Mineral resources base of the south of Kemerovo region (Mezhdurechensky administrative district)

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Abstract. The article considers current state of mineral resources base of Mezhdurechensky administrative district of Kemerovo region. The main mineral resource of the region for the present and the near future is coal, explored reserves of which ensure operation of coal-mining enterprises for a period of 15 to 85 years. Another relevant mineral resource in the district is placer gold, which is mined by small diggers at several placers in Kuznetsk Alatau and Mountain Shoria. The district has significant resources of metallic (manganese, ore gold) and non-metallic (talc, tremolite, vermiculite, etc.) minerals.

1. Introduction

Mezhdurechensky administrative district is located in the southeast of Kemerovo region. It covers the valley of the river Tom in its latitudinal part and adjacent areas of Kuznetsk Alatau (in the north) and Mountain Shoria (in the south). Geologically, area is located at junction of the Caledonian structures of Kuznetsk Alatau and Mountain Shoria (border is drawn along the latitudinal section of the Tom river) with the Hercynian Kuznetsk marginal trough (large coal basin is formed in the trough in the Late Paleozoic). This defines metallogenic specialization of the area and its minerals, of which only coal and gold are currently relevant. Analysis of district mineral resources base starts with coal, then resource potential for metallic and non-metallic minerals is examined.

2. Mineral resources overview

2.1. Coal

Resources of coal in Mezhdurechensky district are genetically related to the Permian deposits of Kuznetsk coal basin (Tom-Usinsky geological and economic region). Within the latter, four sites with prospects of coal extraction are distinguished (the sites are often referred to as the deposits): Cheksinskoye, Raspadskoye, Olzherasskoye and Tomskoye. Commercial coal mineralisation is associated with deposits of Balakhon (Upper Balakhon sub-series) and Kolchuginskaya series of the Permian system. Systematic geological prospecting and exploration for coal in the district had begun in the late twenties of the last century and is closely associated with V.I. Yavorsky, outstanding Russian geologist. At present, coal mining is conducted by Raspadskaya PJSC: Raspadskaya Mine, Raspadskaya Coke Mine, Raspadskaya Open Pit Mine (43.9% of coal production in the region); South Kuzbass PJSC: Olzherasskaya Novaya Mine, V.I. Lenin Mine, Krasnogorsky, Olzherassky, Tomusinsky open pit mines (29% of coal production), Sibuglemet Holding of Mezhdurechye JSC: Mezhdurechensky Open Pit Mine (25.1% of production). Coal mining is conducted on Raspadskoye, Olzherasskoye and Tomskoye coal deposits. Reserves life of enterprises varies from 15 to 85 years.
Cheksinskoye coal field is considered as a long term reserve (due to remoteness and inaccessibility). Tom-Usinsky geological and economic area is characterized by a wide range of coal grades, such as: G, GZH, KZh, K, KO, OS, T and A. Total inferred resources of the area are estimated as 2.7 billion tons. Of these, by the beginning of our century, explored by A, B and C1 categories are 10527 million tons [5]. Immediate industrial prospects of the district are associated with refinement of reserves of the Tomskoye, Olzherasskoye, and Raspadskoye fields upper horizons and commissioning of their deep horizons.

2.2. Ferrous metals

2.2.1. Manganese. Usinskoye deposit. Located 60 km to the north of Mezhdurechensk in the Usa river basin in the middle part of Kuznetsk Alatau mountain range. Discovered by K.V. Radugin in 1939. Manganese reserves are 98.5 million tons (including 69339 thousand tons by A + B + C1 categories) [1,3].

Ores include rhodochrosite and manganocalcite. Stratiform deposit (the Lower Cambrian limestones) is confined to the western steeply dipping wing (70-90°) of synclinal fold and is formed by structural and lenticular accumulations (several hundred meters long, and 20-65m thick) extending 4-6km to the north-west. Ore bodies are traced to depths of more than 500 meters in patches. In northern and central areas, rhodochrosite and manganocalcite ores are predominant, interbedded with manganese limestone (Mn content in ore is 16.7-19.6%). Total thickness of layers exceeds 150m. Carbonate manganese ores from the surface are oxidized: oxidation zone is up to 40m in the north and 50-75m in the south. Oxidized ores are composed of psilomelane, vernadite, less often of pyrolusite (Mn content is 26.5-27.7%). Operational work at the deposit had been started several times, but each time it ended with nothing. The last attempt was made in this century by Cheksu Co (Republic of Khakassia). The reason is carbonate mineral form of manganese ores, which is inapplicable in metallurgy, low average manganese content in ores and inaccessibility of the site.

