

Research Group



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into mineral resources, mining metal and chemical industry in the CIS

Titanium Market Research in the CIS

Demo

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1. Mineral resources base of titanium in CIS countries

Titanium the ninth most widespread element in the earth crust, its clark is around 0.6 %. Titanium is characterized by rather unique properties: high specific strength, corrosion-resistance and heat resistance that owed its wide application in military and civic aircraft building, aerospace industry, production of engines and components of motor cars.

The main resources for titanium production are ilmenite, rutile and leucoxene concentrates, containing 44-70%, 93-96% and up to 90 % TiO_2 , respectively.

There are 38 deposits in the territory of the ex-USSR with balance reserves of Ti (balance demonstrated reserves category), confirmed by former State Committee of the USSR on reserves of mineral resources (table 1).

On the InfoMine estimate, TiO_2 confirmed (balance or certified) reserves in the ex-USSR account for about 250 mln. tonnes (without titanomagnetites of Urals).

Most of Ti-bearing deposits of the CIS refers to placer deposits (23), among which the following commercial types are distinguished: complex zircon-rutile-ilmenite, ilmenite, and leucoxene types. The placers contain 54% of prospected Ti reserves; 13 deposits with confirmed Ti reserves are primary (bedrock): apatite-ilmenite, ilmenite-titanomagnetite, titanomagnetite ones. Besides, Ti reserves are also counted up in bedrock deposits of loparite and apatite-nepheline ores, in which Ti is accompany component. Primary (bedrock) deposits contain totally 42% of Ti reserves of the ex-USSR. Besides above-mentioned types, small portion of Ti reserves (4%) is counted up in deposits of weathering crust; only one deposit of this type occurs at the CIS territory.

Ti deposits in the ex-USSR have been explored at the territories of 3 countries only: Russia, Ukraine, and Kazakhstan, of which Russia owns about 59%, Ukraine owns about 40%, and Kazakhstan owns about 1% of total Ti reserves of the ex-USSR.

Ukraine

In the Ukrainian territory, 13 titanium deposits have been explored, of which one deposit is primary (Stremigorodskoe), another one is connected with weathering crust, other 11 deposits are placers. Of these 13 deposits, 4 are exploited, and one placer (Mezhdurechensky) is prepared for exploitation. Besides, 4 deposits are stand-by, 5 placers are not scheduled for exploitation.

Zircon-rutile-ilmenite placers (typical representative of which is large deposit Malyshevskoe) include 13.4% of Ti reserves of Ukraine. These placers formation is caused by erosion of chemical weathering crusts on various rocks. Placers of this type are complex, in which of practical interest, along with Ti minerals (ilmenite, rutile, leucoxene), are zircon, disthene, sillimanite, staurolite, and others. Productive deposits of zircon-rutile-ilmenite placers are presented by sands of quartz, quartz-kaolin, and quartzglaucanite composition, characterized by high content of valuable components.

The **Malyshevskoe** (Samotkansko) deposit in the Ukraine, discovered in 1955, has large TiO_2 reserves. The deposit is located in Pyatikhatsky district of Dnepropetrovsk oblast in upper reaches of the Samotkan river. Ore-bearing sands are situated in sandy deposits of Sarmatsky stage and Poltavsky suite (the latter occurs below the former), and the Sarmatsky sands are rather more enriched in Ti than Poltavsky ones. The sands of the deposit are fine-grained with considerable amount of material fraction smaller than 50 μm (22-24%), the bulk of the sands (90-95%) is presented by fine quartz and clay minerals. Ti in these sands is mainly concentrated in ilmenite and rutile, as a whole mean TiO_2 content is about 2-3%, and most of TiO_2 (almost 80%) is concentrated in fraction 0.15-0.074 mm.

Ilmenite placers of **Irshansky** group include estimated reserves of 5-7 mln tonnes Ti reserves. This type placers are formed in continental conditions in connection with area weathering crusts on gabbroid rocks, enriched in ilmenite; these placers are associated with alluvial and alluvial-talus deposits, presented by ilmenite-bearing sands, loams, clays. Ilmenite content in these placers ranges from first tens to 100 kg/cub. meter and higher; these placers are less common than the complex ones.

The sole weathering crust deposit **Torchinskoe** of apatite-ilmenite type includes around 10% of the Ukraine titanium reserves. The deposit is presented by eluvial (residual) rocks, formed on massifs of basic rocks (gabbro-anorthosites, gabbro-norites), enriched in ilmenite. Productive layer of the deposit is presented by kaolin weathering crust, in which primary kaolin and gravel are distinguished.

