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# Mineral resources of Novokuznetsk administrative district of Kemerovo region (metallic and non-metallic minerals)

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**Abstract.** The article summarizes data on metallic and non-metallic minerals of Novokuznetsk district of Kemerovo region. Consistently reviewed are iron deposits (Tersinskaya group of deposits), gold deposits (placer accumulations and vein gold deposits), mineral water deposits (Tersinskoe deposit), deposit of refractory clay (Barkinskoe) and wide spread mineral deposits such as brick clay, keramzite materials, sand and gravel, building stones, ornamental stones, facing stones, peat, materials for lime production. It is indicated that resource base of metallic and nonmetallic minerals is inferior to that of mineral coal. At the same time it can be of considerable interest to small and medium-size businesses as objects with quick return of investment (facing and ornamental stones). For a number of wide spread mineral resources (brick clay, keramzite materials, sand and gravel) it is an important component of local industry.

## 1. Introduction

The resource base for metallic and nonmetallic minerals in Novokuznetsk district is much inferior to coal resources (only deposits of common non-metallic minerals such as gravel-sand mixtures, brick clays, mineral water in small amounts) are under operation. At the same time, a number of promising deposits of various minerals are known in the district, development of which would diversify local mining industry and prevent its dependence on a single type of minerals. Traditionally, review is started with metal minerals, of which iron and gold are presented in Novokuznetsk district.

## 2. Results and discussion

**Iron.** Resource base of the Novokuznetsk administrative district for this type of raw material, which is very important for economy in Kemerovo region, includes Lavrenovskoye and Zapovednoe deposits and a number of ore occurrences (Levoberezhnoye, Zaozernoye, Podhrebetnoye, Savelievskoe, Chernoyusskoye, Goltsovoe, Shatskoye) of Tersinskaya group located in the watershed of Kuznetsk Alatau near the border with the Republic of Khakassia. Economically, area is not developed. It is a part of the “Kuznetsk Alatau” state park, any economic activity is prohibited within its borders. Thus, iron ore area of the Upper Ters River currently is only of cognitive significance. The total balance reserves of iron ore here are estimated as 68.1 million tons, including 17.9 million tons of A + B + C category reserves. Deposits are located in the upper flow of the rivers Verhnyaya Ters and Kibras, 110km to the NE from Novokuznetsk. Ores are represented by magnetite scarns. Iron content in ore ranges from 43.2% to 55%. The inferred iron ore resources are estimated at several hundred million tons. Length of ore strip is about 16km. It is confined to the Kanym graben-syncline (volcanic depression, filled with the Middle Cambrian volcanic-sedimentary deposits of the Kanymskaya suite)



on its contact with breakthrough intrusions of diorites, gabbro diorites and plagiogranites. Magnetite ore deposits are located conformable to rocks of ore-bearing strata (scarned marble limestones, and metamorphosed tuffaceous sandstones). Mineral composition of ore is of the same type: magnetite (30-90%), amphibole (up to 40%), garnet (up to 18%). Permanent impurities: pyrite, pyroxene, chlorite, carbonates, feldspar, quartz [4, 7].

**Gold.** Gold mineralization in Novokuznetsk district is represented by lode and placer occurrences. Placer gold mineralization was established in the district in the middle of the nineteenth century. For a long time this was the only source of metal mining in here. By the beginning of the 20th century, alluvial placers of the rivers in Kemerovo region were largely depleted, gold mining declined [3]. Introduction of new methods of extraction and its intensification, made a number of valleys of the Kuznetsk Alatau rivers of certain interest for goldmining operation. Among them, the valley of the river Tutuyas (right tributary of the Tom River above the Tomusinskaya power plant) and the valley of the river Middle Ters (right tributary of the Tom River lower Osinovie Pleso village) belong to the territory of Novokuznetsk district.

