

# THE MINERAL RESOURCES OF UKRAINE

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**TIERRA Y TECNOLOGÍA Nº 59 |**

**DOI:** <https://dx.doi.org/10.21028/hl.2022.05.17> | **Autora:** Hanna Liventseva. Chairman of the Board of Ukrainian Association of Geologists.

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for several raw materials (metallic and non-metallic) such as **titanium, ball clays, Fe-Mn & Fe-Si-Mn alloys and gallium. Lithium, graphite or magnesium**, among others, are also present in Ukraine. The abundance and diversity of minerals and metals is due to the complexity and variety of the Ukrainian geology.

This article presents the main metallic and non-metallic mineral resources of Ukraine and its geological context.

## INTRODUCTION. GENERAL INFORMATION

Ukraine (Ukrainian: Україна) is a country located in Eastern Europe. It has a surface of 603,500 km<sup>2</sup> (for comparison – Spain has an area of 504,782 km<sup>2</sup> and France 674,685 km<sup>2</sup>).

Before Russia's attack on Ukraine on February 24<sup>th</sup>, Ukraine's population was about 40 million (5.2 million temporarily have left Ukraine during the war, and the total number of casualties is not precise).

Ukraine has 0.4% of the Earth's surface but about 5% of the world's mineral resources. Ukraine is a country with a developed mineral resource base, the diversity of which is due to the peculiarities of the geology of its territory.

The first feature is that the country contains the three main components of the geostructural zones of the earth's crust: platform, folded structures and transitional areas between them – the foredeeps and depressions.

Each of these zones is characterized by a specific geological structure and by the distribution of certain types of minerals.

Another feature is that its geological structure involves very diverse rocks in composition and origin, which in terms of geological age belong to all periods – from the oldest Archean era to the modern Quaternary period.



# GEOLOGY

The southwestern part of the Eastern European Platform and the surrounding mountain structures of the Carpathians and Crimea, which are part of the Alpine Folding Region, are located on the territory of Ukraine.