Primary apatite-ilmenite **Stremigorodskoe** deposit includes above a half of Ukrainian Ti reserves. It is associated with small gabbroid intrusion, having the shape of stock. In this case ilmenite is not altered (leucoxene is not formed) and contains about 80-85% of TiO_2 , the rest of TiO_2 is contained in titanomagnetite and rock-forming minerals.

Russia

There are 12 deposits of Ti-bearing ores with confirmed Ti reserves in Russia, the bulk of which (59.4% of the total Russian reserves) are in North-Western territory; 22.9% are in Eastern Siberia, and 17.7% are in Urals and Western Siberia. Officially, at Russian State Balance, tremendous titanium reserves are available, which are enough to satisfy Russian demand for titanium within many tens of years. However, the great bulk of these reserves are contained in deposits, whose development and exploitation will hardly be profitable in nearest tens of years.

In the 3 Russian bedrock deposits Ti is contained in ilmenite-titanomagnetite ores (Medvedevskoe, Kopanskoe (Ural region), Kruchininskoe (Chita oblast)).

The deposits of such type are associated with gabbro-anorthosite differentiated intrusions. The ores are mainly of disseminated type, they form linearly extended zones. Mineral composition of the ores is simple: ilmenite, magnetite-ilmenite, titanomagnetite, apatite; Ti content ranges from 7 to 10%. Amongst ilmenite-titanomagnetite deposits of Russia the **Medvedevskoe** one, located near cities Kusa

and Zlatoust (Chelyabinsk oblast) stands out. It is 2.5 km long by 200 m wide, its prospected reserves constitute above 22 mln. tonnes of TiO₂ (predicted reserves may be three times as great). Suitable shallow occurring of the ore permits to exploit the deposit by open-pit.

There is a number of titanomagnetite deposits at the territory of Russia, among which are **Gusevskoe**, **Pervoural'skoe**, **Kachkanarskoe** ones (Ural region), associated with Kachkanarsky and Gusevsky massifs and presented by low-titanium vanadium-bearing magnetite ores.

Titanomagnetite deposits are associated with gabbro-pyroxenite-dunite formation, ore lodes are mainly presented by vein-shaped steeply dipping bodies and rarely by lenses. The main minerals are magnetite, ilmenite and rutile. TiO₂ content in the titanomagnetite ores of Ural ranges from 1.3 to 2.2%, TiO₂ reserves account for above 100 mln. tonnes.

Besides, a part of Ti reserves, explored in the territory of Russia, is concentrated in apatite-nepheline ores of Kola peninsula (Murmansk oblast), where the main bearers of Ti are sphene (constituting 1.2-1.9% of the ore) and titanomagnetite (1-1.8%). TiO₂ content in the apatite-nepheline ores of Khibinsky massif averages about 1.5-1.6%.

A part of Ti reserves of Russia falls to loparite ores of **Lovozerky** deposit (Murmansk oblast). In this case Ti is concentrated in main ore mineral loparite, mean TiO₂ content in the ores is 0.95-1.03%.

Amongst Russian deposits, including Ti resources, one should also distinguish **Yaregskoe** deposit (prepared for development) with Ti reserves in leucoxene sandstones of around 640 mln tonnes ores at 11% of TiO₂. The deposit, located in Komi Republic in 18 km of Ukhta city, is presented by blind littoral sea placer, associated with oil-bearing weakly cemented quartz sandstones and gritstones of Devon age. The main ore mineral of the placer is leucoxene, including 62.5% of TiO₂.

All the Ti-bearing placer deposits of Russia are characterized by complex composition (availability of ilmenite, rutile, and zircon). Most of Ti-Zr placers of Russia have rather long since been prospected (mainly in 1950s), but, in connection with availability in the USSR of the large Malyshevskoe deposit, as well as Irshanskoe one, which provided the USSR with Ti resources, the Ti-Zr placers did not receive proper attention until recently. Ti-Zr placers of Russia are mainly characterized by intermediate volumes of Ti reserves: up to 5 mln. tonnes.

The most famous and well-studied deposit is **Tuganskoe**, located in 32 km to the south of Tomsk city, consists of 2 sections: Yuzhno-Aleksandrovsky and Kuskovo-Shiryayevsky. Balance reserves of the Tuganskoe deposit account for above 2 mln. tonnes.