Tutuyas alluvial valley placer. Thickness of loose sediments is 3 to 4m in average, slopes of the valley are no more than 0.006. Alluvium stone content is less than 10%, good washability. Hydrogeological and technical mining conditions enable operation of 80-liter dredger. The plot of placer proposed for further study and development has length of 30km (beginning of site is 19km upstream from the river mouth) with a width of inferred resources contour of 40m. Gold is fine with predominance of 0.2mm size. Inferred resources are calculated by estimated parameters of the Taidon-Tersinsky area and amount to 416kg of uncleaned gold. In individual samples from the placer, zircon content of 70-80g/m<sup>3</sup>, ilmenite - of 150g/m<sup>3</sup> is detected. Researchers believe that conglomerates of the Tarbagan series of the Lower Jurassic are the main sources of gold of this placer [3].

Placer of the Middle Ters river. For this placer, alluvial gold reserves were approved for open mining at a site 10km from the mouth of the Middle Ters river to confluence of its right tributary the Alexandrovka river. They include in C<sub>1</sub> category: sand 4112.3 thousand m<sup>3</sup>; metal 2679.43kg with an average content of 797 mg/m<sup>3</sup> of chemically pure gold; in C<sub>2</sub> category - sand 889.96 thousand m<sup>3</sup>, gold 646.2kg, with content of 825mg/m<sup>3</sup>. By complexity of geological structure the placer is attributed to the third group of deposits. The main limit for mining operation, is proximity of the Kuznetsk Alatau state park and need to install a water purification system to prevent pollution of the river Tom [3].

The hardrock gold mineralization in Novokuznetsk district is represented by the Fedorovsko-Talanovskoye deposit [7, 10]. It is located in the left-bank part of the river Sayansas (left tributary of the Tylon river, Kuznetsk Alatau). Distance to Novokuznetsk is 135km through villages Osinove Plesso, Mutny and Pesas. It was discovered in 1968 during geochemical prospecting. The deposit is localized in scarns of the Early Devonian age. Gold-beresitic mineralization is controlled by a series of dykes. Tectonic zones in the south of ore field contain gold-listvenite and gold-sulfide mineralization, accompanied by the exposure of cinnabar, fluorite, barite, and fahl ores. It is believed that high-temperature scarns, medium-temperature gold-bearing beresites and low-temperature gold-listvenitic and gold-sulfide mineralization represent stages of development of single orogenetic system. Gold content reaches tens of g/t. The veins contain variations of hackly gold (1-5mm) and dust gold. Fineness is 820-840‰. Thickness of ore metasomatites with gold content in the first g/t (fineness 701-776‰, 725 ‰ on an average) varies from 10-40m to 300m. The Cretaceous kaolinite and the Cenozoic hydromica-kaolinite gold-bearing weathering crusts (thickness of 90m to 200m, Au content of 1.5g/t) remain in the deposit. Gold from crusts have dimension of up to 0.5mm. Their fineness is 530-890‰, 730‰ on an average. Almost none impurities, apart from silver. The main potential of the Fedorovsko-Talanovsky ore field is associated with large and extended mineralization zones, suitable for open and underground mining. Some researchers have estimated the total potential of the Fedorovsko-Talanovsky ore field (26km<sup>2</sup>) to be at least 150 tons of gold [2]. The deposit is located on the territory of the Kuznetsk Alatau state park and for this reason there is no prospect of its industrial development in a short term.

The list of non-metallic mineral deposits in the district is much wider, but few are involved in industrial development.

**Mineral water.** Tersinskoye field. It is located in the valley of the river Upper Ters to the NE from Novokuznetsk. It was discovered when drilling a well for exploration of the Makarevskoye coal deposit in 1967. In addition to production well, there are three monitoring wells on the field. The deposit is known to consumers under the name “Tersinka”. Water is certified by the GOST “Mineral water drinking medical and therapeutic” as a separate “Tersinsky” type - therapeutic and drinking hydrocarbonate calcium-sodium carbon dioxide water. Commercial reserves of the field are approved for operating well № 1011 for a 10-year service life as 90m<sup>3</sup> per day. Water-bearing rocks are carboniferous sediments of the Carboniferous and the Permian (sandstones, siltstones, mudstones, and coal seams) forming the Tersinskaya anticline. Basalts and diabases are introduced into sedimentary rocks. Composition of “Tersinka” mineral water is close to “Borjomi” and can be used as therapeutic and drinking water[5]. According to Department of Subsoil Management in Kemerovo region (Kuzbassnedra), the Tersinskoye field is industrially equipped, a road and a power line are laid to it. “MVM” LLC extracts water, and another Tersinka LLC company bottles it. In regard to anticipated start of mining operations at the Makaryevskoye coal field, future of the mineral stream causes certain concerns.

**Refractory clay.** Barkinskoye deposit. It is located 3.5 km from Kuzedeevo village. Refractory clays form a series of plastoid bodies confined to the upper part of cyclically constructed clayey-sandy stratum of lake genesis, lying on the weathering crust of the Cretaceous-Paleogene age, overlapping with quaternary loams. The deposit was explored by wells and pits. The reserves of refractory clays in A + B + C<sub>1</sub> categories are 9 million tons. It is classified as a state reserve [5, 8].

**Brick clay.** Deposits serve as a base for brick factories operation. Demand for these products in the region is growing from year to year along with the growth of construction works. Bricks were produced at brick factories located in large settlements. Factories had used resources of small and medium-sized deposits of brick clay in the alluvial plain of the Tom and Kondoma rivers. The period of operation of such enterprises, as a rule, is small and is estimated as the first ten years [5, 8]. Thus, on basis of Abashevskoye field discovered in 1960 (located in the right bank of the Tom river 1-1.5 km from Staro-Abashevo village, 25km from the center of Novokuznetsk), from 1986 to December 2006, “Abashevsky brick plant” was operating. By now, Novokuznetsk brickworks No21 deposit, located in the south-western part of the city, has been developed by Novokuznetsk brick factory. In 2008, Kaltansky brick plant completed development of the Kaltanskoye deposit (the bank of the Kondoma river in the northeastern part of Kaltan). Myskovsky brick factory completed development of the Myskovskoye deposit.

At present, only two fields are being exploited, one in Novokuznetsk, one in Osinniki.

Baidayevsky brick plant is developing an average size *Baydaevskoe 1 and 2 deposits* of expanded clay and brick clay. Clays are suitable for bricks and keramzit production. For the second plot, commercial reserves of brick clays have been approved for production of: an ordinary construction brick of “100” – “150” grades; ceramic brick with 32 cells of the “125” grade; ceramic brick with 18 cells of the “100” grade; ceramic stones with 28 cells of the “150” grade; keramzit gravel of the “700” grade by bulk density as a filler for lightweight concrete. Total reserves of raw materials of A category estimated as 1861.1 thousand m<sup>3</sup>; B category -2860.1 thousand m<sup>3</sup>; C<sub>1</sub> -1346 thousand m<sup>3</sup>. This amount of reserves corresponds to 204.4 thousand m<sup>3</sup> of overburden. Preliminary reserves of raw materials of C<sub>2</sub> category on the site are 2262.9 thousand m<sup>3</sup>.

*Osinnikovskoye deposit* is located on the southeastern outskirts of the town of Osinniki, and includes three plots - Osinnikovsky, Osinnikovsky Eastern and Osinnikovsky Southern. It is being developed by “Osinnikovskiy brick factory” JSC. To date, work in the southern plot has been stopped, the eastern plot with reserves of brick clays of A + B + C<sub>1</sub> category of 2,438 thousand m<sup>3</sup> is in reserve. Mining operations are carried out at the Osinnikovskoye deposit where the clay reserves of A + B + C<sub>1</sub> categories of 1007 thousand m<sup>3</sup> are concentrated. The loams of the deposit are suitable for the “50” grade brick production.

Undistributed fund currently includes 4 deposits. Among them are the medium-size Abagur deposit of brick clays (deluvial loams of the slope of the Tom river valley). The raw material is suitable for production of the “125” grade brick. The total reserves of A + B + C<sub>1</sub> categories amount to 8756 thousand m<sup>3</sup>.

*Nekrasovskoye deposit* is located 0.5km from the town of Kaltan. The quality of clays meets requirements of GOST 530-80 “Brick and ceramic stones”. Commercial reserves of the Nekrasovskoye deposit clays for production of common brick Kr 125/1450/25, subjected to introduction of 4-5% of sawdust and 3-4% of coal as a leaner, are approved by the Protocol of the TCNR in Kemerovo region No. 631 of 01.01.1993 in the amount and by categories (thousand m<sup>3</sup>): B - 49.2, C<sub>1</sub> - 169.0, total B + C<sub>1</sub> - 218.2. By conditions of occurrence, consistency, quality of clays, the Nekrasovskoye deposit is assigned to the first group of medium-sized blanket deposits, simple in structure, thickness and quality of raw materials.

*Alardinskoye deposit* is located in one kilometer from Malinovka village. Loams of the deposits are suitable for production of building bricks of the “100” and the “150” grades, if subjected to introduction of 12-15% of leaner (sawdust). Approved reserves of A + B + C<sub>1</sub> categories are 3845 thousand m<sup>3</sup>.

*Shushtalekskoe deposit* located 5 km to the west from the town of Kaltan with loam resources suitable for production of brick of the “100” grade of A + B categories estimated as 5105 thousand m<sup>3</sup> is in reserve. A condition for development of this deposit is mandatory introduction of large amount of leaner (sawdust) into the batch for bricks production.

**Keramzit raw materials** in Novokuznetsk district are represented by Myskovskoye expanded clay deposit which is the resource base for Myskovsky keramzit gravel plant OJSC operation. Approved commercial reserves of loams for production of keramzit gravel of the “400” – “500” grades with introduction of 1% of fuel oil or 1% of used oils are: of A category - 434.8 thousand m<sup>3</sup>; of B category - 1052.6 thousand m<sup>3</sup>; C<sub>1</sub> category - 1209.3 thousand m<sup>3</sup>. By complexity of geological structure, the deposit is assigned to the 1st group.

**Sand and gravel materials.** In Novokuznetsk administrative district, the main reserves were concentrated in the fields near major cities (Novokuznetsk, Kaltan, Myski, Osinniki). Some of them have already been exploited by now (Karchitskoye, Topolniki-Feski, Ostrovskoye, Antonovskoe). The remaining reserves are concentrated in alluvial plains of the rivers Tom and Kondoma. Among them are Abaguro-Atamanovskoye, Kuznetskoye, Borodinskoye, Sidorovskoye. Sand-gravel mixture of these deposits is suitable as large and fine filler in concrete of the “50” to “500” grades, as well as for railroads and highways gravelling [8]. Development of deposits in alluvial plain of the river Kondoma (Ashmarinskoye, Kaltanskoe, Osmanskoye 1 and 2) is now considered unprofitable due to poor quality of raw materials, or because of location in water protection zone of the river [8]. Three small-size deposits of construction sand (Sredinnoye, Osmanovskoye and Kuzedeevskoye) located in alluvial plains of the rivers Tom and Kondoma are of definite importance for local construction industry. Sands of the Kuzedeevskoye deposit are suitable as molding compound. Reserves of the deposit are small and amount to 503 thousand tons for the Sredinnoye deposit, 583.000 tons for the Osmanovskoye deposit, and about 300.000 tons for the Kuzedeevskoye deposit.

**Building stones.** Gravelstone and sandstone of coal-free parts of Kuzbass (for example, the Kuznetsk suite) are of certain interest as quarry stone. In the post-war period these sandstones were developed by small quarries in outskirts of Novokuznetsk. However, quality of this material by mechanical strength and consistency of physical and mechanical properties left much to be desired. At present, almost every operating local coal open pit mine has subsidiary production units producing sandstone-gravel mixtures from overburden sandstones. Quarry stone is extracted by small quarries in a number of plots in Novokuznetsk district. A quarry at Kuzedeevo village entrance may serve as an example. Coarse-grained sandstone of the Upper Devonian appeared to be quarry stone. The author had studied this quarry in 2008 [1], since these sandstones contain imprints of the Late Devonian plants. Local residents evidence small-scale mining operations conducting there in summer. As a rule, such objects mined without carrying out geological prospecting and reserves estimation. The latest



report on the deposits of nonmetallic resources in Kemerovo region [8] provides data on the Shushtalepskoye deposit as the only quarry in the district (southeastern outskirts of the Malyshev Log settlement), which was discovered in 1950 by the Shushtalepskaya PE. Reserves of quarry sandstone here are estimated by A + B categories in the amount of 1.102 thousand tons, low quality of raw materials is noted. Sandstones of the deposit lie directly on coal seams. Their extraction is only possible in conjunction with coal seams development.

**Ornamental stones (agates).** Tersyukskoe deposit. It is located in the northern part of Novokuznetsk district, in the upper flow of the river Middle Tersyuk, right tributary of the river Tom, with a mouth in Yachmenyukha village. The nearest settlements are the villages of Yachmenyuha (about 15km) and Osinovoe Pleso (about 50km), with which the deposit is connected by gravel roads. Agates are formed with siliceous, zone-colored amygdales in the basalts of the Yamino suit of the Lower Triassic. Amygdales aggregates form a layer-like productive stratum, lying at angles of 7-25° falling to the northeast, with thickness of 0.7-2m. The amygdales in productive strata range insignificantly and are of 36 kg/m<sup>3</sup> on an average. The size of amygdales is 5 × 5 × 2cm on an average. The reserves of amygdales are 140.000 tons. Commercial yield is 25% (conclusion of the “Baikalvartsamotsvetsy” IGE). Standard reserves of conditioned agates are 5600 tons. Experimental quarries are in operation on the deposit, about 42 tons of conditioned agates were mined [6, 8].

**Facing stones.** Description of deposits of this type in Kemerovo region has many pages in the last report on nonmetallic deposits of Kemerovo region [8]. The illusion of significant resource potential of the region, including the Novokuznetsk district, is created. The real situation is quite different. In the city of Novokuznetsk there is no a single building and construction that would have been trimmed with local facing stone. The data on deposits and reserves of the facing and finishing stone given in the mentioned above monograph should at best be considered as inferred resources, since no experimental quarries have been created anywhere, there is no data on the blocky structure of rock massif and other parameters necessary for this type of raw material. A number of occurrences are located in places located far from human habitats and there are no roads, no electricity, no shelter, or located in water protection zone of rivers. Nevertheless, this type of raw materials should be considered as potential basis for local industry development, including small businesses. The author saw examples of such private small stone cutting enterprises in Serbia during geological expedition organized by NIS “Naftogas”, Serbia in 2005. Small business can successfully be engaged in development of such deposits and meet local needs in natural facing raw materials. Objects of extraction and processing of facing stone can be as follows:

- *Ust-Talovskoye deposit of labradorite porphyrites* - located opposite to Osman village on the left bank of the river Kondoma. It is localized in volcanic-sedimentary stratum of the Lower Devonian (the Tel'bes series), is an extensive coastal cliff of the river Kondoma, inferred resources of labradorite porphyrites are about 2 million tons, it is necessary to take into account the position of the deposit in protected zone of the river;
- *Atlaskoye deposit of decorative limestone* – the right side of the valley of the Lower Ters river in the area of the former Pesas settlement, cherry-red and archeocyanate limestones of the Early Cambrian. Certain decorative properties have cherry-red listvenites, sealing wax lava breccia, conglomerate breccia of the deposit. Inferred resources of raw materials are 112 million tons with a pit depth of 30 meters.
- *Tachelginskoye deposit of marble* - the valley of the river Tashelga (the right tributary of the river Mrassu, explored by the Tashkelginskaya prospecting party in 1975 with the organization of experimental quarries, marble from white to green and pink color, marbled breccia (right bank plot) are decorative. Reserves of B+C<sub>1</sub> categories are estimated as 2728 thousand m<sup>3</sup>, of C<sub>2</sub> category - 14.6 million m<sup>3</sup>. On the right-bank plot, reserves of C<sub>2</sub> category are 8.8 million m<sup>3</sup>.
- *Porozhinskoye granite deposit* - the valley of the river Mrassu between the estuaries of the Tashelga and Kizes rivers, the Porozhinskiy massif of subalkaline granites and leucogranites of the Late Triassic age [11] (the Middle Riphean age is erroneously indicated in the summary

[8]). Granites are suitable for building panels and flooring coating production. Reserves of C<sub>2</sub> category estimated as 5.4 million m<sup>3</sup>. The deposit is located in a remote area.

**Peat.** Summary report on nonmetallic deposits in Kemerovo region [8] indicates that there are 4 explored peat deposits in Novokuznetsk district (Atamanovskoye, Kurgany, Borovskoye, Akushkinskoe, Tailepskoye). Peat is suitable for introduction into the soil as a disintegrant, as well as for peat mixtures preparation. Phosphorus-containing peat can be used as a fertilizer. Currently, peat extraction is not carried out at these locations, except for small amount used on private farms by local residents.

*Akushkinskoye deposit*, located in alluvial plain of the river Kondoma 6 km from village Sarbala, was studied in the most detailed way. Peat reserves of A category estimated as 214 thousand tons with its ash content of 22%.

Peat of the Kurgany deposit on the left bank of the river Tom is enriched with phosphorus boggy phosphates) with P<sub>2</sub>O<sub>5</sub> content of 1.81%.

At the Tailepskoye deposit, as a result of preliminary prospecting, inferred peat reserves of C<sub>2</sub> category in the amount of 772 thousand tons were calculated in an area of 334 hectares.

**Raw materials for lime production.** In Novokuznetsk district, one deposit of limestone feasible for lime production - *Abramovskoe* is known. It is located on the right bank of the river Kondoma near the Osman railway station (former Ail Abramovsky) in 9km from Kuzedeevo village. The deposit is confined to the sediments of the Vassinsky horizon (the Frasnian stage) of the Upper Devonian and is composed of monoclinically falling sequence of organogenic detritus limestones (incidence angles of 10-200). Thickness of limestone sequence is 10-14m. It was studied and developed in the 1940s, as is evidenced by numerous small open pit mines on limestone outcrops. Geological section of the Devonian in the area of the Abramovskoye deposit is one of reference sections of the Devonian of the south of the Kuznetsk Basin, containing locations of the Upper Devonian fossils and the Middle Devonian vegetation [9]. Reserves of limestone suitable for lime production according to prospect data of 1941 amount to 734 thousand tons.

### 3. Conclusions

The above review shows significant potential of Novokuznetsk district in a wide range of minerals. As for metal minerals, some at the moment have only cognitive significance (iron ore deposits) because of their location within state park, others (alluvial gold) may be involved industrial development in the near future. It is necessary to take into account that the resources of alluvial gold are significantly inferior to coal resources and for this reason large business can hardly be of interest in it. At the same time, for small and medium-size enterprises, they can be of considerable interest as objects with a rapid return of investments.

Common mineral resources (sand and gravel materials, expanded clay, brick clays, mineral water) are of significant importance for local industry. Some of the deposits of this group known in the district have only theoretical value and are unlikely to ever be developed (peat, raw materials for lime production). In the foreseeable future, deposits of ornamental (agate) and facing (marbled porphyrites, decorative limestones, marbles, granites) stones may be in demand.

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