Mineral resources of the south of Kemerovo region (Tashtagol administrative district)

IOP Conf. Series: Earth and Environmental Science **377** (2019) 012007 doi:10.1088/1755-1315/377/1/012007

Mineral resources of the south of Kemerovo region (Tashtagol administrative district)

Ja M Gutak, O Ya Gutak and V N Tokarev

Siberian State Industrial University, 42 Kirova Street, Novokuznetsk, 654007, Russia

E-mail: gutakjaroslav@yandex.ru

Abstract. Tashtagol administrative district of the Kemerovo region is located in its southern part occupying the up-streams of the Mras-su and the Kondoma rivers. Deposits of the Late Precambrian (Vendian) and the Paleozoic (Early Cambrian), which are relics of oceanic carbonate platform, youthful and mature island arc, form geological structure of the territory. The sequence is broken through by intrusive bodies, of which plagiogranite intrusions of the Late Cambrian (skarn deposits of iron ore) are of the greatest impact for metallogeny of the region. Analysis of regional mineral resources begins with a survey of reserves and resources of ferrous metals (iron, manganese), then resource potential for noble metals and non-metallic minerals is considered consistently. Iron has historically been the main mineral resource of the region, but as of the present, prospects remain only for the Tashtagolskoye deposit. The gold placers has practically been exhausted, development of the Selezenskoye manganese deposit has been stopped due to complexity of its geological structure. Other diverse deposits of metallic and nonmetallic minerals are practically not explored, framing reserves for the future.

1. Introduction

Tashtagol district as for available mineral resources differs sharply from other districts of the Kemerovo region. Located in the southern part of the region in the basins of up-streams of the Kondoma and the Mras-su rivers, it is one of the few that does not have coal deposits. This feature of the district is defined by geological structure of its territory. Most of it is composed of the Vendian and the Early Cambrian carbonate sediments had been formed within carbonate oceanic platform [4] and volcanic-sedimentary bodies of youthful island arc of the Middle and the Late Cambrian replacing it [15]. Indicated bodies are overlapped by transgressive sediments of the Ordovician system, formed in continental shelf. This structure in geological descriptions is often referred to as the Mrassky knoll. Along its western contact, volcanogenic and sedimentary bodies of the Kuznetsk-Altai volcano-plutonic belt (Telbess volcanic area) were formed in the Devonian period [5; 6; 15], which refer to the mature island arc stage of the territory development. Numerous intrusions invade sediments that determine metallogenic specialization of the area.

Despite a long and very detailed study of geological structure of the area, a number of incredibly important issues in respect of metallogeny have not been resolved until now. Carbonate sediments of the Ulutag Mountain and volcanic and sedimentary bodies overlapping them (the Ulutag formation) require their further study. The former used to be mapped as the Late Precambrian and included in the Vendian-Early Cambrian carbonate oceanic platform. In the nineties of the last century, there were reports of findings of stromatoporates remains in these sediments [12; 13]. It would seem a small question that is only of paleontologists interest. However, recent metallogenic prospects of the district depend on its clarification. If the sediments are the Vendian and the Early Cambrian then they are promising. And if they are the Ordovician, then this area can be excluded from potentially ore-bearing ones. If carbonate rocks of the Ulutag Mountain are the Ordovician ones, then what is the relative age of the overlying sediments? Until now, they have been mapped as the Late Cambrian on the ground of the findings of trilobites in the basal layers of sequence. Study of primary diaries of researchers have shown that trilobite findings come from fragments of limestone of an unclear stratigraphic location (there may be pebbles from conglomerates of the basal part of sequence of the Ulutag formation). An issue of distribution of the Early Silurian sediments, recently identified in the river basin of the river Lebed in the Mountain Shoria [9], also needs to be addressed. The border between the Mras-su block and adjacent territories is in for the detailed study. In the authors' opinion, this boundary is represented by tectonic melange zone in which plates of the Lower, the Middle, and the Upper Devonian age are presented. The above list of unsolved issues in geology of the Tashtagol district is far from complete and can be continued. Unfortunately, cut of funding for regional studies of mineral resources and concurrent scientific research impede refining of data on geological structure of the Mountain Shoria, thus our ideas about its metallogeny, local prospects for possible presence of new deposits of various minerals will be largely inferior.