The Tuganskoe deposit is presented by littoral sea placer. At Yuzhno-Aleksandrovsky section, ore layer 5 m thick occurs at a depth of 7 m. The layer contains around 30 kg TiO₂ per m³ and 4.6 kg/m³ rutile-leucoxene. Kuskovo-Shiryayevsky section, in which the bulk of the deposit titanium reserves are

accumulated, is presented by ore layer 8 m thick occurring at a depth of around 100 m. The layer contains around 32 kg TiO₂ per m³ and 5.1 kg/m³ rutile-leucoxene.

In addition, in Russia, a number of primary deposits of titanium are prospected (not explored) but are not included in State Balance (List of confirmed reserves), first of all, **Gremyakha-Vyrmes** (Murmansk oblast) and **Bolshoi Seim** (Amursky oblast), as well as Kuranakh (Amursky oblast). The deposits are characterized by rather great TiO₂ content, ranging 7-12% in Gremyakha-Vyrmes and 7.3-11.5% in Bolshoi Seim (at average content of 8.45%).

Of some interest are placer titanomagnetite deposits in Far East, which are prospected, but their reserves are also not included in State Balance as yet. The most well-studied are Khalaktyrka (Kamchatka), Rucharskoe, Reidovskoe, Vetrovoe (Kuril islands: Iturup, Kunashir). In the deposits, iron content ranges 11-15%, TiO₂ content ranges 2-10%. Of the deposits, the greatest is Khalaktyrka with predicted reserves of around 80 Mt sands containing 9.7% TiO₂. According to estimates of experts, titanomagnetite reserves of the deposits are enough for construction of large processing combine (for instance, in Komsomolsk-on-Amur city) with capacity of around 150,000 tpy TiO₂ pigment.

Kazakhstan

In Kazakhstan, 7 zircon-rutile-ilmenite placers, having small titanium reserves, have been explored. Exploitation of Bektemirovskoe (Satpaevskoe) deposit is in progress; pilot-commercial works are conducted in Obukhovskoe deposit (Kokchetav oblast) and Shokashskoe deposit (Aktyubinsk oblast). The other placers are not scheduled for exploitation.

2. Mining and processing of titanium-containing resources in CIS countries

Ukraine

The great bulk of volume of Ti-bearing ores mining falls to Ukraine, where Malishevskoe and Irshinskoe deposits are exploited Volnogorsk state mining-metallurgical combine (VGGMK, Volnogorsk) and Irshansky GOK (Irsha city), respectively (Table 1)

Table 1: Production of titanium concentrates in Ukraine
(in recalculation to TiO₂, kt)

Company	Product	Average content of TiO ₂ , %	1995	1996	1997	1998	1999	2000	2001	2002	2003
VGGMK*	Ilmenite concentrate	63									
	Rutile concentrate	96									
Irshansky GOK	Ilmenite concentrate	56									
Total:											

* - together with PJSC «Tsvetmet» (2000-2003), involved in processing tails

Source: Derzhzovnishinform (National Statistics agency of Ukraine), reports of the companies, estimate of «InfoMine» (VGGMK 1995-98)

Volnogorsk state mining-metallurgical combine (VGGMK)

The main source of ilmenite and the sole one of rutile in the former USSR are ores of the Malishevskoe deposit, which is mined by Volnogorsk (Verkhnedneprovsky until recently) state mining and metallurgical combine (VGGMK). The combine capacity is 5 mln cub m titanium sands per year. This enterprise project was elaborated by the institute Giredmet in 1956; the first turn of the enterprise was commissioned, and output of ilmenite and rutile Ti-bearing concentrates was started in 1961-1962.

At the deposit, 3 sections are distinguished: Western, Central and Eastern. By now, the Western section, broken into 6 quarry fields, has been completely exhausted. Currently quarry No. 7 in the Central section operates. Content of ilmenite in the sands mined is around 40 kg/m³, that of rutile is around 15 kg/m³. In the course of the enterprise operation, the best blocks with highest titanium content and optimal mining conditions have already been mined, and content of valuable components in ores mined gradually decreases. On the whole, reserves of Malyshevskoe deposit are enough for 25 years of mining. However, to maintain current ore mining level, it is necessary to commissioning mining capacities of around 2 mln.m³ ore per year within the Eastern section.

Ti-bearing sands, being mined by the quarry, are subjected to processing at the combine concentration plant, and technological scheme of the sands concentration includes: