will increase. These include raw materials such as kaolin, graphite, garnet, pelicanite, phlogopite and fluorite (strategic raw material) for Vinnytsia, chalk, glauconite (as a unique natural sorbent), apatite, saponite and granular phosphorites - for Khmelnytskyi, flux and glass raw materials - for the West, gypsum, anhydrite and phosphorites - for the Podnistrovskiyi region.

8. According to the degree of industrial development of the existing explored reserves of the mineral resources, mineral raw material resources of Podillya belong, according to the classification [3], to the first (20-30%) and second (30-40%) groups.

9. On the basis of the explored deposits of solid mineral resources of the region, several mineral-oriented mining hubs were formed and are functioning now: Shepetivka-Polonno, Glukhiv-Turbiv, Slavuta and Kamianets-Podilskiyi - Chemerivtsi. In the long term, it is possible to form a Nova Ushytsia mining hub focused on the extraction and processing of agrochemical raw materials (phosphorites, apa-

tite, glauconite), as well as the merger of three mining hubs in the northern part of the Podillya region. In the near future, the formation of a small mining hub may begin, subject to the commissioning of the integrated Bakhtyn deposits of luorspar.

10. The fields of medicinal and medical-table waters of Podillya are basic for formation in the region of resort and recreation hub: Konopkiv, Sataniv-Makiv and Khmilnyk. The health-specificity of the latter is determined, first of all, by the properties of the mineral waters on the basis of which they function. The further expansion of the Sataniv-Makiv resort and recreation hub is projected with the prospect of creating a large resort of international importance. Formation of small blood vessels can be predicted after the beginning of development of radon mineral water deposits in the North-East region.

11. There is an urgent need to create cadastres of mineral resources at the regional level (regions, administrative districts, integrated territorial communities) in order to accurately assess their potential, determine priorities in the development of local mineral raw materials complexes, provide scarce mineral resources for the territories .

12. We consider that results presented in the article are only the first stage of the research. The next stages will include detailing the mineral potential of the region, in particular the balance, off-balance and forecast resources of minerals, the degree of deposits exploration, current and potential opportunities of their use within selected mineral areas which may serve as a basis for clarifying their boundaries or even the allocation of new structural units of the territory.

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**Authors Contribution:** All authors have made an equal contribution to this work.

UDC 911.9:553.04

**Myroslav Yakovych Syvyi,**

Doctor of Science (Geography), Professor, Head of the Department of Geography and its Teaching Methods,  
Ternopil National Volodymyr Hnatyuk Pedagogical University,  
2 Maxyma Kryvonosa St., 46027, Ternopil, Ukraine,  
e-mail: [syvyjm@ukr.net](mailto:syvyjm@ukr.net), <https://orcid.org/0000-0002-3150-4848>;

**Serhij Wolodymyrowych Hulyk,**

PhD (Geography), Lecturer, Department of Geography and its Teaching Methods,  
Ternopil National Volodymyr Hnatyuk Pedagogical University,  
e-mail: [ser\\_gul@ukr.net](mailto:ser_gul@ukr.net), <https://orcid.org/0000-0001-8415-8304>;

**Petro Mychailovych Demyanchuk,**

PhD (Geography), Associate Professor, Department of Geography and its Teaching Methods,  
Ternopil National Volodymyr Hnatyuk Pedagogical University,  
e-mail: [dempetrom@gmail.com](mailto:dempetrom@gmail.com), <https://orcid.org/0000-0003-4860-7808>

**THE REGIONALIZATION OF PODILLYA TERRITORY (TERNOPIL,  
KHYMLNYTSKYI AND VINNYTSIA REGIONS) BY MINERAL RESOURCES**

**The aim of the study.** Using the latest data of Geoinform of Ukraine, to carry out economic and geographical zoning of the territory of Podillya by mineral resources in order to identify spatial and temporal and dynamic patterns of concentration of mineral deposits, their place and role in the economic complex of the region, substantiation of proposals for optimization of its structure and optimization.

**Research results.** Within the Podilskyi macrodistrict, six mineral-raw areas were distinguished: Vinnytsia, Khmelnytskyi, Tovtry, Chortkiv, Western and Podnistrovskyi. All districts (except Chortkiv and Podnistrovskyi) are of a complex type, that is, mineral resources are concentrated within their limits in the form of macrobunches, deposits, separate deposits. In particular, it is established that the main components of the component structure of mineral resources of Podillya are different types of construction materials. Agrochemical and technological raw materials are of subordinate importance. The isolated mineral resources are characterized by a well-defined set of major and specific (area-specific) mineral resources and a distinct genetic link between the latter and the individual stratigraphic and structural-geomorphological taxones of the territory. Most territorial structures of the region's mineral resources are complex and only a few are classified as grouped. Within the region, multicomponent concentrations of mineral deposits and deposits dominate, in which raw materials for the construction industry most often play a dominant role. On the basis of the explored deposits of solid mineral resources of the region, several mineral-oriented mining hubs were formed and are functioning: Shepetivka-Polonne, Glukhiv-Turbiv, Slavuta and Kamianets-Podilskyi - Chemerivtsi. The fields of medicinal and medical-table waters of Podillya are basic for the formation in the region of territorial and recreational complexes: Konopkiv, Sataniv-Makiv and Khmilnyk.

**Scientific novelty.** Own interpretation of such territorial structural unit of mineral resources as an area is given, regionalization of Podillya territory by combinations of mineral resources is carried out for the first time, the set of basic and specific (peculiar to this area only) types of mineral raw materials and a distinct genetic link of the latter with separate stratigraphs are established - geomorphological taxons of the territory, which are separately formed on the basis of combinations of mineral resources, mining sites and their specificity was outlined.

**Practical importance.** Economic and geographical zoning of the Podillya area by mineral resources is conducted which will help to form a reliable, holistic view of the actual resource potential of the region and to plan and conduct on this basis by local administrative bodies aimed at optimizing the structure of the present mineral resources and raw materials.

**Keywords:** mineral resources, economic and geographical regionalization, raw mineral resources, construction materials, mining units.

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