Longstanding prospecting and evaluation works in the Tashtagol district have revealed incredibly wide range of deposits and mineral occurrences. Consistent description of all the minerals explored in the area is given below. The first place legitimately belongs to iron deposits.

2. Iron

Iron ore deposits of the Tashtagol district are arranged into two groups the Telbess group and the Kondoma group [2; 12; 14; 16]. The first includes Sukharinskoye, Telbesskoye, Temirtauskoye and Kazskoye deposits. The second is Tashtagolskoye, Sheregeshevskoye and Shalymskoye deposits. All of them are formed in island-arc bodies of the Middle and the Upper Cambrian under the impact of contact-metosomatic processes at contacts of alkaline subplastic intrusions (gabbro-syenites, syenites) with carbonate rocks. Historically, the first deposits were discovered in the Telbess group (Sukharinskoye, 1773, Telbesskoye, 1858, Temirtauskoye, 1897 and Kazskoye, 1930). Deposits of the Kondoma group were discovered later: Sheregeshevskoye in 1908-1912, Tashtagolskoye in 1911, Shalymskoye in 1931.

At present, most of them have been worked out and are of only historical and mineralogical interest. Kazskoye deposit of the Telbess group, Tashtagolskoye and Sheregeshevskoye deposites of the Kondoma group remain in operation. It should be noted that mining at Kazskoye deposit is close to completion. It’s ore reserves only allow for commercial mining until 2021 (commercial resources for 2015 of C_1 and C_2 categories comprise 51,982 th t). There are no significant prospects for discovery of magnetite ores in flanks of the deposit.

2.1. Tashtagolskoye deposit

Tashtagolskoye deposit is located 220 km south of Novokuznetsk. The first information about deposit is contained in the application of Skvortsov, a local hunter (1911). Exploration took place in 1931-1935. Operational work had began in 1941. Since 2004, development of the deposit has been carried out by Evraz-ZSMK OJSC.

Geologically, the field is confined to the southern part of the Kondoma graben-syncline, in Tashelgino-Kondoma fault zone, lying among volcano-sedimentary rocks of Mundybash formation of the Middle Cambrian. Ore zone is confined to volcanic dome structure and lies in accordance with host rocks. Intrusive formations are the Middle Cambrian syenites and gabbro-porphyrites, diabases of the Devonian. Total length of ore zone is 3500m. Bedding of ore zone is abrupt, 60-90 degrees. The length of ore bodies is 40–1300m along the strike, 80–1700 m to the dip, and their capacity is 5–90m. Bodies are of lenticular and blanket shape. Exploration revealed dying out at depths of ore bodies located in the central part of the deposit and appearance of new blind ore lenses in the southeastern and northwestern parts. The ores are magnetite, rarely are sulfide-magnetite with an average deposit

IOP Conf. Series: Earth and Environmental Science **377** (2019) 012007 doi:10.1088/1755-1315/377/1/012007

iron content of 44.7%. Content of harmful impurities is insignificant (sulfur - 0.11%, phosphorus 0.4%).

Since the start of operations, about 135 million tons of raw ore have been mined. Total ore reserves of A + B + C_1 category are 315 million tons, of C_2 category are 90 million tons. Inferred resources of the deposit are twice the explored reserves. Prospects are associated with development of deep horizons. The mine is currently under reconstruction, which will provide increase of ore production to 3.25 million tons per annum. Reserves of Tashtagolskoye deposit are enough for 55 years of operation (excluding reserves of deep horizons).

