Magnesite Raw Material Base of Russia and Prospects of its Development

T.A. Scherbakova[1], A.I. Shevelev[2]
[1]FSUE «Central Research Institute of Geology of Non-metallic Mineral Resources» («TsNIIgeolnerud»), Kazan, Russia
[2]Kazan Federal University, Kazan, Russia

Abstract. Magnesite is one of the main raw materials used in production of refractory materials for the metallurgical industry. Reserves and resources of crystalline magnesite of ancient sedimentary strata, as well as inferred reserves of chemoclastic magnesite of Cenozoic depressions (new geological and industrial raw material for our country) represent magnesite raw material base in Russia. Search works are conducted and inferred resources are determined on one of the promising areas of Cenozoic magnesite. To develop and strengthen the mineral resources base of magnesite in Russia we need to continue research and begin preparation of commercial reserves of magnesite associated with Cenozoic complexes.

Keywords: magnesite, hydromagnesite, raw material base, reserves, forecast, promising areas, the Cenozoic, depression, complex

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Magnesite is one of the main raw materials used in production of refractory materials for the metallurgical industry – large-block molded products, unmolded materials (powders, masses, mixtures). Magnesite is used in other industries, including construction.

The resource potential of the Russian magnesite is concentrated mainly in magnesite-bearing subprovinces of the South Urals, Urals, Udereysky, Prishilkinsko-Argunsky, Khingansky and presented by the approved (as of 2015) reserves in the amount of 806,017 thousand tons for the cat. A + B + C_1 and 1,786,371 thousand tons for the cat. C_2, as well as the inferred resources for categories P_1 = 71.4 million tons, P_2 = 62 million tons, P_3 = 2441.9 million tons.

Reserves

Explored reserves of magnesite in Russia are accounted by the national register and distributed extremely uneven (Fig. 1). Most of them concentrated in the Siberian region – 94.3% (Irkutsk region 83.2%, Krasnoyarsk Territory 11.1%), the Urals (Chelyabinsk region) – 5.3% and the Far East (Jewish Autonomous Region) – 0.4%.

More than 90% of the magnesite reserves in Russia are in the undistributed fund. The share of unique Savinsky field of crystalline magnesite in the Irkutsk region accounts for 75.1%. The undistributed fund includes reserves of talcose magnesite of Onotsky field (8.1%), developing talc. The remaining share of undistributed fund (7.3%) consists of reserves of Udereysky group (Kardakansky, Rybinsky, Udorongsky, Verhoturovsky fields) in the Krasnoyarsk region and the average in size – Safonikhinsky field in the Jewish Autonomous Region.

Fields with undistributed reserves are in poorly developed areas with weak infrastructure, at a considerable distance from the processing and application centers that determines the long transportation and, consequently, low profitability of their development.

In one of the main developed objects – Satkisnky field (Chelyabinsk region), reserves available for open-pit mining are almost worked out. The enterprise forcedly goes to an underground mining, which leads to greater financial costs. Underground mining of magnesite increases the cost of 1-ton raw materials three times, and the loss in production is 30%, which reduces the profitability of production. We should also note low productivity of underground mining. Enterprise provision with reserves is for 10-15 years.

Inadequate volume of production of high quality magnesia products is compensated by significant import deliveries (up to 60 thousand tons in 2012, according to the Federal Customs Service of Russia).

All this calls for the strengthening and development of raw material base of magnesite.

Inferred resources

Resource potential of magnesite in the country is represented by two geological and industrial types of crystalline magnesite of the ancient sedimentary sequences and chemoclastic magnesite of Cenozoic depressions.

Inferred resources of the crystalline magnesite are estimated on 22 objects placed in four federal districts of the Volga, Urals, Siberian and Far East.

Resources of the crystalline magnesite, according to the testing as of 01.01.2015, are located in the Chelyabinsk region, Bashkortostan, Chita region in the Jewish Autonomous Region and comprised of categories: P_1 – 71.4 million tons, P_2 – 55 million tons, P_3 – 1291.9 million tons.

In the Chelyabinsk region the crystalline magnesite resources are defined on Malchihinsky and Berezovsky fields by category P_2 – 25 million tons; on Zaprudny, Bakalsky and South-Satkinsky plots of Elnichny area by cat. P_3 – 31.5 million tons. They are flank parts of magnesite ore deposits with good quality and satisfactory geological and economic parameters. They may be the prime targets for the enterprise “Magnesite”.

In Bashkortostan the crystalline magnesite resources are estimated in Mayardaksky magnesite-bearing area by cat. P_3 – 1300.4 million tons. Magnesite quality is quite low due to the high content of silicon, calcium, and iron oxides. They may be of interest to consumers who do not impose strict quality requirements. For example, the production of magnesia binders, demand for which in recent years is greatly increased with the development of the construction industry. They can also be used in the development and application of effective technological enrichment schemes. It is advisable to perform survey and assessment works on the area.

In the Chita region inferred resources by cat. P_1 – 49.4 million tons and cat. P_3 – 260 million tons are approved for the objects in Larginsko-Kaktolginsky area between the rivers Shilka and Gazimur where more than ten magnesite-bearing knots are allocated. The most studied are Gorevsky, Timokhinsky, Luchuysky, Bereinsky, Larginsky, Larginsky-1 fields. On Larginsky and Bereinsky fields exploration works were carried out, and for the rest – evaluation works. Magnesite is confined to the magnesia-carbonate formations of the Upper Proterozoic kaktolginskian suite, developed on an area of 2500 km^2. The ore bodies are presented with lenticular and tabular deposits, often crumpled in flat brachiform folds.

In the Jewish Autonomous inferred resources of magnesite by cat. P_1 (2 million tons) are estimated on the flanks of Safonikhinsky field. It is located in the southeast of the Bureya array within the Khingansky provinфce. Magnesite is of high

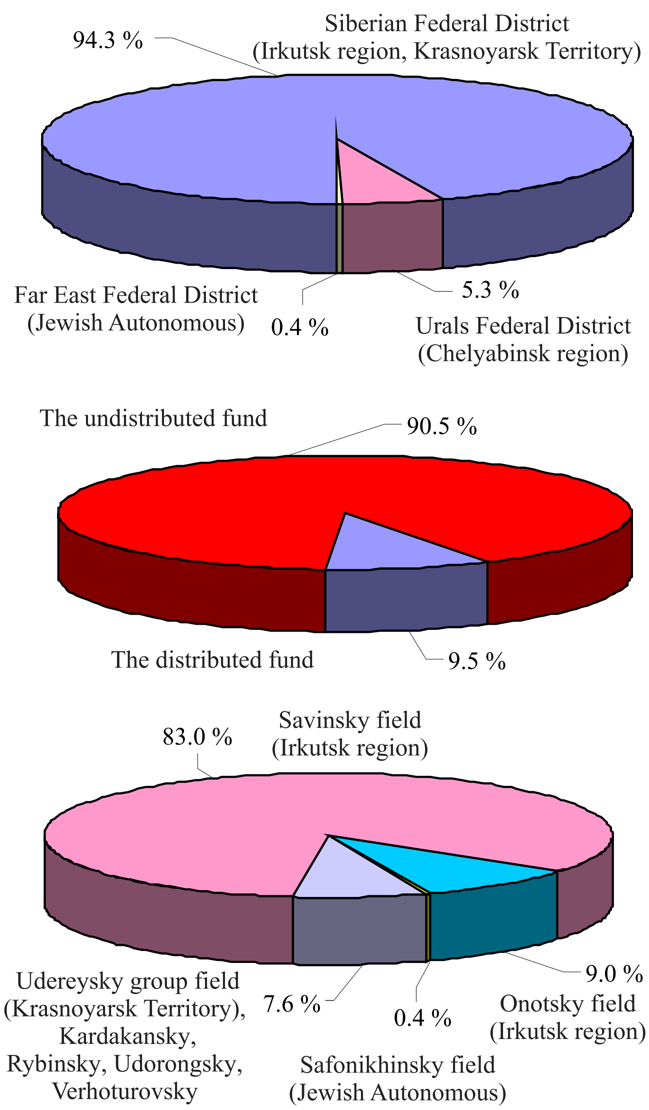

Fig. 1. Distribution of magnesite reserves by regions and objects.

quality (the content of MgO 44.7-46.2%), which determines the need for their study and, respectively, for geological exploration.

Magnesite of Cenozoic depressions is available in Europe, Asia, North America and Australia. Some fields are developed from the beginning of the twentieth century (Ilic, 1974, 1976; Schmid, 1987, etc.).

The deposits are confined to the lake and river facies, developing in regressive regime in arid and humid climate. They are genetically linked to ultrabasic arrays and located either directly on them or in their immediate vicinity.

In Russia, there are some promising areas for identifying Cenozoic magnesite: Altai-Sayan fold region, Gorny Altai, Central and Eastern Trans-Baikal, Barguzin and Ol'khon depressions, Cenozoic structures of Chukotka (basins of the rivers Penzhina and Maina), the western slopes of Sikhote-Alin, etc. (Shevelev, Shcherbakova, 1991).

There are three types of geological and genetic magnesia raw materials. The first and second types are associated with serpentinite weathering crusts, amorphous magnesite zone of carbonated serpentinite and dispersion zone of hydromagnesite weathered serpentinite. The third type – magnesite-chemoclastogenic hydromagnesite formed by redeposition of the first two types into lake-river facies of Cenozoic superimposed structures.

By way of formation there are chemogenic, clastogenic and chemoclastogenic (mixed) magnesite-hydromagnesite differences (Shevelev, Shcherbakova, 1991; Shcherbakova, 2008; Shcherbakova, Shevelev, 2009).

Chemogenic magnesite occurs at the chemical transportation and deposition of substances by bicarbonate groundwater (residual lake lagoon Coorong, Australia), hypogenic solutions and cold meteoric water enriched by ions of Mg (mine Karent-Creek, North America) and other infiltration flows that pass through the stratum rich in magnesium (Serbian group of deposits), followed by the accumulation in the most favorable conditions of shallow lakes.

Clastogenic type of Cenozoic deposits is formed during transfer of supergene magnesite material with ultrabasic substrate by surface water flows (river, rain, etc.). Particularly active areal removal is marked intensely in eroded areas with the most prolonged rain periods (deposits of Turkey and Australia). Particle size distribution of clastic magnesite is very diverse: from boulders and gravel (mine Nevade, Serbia and fields Servia, Alia, Greece) to pelitomorphic differences (Lake Salda, Turkey, etc.). The size of fragments depends on the speed and distance of transfer.

Chemoclastogenic deposits are mixed type composed of clastic and chemogenic differences of magnesite and having a brecciated texture. For example, near the village Nevade (Serbia) brecciated ore are composed of white magnesite fragments ranging in size from fractions of a millimeter to 1 centimeter, cemented by dark gray chemogenic magnesite with abundant admixture of siliceous material and organic pigment.

1. The morphology of ore bodies is usually lenticular or tabular and determined by the hydrodynamic regime.

2. Ultrabasic complexes located in the immediate vicinity of the Cenozoic depressions are the source of MgO for

hemogenic magnesite and $MgCO_2$ for clastogenic magnesite. The nature and amount of magnesite deposits in Cenozoic complexes depend on the ultrabasic arrays size, their mineral composition and intensity of supergene changes.

The authors have created a formation model of magnesite-hydromagnesite ores in sedimentary sequences of lake-river facies, which made the forecast of new for our country geological and industrial type chemoclastogenic magnesite (hydromagnesite) of Cenozoic depressions (Shcherbakova, Shevelev, 2015).

