Journal of Geology, Geography and Geoecology

Journal home page: geology-dnu-dp.ua

ISSN 2617-2909 (print)
ISSN 2617-2119 (online)

Journ.Geol.Geograph.
Geology,
29(4), 637–646.
doi: 10.15421/112057

World mineral deposits in the table of periodic chemical elements

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Received: 06.03.2020
Received in revised form: 02.06.2020
Accepted: 21.08.2020

Abstract. The distribution of mineral deposits and the distribution of chemical elements on the globe are characterized by heterogeneity. A wide range of publications of domestic and foreign specialists - geologists, geographers, geochemists, economists - were dedicated to mineral resources of the world, mineral deposits. During processing the material the comparative-geographical, cartographic (analysis of minerals maps, mineral resources in the context of continents and regions of the world, cartographic interpretation of Mendeleev periodical table), monographic (analysis of fundamental works of leading domestic and foreign geologists and resource scientists, geologists and geologists, and geologists and geologists) directories, multi-volume editions devoted to geology and mineral resources of individual countries and regions of the world) methods, systematic approach, and GIS technologies - all these were used for received data processing and systematization. Explored mineral deposits (current and potential) form on the planet both individual local deposits and geochemical zones – areas where economically valuable chemical elements and their compounds are concentrated, which are diverse in genesis, stocks, and possibilities of exploitation. The largest of the latter is the Appalachians in the US - the Western Hemisphere, the Highveld in South Africa, Khibiny and the Ural Mountains in Russia - the Eastern Hemisphere. The leading countries in which most geochemical resources are extracted from the subsoil are the United States (65% of the total elements of Mendeleev periodical table), Russia (48%), China (38%), Canada (38%), South Africa (30%), Australia, (27%), Kazakhstan (19%), India (14%), Mexico (13%). The ideas about the level of provision of mineral resources and minerals in individual countries and territories of the world were systematized. The Mendeleev periodical table and its mineral and raw content were presented as an objective factor in the international geographical distribution of labor. The illuminated issues are confirmed high density of interdisciplinary links (geology, geography, chemistry, geochemistry, ecology, economics, regional studies, zoning).

Keywords: mineral and raw resources, minerals, countries and territories, system of chemical elements, Mendeleyev periodical table, deposits, mapping and structural-logical models

Світові родовища корисних копалин в періодичній системі хімічних елементів

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Анотація. Поширення родовищ корисних копалин та розподіл хімічних елементів на земній кулі характеризується неоднорідністю. Мінерально-сировинним ресурсам світу, родовищам корисних копалин присвячений значний масив публікацій вітчизняних та зарубіжних фахівців – геологів, географів, геохіміків, економістів. При опануванні матеріалу використовувались порівняльно-географічний, картографічний (аналіз карт корисних копалин, мінерально-сировинних ресурсів в розрізі материків і регіонів світу, картографічна інтерпретація таблиці Д.І. Менделєєва), монографічний (аналіз фундаментальних праць провідних вітчизняних та зарубіжних геологів та ресурсознавців, геологічних та мінерально-сировинних довідників, багатотомних видань, присвячених геології та мінерально-сировинним ресурсам окремих країн та регіонів світу) методи, системний підхід, при обробці та систематизації даних застосовувались ГІС-технології. Розвідані родовища мінеральної сировини (актуальні й потенційні) утворюють на планеті як окремі локальні поклади, так і геохімічні пояси – ділянки, де сконцентровані економічно цінні хімічні елементи та їх сполуки, різноманітні за генезисом, запасами, можливостями експлуатації. Найбільшими з останніх є: Аппалачі в США – західна півкуля, Високий Велд в ПАР, Хібіни та Урал в Росії – східна півкуля. Країнами-лідерами, на території яких з надр видобувається найбільше геохімічної сировини, є США (65% загальної кількості елементів таблиці Менделєєва), Росія (48%), Китай (38%), Канада (38%), ПАР (30%), Австралія (27%), Казахстан (19%), Індія (14%), Мексика (13%). Систематизовані уявлення про рівні забезпечення мінерально-сировинними ресурсами та корисними копалинами окремих країн та територій світу. Таблицю Д. І. Менделєєва та її мінерально-сировинне наповнення представлено у вигляді об'єктивного чинника міжнародного географічного розподілу праці. Висвітлена проблематика підтвердила високу щільність міжпредметних зв'язків (геологія, географія, хімія, геохімія, екологія, економіка, регіоналістика, районування).

Ключові слова: мінерально-сировинні ресурси, корисні копалини, країни та території, система хімічних елементів, таблиця Д.І. Менделєєва, родовища, картографічні та структурно-логічні моделі

Introduction. The idea and materials of this article were discussed by one of its authors with the acad. V.V. Skopenko back in 1994, whose constructive remarks were gratefully taken into account in this publication. The territorial distribution of mineral deposits and the distribution of chemical elements on the globe are characterized by heterogeneity. This heterogeneity is reflected by the following range of mineral resources in the territory: ***very low → low → medium → high → very high***. The extreme links of this range are, for example, Denmark (very low range of mineral resources) and South Africa (very high range of mineral resources). With regard to the three central links, mineral resources, for example, of Japan (low), Spain (medium), Kazakhstan (high), can correspond to them. For example, Ukraine occupies the third (middle) link in this range (Gursky, Yeysipchuk, Kalinin, 2006.). This publication serves as the objective basis for such assessments and aims to demonstrate a certain raw, energetic independence of the countries of the world as to supplying of the most important minerals (it demonstrates the "mineral-raw" filling of D. Mendeleev's periodic table).

Literature review. A huge array of publications by domestic and foreign specialists such as geologists, geographers, geochemists, economists - monographs (Beydik, Padoon, 1996; Gursky, Yeysipchuk, Kalinin, 2006; Lunev, Pavlun, 2013; Voyloshnikov, Voyloshnikova, 1991; Yatsenko, Kiptenko, 2009), encyclopedias and encyclopedic reference books (Biletsky, Boyko, Dovgy, 2004, 2007, 2013), laws, by-laws acts, certificates of copyright registration (State Service of Geology and Subsoil of Ukraine, 2016, February 29; Beydik, 2016, November 27), articles in scientific journals (Beydik, 2018, 2019) – were devoted to mineral-raw resources of the world and mineral deposits. On the other hand, D. Mendeleev's unique creation, his invention - periodic system of chemical elements is used for more than a century in numerous branches of the world economy. Filling the table's cells with qualitative characteristics, with examples of specific minerals globally, was one of the main tasks of this publication. The proposed material is positioned as an attempt of resource and geological, political and economic-geographical strengthening of D. Mendeleev's periodic table (Fig. 1), also demonstration of cross-curricular links in the study of geology, mineralogy, tectonics and geography. The map used a long, and the text - a short form of the table, although three forms of the Periodic Table of Chemical Elements are known: short (short-term), long (long-term) and ultra-long.

The purpose of the article is to provide a mapping and regional study interpretation of D. Mendeleev's periodic system of chemical elements and adapt it to systematize ideas about the distribution of minerals on the planet Earth (with a particular emphasis on the territory of Ukraine), using current ideas about the political map of the world and global geopolitical landscape, demonstration of the raw independence (or dependence) of the countries in the world.

Methods and methodology. In this section of the paper, we used comparative-geographical (analysis of the maps of minerals and mineral resources in the context of continents and regions of the world), cartographic (analysis of the world-wide deposits of major minerals, their cartographic interpretation of D. Mendeleev's table) (Fig. 2), modelling (structural-logical models building), monograph (analysis of fundamental works of leading domestic and foreign geologists and resource scientists, a geological and mineral resources reference books and dictionaries, multi-volume editions devoted to geology and mineral resources of individual countries and regions of the world) methods, systematic approach and modern computer technologies (Arc GIS Online, Adobe Illustrator CC). Making cartographic models we used both GIS technology and classical methods of cartographic imagine (badges, cartograms and charts).

Results and discussion. It should be noted that today 2200 minerals have been found on the globe, however, 10 of them are the most widespread in nature, and 118 elements are presented in the Mendeleev's table. The information in the table's cells was completed by data on the location of minerals or the consolidation of certain chemical elements in the continents and parts of the world by country. Invaluable minerals for human life, development of industry, science, technology, agriculture, have unevenly spread on the globe. Explored mineral deposits (actual and potential) form on the planet both individual local deposits and geochemical zones – areas where concentrated economically valuable chemical elements and their compounds (minerals and rocks), diverse in genesis (origin), reserves, exploitation opportunities. The largest of the latter is the Appalachians in the US – the Western Hemisphere, the Highveld in South Africa, Khibiny and the Ural Mountains in Russia – the