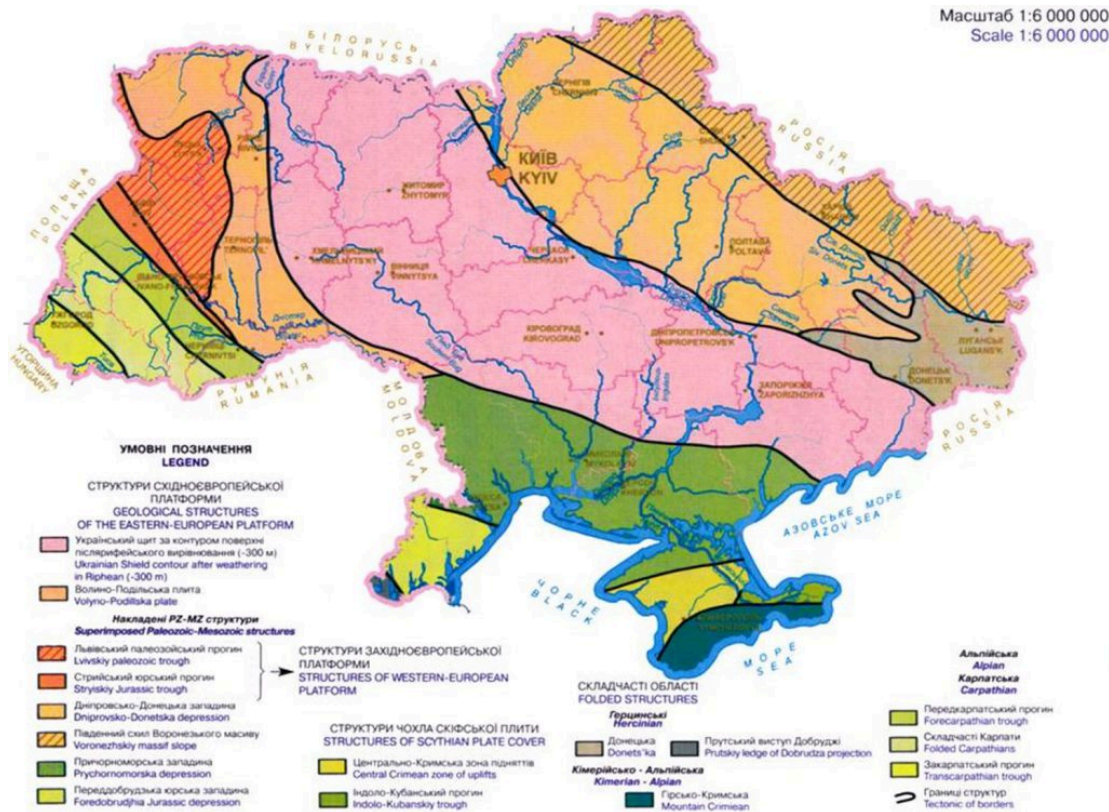


Fig.1. Tectonic map of Ukraine.

The most important structures that stand out in the platform part are: i) the Ukrainian crystal Shield (Ukrainian Shield), ii) Volyn-Podillya plate, iii) DiSnerns fold belt, iv) Dnipro-Donets depression and v) Black Sea depression

Precambrian formations form the foundation of the Eastern European platform and reach the surface within the Ukrainian Crystal Shield. The sedimentary cover of the platform is composed of all systems of the Palaeozoic.

The Ukrainian shield, located in the central part of Ukraine, is composed of strongly disturbed metamorphic, intrusive and metasomatic

crystalline rocks of early Precambrian age (AR-PR1[1]) and their weathering crusts.

Most of the deposits of metallic minerals and the largest **Kryvyi Rih iron ore basin**, are connected with the crystalline base of the Ukrainian Shield. In addition, complex primary deposits of **ilmenite-apatite** ores, deposits of other non-ferrous, precious and rare metals (**uranium, aluminium, copper, molybdenum, nickel, beryllium, lithium, germanium, niobium, tantalum, rare earth metals, scandium, gold, platinum**). **Diamonds, piezoelectric raw material, fluorite, graphite, talc magnesite, nepheline, and a large number of deposits dimensional stones** and much more can also be found.

The platform cover, which overlies the crystalline basement, contains large deposits of **manganese ores** in the Nikopol Basin, complex **ilmenite-rutile-zirconium ores** in the middle of the Dnipro region, as well as **exogenous uranium deposits**, rare in quality and reserves of **kaolin, bentonite clay, tungolites, benthones, benthones brown coal and other minerals**.

The Volyn-Podillya plate, which passes into the Dniester pericratonic depression, is located west of the Ukrainian Shield and is an area of gradual immersion of the Precambrian crystalline base to a depth of 3 km.

Deposits of **coal, sulphur, gypsum, and phosphorites** are associated with sedimentary rocks of the Paleozoic, Mesozoic, and Cenozoic.

The Dnipro-Donets depression is located northeast of the Ukrainian Shield, separating it from the southwestern slope of the Voronezh Anticlis. In the axial part of the Dnipro-Donets depression (Aulacogen), the Precambrian foundation is lowered by 6–15 km. At the base of the Dnipro-Donets depression lie volcanics and evaporite formations, covered by a thick stratum of terrigenous and carbonate rocks. The depression is filled with a thick layer of Paleozoic and Mesozoic sedimentary rocks. This led to the presence of salt dome tectonics, which plays a significant role in the formation of positive structures that



complicate the structure of the sedimentary cover of the depression. On the southeastern continuation of the depression, the Donetsk folding structure (Donetsk coal basin) stands out with a depth of the base of 48-20 km.

The Dnipro-Donets depression is associated with **oil and gas deposits, rock salt, gypsum**, and the Donets fold structure – with **coal, mercury ores, fluorite**, etc.

The Black Sea depression is a deeply lowered southern edge of the platform with a thick thickness (up to 4–5 km) of Mesozoic deposits. **Manganese ores**, occurrences of **coal, bauxite**, and **poly metals** are known here.

The Mountain of Crimea is a fragment of the Alpine-Himalayan folding-sliding belt. It is composed of intensively dislocated Triassic-Jurassic flysch deposits and more calmly overlying Upper Jurassic carbonate and sandy-clay Cretaceous, Paleogene and Neogene strata. This are associated with **iron ores various salt types, limestones**, etc.

The Ukrainian Carpathians include the Precarpathian regional depression with gray-, gas- and oil-bearing sedimentary rocks, the folded-cover region of the Carpathians with strong flysch and the Transcarpathian inner depression hosts volcanic-sedimentary formations associated with **rock salt, zeolites, barytes, alunites, mercury and polymetallic mineralizations**.

## GENERAL OVERVIEW OF THE MAIN MINERAL RESOURCES IN UKRAINE

Ukraine belongs to the leading mineral-raw countries of the world with a wide range of minerals.

About **20.000 mineral deposits and occurrences of 117 mineral types are found in subsurface of the country**. Of these, 8,761 deposits and 1,288 recorded sites for 95 minerals types are of



commercial value and are included in the **Ukrainian Recorded Mineral Reserves** (the state inventory). Of these 3,055 deposits were in production before the war, 147 are deposits of metallic minerals and 4,676 are non-metallic minerals (plus 2,233 combustible minerals and 1,705 ground waters) (Source: Information service on Mineral Resources of Ukraine- State Research and Development Enterprise "State Geological Information Fund of Ukraine" (SRDE "Geoinform of Ukraine") under the joint project with Geological Survey of Norway).

Of all these, about 10,000 deposits are of industrial importance and are taken into account by the State Balance of Mineral Reserves of Ukraine.

The industry has developed more than 3,500 deposits of 100 types of minerals. More than 2,000 mining, concentrating and processing enterprises were operating these deposits.

In 2018, Ukraine was the 3<sup>rd</sup> world producer of gallium (1.3% of world output) and rutile (12.3% of world output); the 5<sup>th</sup> world producer of titanium sponge (4.4% of world output), graphite (2.2% of world output), and bromine (1.3% of world output); the 7<sup>th</sup> world producer of iron ore (2.5% of world output) and manganese ore (4.2% of world output); the 8<sup>th</sup> world producer of kaolin/ball clays (4.9% of world output) and magnesium metal (0.8% of world output); the 9<sup>th</sup> world producer of ilmenite (4.2% of world output) and pig iron (1.7% of world output); and the 11<sup>th</sup> world producer of bentonite (1.0% of world output), peat (2.1% of world output), and raw steel (1.2% of world output) (Source: 2017-2018 Minerals Yearbook USGS)

Ukraine is a significant supplier for titanium ores, manganese ore, kaolin/ball clays, iron and gallium. It has great potential for extracting key minerals such as lithium (see fig 2.).



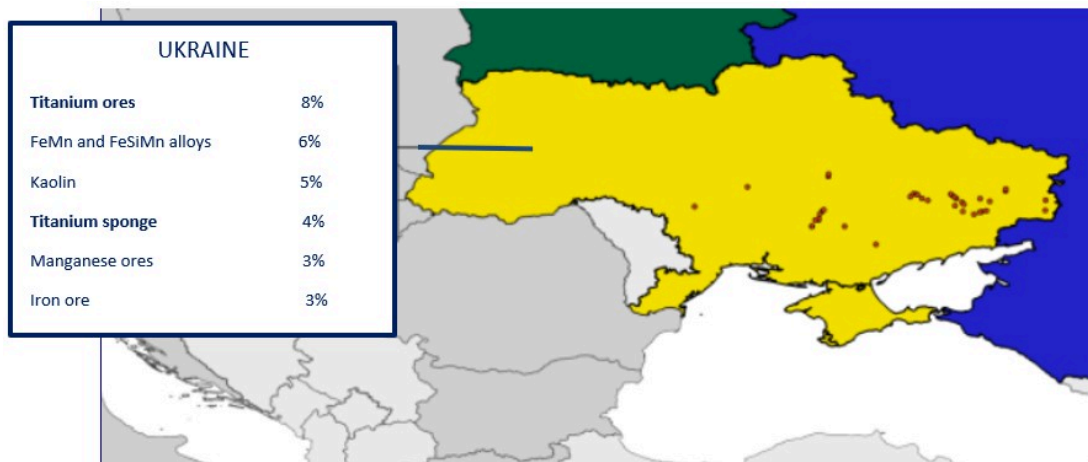


Fig.2. Ukraine is a significant global supplier of titanium, Mn-ferroalloys and kaolin/ball clays. In bold the Critical Raw Materials (CRMs), referring to the EC 2020 List of CRMs, the red dots represent the location of the mining sites of non-food, non-energy raw materials in Ukraine (source: S&P Global Market Intelligence). The materials with a share of less than 3% are excluded (source: RMIS European Commission).