2.2. Sheregeshevskoye deposit.

Sheregeshevskoye deposit is located 20 km northwest of the Tashtagol town in the area of the Kubes and the Mustag mountains. I was opened by brothers Alexander and Mikhail Sheregeshevs in 1908-1912. In 1931, exploration of the deposit began. Since 1952, the deposit has been operated as open pit mine, and since 1961 underground mining has started. Deposit is mined up to the horizon of 85m (surface mark +630m).

Ore field of Sheregeshevskoye iron ore deposit is composed of the Middle Cambrian effusive-sedimentary deposits of the Mundybashskaya formation and sandy-clay sediments of the Lower Ordovician discordantly overlapping them. Deposits of the Mundybashskaya formation were broken through by the Kubesskaya syenite and the Sarlyk granite intrusions. Horizon of terrigenous sedimentary rocks of the Mundybash formation (tuffs and tuffites of trachitic and andesitic porphyrites, marls, dolomites, limestones) is ore-bearing. Structure of ore-skarn zone is very complex: it is synclinal in the east, steeply dipping with flattening to horizontal in the central part and monocline dipping in the west. Total length of ore-skarn zone to the strike is about 3.5km, to the dip is to 1 km. The number of ore bodies in particular areas is from 2 to 24. Their size to the strike and the dip is from several tens of centimeters to 800-900m, capacity is from 2m to 160m. The shape of ore bodies is diverse - from the complex dendritic form with lenses bulges and twitches to the plain ones. Distribution of iron in ores is uneven. Ores are magnetite with impurities of zinc, cobalt, sulfur and phosphorus. Ores are easy. An average iron content is 29-32% in raw ore, 48-50% in primary concentrate, 10-14% in tailings.

During the deposit operation 129 million tons of raw ore were mined. Total reserves of iron ores of A + B + C_1 categories amounted to 156 million tons as of the beginning of 2007. Currently, the deposit is being operated by Evraz-ZSMK OJSC, reconstruction of mine has begun, which will increase annual ore production to 4.8 million tons per year. Its reserves life is about 60 years of operation.

It can be stated that reserve of easily discovered iron ore deposits (reaching the surface or located near the surface) in the district has been exhausted. With a sufficient degree of certainty, we can state that all iron ore deposits are associated with island-arc strata of the Middle Cambrian (necessarily containing limestone horizons), which are interrupted by subtabular intrusions of the base composition. Ore-bearing strata are discordantly overlapped by terrigenous-carbonate sediments of the Early Ordovician, fragments of martite ores are indicated in the basal conglomerates of the latter. Thus, both lithological and temporal criteria of ore formation are clearly outlined. All outcrops areas of promising bodies on the surface are studied in detail from the surface, including drilling of prospecting wells. Prospects of the area can only be associated with deep-seated bodies, which means that their search entail significant material costs. Without well-developed local prediction, such work is meaningless.

3. Manganese

One comparatively small Selezenskoe deposit of this metal extremely scarce in the Kemerovo region is known in the district [2, 11]. It is located on the bank of the river Selezen 65 km south-west of Tashtagol, with which it is connected by automobile road. It is opened in 1934 by Afanasyev G.D. Exploration of the deposit was carried out discontinuously from 1935 to 2008. The deposit has been

IOP Conf. Series: Earth and Environmental Science **377** (2019) 012007 doi:10.1088/1755-1315/377/1/012007

operated by the Siberian mining and metallurgical company (SMMC) since 2006. In 2011, enrichment plant was launched, with annual output of 600 thousand tons annually. The capacity allows production of 120 thousand tons of concentrate with manganese content of up to 45%. Currently, work at the deposit has been stopped because reserves have not been confirmed and because of complex geology.

Selezenskoe deposit is confined to weathering crust of the Upper Cretaceous-Lower Paleogene and products of its reprecipitation. Weathering crust is formed by siliceous-carbonate and shale strata of the Vendian and the Lower Cambrian age. Ores are iron-manganese, oxidic, of infiltration type. The deposit is localized in several plots at the area of about 90km^2. Ore bodies shape is mostly patchy, lenticular or a spot of irregular shape. Size of ore bodies starts from 5-15m in width and 15-25m (rarely 50m or more) in length; contacts with host rocks are sharp, subvertical. The initial ore of the deposit is low-grade, requiring enrichment. Average composition of ore is as follows (%): total manganese -15.75; total iron - 8.76; silica - 76.86; phosphorus - 0.14. Reserves of C_1 and C_2 categories are 297.56 thousand tons.

Inferred resources of manganese in the Tashtagol district amount to 11.7 million tons, however, as the authors believe, this figure is way overestimated.

4. Gold

Tashtagol district abounds with ore occurrences of vein gold, but there are no deposits with industrial parameters. It seems to the authors that mountain gold of the Mountain Shoria by its genesis belongs to several formation types: skarn-magnetite, gold-quartz, gold-sulfide in metosomatites.

Occurrences of the first type are not likely to ever be in demand, although increased gold content of magnetite skarns of iron ore deposits in the Tashtagol district has long been known. The main problem here is no acceptable technology for gold extraction from magnetite, and without it, there is no reason to discuss prospects for gold of crane-magnetite deposits. In addition, most of these deposits have already been worked out, development and implementation of new ore processing technologies will require a lot of time and additional costs. It is hardly advisable at present (only two fields are under development, of which only Tashtagolskoye has long term prospects).

The second gold-quartz type of ore occurrence is associated with hydrothermal quartz veins. There are a lot of ore occurrences of this type, but each of them is not of industrial interest (because of low capacity and length of veins, sharply uneven distribution of gold). However, in some cases this does not interfere with development of individual veins by manual method (if such veins are located near the developed placers). This type of gold ore mineralization plays a decisive role in placer deposits origin in the region.

The most potentially productive in the district are ore occurrences associated with the third gold-sulfide type. Kalarskoye ore occurrence belongs to this type (currently it is under prospecting and exploration). It is located in the middle flow of the river Kaz 6 km southwest of the Kalary railway station on a feeder Novokuznetsk-Tashtagol [11]. It was revealed in 1967 during geochemical searches. 8 gold-bearing zones of hydrothermally altered rocks with length of up to 800m and thickness of up to 50m were identified within the occurrence. Inferred resources of the occurrence assume appearance of gold deposit of medium-size here. Among the assessed occurrences of ore gold, it is worth noting the small in size Dzhelsayskoye deposit, located 28km of Tashtagol (discovered in 1914). Ore gold reserves of C_1 category are 670kg. In 1930-1933 during the test production 43 kg of metal was mined here.

Alluvial deposits in the Tashtagol district (alluvial placers) have been known since the century before last. Since that time, deposit has been mined until today by small prospectors teams. Reserves remaining in placers total to the first tens and hundreds of kilograms, but their mining remains economically viable and brings several hundred kilograms of metal annually [1]. The data on the main placers in the district are the following:

- the Zaslonka river with tributaries (“Pai Cher” LLC). Gold reserves of C_1 + C_2 categories are 43 kg;
- the Taenza river (Altai Gold Mine OJSC) - C_1 - 175 kg;

- the Karyshlan river, the Malaya Nikolka stream (Altai Gold Mine OJSC) - C_1 - 289kg;
- the Mrassu river (Altai Gold Mining OJSC) - $C_1 + C_2$ - 1535kg;
- the Bolshaya Sujeta river, the Troitsky stream - C_1 - 151 kg;
- the Ganova river, left tributary of the Kondoma river - $C_1 + C_2$ - 72 kg;
- the Kamzas river, left tributary of the Mrassu river - C_1–20 kg;
- the Kondoma river (Kashken-Shushtangol streams) - $C_1 + C_2$ - 147 kg;
- the Lyapinka river, left tributary of the Aleksandrovka river - C_2– 69 kg;
- the Malaya Kondoma river -C_1– 80 kg;
- the Munzha-Kuban rivers, tributaries of the Kondoma river - $C_1 + C_2$ - 29 kg;
- the Synsas river - $C_1 + C_2$ - 217 kg;
- the Bazas-Sunzas rivers - $C_1 + C_2$ - 432 kg;
- the Osynovy stream, left tributary of the Kondoma river - C_1–14 kg;
- the Chugunash stream, right tributary of the Mundybash river - C_1– 86 kg.

Among the listed objects, placers of the upper basin of the river Mras-su are of the greatest value. But for the economy of the district, they are of secondary importance.

5. Non-metallic minerals

The Tashtagol district is rich in various non-metallic minerals [3; 11; 16]. Only few of them are currently developed. Among them are as follows: Taenzinskoye dolomite deposit for glass production, developed by “Taenzinsky Quarry” LLC. Reserves of C_1 category amount to 12,876 thousand tons; the Bolshaya Gora deposit of fluxing limestones developed by “Temirsky Mine” LLC with reserves of B + C_1 category of 101,863 thousand tons.

The rest of non-metallic mineral deposits of the district remain unclaimed for various reasons. Among them are large Belkinskoye deposit of phosphorites with 43,714 thousand tons of A + B + C_1 categories and 146,813 thousand tons of C_2 category reserves; Sheregeshevskoye deposit of brick clay with 545 thousand m^3 of B category and 1666.3 thousand m^3 of C_1 category reserves; Kedrovskoye deposit of cement and fluxing limestones (A + B + C_1 categories reserves – 28869 thousand t, C_2 - 2660 thousand t); Mundybashskoye quarrystone deposit with C_1 reserves of 14.2 million m^3; Sarlykskoye deposit of granites suitable for surfacing and craft products manufacturing, stairs, floors; facing products with mirror surface texture (reserves by categories are: B - 5251 thousand m^3, C_1 - 6111 thousand m^3, C_2 - 5605 thousand m^3; Sheregeshevskoye deposit of granite grus used as concrete aggregate for concrete of 150, 300, 400, 500 grades, fresh rock massif meets industrial requirements for facing raw materials, stocks of grus of B + C_1 categories are 6978 thousand m^3; Svetloklyuchevskoye deposit of talc shale, used in rubber industry, production of insecticides, ceramic industry (reserves by categories are as follows: A - 1450.7 thousand t, B - 205.8 thousand t, C_1 - 3765.8 thousand t; C_2 - 6875 thousand t); Lespromkhoznoe deposit of brucite marbles (facing and craft products, construction materials production), C_2 category reserves of facing stone (marble) are 1558 thousand m^3, building stone - 768 thousand m^3; Sukharinskoye deposit of limestone suitable for common lime production with reserves of categories B - 164.5 thousand m^3, C_1 = 551.3 thousand m^3 and unlimited inferred resources; Podkatunskoye deposit of limestone suitable for common lime production with C_2 categories reserves of 200 thousand m^3; Shalymskoe deposit of building stone used in production of high-quality gravel (“1200”) and as a concrete filler, ballast of railways (reserves of C_2 category are 636 million m^3); Chugunashskoye deposit of quartzite used in production of ferroalloys with reserves of B category of 2512 thousand t, C_1 category - 2224 thousand t, C_2 category - 1864 thousand t; Kazskoye deposit of diabases used in production of gravel ballast for railway track and concrete filler in road construction (reserves of C_2 category are 11.2 million m^3; Verkhneuchulenskoye deposit of dolomitic limestone used as metallurgical fluxes and in lime production (previously developed by local residents) (reserves of C_1 category are 200 thousand m^3); Krasno-Teneshskoye deposit of dolomitic limestones used as metallurgical fluxes and in glass production, with C_1 category reserves of 1950.7 thousand m^3). In addition to the above listed, within the Tashtagol district, there are various occurrences of non-metallic minerals (mainly facing stones, building materials, materials for building ceramic manufacturing). All of them need further study and reserves estimate (today only inferred resources are available).