2.3. Precious metals. Gold

2.3.1. Placers. Alluvial gold of Mezhdurechensky district is known since the mid-thirties of the nineteenth century, when the party of Aboltin, second lieutenant of the corps of mining engineers had discovered a rich placer on the river Petropavlovka (the right tributary of the river Bazas). In 1836, the placer along the river Fedorovka was discovered, and in 1837 its operation had started. In 1842, the placer of the river Veselaya and in 1843 the placer of the river Bazas were discovered. From those times to the present, mining operations are periodically carried out at alluvial deposits. There is no exact data on the amount of gold produced at the placers. Obviously, each new development of placers, decreases gold content in sands. Currently, the minimum industrial gold content in placers of Mezhdurechensky district is stated at 125 mg/m³.

Alluvial placer in the middle flow of the river Usa and its tributaries - Berezovaya, Shatay, Murta. Mining operations are currently being conducted by the “Golden Pole” CJSC.

Tebinskaya placer originates 10km above the mouth of the river Teba and extends to its headwaters, and from the mouth of the river Koksu (the right tributary) to its headwaters. The placer had been operated by Altai gold-mine of Zapsibzoloto industrial association using gold dredgers since 1977 to 1985.

Placer on the river Zaslonka includes placer of the river Zaslonka itself (the right tributary of the river Mrassu) in its middle flow and placer of its right tributary, the river Ploskaya. Placer of the river Zaslonka is explored on its valley segment with the length of 8.5km, the placer of the river Ploskaya is explored from its mouth 0.5km up the valley. Pay-Cher 2 prospectors association has obtained the license to develop the placer.

The Orton-Fedorovsky placer cluster (three alluvial gold deposits along the rivers Fedorovka, Orton, Maly Orton, Bazas and their tributaries, which are currently in operation). Placer of the river
Fedorovka is considered the largest in the Mountain Shoria. Reserves by C1 + C2 categories here are 1.187 tons, and inferred resources (P1) are 2.01 tons. The placer is alluvial, valley, its length is 12.1km with a width of 50m. Peat capacity is 3.1m, sands capacity is 1.3m; average metal content in sands is 3 g/m³, and in total mass is 0.183 g/m³. Gold is coarse, mostly lamellar, during mining nuggets up to 20kg in weight were encountered. The placers of the Orton and Bazas rivers (with tributaries) are significantly inferior to those of the Fedorovka river in terms of the amount of mined, in-place and prospected gold. The main indigenous sources of the Orton-Fedorovsky alluvial gold placer cluster are Fedorovskyaya, Orton-Magyzinskaya and Asanovskaya ore zones belonging to placer-generating gold ore quartz formation. Inferred resources of alluvial gold in cluster are 2.81 tons by P1 category, and 0.11 tons by P category [6]. Since 1993, development of placer gold along the rivers Orton and Small Orton, as well as in three blocks of placer adjacent to the bottom of the placer along the rivers Orton and Fedorovka, is provided by Kuznetskaya prospectors association (since 2006 - Aurum prospectors association). Bazas prospectors association conducts mining along the Bolshoi Orton and the Maly Orton rivers.

2.3.2. Primary deposits. Fedorovskoe 1 (Kashkatskoye) deposit. Located on the left side of the river Orton (headstream of the left tributary of the Fedorovka river). It was discovered by the Orton party of Krasnoyarsk geological department in 1959. It is a series of vein-stockwork zones in the intensively deployed Late Precambrian and Lower Cambrian volcanogenic-sediments and magmatic associations penetrating in them. Gold content in traces is up to 248g/t. Gold is free, mostly coarse with gold grain size of 1 to 6mm. Distribution of metal is uneven with rich nests alternating by empty intervals. Total resources of the deposit by P2 category are 8.1 tons of gold. Part of ore of the deposit has been mined from the surface to a depth of 10-15m [6].

2.4. Non-metallic minerals

2.4.1. Talc. The Alguyskoye deposit of low-iron powder talc is located in the headstreams of the Alguy river, 9km from Luzhba station. Discovered in 1960 by geologists of Tom-Usinskaya exploration expedition. Talc reserves amount to 11 million tons. High quality talc. In recent years, there have been several attempts to launch exploitation of the deposit. The last attempt was made by Rusotalk CJSC in 1998. However, due to the deposit inaccessibility, cost of talc does not ensure profitability of its extraction.

2.4.2. Asbestos. Topchulskoye deposit. Located 3.0 km to the south of the village Luzhba. It is confined to massif of hyperbasites of the Konchik mountain. It is explored from the surface by ditches and pits. Two asbestos zones with length of 4 and 1km were traced with power of 370m and 200m, respectively. Within the zones, 15 deposits of chrysotile asbestos with thickness of 10-22mm with length of fibers up to 12mm are allocated. Fiber content is 1.5-11%, average content over the deposit - 4.1% (content of grade I and II fiber is 1.03%). Inferred resources by P1 category is 1.0 million tons [2,4]. It should be noted that this type of minerals is considered carcinogenic overseas and its development is prohibited by law.

2.4.3. Tremolite rocks. Alguyskoye deposit. Located in the same ore field with the Alguyskoye talc deposit. Evaluation of the deposit was carried out to a depth of 100m. Four main tremolite deposits lying on the folds wings were identified and outlined. The deposits are in form of consonant lenses and layers with capacity of up to 150m and length of up to 800m. The main components of tremolite rocks are tremolite (65-75%) and calcite (20-30%). Tremolite reserves by C2 category are about 12 million tons. Rocks are suitable for production of household semi-porcelain and construction ceramics.

Degtyarnoye deposit. Located on the right side of the river Orton, along the river Degtyarnaya 2.5 km from its mouth. It is represented by large reservoir with capacity of 80–100m of intensively tremolitized dolomites of Mrasskaya formation of the Lower Cambrian. The strike is sublatitudinal,
transferring to the south-west on its western flank. Established length of reservoir is 1.5km. Ores are composed of tremolite (50.6%), talcum (13.73%), dolomite (16.94%), calcite (11.68%) and quartz (6.1%). In terms of quality, tremolites correspond to that of Alguyskoye deposit. Inferred resources by P1 category are estimated at 50 million tons, by P2 category at 25 million tons, which is 3-4 times higher than reserves of the Alguyskoye deposit.

2.4.4. **Graphite.** Konyukhovskoye deposit. Located 9km to the NNW from the station Teba (the Konyukhovsky stream, left tributary of the river Izrass). It is localized in metamorphic formations of the Yenisei series (biotite gneisses, slates with marbles and small bodies of amphibolites). Stratiform-type deposit. Thickness of the graphitized stratum is 160–200m. Stratum is traced 1.5km along the strike. Content of graphite in rich ores is 4-20.5%, in poor ores - 1-3%. Graphite concentrate belongs to clearly crystalline natural graphite. Estimated reserves of the deposit at depth of 200m are defined in the amount of 4.5 million tons.

2.4.5. **Vermiculite.** Tebinskoye deposit. Located 3-4km north from the station Teba. It is localized in weathering crust with thickness of 6-17m (area 1km²) along gorglendites, amphibolites, and amphibole-feldspathic gneiso-granites of the Tomsk association. Vermiculite is formed due to hydration in the zone of hypergenese phlogopite and biotite. Content of vermiculite in the deposit varies from 5 to 70%. C1 reserves are 425.9 thousand tons, - C2 reserves are 280.1 thousand tons. Vermiculite can be used to manufacture thermal insulating products, lightweight concrete and mortar, as a filler in production of plastics, rubber, enamels and paints.

2.4.6. **Marshallite.** As part of Alguyskoye talc deposit. Marshallite here forms independent deposits and is present in talc ores. In the northeast of the deposits, marshallite contain talc mineralization. Identified reserves of raw materials amount to about 2.1 million tons. It can be used in foundry and ceramic production.

2.5. **Stone-cast materials**

2.5.1. **Diabase.** Usinskoye field. Located 8km from the mouth of the river Usa. It is associated with the Syrkahevsky site of the lower Triassic, localized in the Intermediate and Ishanovskaya suite of the Permian system. Industrial stone reserves were approved in 1956 by categories A + B in the amount of 35,812 thousand m³. Rocks can be used as a quarrystone, paving stone and in facing products manufacturing. Production tests had shown good foundry ability of diabase.

2.6. **Brick and tile clay and loam**

Mezdurechenskoye deposit. On the right board of the Usa river 2.5km north from Mezdurechensk. Eluvial-deluvial loams of the Upper Quaternary age. Average capacity is 4.8m. Subject to introduction of mineral filler into the mixture, it is suitable for production of grade “100” solid brick. Reserves of loam by C1 category is 227.0 thousand m³.

Olzherasskoye deposit. Located in confluence of the rivers Olzheras and Usa (3.0km eastward from Mezdurechensk). Brownish heavy loam. Thickness of productive layer is 3.0 - 7.0m. With introduction of mineral fillers, it is possible to use in production of “125” and “150” grades construction bricks. Category A reserves are 487.9 thousand m³.

2.7. **Carbonate mineral materials for finish lime production**

Belsynskoe deposit. Located 1.5km from the mouth of the river Belsu. Deposit is localized in the Lower Carboniferous sediments and is represented by limestone stratum of 17.5m. Limestone is suitable as a mineral for production of air lime of 1 and 2 grades, hydraulic fluid and silica Portland cement. Limestone reserves by A + B + C1 category are 11924.0 thousand tons. Large stripping ratio is indicated as a negative feature of the deposit structure.
2.8. Sand-gravel mix
Tom-Usinskoye deposit. Located within the boundaries of Mezhdurechensk on two neighbouring islands. It is composed of channel alluvial deposits of the river Tom. Capacity of the deposit body is from 5.0 to 7.0m. Reserves by B + C₁ categories were approved in 1956, and registered in State Reserve in the amount of 2,618 thousand m³, including 1027 thousand m³ of B category resources. Deposit is located in water protection zone of the river Tom.

Chulzhansky deposit. Located along the Novokuznetsk-Abakan railroad from the village Karai to the village Kameshok. Localized in sediments of the first floodplain terrace of the river Tom. Sand-gravel mix forms a bedding plain body with thickness of 0.4 to 1.2m. Sediments are water-flooded. Estimated gravel reserves by C₂ category are 3917.0 thousand m³; reserves of sand are 3123.0 thousand m³.

2.9. Building stones

2.9.1. Sandstones. Usinskoye field. Located 2km from the mouth of the river Olzheras upstream the river Usa along its right bank. Sandstone layer of 70 to 77m thickness is placed in sediments of the Permian system (Ishanovskaya suite). Sandstone reserves by A + B category are 4635.0 thousand m³.

2.9.2. Granites. The Elk Stone deposit. Located on the right bank of the river Tom 6.0km from the Teba station. Intrusive body is composed of fine crystalline granites, granite-porphyries, crystalline diabase porphyrites. Granites prevail. Minerals are applied as crushed stone in pavements foundation, heavy concrete filling, railway ballast, asphalt concrete roadway aggregates. Reserves by C₁ category are 6,318.0 thousand m³, by C₂ category - 65,388.0 thousand m³. The facility is located in water protection zone of the river Tom.

2.10. Facing and ornamental stones
Mezhdurechensky district has a significant number of promising occurrence of this type of minerals. Unfortunately, absence of stone processing production in the district and underdeveloped market leave this type of mineral resources outside of business interest. On promising occurrences, only preliminary assessment was carried out.

2.10.1. Marble. Chernousovskaya group of occurrences are on the left bank of the river Chernaya Usa; Belousovskoye occurrence is in the upstream of the river Belaya Usa; Usinskoye occurrence is in the Usinskoye manganese deposit area; Belyskoye occurrence is 15km north from Luzhba station; Izrasskoye occurrence is Bels-Izrass interfllve area; Ust-Zaslonkovskoe occurrence is in the estuary of the river Zaslonka (right tributary of the river Mrassu); Orton occurrence is in the basin of the river Orton and its left tributary - river Bazas; Kolosovskoye occurrence in the upstream of the river Kolos (right tributary of the Orton river); Ust-Fedorovskoye occurrence above the mouth of the river Fedorovka (left tributary of the Orton river); Degtystarnoye occurrence along the Degtystarny stream (right tributary of the Orton river) in the area of tremolite deposite of the same name; Fedorovskoye occurrence in the upstream of the Koreysky stream (left tributary of the Fedorovka river); Upper Orton occurrence in the left side of the river Bolshoy Orton above the mouth of the Maly Orton river.

2.10.2. Dolomites and dolomitic marbles. Shorskoye occurrence in the left side of the river Orton above the mouth of the river Fedorovka; Zaslonskovskoye occurrence at the mouth of the river Sukhoy Log (right side of the river Zaslonka); Zaslonskovskoye occurrence in the upstream of the river of the same name. Ophicalcites (serpentinized calcite-dolomite and dolomite marbles): Luzhbinskoe occurrence in the left side of the river Alguy (right tributary of the Tom river); Zaslonskovskoye occurrence in the valley of the river of the same name 2km from its mouth.
2.10.3. Magmatic intrusive rocks. Tebinskoye deposit (granitoids) on the left bank of the river Tom in the area of Teba station, Izygashskoye occurrence (granites) on the right board of Mrassu (valley of the river Izygash); Zaslonka occurrence (Ekaterininskoe) (pegmatite) at the estuary of the Yekaterinovka stream (right tributary of the river Zaslonka).

2.10.4. Volcanic and subvolcanic rocks. Nazasskoye occurrence (plagioclase porphyrites, metatrachites tuffs) in the left side of the river Nazas (left tributary of the Usa river). The rocks of these occurrence have good polishing ability and are suitable for facing slabs production.

3. Conclusions
Despite the significant resource potential of Mezhdurechensky district, only coal and alluvial gold are currently of practical impact, with overwhelming predominance of coal. This disproportion reflects regional geological and economic conditions, and indicates general dependence of economy on only one type of mineral. The way to improve current situation is seen in development of regional road network and restart of exploration of a wide range of mineral resources. Absence of good roads in most parts of the district leads to unreasonably high cost of transportation and greatly increases cost of extracted minerals. Plans to build the Abakan-Tashtagol highway have been announced recently. In case of such project fulfillment, many of the described minerals may become profitable for mining. It also seems necessary to compexify mining process, especially in the areas with close location of deposits of several types of minerals. In this sense, the Alguytsky site looks very promising, where significant reserves of high-quality talc, tremolite rocks, marshallite, and opicalcite are concentrated almost in one deposit. It probably makes sense to study ores of the Usinskoye manganese deposit in more details in order to develop modern technologies for their application. Development of small mining enterprises seems to be expedient (for example, in stone-cutting). Such an enterprises do not require significant stocks of minerals. It can promptly change types of processing raw materials and supply necessary products from local natural facing stone.

References
[1] Geology of the USSR. Volume XIV. Western Siberia (Kemerovo, Novosibirsk, Omsk, Tomsk regions, Altai Territory). Minerals. Book 1 1982 (Moscow) p 319
[2] Geology of the USSR. Volume. XIV. Western Siberia (Kemerovo, Novosibirsk, Omsk, Tomsk regions, Altai Territory). Minerals. Book 2 1982 (Moscow) p 196
[3] Kondakov A N and Voznaya A A 2013 Mineral Resources of the Kemerovo Region. Book 1. Metallic Minerals. (Kemerovo) p 290
[4] Kondakov A N and Vvoznaya A A 2016 Mineral Resources of Kemerovo Region. Book 2. Nonmetallic Solid Minerals (Kemerovo) p 496
[5] Coal base of Russia. Volume II. Coal basins and deposits of Western Siberia (Kuznetsky, Gorlovsky, West Siberian basins; deposits of the Altai Krai and the Altai Republic) 2003 (Moscow) p 604
[6] Yuriev A A, Rynda G S, Zeyfert L L, et al 2002 State Geological Map of the Russian Federation scale 1: 200000. 2nd edition. Kuzbass series. Novokuznetsk N-45-XXIX