## METALLIC AND NON-METALLIC MINERALS

As commented above, the Ukrainian metallogenic provinces are divided into: i) Ukrainian Shield, ii) Dniprovsko-Donetska metallogenic province, iii) Dnister – Fore Black Sea metallogenic province and the iv) Carpathian-Crimean metallogenic province (Fig 3).

**The Ukrainian Shield** is characterized by the most variety of deposits. It is very common to find several types of minerals such as **iron**, **titanium or uranium**, among others. Granite-greenstone belts, developed in the Middle-Dniprean area are prominent in **gold** mineralization. **Lithium** pegmatite fields are located in the synclinal troughs and epicratonic depressions filled with Proterozoic volcanic-sedimentary formations.

**The Dnirovsko-Donetska metallogenic province** is characterized by the development of **mercury, gold, polymetallic, copper mineralization**, associated with carbonate-terrigenous, salt lagoon, evaporate and terrigenous red-color Paleozoic formations (Central, Bahmutsko-Nagolna tectonic-metallogenic zones).

The **Dnister – Fore Black Sea metallogenic province** is distinct in the native **copper** mineralization in Vendian flood basalts (Lukivsko-



Ratnivska metallogenic zone) and **fluorspar** in Vendian terrigenous-continental formation (Podilsko-Dnisterska metallogenic zone).

In the **Carpathian-Crimean metallogenic province** are typical the mineralizations of **gold, polymetallic ores, mercury** in andesite-basalt, liparite-dacite and green-schist formations (Transcarpathians, Marmaroska tectonic-metallogenic zone), and **iron** in the iron-sandy-clayey formation (Kerch iron ore area).

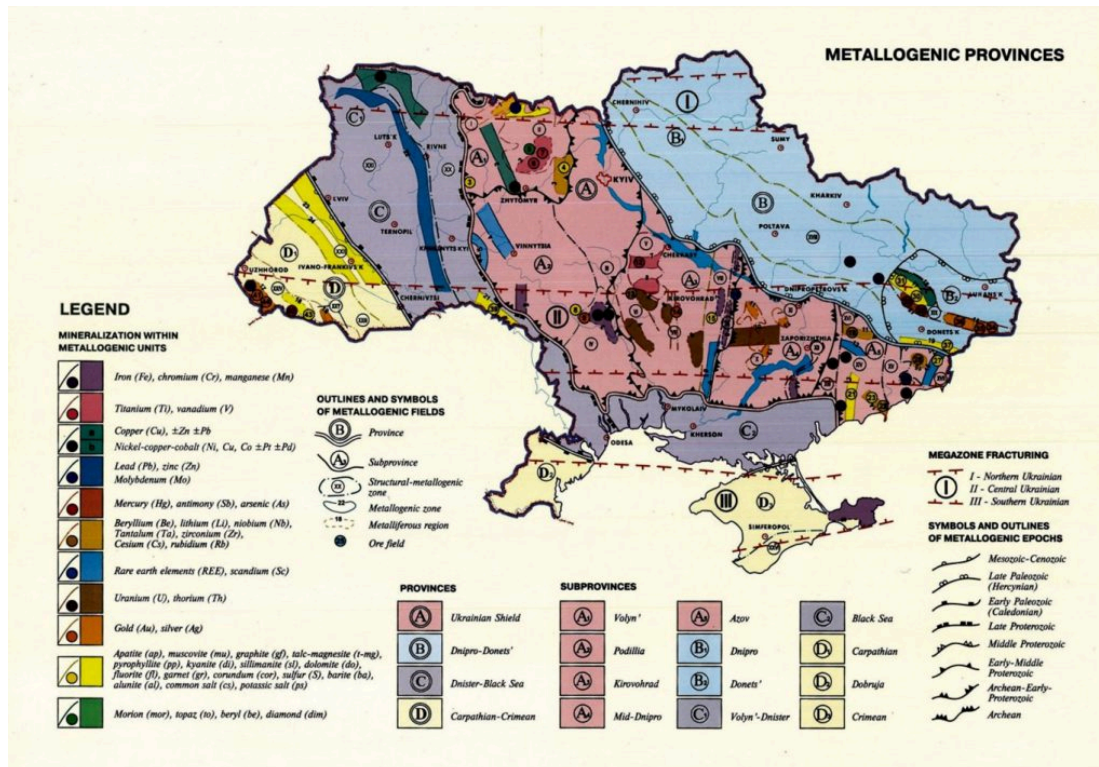


Fig.3 Metallogenic map of Ukraine (Source: SRDE " Geoinform of Ukraine & Geological Survey of Norway).

## KAOLIN/BALL CLAYS

About 10% of the world's **kaolin/ball clays** reserves are concentrated in Ukraine. At the same time, Ukraine accounts for 5% of world production of kaolin/ball clays, however only 20-30% of the extracted kaolin is processed, being most of it exported to other European countries such as Italy, Spain, Germany, Poland, France or Turkey for its use in ceramics. At the same time, during the Soviet era, Ukraine provided 70% of the Union's needs for kaolin.



Kaolin/Ball clays deposits are located mainly in the Ukrainian Shield, where a kaoline-bearing province is located in a 350 km wide band that extends from north Polissya to Azov Sea for about 950 km. Kaolin/Ball clays deposits are also found in the Trans-Carpathian inner depression and in junction area of Dniprovsko-Donetska Depression and southern slope of Voronezskiy crystalline massif.

Today, the largest domestic producers of kaolin/ball clays concentrate were there are two kaolin mining and processing plants: Glukhovetsky in Vinnytsia and Prosyanyivsky in the Dnipropetrovsk region, which operate on the basis of eponymous primary kaolin deposits

Fig 4 shows the Ukranian reserves and production of kaolin/ball clays.

#### RESERVES AND PRODUCTION BY 01.01.2020

##### NUMBER OF DEPOSITS

Minerals	Total Number of deposits	In production
Kaolin	42	22

##### RESERVES IN TOTAL

Minerals	Units	Recorded reserves total	
		A + B + C1	C2
Kaolin	th.t	477 582.18	545 078.38

Fig.4 Ukranian reserves and production by 1/1/2021. Source: SRDE " Geoinform of Ukraine & Geological Survey of Norway).

## TITANIUM

Ukraine is one of the few countries in the world where titanium ores are mined. Ukraine has the largest reserves of titanium in Europe. 15 titanium deposits have been discovered in the country (4 of which are being developed). The main titanium resources are concentrated in bedrock deposits, although nowadays titanium production in Ukraine is only from placer deposits. The deposits are located in the Kyiv, Dnipro, Kharkiv, and Donetsk regions. The titanium industry in Ukraine consists of ilmenite and rutile production, titanium sponge production at the

Zaporozhye Titanium & Magnesium Combine (ZTMK) and titanium ingot production by a few different smaller producers.

Titanium is considered as a Critical Raw Material (CRM) by the European Commission 2020 list of CRMs

The Ukrainian production of titanium in 2018 is shown in Fig 5.

	2014	2015	2016	2017	2018
<b>Titanium:</b>					
Ilmenite and leucoxene, mineral concentrate:					
Gross weight	450,000	350,000	350,00	392,000	755,417
TiO <sub>2</sub> content	200,000	155,000	155,000	160,000	300,000
Rutile, 95% TiO <sub>2</sub>	110,000	90,000	100,000	100,000	106,858
Sponge	7,200	7,700	6,770	7,300	9,342
					metric tons

Fig. 5 Titanium commodities from 2014 to 2018. Source; The Geological Surveys of United State-USGS.

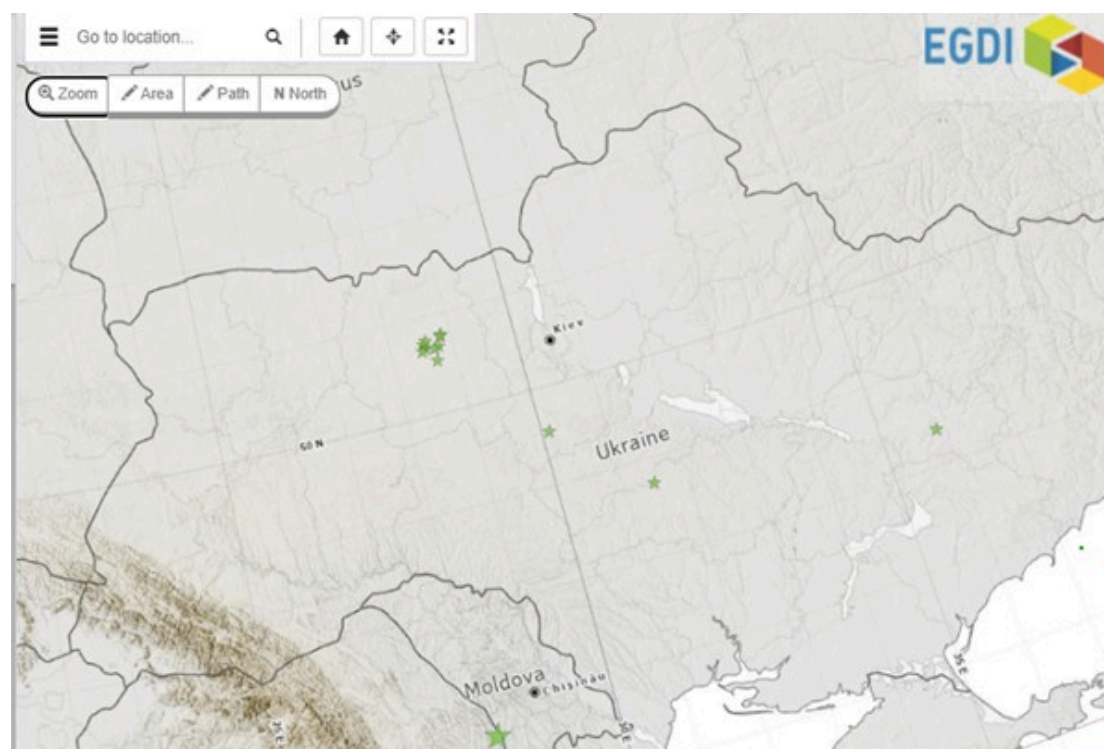


Fig 6: Titanium concurrences (predictive map). Source: European Geological Data Information-EGDI.

## MANGANESE

Ukraine has the largest reserves of manganese ores in Europe and one of the largest reserves in the world (see figure 7). The main reserves



(about 228 Mt) are concentrated in the south of Ukraine: the Nikopol manganese basin in the Dnipropetrovsk and Zaporizhzhia regions (33% of the explored reserves of the country) and the Veliko-Tokmanskoye field in the Zaporizhzhia region (67%). The Ukrainian production of manganese from 2014 to 2018 is shown in Fig 8.

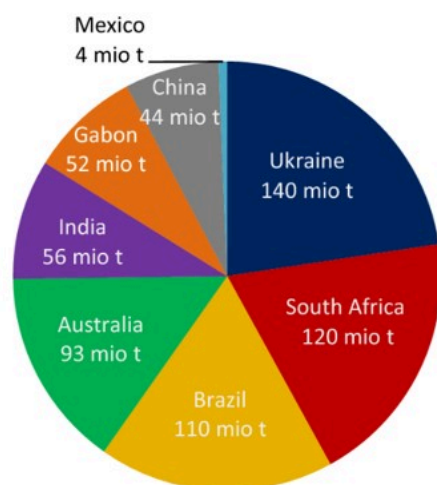


Figure 7: Distribution of manganese reserves in the world. ( Source: The future of mobility and its critical raw materials – Scientific Figure on ResearchGate).

	2014	2015	2016	2017	2018
Manganese:					
Mine, marketable:	1,526,222	1,203,320	1,250,000	1,424,650	1,521,140
Gross weight	519,000	409,000	425,000	484,000	517,140
Mn content	1,300	10,100	7,420	7,640	7,460
					metric tons

Fig. 8 Manganese commodities from 2014 to 2018. Source; United State Geological Survey – USGS.

## GALLIUM

In 2019 Ukraine was the 3<sup>th</sup> world producer of gallium (1.3% of world output). Gallium occurs in very small concentrations in ores of other metals. Most gallium is produced as a by-product of bauxite processing and the remainder is produced from zinc-processing residues.