Periods	Groups of elements									
	I	II	III	IV	V	VI	VII	VIII		
I	^{1}H							^{2}He		
II	^{3}Li Chile, USA, China, Bolivia, Australia, Argentina, Canada	^{4}Be Brazil, USA, Argentina, India, China, Russia	^{5}B Turkey, USA, Argentina, Chili, Peru	^{6}C Chile, India, USA, Russia, Australia, South Africa, Angola, Germany, Sri Lanka	^{7}N	^{8}O	^{9}F China, Mexico, South Africa, Russia, Mongolia, France, Morocco	^{10}Ne		
III	^{11}Na USA, Chili, India	^{12}Mg Kazakhstan, Austria, Greece, Czech Republic, North Korea, China, Canada, Russia, USA	^{13}Al Australia, Brazil, Guinea, Russia, Transcaucasia, Kazakhstan, Slovenia, Suriname, Hungary, France, Jamaica	^{14}Si China, Brazil, USA, Norway, France, Russia	^{15}P Morocco, Kazakhstan, South Africa, USA, Jordan, China, Russia, Egypt, Nauru	^{16}S Ukraine, Russia, USA, Italy, Japan, Poland	^{17}Cl Germany, Spain, Russia, India, Poland, Ukraine	^{18}Ar		
IV	^{19}K Canada, Russia, Germany, Belarusian, USA	^{20}Ca USA, Germany, Austria, Italy	^{21}Sc Russia, China, Kazakhstan, Ukraine, Australia, Canada, Brazil	^{22}Ti Australia, South Africa, Norway, Canada, India, Brazil, China, Ukraine	^{23}V Russia, South Africa, Venezuela, USA, Kazakhstan, China	^{24}Cr South Africa, Kazakhstan, Zimbabwe, USA, India, Greenland, Finland, Albania	^{25}Mn South Africa, Ukraine, Kazakhstan, Georgia, Brazil, Gabon, Australia, Bulgaria	^{26}Fe China, Australia, Brazil, India, South Africa, Russia, Ukraine, USA	^{27}Co DR of the Congo, Cuba, New Caledonia, Zambia, Indonesia	^{28}Ni Canada, Russia, Australia, Cuba, New Caledonia
	^{29}Cu Chili, USA, Peru, China, Kazakhstan, Indonesia, Congo, Zambia, South Africa, Australia	^{30}Zn Russia, Australia, Kazakhstan, Canada, USA, China, India, South Africa	^{31}Ga USA, Great Britain, Italy	^{32}Ge USA, Canada, Bolivia	^{33}As USA, Sweden, Mexico, Japan, Bolivia	^{34}Se Kyrgyzstan, Russia, Congo, Bolivia, Germany, Argentina, Romania	^{35}Br Turkmenistan, Israel, Russia, Ukraine, Bulgaria	^{36}Kr		
V	^{37}Rb Canada, USA, Sweden	^{38}Sr Mexico, Canada, Spain, Great Britain, Italy, Argentina, USA	^{39}Y Sweden, USA, Italy	^{40}Zr Norway, Brazil, USA, Sri Lanka, Madagascar	^{41}Nb Brazil, Canada, India, Malaysia, Russia	^{42}Mo Russia, USA, Chili, China, Peru, Armenia, Kazakhstan	^{43}Tc	^{44}Ru South Africa, USA, Russia, China, Zimbabwe, Canada	^{45}Rh South Africa, USA, Russia, Zimbabwe, China, Canada	^{46}Pd South Africa, USA, Russia, Zimbabwe, China, Canada

V	**^{47}Ag** Poland, USA, Canada, Peru, Mexico, Chili, Australia, Kazakhstan, Tajikistan, Bolivia, Russia	**^{48}Cd** USA, Canada, Australia	**^{49}In** Canada, USA, Bolivia	**^{50}Sn** Brazil, China, Indonesia, Malaysia, Thailand, Russia, Bolivia, DR of the Congo	**^{51}Sb** China, Russia, Tajikistan, Bolivia, Thailand	**^{52}Te** USA, Japan, Mexico	**^{53}I** Chili, USA, Mexico	**^{54}Xe**		
VI	**^{55}Cs** Italy, Canada, USA	**^{56}Ba** Great Britain, USA, Italy, Russia, Romania	**^{57}La*** USA, South Africa, India	**^{72}Hf** Nigeria, Norway, USA, Canada	**^{3}Ta** Saudi Arabia, Greenland, North Korea, France, Mozambique, Australia	**^{74}W** China, Kazakhstan, Russia, USA, Canada	**^{75}Re** USA, Mexico, Chili, Canada	**^{76}Os** South Africa, USA, Russia, Zimbabwe, China, Canada	**^{77}Ir** South Africa, USA, Russia, Zimbabwe, China, Canada	**^{78}Pt** South Africa, USA, Russia, Zimbabwe, China, Canada
	^{79}Au China, Australia, USA, South Africa, Peru, Russia	**^{80}Hg** Spain, Italy, China, Kyrgyzstan, Canada, Australia, South Africa, China	**^{81}TI** USA, Spain, Norway	**^{82}Pb** Russia, India, Kazakhstan Canada, Australia, South Africa, China	**^{83}Bi** Australia, Mexico, Japan,	**^{84}Po** USA, Mexico, Canada, Russia	**^{85}At**	**^{86}Rn**		
VII	**^{87}Fr**	**^{88}Ra**	**^{89}Ac****	**^{104}Rf**	**^{105}Db**	**^{106}Sg**	**^{107}Bh**	**^{108}Hs**	**^{09}Mt**	**^{110}Ds**

Lanthanides													
^{58}Ce	**^{59}Pr**	**^{60}Nd**	**^{61}Pm**	**^{62}Sm**	**^{63}Eu**	**^{64}Gd**	**^{65}Tb**	**^{66}Dy**	**^{67}Ho**	**^{68}Er**	**^{69}Tm**	**^{70}Yb**	**^{71}Lu**
^{90}Th	**^{91}Pa**	**^{92}U** Australia, Canada, Kazakhstan, Russia, South Africa, Namibia, USA, Brazil	**^{93}Np**	**^{94}Pu**	**^{95}Am**	**^{96}Cm**	**^{97}Bk**	**^{98}Cr**	**^{99}Es**	**^{100}Fm**	**^{101}Md**	**^{102}No**	**^{103}Lr**

Fig 1. World mineral deposits in terms of countries and territories in the periodic system of chemical elements (D. Mendeleev's Periodic Table) (Beydik, 2018, with refinements)

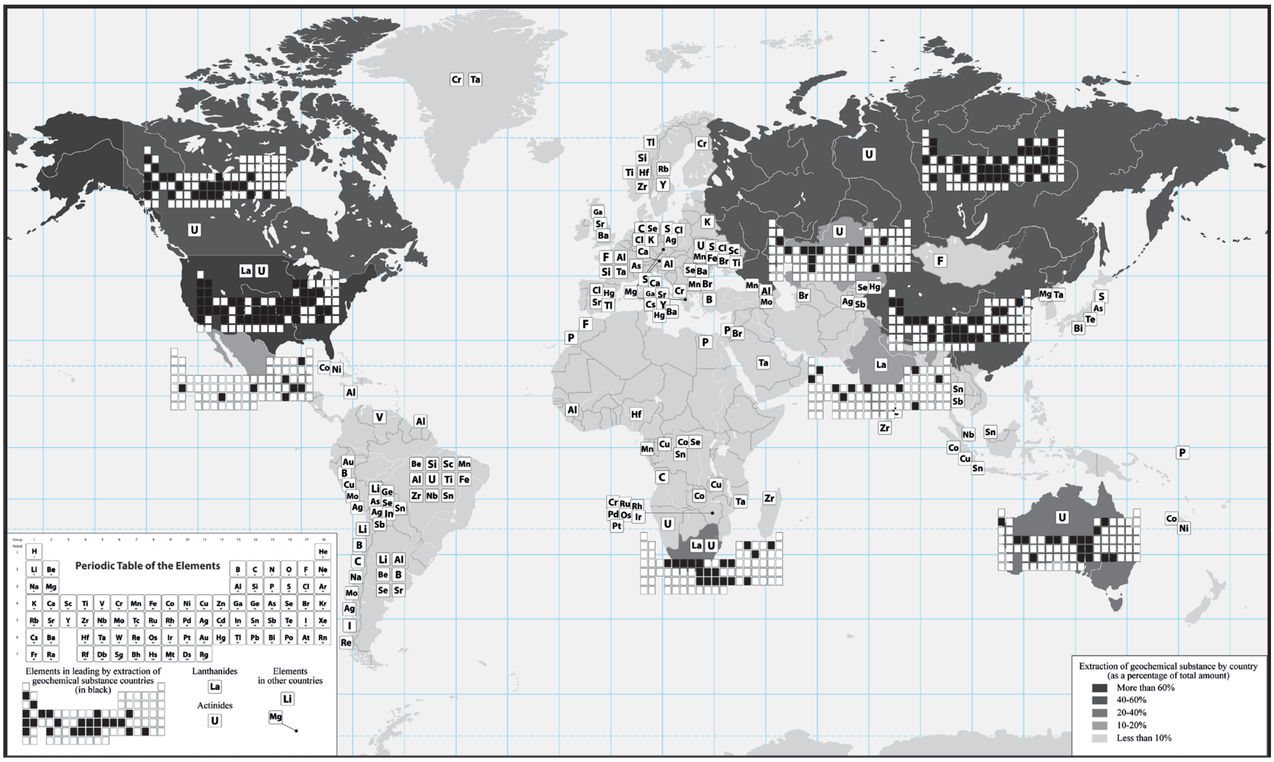

Fig. 2. The world leading countries for mineral resources in D. Mendeleev's periodic table (designed based on Beydik, 2018)

Eastern Hemisphere. D. Mendeleev's table, where the countries and territories of the location and production of the chemical elements are indicated that correspond to specific minerals and mineral resources (Fig. 1), and the provision of individual countries and regions gives a systematic conception of the global distribution of chemical elements that are a part (geochemical) of compounds (rocks, minerals, minerals).

This paper contains the data for the last 20-25 years about the extraction of the most important raw materials on the Earth (including the countries of the former USSR) was summed up, systematized and generalized. The place of a country in the table's cells may not coincide with the production of natural resources or the producing of clean products.

The number of countries and regions within a specific order number (from three, for example, No 11 – «sodium» to eleven in No 13 – «aluminum»), and their place in group (I-VI) are not constant, canonical quantities, and those that have to be taken dialectically, in development - with possible additions, remarks or objections. The table should help form a systematic approach to the study of natural resources, mineral deposits, remind of their connection with the political map of the world, the importance of understanding certain provisions of geology, chemistry, government, the degree of economic development, natural resources using, about cross-curricular connections.