6. Results

Despite a significant number of identified and evaluated mineral deposits, the Tashtagol district continues to depend on one mineral resource (iron ore). Three mines of “Evraz-ZSMK” OJSC are operating in the district. Of them, significant prospects are associated with the Tashtagolsky mine. Completion of work at the Kazsky mine and lack of significant prospects at Sheregeshevsky mine causes tricky economic situation. At the same time, it is very difficult to diversify mining production, since known deposits of metallic minerals are either very small in reserves (placers and gold deposits), or have an extremely complex geological structure (manganese ores). Development of the vast majority of non-metallic mineral deposits is possible only with general economic upturn of Kemerovo region, since in the most cases production can be profitable only if it is localised. It is proved by the case of Uchulensky Cement Plant design with construction started on July 7, 2008. An enterprise was designed with estimated annual output of 1.2–1.3 million tons; it was designed for processing of resources of Kedrovskoye limestone deposit and industrial wastes of local mining enterprises. Overhyped at the initial stage, the project was soon neglected and had not yet been implemented. Economic feasibility of plant construction is very doubtful considering operation of large enterprises of the cement industry (“Topkinsky Cement” LLC) in the Kemerovo region and recent closure of such an enterprise in Yashkino village. However, as previously stated for Novokuznetsk and Mezhdurechensk districts, [7; 8] - many deposits of non-metallic minerals may be considered as a resource base for small and medium businesses and thereby could have contributed to local economic development.

References

[1] Butvilovsky V V, Avvakumov A E and Gutak O Ya 2011 *Placer Gold Mineralization of the South of Western Siberia. Historical and Geological Survey and Assessment of Opportunities* (Novokuznetsk) p 241
[2] *Geology of the USSR. Volume XIV. Western Siberia (Kemerovo, Novosibirsk, Omsk, Tomsk regions, Altai Territory). Minerals. Book 1.* 1982 (Moscow) p 319
[3] *Geology of the USSR. Volume. XIV. Western Siberia (Kemerovo, Novosibirsk, Omsk, Tomsk regions, Altai Territory). Minerals. Book 2.* 1982 (Moscow) p 196
[4] Gutak Ja M 2015 *Proceedings of the 8th All-Russian Lithological Conference* pp 85–87
[5] Gutak Ja M 2015 *Nature and Economics of the Kemerovo Region and Adjacent Territories. Collection of Papers* Novokuznetsk pp 6–13
[6] Gutak Ja M 2016 *Proc. of 8th Int. Conf. on Volcanism, Biosphere and Env. Problems* pp 58–80
[7] Gutak Ja M 2017 *IOP Conf. Ser.: Earth Environ. Sci.* **84** 012009
[8] Gutak Ja M and Gutak O Ya 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **206** 012013
[9] Gutak Ja M et al 2005 *Proc. of the III Int. Symp. on Evolution of Life on Earth.* pp 121–122
[10] Kondakov A N and Voznaya A A 2013 *Mineral Resources of the Kemerovo Region. Book 1. Metallic Minerals* (Kemerovo) p 290
[11] Kondakov A N and Vvoznaya A A 2016 *Mineral Resources of the Kemerovo Region. Book 2. Nonmetallic Solid Minerals* (Kemerovo) p 496
[12] Lyakhnitsky V N et al 2002 *Formation Analysis in Geological Studies. Materials of Scientific Conference Dedicated to the 80th Anniversary of Prof. I.A. Vyltsan* (Tomsk) pp 77–79
[13] Lyakhnitsky V N and Khromykh V G 2009 *Paleontology and Stratigraphy News* **12** 71–79
[14] Rakhuba O A, Karaseva V V and Lapshova E O 2019 *Proc. of the All-Russian Sci. Conf. of Students, Postgraduates and Young Scientists* (Novokuznetsk: SibSIU) **23** pp 170–176
[15] Shpayher E D et al 2006 *Geological Structure and Minerals of Kemerovo Region* (Novokuznetsk) p 170