Gallium is considered as a Critical Raw Material (CRM) by the European Commission 2020 list of CRMs.



#### World Production and Reserves:

	Primary production		Reserves <sup>5</sup>
	2018	2019*	
United States	—	—	Quantitative estimates of reserves are not available.
China	397,000	310,000	
Japan	3,000	3,000	
Korea, Republic of	3,000	3,000	
Russia	6,000	4,000	
Ukraine	4,000	4,000	
World total (rounded)	413,000	320,000	

Fig. 9: World Gallium Production and Reserves. Source: U.S. Geological Survey, Mineral Commodity Summaries, January 2020.

## LITHIUM

Proterozoic rare-earth granite pegmatites comprise the potential source of lithium in Ukraine. Ukraine's confirmed reserves of lithium are the largest in Europe.

Lithium is considered as a Critical Raw Material (CRM) by the European Commission 2020 list of CRMs.



Fig.10 Lithium deposits (Source: Renewablenmatter.eu magazine).

## IRON ORE

At the end of the 20<sup>th</sup> century, Ukraine produced 13.5% of the world's iron ore production. The total reserves of iron ore in Ukraine are estimated at 27.4 billion tons. The main area of the iron ore industry is



the Kryvyi Rih iron ore basin, which provides more than 90% of iron ore production.

60 out of 88 deposits are located in the Kryvyi Rih basin, with reserves of 18.7 billion tons. Iron ore reserves in the Kremenchuk basin are 4.5 billion tons, and in the Belozersky iron ore district (Zaporizhzhia region) – 2.5 billion tons. A significant part of the deposits of iron ore is developed by surface mining.

The Kerch iron ore basin is located on the Kerch Peninsula of the temporarily occupied Crimea. The deposits were developed by quarries. Iron ore mining has stopped. Due to the large number of commodities and deposits in Ukraine, this article only focuses on few raw materials. It is recommended to visit the site EIMIDA project – European Integration of Mineral Raw Materials Data elaborated by the SRDE “Geoinform of Ukraine” and the Geological Survey of Norway with a database directly provided by the State inventory of mineral deposits and occurrences : <https://eng.minerals-ua.info/>

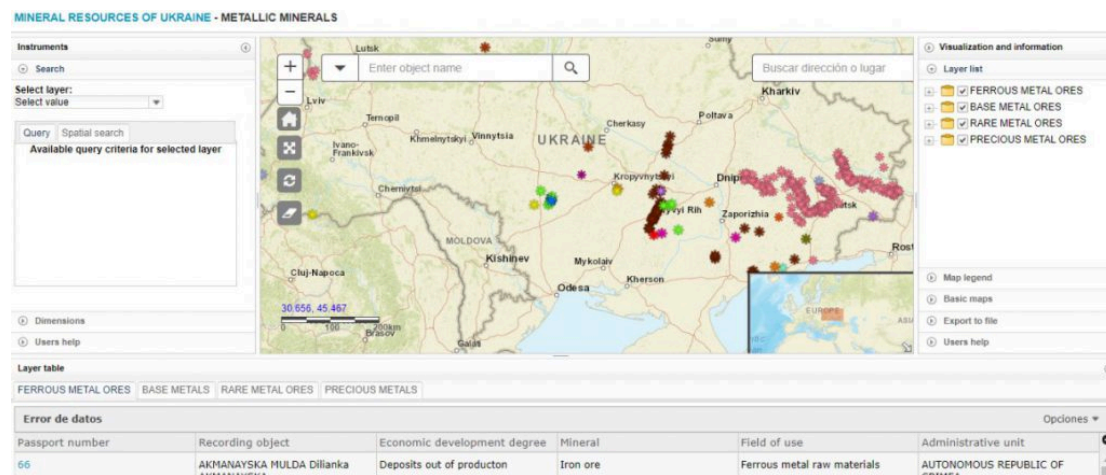


Fig 11. Example for the interactive maps provided by the EIMIDA platform service.

# REFERENCES

- <https://minerals-ua.info/mapviewer/metallic.php>
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- *Raw Materials Information System:* <https://rmis.jrc.ec.europa.eu/>
- Critical Raw Materials list 2020 European Commission: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0474>

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[1] Archean and Lower Proterozoic  
formation

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