The countries which lead in the most geochemical resources are extracted from the subsoil are the United States (65% of the total elements of D. Mendeleev's periodic table), Russia (48%), China (38%), Canada (38%), South Africa (30%), Australia, (27%), Kazakhstan (19%), India (14%), Mexico (13%) are confirmed by fig. 1 and 2. The name of at least one country (for example, Albania in cell No 24 – chromium) can be the basis for its inclusion in one or another part of the international geographical division of labor, information regarding its specialization in the world market of mining and chemical raw materials, etc.

Thus, acquaintance with the map (Fig. 2) gives grounds to identify four conditional areas of relative concentration of minerals: North American (USA, Canada, Mexico - more than 60% of the total number of table elements), North Asian (Russia – about 50%), Central Asian (China, Kazakhstan – about 40%) South Asian (India – about 15%), which indicates not only significant current deposits, but also on the high mineral potential of these territories (latent deposits). At the same time, a significant part of the globe still remains a mineral terra incognita, the bowels of which are waiting to be used. This factor is fundamental that will give humanity optimism about its future, isn't it?

It is natural that Ukraine is not in this top-9, because it cannot compete with such "mineral heavyweights". At the same time, in terms of minerals it has enough high chance to get into the leading countries and find its own cells in Mendeleev's table (Table 1).

Table 1. Mineral raw material independency of Ukraine, 2013-2018

Mineral	Production position in Europe	Production position in the world
Uranium (U)	*1 (2015)*	*12 (2015)*
Iron (Fe)	*1 (2015)*	*6 (2015)*
Manganese (Mn)	*1 (2015)*	*8 (2015)*
Natural gas	*3 (2013)*	*31 (2013)*
Titanium (Ti)	*3 (2015)*	*12 (2015)*
Lithium (Li)	*1 (2018)*	*13 (2018)*

Today, coal mining (1.7% of the world's total production), commodity iron (4.5%) and manganese (9%) ores, uranium, titanium, zirconium, graphite (4%), kaolin (18%), bromine ochre, non-metallic metallurgical raw materials (quartzite, flux limestones and dolomites), chemical raw materials (native sulfur, rock and potassium salts) are produced in considerable volumes in Ukraine. Hydrocarbon raw materials, brown coal, peat, cement raw materials, heat-resistant and refractory clays, raw for the production of building materials, iodine, bromine, various mineral waters, precious and precious stones, piezo quartz are also produced in Ukraine (Beydik, 2018).

Chemical elements in the free state occur very rarely, more often they are part of various compounds, so we consider them as constituents of minerals (Table 2), for example: copper (Cu) is a component of copper(i) sulfide (Cu_2S), tetrahedrite ($Cu_{12}Sb_4S_{13}$), copper iron sulfide ($CuFeS_2$); lead (Pb) is a part of lead(II) sulfide (PbS), boulangerite ($5PbS * 2Sb_2S_3$), lead carbonate ($PbCO_3$); silicon (Si) is composed of quartz (SiO_2), opal (SiO_2 * nH2O), silicon dioxide (SiO_2), staurolite (Fe $[OH]_2 * 2Al_2SiO_5$), and twenty others. And so is every element. Various combustible hydrocarbons (CH_3 and CH_4) in the mixture are included in the oil. Inert elements are a constituent of combustible gas.

Water resources, climate, land resources, flora and fauna should be considered as natural resource potential in addition to the considered minerals. Survey

Table 2. World mineral recourses (designed based on Beydik, 2019)

Elements of rock-forming minerals	Rock-forming minerals	The main deposits
Aluminum	bauxite, alunite, staurolite, pyrophyllite, augite, epidote, spesartine, almandine, pyralspit	Bauxites: Australia, Brazil, Guinea, Kazakhstan (Torgay), Russia (North & South Urals, Siberia, Kola Peninsula), Slovenia, Suriname, Hungary, France, Jamaica, Nifeline Sienites: Transcaucasia and Trans-Baikal, Alunzites: Transcaucasians
Barium	barytes	Accumulations of large crystals - Cumberland, Cornwall, Westmoreland and others. (England), Felshoban (Romania), in the form of nodules in marls - Paterno (Italy), massive deposits in the states of Arkansas, Georgia, California, Missouri, Oklahoma, Tennessee (USA), Russia (Kuzbass, Khakassia)
Beryllium	beryl, freakin, chrysoberyl, etc.	Brazil, USA, Argentina
Carbon	diamonds, graphite, calcite, magnesite, dolomite, siderite, smithsonite, aragonite, cerusin, malachite	China, India, USA, Russia, Australia, Germany, Angola, South Africa
Iron	pyrrhotite, chalcopyrite, pyrite, marcasite, arsenopyrite, hematite, magnetite, chromite, ilmenite, goethite, limonite, siderite, vivonite, staurolite, olivine, augite, egerin, muscovite, biotite, vermiculite, epidote, chlorite	China, Australia, Brazil, India, Russia, Ukraine, South Africa, USA, Canada
Gold	-	China, Australia, USA, South Africa, Peru, Russia.
Potassium	alunite, muscovite, biotite, lepidolite, sylvin, nepheline, feldspars	Canada, Russia, Germany, Belarus, USA, Ukraine

Calcium	calcite, dolomite, aragonite, anhydrite, epidote, diopside, augite, fluorite, chabazite, titanite	USA, Germany, Austria, Italy
Silicon	quartz, opal, chalcedony, staurolite, olivine, pyralspit, almandine, spesartine, epidote, diopside, augite, aegirine, talc, pyrophyllite, chlorite, muscovite, biotite, lepidolite, verminulite, topaz, titanite, zircon	China, Brazil, USA, Norway, France, Russia
Lithium	lepidolite	Chile, USA, China, Bolivia, Australia, Argentina, Canada
Magnesium	magnesite, dolomite, olivine, pyralspit, diopside, augite, talc, chlorite, biotite, bischofite, vermiculite	Kazakhstan, Austria, Greece, Czech Republic, North Korea, China, Canada, Russia (Urals, Baikal region, Krasnoyarsk region), USA
Manganese	pyrolusite, manganite	South Africa (Kalahari), Ukraine (Manganese), Kazakhstan (Jessazgan), Georgia (Chiatura), Brazil (Urukum), Gabon, Australia (Grte Island), Bulgaria (Obrochishte)
Arsenic	realgar, auripigment	The United States (Butte, Gold Hill), Sweden (Buliden), Mexico (Mateuala, Chihuahua), Japan (Kassioka, Sasatatani), Bolivia (Potosi)
Copper	malachite, azurite	Chile, USA, Peru (San Rafael), China, Kazakhstan, Indonesia, Congo, Zambia, South Africa, Australia
Molybdenum	in the composition of molybdenite	Russia (Sorske, Tirniauz), USA (Climax, Henderson), Chile, China, Peru, Armenia, Kazakhstan
Sodium	nitrate, mirabilite, aegirine, nepheline, halite, feldspars	Deposits: Chile, USA, India
Nickel	nickel, millerite, pentlandite	Canada, Russia, Australia, Cuba, New Caledonia
Niobium	pyrochlor, columbite	Deposits: Brazil (Goias, Minas Gerais), Canada, India, Malaysia, Russia (Lovozero)
Tin	cassiteritis	Brazil, China, Indonesia (Bank and Belitung Islands), Malaysia, Thailand, Russia (Saha), DR Congo, Bolivia (Morocco)
Platinum	platinum group metals (palladium, iridium, rhodium, osmium, ruthenium)	South Africa (Bushveld), Russia, Zimbabwe, Canada, USA
Mercury	cinnabar	Spain (Almaden), Italy, China (Wanshan), Kyrgyzstan, Algeria (Mra-S'Ma), Ukraine (Nikitovske)
Lead	galena, bulanerite, cerusite	Russia (Gorevskoye), India, Kazakhstan (Zhairem), Canada (Brunswick, Sullivan), Australia (Broken Hill, MacArthur River), China, South Africa
Selenium	-	Kyrgyzstan (Akjilga), Russia (Upper-Seymchansk), Bolivia (Pakahaka), Germany (San Andreasberg), Argentina (Sierra de Umango), Congo (Shinkolobwe), Romania (Nagyag, Fatze-Baia)

of the table, the map and the relevant publications indicate that mineral-heavy heavyweights are also the world's largest environmental pollutants. Thus, according to the Blacksmith Institute (USA) in recent years, the dirtiest places in the world are a number of Chinese and Indian industrial cities (Linfen, Tianjin – in China, Sukinda – in India, where chrome ore is mined). The illustrative component of the article (the table of chemical elements and the map) is considered as a separate demonstration of the geopolitical power of individual states – planetary and regional mineral resources leaders, a factor of global interstate strategic relations. There is a regular pattern: the larger the country's territory, the more diverse and numerous its mineral resources (for example, all top 9 countries have an area from 1 million to 17 million km^2 and are the largest in the world). The "white spots" on the map are intended to induce the search for latent areas of mineral resources, and their antipodes – places of concentration of minerals – to motivate the scientific and practical «key factors» to intensify and higher efficiency of the use of natural resources. Antarctica

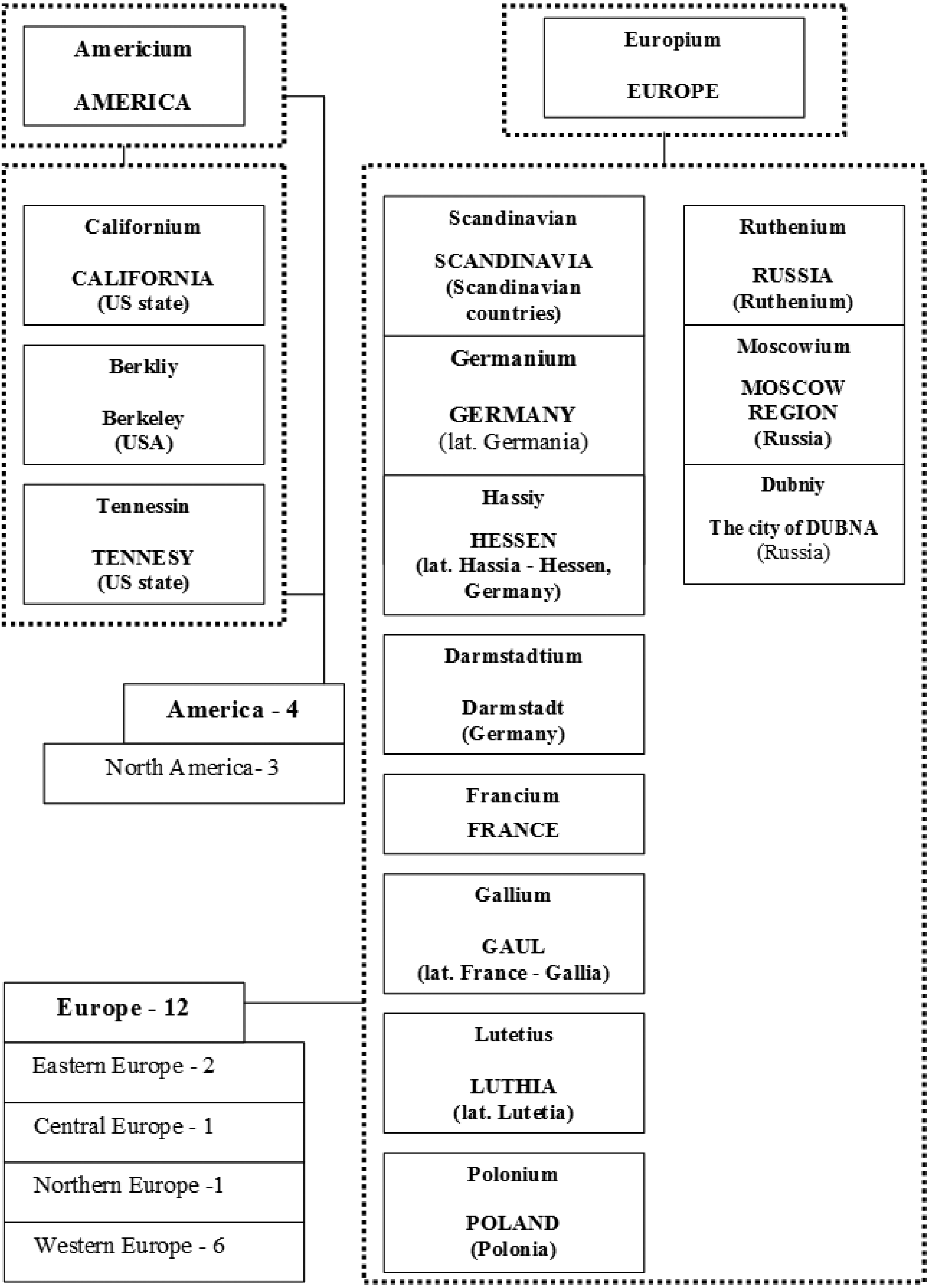

Fig. 3. Etymological-geographical and structural-logical model of the periodic system of chemical elements (based on Beydik, 2019)

has been set aside in Fig. 2, taking into consideration that it's international, specific status and mode of development. But Antarctica is considered to be a «mineral resource Klondike» with its potentially colossal deposits of coal, oil, rare earth and precious metals. And water. If the 20th century was called the century of oil, the 21st century is the century of water. Only 90% of the world's freshwater reserves are concentrated in Antarctica.

It should be reminded, that D. Mendeleev's table presents 118 elements. Their names are related to their discovery history: one group honors the memory of distinguished scientists, the second one, as the discoverers wished, the names of the gods, and the third – geographical objects associated with the discovery history, the homeland of the discovery scientists, the cities (4 names) and territories (5 names) where these discoveries took place. Nowadays, there are 18 such elements: polonium – Polonia (Poland), californium – California (USA), germanium – Germany (lat. name of Germany – Germania), ruthenium - Russia, moscowium – Moscow (Russia), scandinavian - Scandinavia (Scandinavian countries), berkliy - Berkeley (USA), francium – France, dubniy – the city of Dubna (Russia), uranium – Uranus (planet of the solar system), neptunium – Neptune (planet of the solar system), americium – America, europium – Europe, gallium – Gaul (lat. name of France – Gaul), tennessin - Tennesy (USA state), lutetius – Lutetia (lat. Lutetia), hassiy – Hessen (lat. Hassia – Hessen, Germany), darmstadtium – Darmstadt (Germany). Figure 3 presents a visual-imaginary (structural-logical) model of the above, which elements of political and geographical zoning were determined by Yatsenko, Kiptenko, 2009. The figure 3 is also considered as an attempt to combine a geographical and etymological factors in interpreting a periodic table of chemical elements. A brief survey of the figure shows the dominance of the names of two parts of the world – Europe (12 names) and America (4 names), crowning both the territories, where the discovery of chemical elements took place and the national affiliations of pioneering scientists.

The visual and textual information contained in the article is open to interpretation and further steps to deepen and expand the understanding of qualitative and quantitative analytics of major world and regional mineral deposits.

Conclusions:

visual interpretation of the world's most important mineral deposits is submitted, which is reflected in D. Mendeleev's periodic table of chemical elements and cartographic model;

D. Mendeleev's table and its mineral raw material content are presented as an objective factor of the international geographical distribution of labor;

a cartographic interpretation of the periodic table of chemical elements in the context of hemispheres, continents, leading mineral resources was submitted for the first time;

ideas about the level of supply of mineral resources and minerals of individual countries and territories of the world were systematized;

top-9 countries of the most affluent by minerals were determined by the number of mentions of pairs "country – chemical element»;

an etymological-geographical structural-logical model of the periodic system of chemical elements has been proposed;

highlighted issues confirmed the high density of cross-curricular links (geology, geography, geochemistry, ecology, economics, regional studies);

the statements and the conclusions of the article can be implemented in the latest programs of reformed education in Ukraine.

References:

Beydik, O., 2018. Osnovni rodovyshcha korysnykh kopalyn u tablytsi D.I.Mendelyeyeva: natsionalʹnyy vymir [Significant deposits of minerals in the table D.I.Mendeleev: national dimension]. Bulletin of Taras Shevchenko National University of Kyiv, Geography, 3(72), 24-28. doi:10.17721/1728-2721.2018.72.5 (In Ukranian).

Beydik, O., 2019. Vyznachni rodovyshcha korysnykh kopalyn u tablytsi D. I. Mendelyeyeva: svitovyy vymir [Indigenous mineral deposits in the table D. I. Mendeleev: world dimension]. Bulletin of Taras Shevchenko National University of Kyiv, Geography, 1(74), 13-17. doi:10.17721/1728-2721.2019.74.3 (In Ukranian).

Beydik, O.O., Padoon, M.M., 1996. Heohrafiya: Posibnyk dlya vstupnykiv do vyshchykh navchalʹnykh zakladiv. [Geography: A Guide for Entrants to Higher Educational Institutions] (2nd ed.). Kyiv: Lybid (In Ukranian).

Beydik, O.O., (2016, November 27). Svidotstvo pro reyestratsiyu avtorsʹkoho prava na tvir №75014. Ukrayina. Vydatni rodovyshcha korysnykh kopalyn v tablytsi Mendeleyeva: svitovyy ta natsionalʹnyy vymir. [Certificate of registration of copyright for the product number 75014. Ukraine. Outstanding mineral deposits in Mendeleev table: world and national dimension] (In Ukranian).

Biletsky, V.S., Boyko, V.S., Dovgy, S.O., 2004, 2007, 2013. Mala hirnycha entsyklopediya: u 3-kh tomakh [Minor Mining Encyclopedia: in three volums].

Vol.I-II: Donetsk: Donbass; Vol.III: Donetsk: Eastern Publishing House (In Ukranian).

Gursky, D. S., Yeysipchuk, K. Yu., Kalinin, V.I., 2006. Metalichni i nemetalichni ta korysni kopalyny Ukrayiny [Metallic and nonmetallic minerals and minerals of Ukraine]. Kyiv - Lviv: Center of Europe (In Ukranian).

Lunev, G.O., Pavlun, M. M., 2013. Rozshuky i rozvidka rodovyshch korysnykh kopalyn: pidruchnyk [Investigation and exploration of mineral deposits: a textbook]. Lviv (In Ukranian).

State Service of Geology and Subsoil of Ukraine (2016, February 29). Porivnyal′na tablytsya do proektu Zakonu Ukrayiny «Pro vnesennya zmin do Zakonu Ukrayiny «Pro zatverdzhennya Zahal′noderzhavnoyi prohramy rozvytku mineral′no-syrovynnoyi bazy Ukrayiny na period do 2030 roku» [Comparative table of the draft Law of Ukraine "On Amendments to the Law of Ukraine" On Approval of the National Program of Development of the Mineral Resources Base of Ukraine for the Period up to 2030]. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&uact=8&ved=2ahUKEwj70Jvwi7DmAhWLzMQBHXhWBEkQFjADegQIBRAC&url=http%3A%2F%2Fwww.geo.gov.ua%2Fwp-content%2Fuploads%2F2018%2F05%2Fporivnyalna_23.11.2015_29.02.2016.doc&usg=AOvVaw2d_mM4oXC0ukW20PV21kEU (In Ukranian).

Voyloshnikov, V., Voyloshnikova, N., 1991. Knyha o poleznykh yskopaemykh [Book of minerals]. Moscow: Nedra (In Russian).

Yatsenko, B.P., Kiptenko, V.K., 2009. Krayinoznavstvo: osnovy teoriyi [Regional Studies: Foundations of Theory]. Kyiv: Lybid′ (In Ukranian).