One of these objects, studied by us, is Khalilovsky area in the Orenburg region. The area includes Khalilovsky ultrabasic array of up to 260 km^2, which is a huge link in the chain of hyperbasic intrusions, elongated by narrow strip along the border with Uraltausky anticlinorium and greenstone synclinorium. The array is composed mainly of apoperidotite serpentinites, and as individual lenses of serpentinites on dunites. In serpentinites of the array the weathering crust is developed, the maturity degree and depth of which in different parts of the array is ambiguous.

Forecast-audit works were carried out by specialists of TsNIIgeolnerud in 2012-2013. They showed that the southern, western, central, and partially eastern parts of the array are marked by full profile of the weathering crust. There are following areas (top to bottom): zone of ochres and nontronite serpentinite, silicite serpentinite zone, zone of carbonate serpentinite, weathered serpentinite zone and zone of poorly changed serpentinite. Thickness of zones varies from 1-3 m to 5-6 m. Carbonation zone is represented mainly with magnesite, in rare cases – dolomite and calcite.

One of the most promising areas in the magnesite mineralization is Central Khalilovsky plot located in the middle of serpentinite array in the basin of river Guberlya (left bank, average flow). The object is a series of intermountain river valleys (depressions), well developed by processes of disintegration and denudation, in the bed of which Holocene delluvial and alluvial deposits are developed. The sides of the valleys are composed of weathered serpentinite.

Inferred resources of category P_2 – 7 million tons and category P_3 – 150 million tons. Quality and quantity of inferred resources are determined by analogy with the Australian Cenozoic deposits, which are successfully developed.

In the Sverdlovsk region we highlighted Sredneuralsky promising area to identify the Cenozoic chemoclastogenic magnesite. Area clearly has regional forecasting and search criteria of magnesite-bearing: the development of the Neogene-Quaternary complexes in the vicinity of ultrabasic arrays, which have supergene and carbonation zones, suggesting a potential source of magnesia component. Inferred resources of category P_3 – 300 million tons.

In Bashkortostan with forecast-mineragenic studies the promising Zilair and Magnitogorsk areas are allocated for Cenozoic chemoclastogenic magnesite with resources of category P_3 – 100 million tons and 200 million tons respectively. Preparation of commercial reserves of magnesite raw materials in these areas is highly relevant, since the areas are located in close proximity to the processing enterprise "Magnesite" and consumers - steel mills of the Middle and South Urals.

In the Altai region inferred resources of Cenozoic chemoclastogenic magnesite are estimated in Biysk-Barnaul prospective area when performing forecast-mineragenic works. They make up for the P_3 category – 400 million tons.

The total volume of forecast resources of chemoclastogenic magnesite of Cenozoic depressions according to the results of testing (as of 01.01.2015) amounts by category: P – 7 million tons, P_3 – 1150 million tons (Orenburg, Sverdlovsk regions, Bashkortostan, Altai Territory) (Shcherbakova, Shevelev, 2010).

Cenozoic geological and industrial type of magnesite has a number of advantages over the crystalline magnesite of the ancient complexes: near-surface occurrence of ore bodies, loose (not rocky) nature of the ore mass, the possibility of using a simple technology for production, processing, enrichment, etc. Promising areas are located in the relative proximity to the metallurgical complexes (Chelyabinsk, Magnitogorsk, etc.), thus avoiding the high transport costs in the processing and sales of raw materials.

We consider it necessary to continue study and begin preparation of commercial reserves of magnesite associated with Cenozoic complexes for the development and strengthening of the mineral resources base of magnesite in Russia.

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Information about authors

Tatyana A. Scherbakova – PhD, Senior Researcher, FSUE «Central Research Institute of Geology of Non-metallic Mineral Resources» («TsNIIgeolnerud»)

Russia, 420097, Kazan, Zinin str. 4

Phone: +7(843)236-54-50, e-mail: root@geolnerud.net

Anatoliy I. Shevelev – Doctor of Science, Professor of the Department of General Geology and Hydrogeology, Kazan Federal University

Russia, 420008, Kazan, Kremlevskaya str. 4/5

Phone: +7(843)233-74-18, e-mail: ashev-2010@yandex.ru

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