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METHODICAL RECOMMENDATION

APPLIED FOR CLASSIFICATION OF MINERAL RESOURCES AND CERTAIN TYPE DEPOSITS' RESERVES OF MONGOLIA

(CARBONATE ROCKS)

ULAANBAATAR
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The METHODOLOGICAL RECOMMENDATION applied for classification of mineral resources and certain type of deposits' reserves of Mongolia:

CARBONATE ROCKS

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This recommendation is designed for employees of enterprises and organizations operating in the sector of subsoil use, regardless of their departmental affiliation (or subordination) and ownership.

The application of the "METHODICAL RECOMMENDATION…" will useful to be provided geological information, the completeness and quality of which are sufficient to make decisions on further exploration or on the involvement of reserves of explored deposits in industrial development, as well as the design of new or reconstruction of existing enterprises for the extraction and processing of minerals.

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CONTENT

Introduction

The recommendation was produced in accordance to a number of provisions of relevant law, decrees and regulations as follows: “State policy on the mineral sector approach”, provision #16 of the Minerals law, “Action program to be implemented by the government of Mongolia in 2016-2020”, “Regulations on Mineral prospecting and exploration activities” approved by order #A/270, dated February 05, 2019 by the Mining & Heavy Industry Minister, as well as a provision approved by a Mining Minister order #203 dated on September 11, 2015, which specifies that “The present recommendation for classification of mineral resources and deposit reserves can be applicable to a mineral resource in compliance with any recommendations for a certain type of mineral on the basis of its characteristics”.

It also specifies how to properly use the categories of geological reserves, production reserves and hypothetical resources for deposits of carbonate rocks.

The recommendation aims to provide professional crew and license holders with methodological assistance to compile a final report on reserve estimation, to have the estimated reserves registered to the state mineral resource register and update reserve data.

One. Basic terms

1.1. Carbonate rocks are one of the world's leading non-metallic minerals in terms of annual production and economic importance. Widespread carbonate rocks include limestone composing of calcite and dolomite, lime, dolomite, marble, marl, dolomite flour, limestone tuff, and alm (calcite sand). Minerals such as magnesite and siderite also belong to carbonate rocks.

This methodical recommendation will be applied to limestone, lime and dolomite deposits that meet mineral-chemical composition requirements in the following types of industries: ferrous and non-ferrous metallurgy, chemical industry, cement production, and other binder materials for rubber, glass and sugar, lime flour to fertilize acidic soils, mineral feed for poultry and livestock, and other branches of industries.

Limestone-is the sedimentary rocks, mostly composed of calcite and rarely aragonite, containing a mixture of clastic and clayey materials, dolomite and organic matter. Clastic materials are quartz, opal, chalcedony, pyrite, iron oxides, glauconite, phosphorite and other mixtures. It has a different structure and texture. Limestone is usually hard and dense (average density is 2.57t/m^3 and density of shelly limestone is 1.2-1.5 t/m^3) with varies porosity. Its compressive strength is 94MPa and tensile strength is 9MPa. The chemical composition of rich lime is close to the theoretical composition of calcite, with 56.04% CaO and 43.96% CO2, respectively.

Lime – a type of limestone containing calcite powder and granules, mollusk shell fragments, composed of coccolithophores, and foraminifer's residues, loosely cemented to each other, and capable of white staining. The average density is 1.5-1.6 t/m^3, the porosity is 40-50%, the natural humidity is up to 20-35%, the hardness is low and the strength in the dry state does not exceed 4-5 MPa.

Dolomite- is a carbonate rock, usually composed of mineral of the same name, calcite, sometimes gypsum, anhydrite, iron oxides, and clayey materials are contained as mixtures. The physical-mechanical properties are close to limestone. Structure-textural feature varies. Pure dolomite contains the 30.41% CaO, 21.86% MgO, and 47.73% CO_2. There is a continuous series of carbonate rock transition between dolomite and limestone. If MgO is contained more than 11% in carbonate rocks, is classified as dolomite.

Dolomite flour – Flour or sandy loose carbonate rocks composed of dolomite particles. It is dissolution and decomposition products of dolomite in the weathering zone.

Marl – is clay-carbonate rock, which consists of 50–75% of calcite and dolomite and 25–50% of an insoluble residue, represented mainly by clay material.

Calcareous tuff (travertine) – is lightweight porous rock formed by the precipitation of calcium carbonate from hot or cold springs enriched with carbon dioxide.

Alm- is a loose crumbly powdery rock consisting of calcium carbonate. Synonyms are lacustrine chalk, meadow limestone, freshwater limestone, and limnocalcite.

1.2. There is no generally accepted classification of carbonate rocks by genesis, composition, and structure. The most complete, simple and convenient for practical use is the classification of V.N. Kirkinskaya (1973).

According to the ratio of calcite and dolomite, limestone-dolomite rocks are distinguished: limestone - with a calcite content of 100–95%, dolomite limestone - 95–75%, limestone with dolomite - 75–50%, calcareous dolomite - 50–25%, dolomite with lime- 25 –5% and dolomite - 5–0% and calcite (95–100% dolomite).

The presence of epigenetic formations of calcite or dolomite is reflected in the name of the rock by the adjective “calcined” or “dolomitized”.

In the presence of clay and clastic material in an amount of up to 5%, carbonate rocks are classified as pure varieties, a higher content of impurities is reflected in the name of the rock. For example, conglomerate containing carbonate clast etc. With an impurity content of 5–25%, depending on their composition, the carbonate rock is called sandy, silty or clayey, with 25–50%, respectively, sandy, silty or marl.

The presence of other minerals (anhydrite, gypsum, phosphate, etc.) in an amount of up to 25% is reflected in the name of the carbonate rock with an indication of their content. The higher content of such minerals (25–50%) gives grounds to characterize the rock with a double name (phosphate-limestone rock, anhydrite-dolomite, etc.).

According to the structural and textural features of carbonate rocks, reflecting the conditions of their formation, four groups are distinguished: granular, organogenic, clastic and mixed.

Natural types of carbonate rocks are determined by the material composition and structural and textural features, technological ones - by a combination of composition and structural and textural properties with production methods of their processing and requirements for the quality of raw materials.

1.3. The most widely developed are carbonate rocks of marine origin. They are associated with carbonate, carbonate-terrigenous, carbonate-salt, and variegated and other formations. Depending on the geotectonic setting, the deposits are characterized by different morphology. In the fold belts, they are characterized by a linear orientation, significant thickness, destructed, and occurrence of magmatism, in platform areas, their distribution is wide, almost horizontal, in troughs, limited extension and very thick.

1.4. Depending on the morphology, bedding conditions, consistency of the material composition and thickness, carbonate deposits are subdivided into **industrial types**, which determine the exploration method and mining methods of deposit.

1.5. The main industrial type of carbonate rocks’ deposit is a strata-like body, to varying degrees of lithological and chemical composition and destructed to some extent. Their dimensions in the plan are measured in hundreds of meters and kilometers, their thickness is up to tens of meters. Large deposits are limestone reef massifs. Their dimensions are hundreds of meters, there is no bedding, the structure is uniform, often zonal. Carbonate rocks are common in nature and are highly useful rocks. So the carbonate rocks are used in large quantities in various industries and agriculture. The total amount of explored reserves of carbonate raw materials, taken into account in various balances of reserves of Russia, currently exceeds 60 billion tons, more than 1900 deposits have been explored, and about 570 are being developed. The main directions of using carbonate rocks with an indication of the share of their reserves, deposits and production in Russia as a whole are given in Table 1.

The structure of the use of carbonate rocks in Russia

Table 1

	Share of the total, %

Usage of carbonate rocks	Mining	Reserve		The deposit being mined
		$A+B+C_1+C_2$	total	
Cement production	19.0	27.4	6.9	8.3
Lime production	10.4	7.1	17.7	16.0
Flux limestone	11.3	13.4	4.3	4.7
Metallurgical dolomite	5.4	4.3	2.3	1.9
Chemical industry	2.3	3.3	1.2	1.5
Neutralizing acidic soils	2.3	1.5	20.8	12.0
Mineral feeding of farm animals and birds	1.2	0.5	1.3	1.0
Glass, sugar and pulp and paper industry	1.9	1.3	3.2	4.2
Lime (not including cement raw materials)	0.8	2.5	9.1	9.5
Building stone	45.4	36.9	28.2	36.3
Saw stones	0.4	0.4	1.9	1.9
Dimension stones	0.3	1.1	3.2	2.6

Areas of carbonate rock usage in Mongolia (as of 2019)

Table 2

Areas of carbonate rock usage	Share of the total, %			
	Mining	Reserve $A+B+C_1+C_2$	Explored deposits	
			Total	The deposit being mined
Construction lime and cement raw material	0.05	96.3	83.4	98.9
Cement raw material	0.02	0.85	4.8	0.52
Dimension stones	0.009	2.7	11.6	0.55

Depending on the direction of carbonate rocks usage, deposit reserves are classified by size. Reserves in Russia are grouped by size as follows (Table 3).

Reserve (Mt) grouping of carbonate raw materials

Table 3

Areas of usage	Reserve grouping (deposit)		
	Large	Medium	Small
Cement raw material	>100	100-50	<50
Flux limestone	>100	100-30	<30
Metallurgical dolomite	>50	50-10	<10
Chemical industry	>50	50-10	<10
Lime production	>20	20-5	<5
Glass, sugar and pulp and paper industry	>15	15-5	<5
Neutralizing acidic soils	>10	10-2	<2
Mineral feeding of farm animals and birds	>10	10-2	<2

By grouping the deposits according to their reserves, it will be possible to provide the mining industry with raw materials during the operational period. In large plants, this period is at least 30 years. It has been noted that due to the scarcity of exploration in large-deposits in Russia over the past decade, it is necessary to determine the reserves of medium and small-sized deposits. In Mongolia, carbonate rocks are widespread, but are distributed unevenly in different parts of the country, as evidenced by prospecting geological surveys of construction materials.

1.6. Based on the geological settings, geodynamic conditions of Mongolia, and decades stratigraphic research materials, it is possible to analyze the genesis, and distribution pattern of carbonate rocks (P. Shaandar, 1996) as follows.

- Carbonate rocks, formed in shelf zone of Paleo-Asian ocean and associated with Pre-Cambrian formation (Khuvsgul, Central Sangilen, Tsagaan-Olom, Ider, Buuraltai, Onon, Idermeg, Tsagaan uul and Urgun-Tseel zones)
- Carbonate rocks, formed in ocean shelf zone of Paleo-Tethys ocean and associated with formations from Ordovician to Devonian (Gobi Altai-Baruun Urt and Gobi-Tianshan-Nukht davaa zones)
- Carbonate rocks, formed in association of continental molasses formation of Cretaceous period (Southern Mongolia).

Characteristics of Mongolian carbonate rocks:

- The average thickness of the surface weathering zone is 8.0 m (weathered-3.0, affected by weathering-5.0 м).
- Rock is usually obliquely 30-35^0 oriented, its dipping angle is vertical 45-85^0 and the vertical angles are dominated.
- Strongly cut by tectonic vertical (50-90^0) and three-way (NW, NE, transverse) fractures. Primary (lithological) and weathering fractures are highly developed. Hydrous iron oxide ointment was formed on the fracture wall, or calcite and quartz veinlets infiltrated along the fracture and welded the fracture.
- Due to strong tectonic faulting, there is a case that a vertically oriented layer-like body of carbonate rock, is wedged into the ground (Shokhoi Tsagaan Bulag deposit).
- Carbonate rocks are actively affected in regional metamorphism to form medium and coarse-grained marblized limestone, and in addition, dolomitization and quartzation processes are observed in a large number of deposits.
- 5-8 m thick vein body of gneissized, and schistosed granite and intrusive are observed along the fracture and weakened zones of carbonate rocks (Shand khudag-II limestone deposit and Tsagaanchuluut marble deposit)
- There are many cases, that the carbonate rocks are intercalated with beds of shale and sandstone.
- Some deposits are located in a flank part of a fold.
- The chemical composition of carbonate rocks is unstable and has a high phase transition.
- Carbonate rocks of any age are rich in (relatively) fossils of fauna and flora.

In relation with the above-mentioned characteristics of Mongolian carbonate rocks, the following factors should be considered during the resource perspective evaluation of any type of raw material and exploration stage:

- Seek to conduct in-depth surveys using diamond and inclined drilling.
- The thickness of weathering zone should be defined by drilling and sort-out the weathered and weathering-beaten zones and sample them separately.
- The surface fracture study should be done and differentiate them by genesis. - Measure per unit area (1 m2) and 10 m2 area (by clearing the area), document the fracture map in

scale, systematically identify and number the fractures, and measure and mark their strike and dip. If the number of fractures per unit area is up to three, it is recommended to study for facing purposes and invite a researcher specialized in this field.

- Select the spacing of boreholes, the inclination angle and the direction of the cross-section to be made for revealing the full thickness of the mineral body on the exploration line.

Information on some carbonate rocks deposits in Mongolia

Table 4

#	Name, location, and license owner of the deposit, started year of operation	Explored year	Area of usage	Deposit group and geological settings	Bedding attitude	Exploration grid	Volume of geology-exploration work	Quality characteristics of mineral resources	Results of technological analysis and reserve /thousand ton/
1	**Khutul II,** Selenge, "Tsement shokhoi" Joint stock company, in operation since 2013	1 .1962-1963 2.1977 3. 1976 4. 1980 5. 1990 6. 2008 7. 2014*	Cement, construction lime	It is composed of metamorphic rocks, sandstone, calcined aleurolite and limestone of Neoproterozoic Darkhan formation. It consists of 2 bodies such as “Undsen” and ‘Umnud”. The “Undsen” body is 620 m long with intermittent along the latitude and 30-150 m wide while the “Umnud” body strikes along the longitude and 170 m long and around 50 m wide.		50 x 40-50	Diamond drilling-12332.7 length/m, sampling-5044 pc, bulk sampling- 31000 t, geochemical-28 pc, petrography-55 pc, physical-mechanical-4 batch sample, radiation analysis-3 pc, topographic mapping-706 ha	CaO-47.34%, MgO-1.86%, SiO_2-6.64%, Al_2O_3-1.85%, Fe_2O_3-1.16%, K_2O-0.28%, Na_2O-0.01-0.02%	OPC-42.5, OPC-52.5 mark cement, cement clinker. Reserve: B-31640.5
2	**Khutul I,** Selenge, "Tsement shokhoi" Joint stock company, in operation since 1984	1962-1963 1977 1980 1990 2014*	Cement, construction lime	It is composed of metamorphic rocks, sandstone, calcined aleurolite and limestone of Neoproterozoic Darkhan formation. It consists of 4 bodies such as “Baruun”, “Baruun-1”, “Tuv”, and “Zuun”. The “Baruun-1” is 150-380 m long, and 5-40 m wide. The “Tuv” is about 1 km long and 20-80 m wide. The “Zuun’” bodies are 2-3 parallel, 620 m long with intermittent and 5-20 m wide.	**Baruun:** Strike-SE110^0 and dip-SW70-75^0, **Baruun-1:** Strike-SE135-140^0 and dip-SW 60^0, **Tuv:** Strike-SE110^0 and dip-SW-60^0 , **Zuun:** Strike-3-90^0 and dip-S30-50^0	50 x 40-50	Diamond drilling-10794.6 length/m, sample-3173 pc, bulk samples-13000 t, petrography-6 pc, physical-mechanical -6 pc, radiation analysis -2 pc, external control-95 pc, topographic mapping-706.2 ha	Cement raw materials. CaO-47.28%, MgO-1.0%, SiO_2-7.8%, Al_2O_3–2.27%, Fe_2O_3–1.0%, K_2O–0.43%, Na_2O–0.38%, lime raw materials. CaO-50.71%, MgO-0.67%, SiO_2-4.23%, Al_2O_3-1.16%, Fe_2O_3-0.65%, K_2O-0.23%, Na_2O-0.26% /2014/	OPC-42.5, OPC-52.5 mark cement, cement clinker, Lime of 3 and 4 grade, Reserve: cement-4002.69 (B category), lime-3734.51 (B category), cement-7635.14 (C category), and lime-1433.00 (C category)

3	**Khukh tsav (Biluut),** Dornogobi, MAK cement LLC, in operation since 2017	1991 2003 2008 2014*	Cement	It is calcareous-carbonate strata-like body with a length of about 2000 m and width of 950 m. The limestone body has a complex structure and it was cut by fault, divided into blocks, intruded by effusive and deep intrusive rock, and slightly folded.	Strike-SW-NE and dip angle is 50-65^0	100x100	Geological traverse-27 length/m, and diamond drilling-26805.6 length/m	CaO-51.41%, MgO-1.12%, SiO_2-3.75%, Al_2O_3-0.51%, Fe_2O_3-0.64%, K_2O–0.07%, Na_2O-0.12%, water insoluble substance-41.7%, $CaCO_3$-84.55–91.2% /1991/	PC 32.5, PC 42.5, PC 52.5, PC 62.5, SRC mark cement Reserve: 201993.6 (B category) and non-conditional 820413.5 Total: 284035.0
4	**Sugdukh,** Dornogobi, "Yalguun-International" LLC,	1.1989-1990* 2.2009-2015	Cement, lime	It consists of lens-shaped 3 bodies of Late Ediacaran-Early Cambrian limestone. It is 700-900 m long and 100-300 m wide. The second lens is 900 m long, 300 m wide in middle part, 40 m and 80 m wide in 2 edges and 10-30 m in the central part, and it contains red-pinkish colored schist layer. The limestone is white grey, blue grey and dark grey-colored, massive, hard and small to medium-grained.	Strike-NW and dip angle is 45 – 70^0 at SW and S		Trenching-1167m^3, diamond drilling-1913.2 length/m, chemical analysis-448 pc, physical-mechanical-13 pc, petrography-5 pc, bulk sample-1 pc,	CaO-46.34-55.96%, MgO-0.13-2.31%, Al_2O_3-0.02–1.01%, P_2O_5-0.04-0.18%, SiO_2-0.1-4.49% silicate modulus 0.032-17.05, clay modulus 0.13-4.59, volumetric mass 2.66-2.7 g/sm^3, specific gravity 2.7-2.71 g/cm^3, water absorption 0.05 – 0.47%,	Compressive strength is 530.16-813.13 kg/cm^2, lime, cement, non-ferrous metal, chemistry, glass, and sugar. Reserve: A+B+C1-15702.0, C_2 - 23701.0, and P-7398.4
5	**Senjit khudag,** Dornobogi, "Moncement building materials" LLC, in operation since 2015	1. 1991* 2. 2007	Cement, construction lime	Strata-like body of limestone bed with size of 1500x400 m. It is slightly affected by folding and faulting.				CaO-52.26-54.07%, MgO-0.3-0.38%, SiO_2-4.64-10.2%, Al_2O_3-0.12-0.42%, TiO_2-0.01%, Fe_2O_3-0.03-0.04%, K_2O-0.01-0.02%, Na_2O-0.01-0.02%, MnO-0.01%, CO_2-40.18-42.5%.	OPC 42.5, PC 42.5, PC 52.5 mark cement

6	**Darkhan II and III** (Bukhyn tolgoi), Darkhan uul, "Silicate" Joint stock company, in operation since 1966	1.1962-1963* 2.2009	Lime mud	Sedimentary-volcanogenic rocks of Neoproterozoic Darkhan (?) formation, marbleized limestone, porphyrites and tuffs are distributed and diorite dyke cuts these rocks. Limestone bodies such as II and III are distinguished. These are 120 m thick, 20-150 m wide and 300-1300 m long. The limestone is grey, dark grey-colored, medium and large-grained and with striped-texture.			Geological traverse-0.2 km^2, diamond drilling - 271.3 length /m, dug hole-56.2 length/m, trench-1450 m^3, channel sample-98 pc	Body II: SiO_2-4.88%, Al_2O_3-1.17%, Fe_2O_3-0.49%, Ca -52.15%, MgO-0.49%, P_2O_5-0.28%, SO_3-0.05%, loss on ignition-40.39, aluminium modulus-2.39, silicate modulus-2.94. Body III: SiO_2-5.11-14.69%, Al_2O_3-0.63-2.05%, Fe_2O_3-0.50-0.97%, MgO-0.31-0.45%, P_2O_5 -0.02-0.05%, SO_3-0.02-0.05%, loss on ignition-35.19-40.91, clayey mixture-6.24-16.3%.	400-500" mark cement, flux limestone. Reserve: A+B+C_1-140002.0, and C_2-3043.0
7	**Khutuliin shar**, Umnugobi, "Olon ovoot" LLC	2012	Lime mud	2nd type of group 1. Limestone of Upper Devonian-carboniferous Tal formation forms the light-grey and white-colored, medium-large-grained, layered, marbleized, massive, and strata-like body. Sometimes it cut by 0.5 m thick granodiorite dyke and slightly fractured.	Strike-SW200-220^0 and dip angle is 45-65^0	80x160	Prospecting traverse-21.31 km^2, diamond drilling-425.8 t/m, trench-528.71 m^3, core and channel samples-240 pc	CaO-52.4-54.9%, MgO-0.4-1.7%, SiO_2-1.5-1.7%, volumetric mass-2.69 kg/cm^3, lime activation on ignition -89.5-91.5, combustion temperature-900-1000^0	lime mud suitable for metal processing. Reserve: B-961.7, C-4110.5
8	**Shand khudag II**, Tuv, "SHTN" State-owned enterprise, in operation since 1963	1.1963 2.1969* 3.1982-1983	Construction lime	2nd type of group 2, Granite porphyry vein body was formed in Permian, thin layer of schistosed amphibolite and sandstone and along the limestone bed. Three bodies of limestone were distinguished. It is small and medium-grained, white-grey and grey-colored marblized limestone.	Strike-SE11-120^0 and dip angle is 40-55^0	50-100, 100-200	Trench-726.0 m^3, dug hole-15 length/m, diamond drilling-539.0 length/m, bulk sample-4 pc, core and channel samples-195 pc	In the south-west part: CaO-48.2-51.28%, MgO-1.72-4.27%, water insoluble substance-2.01-4.22, In the north east part: CaO-49.7 %, MgO-3.91 %, water insoluble substance-3.03	Lime of 1st grade. Reserve: A+B+C_1- 9055.4, and C_2-375.5

9	**Aralt khudag,** Dornod, "Am Ta Tu" LLC	1.1963 2.1968 3.1975	Construction lime, silica brick	300 m long, 110-190 m wide lens-shaped body of marblized limestone was identified within the Paleozoic metamorphosed layer. The limestone is medium and large-grained, light-colored and strongly affected by faulting.			Geological traverse study, diamond drilling-263 length/m, sampling	$CaCO_3$-89.9%, $MgCO_3$-5.98%, H_2O-2.04%	Lime of 1st grade, 200-250 mark silicate lime. Reserve: B-748.5 and C_1-1159.9
10	**Boodogiin khar khoshuu,** Gobi-Altai, "Taishiriin khuder" LLC	2014	Cement, construction lime	1st type of group 1. It is composed of interlacing layers of sandstone and limestone of Late Ediacaran-early Cambrian Bayangol formation. The limestone is grey-colored, marbleized and silicified.	Strikes almost along the longitude and dip angle is SE50-60^0	200x200-400	Magnetic mapping-3.25 km^2, diamond drilling-833.5 length/m, trench-349.6 m^3, core sample-178 pc, channel sample-96 pc, petrography-6 pc, bulk sample-2 pc, radiation analysis-2 pc, external control-16 pc	$SiO_2+Al_2O_3+Fe_2O_3$-4.62%, CaO-53.45%, MgO-0.86%,	Lime of 1st and 2nd grades Reserve: B-14778.3, and C-7941.9
11	**Khovd gol,** Khovd, Khovd lime factory, in operation since 1963	1.1964 2.1965*	Construction lime	9 km long, limestone layer was defined in effusive and terrigenous-carbonate beds of Tsagaan olom formation. Three bodies are distinguished.	It strikes NE40-80^0 and dip angle is 80-90^0			$CaCO_3$-89-94.3%, $MgCO_3$-2.2-6.0%, water insoluble substance-1.6-2.6%	B mark lime, Reserve: B-660.0, C_1-635.0, and P-1320000
12	**Tayannuur-1,** Gobi-Altai, "Altain khuder" LLC	1.2007-2009	Construction lime	1st type of group 2.1500 m long and 500-700 m wide limestone is distributed within Ordovician-Silurian metamorphic rocks. A thin layer of schist is contained in dark blue-grey, white-colored, and marbleized limestone.	Strike-W-E at 290-310^0 and dip angle is $SW60^0$		Diamond drilling-1732.65 length/m, trench-30 m^3dug hole-60 length/m, core sample-313 pc, channel sample-20 pc, grab sample-10 pc, bulk sample-150 kg	SiO_2-1.62%, Al_2O_3-0.5%, CaO-42.9%, SO_3-0.10%, Silicate modulus- 1.6%, clayey modulus-1.9 %, volumetric mass- 2.69 g/cm^3, density- 2.71 g/cm^3, water absorption-0.15%,	Lime of 1st grade, Reserve: B-49370.0, and C-28544.0

13	**Tsagaankhad.** Bayan-Ulgii,	1982	Construction lime	A 150 m long and 40-70 m thick dolomitized limestone layer was defined within Middle Paleozoic metamorphic rocks. The limestone has colors of white-grey and milky-white.	Strike-NE-SW and dip angle is 80-90^0		Diamond drilling-12 2 length/m, trench-750 m^3, dug hole-60 length/m, core sample, channel and bulk sample	SiO_2-0.66-8.84%, Al_2O_3-0.06-1.83%, Fe_2O_3-0.57-1.4%, CaO-46.5-50.7%, MgO-0.09-1.42%, SO_3-0.03-0.04%, loss on ignition-0.04-0.08 %	B and V mark lime Reserve: C_1-713.7 and C_2-185.7
14	**Tsagaanchuluut**, Khuvsgul, "Tuv Asiin Gantig" LLC	1. 1984-1986* 2.2011	Dimension stone	The marble of the Khoridol uul formation of the Early Cambrian is divided into 3 layers of 1400x400 m area with different structure-texture, color and composition. The average thickness of weathered part is 8.0 m, and upper layer is 30 m, middle layer is 46 m, and lower layer is 42 m. The marble has colors of grey, dark-grey, white, small, and medium-grained.	Strike-NW280-290^0 and dip angle is 15-30^0		Diamond drilling-3137.1 length/m, trench-1800 m^3, sampling-1415 pc, fracture analysis-1500 times, experimental open pit,	There are three types of fracture: tectonic, lithology and exogenic. Yield of block-33%, slab yield-13 m^2/m^3, CaO-48.19-55.71%, MgO-1.83%, SiO_2-0.56%,	It has a well polishing and beautiful pattern. In dry basis, the strength is 884.94 kg/cm^2 in upper layer, 705.0 kg/cm^2 in the mid layer and 920.68 kg/cm^2 in the lower layer, waste of abrasion ranges 1.1-2.24 %. Reserve: A-470.0 м^3, B-2770.0 м^3, C_1-1704.0 м^3, and C_2-4900.0 м^3
15	**Tsakhiurt**, Selenge, "Monquartz" LLC	1.1971-1972, 2.1973-1974* 3.1995	Cobble stone, mosaic tile	It is composed of dolomitized and marbleized limestone of Neoproterozoic Buuraltai formation. It forms the lens-shape body of 1400 m long and, 200-500 m wide. The marble has colors of white, yellowish-light and white-grey and strongly cut by fractures in three directions.	Strikes along the latitude		Diamond drilling-932.7 length/m, dug hole-25.5 length/m, trench-2000 m^3, experimental open pit -1500 m^3, sampling	Yield of block-3-4%, SiO_2-0.55-4.51%, Al_2O_3-0.08-0.59%, Fe_2O_3-0.12-0.16%, CaO-30.15-31.28%, MgO-21.27-22.69%, SO_3-0.03-0.04 %, loss on ignition-42.26-46.08%	Mosaic tile, hard concrete mix of 300 mark. Reserve: A+B+C_1-12557.0, and C_2-8114.0

Comment: 1973*: Information on exploration work carried out in 1973.

1.7. Three-quarters of the extracted carbonate raw materials are used in construction and a quarter in other industries in Russia.

In construction, carbonate rock is mainly used in the production of building stone, cement and lime, and in other industries, mainly in metallurgy, and used in small quantity in chemical, sugar, glass and pulp and paper industries, and agriculture.

The main quality requirements for carbonate rocks used in industry and agriculture are often determined by their chemical composition and, to a lesser extent, their physical and mechanical properties, including strength and blocking size (cracks).

Portland cement is currently the main material in civil and industrial buildings, hydraulic and road construction. This hydraulic binder hardens in water and air. The raw material of the limestone (natural lime) and clay mixture burns at a temperature of about 1500°C and melts to form a fine powder compound. When using natural marls, in which the carbonate and clay components are in an optimal ratio, it is not necessary to add clay to the blend (schicht). The raw material mixture usually has two components. The permissible content of toxic impurities in one component depends on their amount in another. The toxic impurities of cement raw materials are magnesium oxide, alkali, sulfur, phosphor and titanium. When producing the cements in dry method, chlorite content (not more than 0.015%) plays important role. There is no any approved standard for cement raw materials.

Currently, the technical specifications for Portland cement clinker production materials are the following requirements for the chemical composition of the raw materials: limestone with carbonate component is allowed to contain not less than 45% CaO, 40-45% in “natural” marl, not more than 15% CaO in the clay component of group I, and 15-44% CaO in the clay component of group II.

The content of toxic oxides should not exceed the following values (%) in carbonate components: MgO-4.0, SO_3-1.3, K_2O+Na_2O-1.0, and P_2O_5-0.4. The content of oxides in the raw material mixture should provide values of the saturation coefficient within 0.88–0.92, silica module 1.90–2.60, and alumina module 0.90–1.60.

To obtain the calculation parameters of the raw material mixture, if necessary, corrective aluminate and iron-containing additives (bauxite, iron ore, pyrite cinders, ocher clays, furnace dust, etc.) are introduced into it.

For limestone of cement and other purpose deposits, requires a specific technical specification.

The rock suitable for cement production should have a stable chemical composition and a homogeneous fine-grained structure.

The physical and mechanical properties of calcite rocks are not regulated, but their low-strength differences (10–20 MPa) are preferable. The allowable moisture content of limestone is up to 5% and that of "natural" marl is up to 10%. When producing the cements in dry method, high moisture lime is not used. In limestone (lime), to producing white and colored cement, the pigment content of iron and manganese oxides is additionally limited, the presence of chromium oxide, is not allowed. The limestone, lime, dolomite and, often marl are used for producing construction lime necessary for the preparation of mortars, concretes, blocks and silicate bricks.

Lime is produced by burning carbonate rocks in shaft or rotary kilns at a temperature of 1000–1200°C until carbon dioxide is completely removed.

"Limestone for construction and technological lime production" (Technical specifications) is controlled by MNS 963-91 standard. According to the standard, carbonate raw materials to produce lime, is divided into 7 classes by content of $CaCO_3$, $MgCO_3$ and clay mixture (Table 5).

Class of carbonate rocks producing lime

Table 5

Content, %	**Class**						
	A	**B**	**V**	**G**	**D**	**YE**	**J**
$CaCO_3$, not less	92	86	77	72	52	47	72
$MgCO_3$, not more	5	6	20	20	45	45	8
Clay mixture (SiO_2+Al_2O_3+Fe_2O_3), not more	3	3	3	8	3	8	20

According to MNS 963-91, the carbonate rocks are divided into hard (more than 60), medium (30-60), soft (10-30) and very soft (less than 10) by its strength (MPa).

The most suitable raw materials to produce lime are rich limestone and natural lime with very low content of MgCO3 and insoluble residues. The most suitable one regarding the strength is rock with compressive strength of 10-40Mpa.

Lime shall meet the requirements and standard of the "Lime for construction and technological needs" (Technical requirements) MNS 347: 2002.

Technical requirements of "Lime for construction and technological needs" MNS 347: 2002

Table 6

#	**Parameters**	**Unslaked**							**Slaked**	
		Calcium				**Magnesium and Dolomite**				
		I	**II**	**III**	**IV**	**I**	**II**	**III**	**I**	**II**
1	Content of active CaO+MgO, not less than %	90	80	70	60	85	75	65	67	60
2	Content of active MgO, not less than %	5	5	5	5	20 -40	20 -40	20 -40		
3	Content of CO_2, not higher than %	3	5	7	9	5	8	11	2	5
4	The size of the incompletely burned part, not higher than %	7	11	14	18	10	15	20		

Dolomite with an MgO content of at least 18.5% is used in the manufacture of magnesium binders. For this, dolomite is fired at a temperature of about 700°C and, after grinding, is mixed with a solution of magnesium chloride. The resulting binder is used for the production of various building products.

Limestone and dolomite are used in the ferrous metallurgy industry.

Limestone, as well as lime obtained from them, are used as a flux in the production of cast iron, steel and ferroalloys to extract and transfer into slags ballast (silica and alumina) and harmful (phosphorus and sulfur) impurities of ore and fuel ash.

In blast furnace production, limestone, dolomite limestone and dolomite are used, while, in steelmaking and ferroalloy production - limestone and lime are used

Natural lime, due to insufficient strength and high humidity, is used only occasionally in foundry. Because the production of steel martens is being replaced by the production line of steel converter furnaces, there is a growing need for limestone suitable for the production of low-impurity converter lime.

Flux limestone is extracted from carbonate raw materials by crushing and concentrating. Depending on chemical composition and grain structure, it is divided into grades and sorts.

Requirements for the quality of commercial flux limestones are defined in OST 14-63-80 (for blast-furnace smelting) and OST 14-64-80 (for steel smelting), Russia but both industry standards have been invalidated.

According to the technical specification and requirement, chemical composition of raw materials are limited such as low MgO (not more than 3-10%), insoluble residue (not more than 2-4%) and CaO+MgO (not less than 50.5-54.0% depending on the brand). Higher requirements apply to the production of electronic steel and iron alloys. In addition, phosphorus and sulfur are limited in here.

Requirements that are even more stringent are set for the chemical composition of limestone used in the production of converter lime in accordance with the specifications of TU 14-15-60-78.

Limestone of the Pikalev deposit is used in the production of alumina, cement, lime and as a flux in ferrous metallurgy. According to technical specification of TU 57-43-060-00196368-97, the limestone must contain CaO+MgO at least 52%, MgO is not more than 8% and SiO_2 is not more than 2% for the first grade and CaO+MgO not less than 50 %, MgO is not more than 8%, and SiO_2 not more than 4% for the second grade, respectively.

In addition to chemical composition, the main characteristics of flux limestone are particle composition, compression strength and a homogeneous fine-grained structure.

For the flux limestone, fine-grained, less porous, and comparatively high in hardness and strength limestone are suitable.

In metallurgy, dolomite is used as a refractory material (raw and burnt) and as an additive.

Raw dolomite is used as a filling material for main open-hearth furnaces and converters.

After burning it, metallurgical dolomite or metallurgical dolomite powder is derived, which is used in the manufacture of dolomite tar and dolomite tar-magnesite refractories. These can be used to make refractory products for special purposes such as compaction masses, bricks, and blocks.

The main characteristics of dolomite used to produce refractory material and additive, is chemical composition, however, structure, homogenous and strength are should be considered.

The TU-14-8-232-77 technical specification controls the requirements of converter dolomite tar and refractory dolomite tar-magnesite dolomite.

The OST 14-84-82 includes the technical specification for quality of raw dolomite intended for firing, filling thresholds and filling open-hearth furnaces.

Regarding, quality requirements for flux dolomite are defined in technical specifications of TU 14-16-28-89 and for metallurgical burnt dolomite are in OST 14-85-82.

The mass fraction of common oxides in the burning the dolomite for metallurgical use should be MgO not less than 16–19%, SiO_2 not more than 3–5%, and R_2O_3 not more than 3–4%.

When producing highly refractory products, dolomites of the following composition are used for lining oxygen converters: MgO not less than 19%, CaO not more than 33%, SiO2 up to 1%, R_2O_3 not more than 2%.

Flux use of dolomite requires technical conditions with MgO 17-19%, SiO_2 not more than 6% and R_2O_3 + MnO not more than 5%.

For non-ferrous metallurgy, limestone and lime are used as technological raw materials and flux.

In the production of alumina from nepheline or bauxite by sintering, the role of limestone and natural limes is reduced to breaking chemical bonds in the ore between Al_2O_3, SiO_2 and R_2O_3 and subsequent carbonization of the aluminate solution. Depending on the type (there are 4 types), the limestone raw material should be CaO not less than 52-53%, MgO not more than 1.0-1.5%, SiO_2 not more than 2.0-3.0%, and Fe_2O_3-0.8-1.0% (TU 5743-060-00196368- 97 technical specifications).

In the copper smelter, limestone is used as a flux and lime is used to extract calcareous milk for flotation. The chemical composition of limestone used in copper production is specified in the technical specification of TU 48-7-2-77 as CaO 48-55% depending on the type.

The limestone and lime are used in non-ferrous metal refinery to cyanidation of gold and silver, and to concentrate ores of oxidized nickel, lead, antimony and tin.

The chemically pure limestone is required for thermal production of metallic calcium, which is used in the production of various alloys and as a reducing agent in the manufacture of high-quality refractory metals.

Limestones are used to prepare calcareous milk in the production of metallic magnesium from brines of salt lakes. It is used to obtain magnesium hydroxide, which, after calcining and obtaining MgO, is chlorinated, and anhydrous magnesium chloride is subjected to electrolysis.

In non-ferrous metallurgy, dolomite is also used as a refractory material and as a raw material for obtaining metallic magnesium as a result of magnesium reduction with ferrosilicon.

The limestone and natural lime are widely used in the chemical factory. Up to 80% of the extracted raw materials are used for the production of soda ash, which is the initial product for the production of crystalline, drinking and caustic soda.

For the production of calcined soda, table salt solution is saturated with carbon dioxide and ammonia and sodium bicarbonate and ammonium chloride are derived. Sodium bicarbonate is decomposed by calcination into soda ash and carbon dioxide. For ammonia regeneration, ammonium chloride is treated with calcareous milk. The production waste is calcium chloride. Calcareous milk is produced using carbon dioxide and lime derived from burning the limestone and chalk. The content of calcium carbonate contained in limestone and lime should be not less than 95-92%. Moreover, minimum content of CaO, MgO, SiO_2, R_2O_3, S, and P, compression strength and size of crushed block are defined in the technical specification of TU 6-28-21-04-85.

Limestone is used in small quantities in the chemical industry to produce calcium carbide, calcium chloride, calcium borate, chlorinated lime, chemically precipitated lime, and feed precipitates used in the production of resin, superphosphate, nitrogen fertilizers, and calcium hydroxide.

For example, to obtain calcium carbide, which is a fusion product at a temperature of 1900-1950°C of a mixture of lime and coke, limestone is required containing as much CaO and as little impurities as possible. The best grade of such limestone should be CaO is not less than 54.5%, MgO, SiO_2, Al_2O_3, S and P are no more than 0.8%, 1.0%, 0.8%, 0.08% and 0.01% respectively.

It requires limiting the content of lead, arsenic and fluoride in limestone to produce feed precipitate while the production of chemical sedimentary lime requires content of copper and manganese

The production of feed precipitates limits the content of lead, arsenic and fluoride in limestone, while the production of chemical sedimentary chalk requires a minimum level of copper and manganese content.

In agriculture, limestone, dolomite, rarely lime, and marl are used to neutralize acidic soil and limestone and lime are used in the production of mineral feed for domestic animals and poultry.

To neutralize acidic soils, limestone (or dolomite) flour is used which is extracted by grinding of carbonate rocks or crushing gravel.

The flour is divided in to 4 classes (GOST 14050-93) depending on strength of carbonate rocks and 3 marks (A, B, C) by grain composition. Mark A flour is divided into two groups according to their moisture content by mass. The minimum permissible content of Ca and Mg carbonate is not less than 80% for the rocks of class 1st and 2nd and not less than 85% for the class of 3rd and 4th (strength is higher than 40 MPa). The structure of the flour grains is determined by the mark and class, but any type or class requires that the grains less than 1 mm make up the majority and the grains larger than 3-5 mm should be in minority. Moreover, finer grinding of rocks with more hardness is also included in the requirements.

Local limestone, dolomite and marl can be used for lime fertilizer and it is regulated by technical specification of TU 2189-326-00008064-99. The fertilizer is divided in to 3 classes (up to 20, 20-40 and more than 40 MPa) depending on strength of limestone and dolomite. For the rock of 2nd and 3rd classes, total of $CaCO_3$+$MgCO_3$ should be not less than 80%, moisture should not exceed 15% and dominant grain size should be smaller than 3 mm and grain size higher than 5 mm is limited by 5-10%. Natural carbonate rocks such as chalk, lake lime, marl, and lime tuff for fertilizer should have calcium and magnesium content in the range of 50-85%.

Lime flour is used as pet food and poultry feed and as a mineral supplement in all-mash. The disadvantages of using flour as an animal feed are that it does not strengthen the skeleton, eggshell, horns, paws and claws. While carbonate feeds, support the growth of animals and birds and increase productivity.

For this purpose, low-magnesium limestone, chalk, seashells (snails, oysters) are used as animal feed for livestock and poultry in the form of lime or chalk flour, sawdust and snail crumbs.

The requirement for limestone flour to produce animal feed for livestock and all-mash, is by GOST 26826-86 while the requirement for limestone of mineral feed limestone and seashells, is monitored by technical specification of TU 21-RSFSR-839-82 respectively.

In calcite-dominated carbonate rocks, the total of $CaCO_3$+$MgCO_3$ should be at least 85-88% and $MgCO_3$ should not exceed 3-5%. Toxic impurities such as fluorine, arsenic and lead are strictly limited and including the angular metal particles in the products is strictly prohibited. Grain composition and moisture content are also regulated by the industry standard and technical specification.

Mainly dolomite and in small quantities of limestone, marble and chalk are used for glass production.

With dolomite, the necessary alkaline earth oxides MgO and CaO are introduced into the glass batch, with limestone - the missing amount of CaO in excess of the amount introduced with dolomite.

Magnesium oxide improves the mechanical strength and chemical stability of glass, reduces its crystallization capacity, increases clarity, reduces the coefficient of expansion, and reduces the operating temperature during molding.

Calcium oxide increases the thermal resistance of glass and its resistance to chemical reaction and weathering, but at the same time increases the tendency of glass to crystallize.

The glass industry uses pure limestone and dolomite, which have a stable chemical composition and minimal impurities. In particular, it is necessary to strictly control the content of iron oxide, which adds green, brown, yellow and reddish glow color to glass.

Carbonate rocks of glass are monitored by standards of “Dolomite for glass production” of GOST 23672-79 and “Limestone particles for glass production” of GOST 23671-79. The MgO content of dolomite should not be less than 18-19%, depending on the mark, and iron oxide should not exceed 0.05-0.4%. While in limestone, content of CaO should not be more than 51-54%, Fe_2O_3 should not exceed 0.1-0.3% and fragment size should be in the range of 20-300 mm.

Limestone and dolomite with iron oxide content of 0.6-0.8%, are used in glass production, especially in bottles.

Quality of glass chalk is controlled by technical specification of “Natural crushed and grinded chalk” TU 5743-007-05346453-96. Limestone with a total CaCO3 + MgCO3 content of 98%, of which $MgCO_3$ does not exceed 2% and Fe_2O_3 content does not exceed 0.1% is used for the production of MKI, MDI and MMI glass.

Lime and carbon dioxide derived from burning of limestone, are used for the production of sugar. Calcareous milk is extracted from the burned lime; it is used for filtering the sugar beet juice to remove impurities (protein particles, phosphoric and oxalic acids, etc.). After that, in saturators, the juice solution is saturated with carbon dioxide in order to remove excess free lime from it. Because of saturation, a fine-grained $CaCO_3$ powder is formed, which actively absorbs the remaining organic substances from the juice and removes them into the sediment. The beet juice is then re-saturated for better cleaning. Harmful impurities in limestone are silica, gypsum and alkalis, ballast MgCO3 and R2O3. Limestone must have a strength of at least 10 MPa

(Technical condition of TU 10RF 1055-92). Natural chalk is not used for sugar production. Limestone is also used in small quantities for the production of citric acid.

Hygienic-radiation analysis (meeting the requirements of MNS 5046-2001 standard) are mandatory for limestone used in food production, such as sugar and citric acid production and purification of sugar beet juice.

In the pulp and paper industry, limestone and lime are used in the production of cellulose, in hydrolysis processes and as paper filler - limestone and chalk. Limestone is also used for pulp bleaching. In the production of wrapping paper and carton, calcareous milk can replace alkali.

Requirements for the quality of limestone and chalk of pulp and paper production vary depending on the production technology. In filler chalk, impurities of sulfur, phosphorus, insoluble residue are undesirable; color, whiteness and fineness of grinding are very important.

For the production of paper, differences are used that meet the requirements of GOST 4415–75 for electrode lime (grade A), GOST 12085–88 - for enriched natural lime and GOST 8253–79 - for chemically precipitated lime.

In the rubber, cable, paint and varnish, polymer industries, lime is used as filler. It must comply with GOST 17498–72 and GOST 12085–88.

In this industry, as well as in the production of cosmetics, medicine and electronics, natural chalk is being replaced by chemically precipitated chalk. The chalk precipitates by carbonation of calcareous milk with carbon dioxide. The quality of the chalk is determined by requirement of GOST 8253-79. Finely crushed limestone is used to produce the filler.

The main requirements for limestone and chalk as a raw material for filler are whiteness, a small amount of insoluble residue, almost complete absence of manganese, copper, alkalis and a high content of calcite.

Chalk as a filler is most widely used in the production of rubber, as well as in the production of leatherette, oilcloth, and linoleum.

Limestone, chalk, marl and dolomite can be used to extract mineral wool. Dolomite is more suitable especially when it contains clayey mixtures. The blend (schicht-шихта) is usually two-component and consists of a mixture of carbonate rock and clay. The composition of the mixture should have an acidity modulus (SiO_2 + Al_2O_3): (CaO + MgO) = 1.0–2.5, Fe_2O_3 content no more than 5%, sulfur no more than 1.0%, refractory inclusions (sand, flint) no more than 5%.

Among other areas of using carbonate rocks, it should be noted: carbonate rock, limestone and chalk in order to aggravate drilling fluids in oil production and partial replacement of chalk clay; dolomite flour or burnt dolomite for the purpose of polishing glass, nickel, bronze, copper and other materials; use of chalk to coat electrodes in electric arc welding; dolomite in the composition of blend (schicht-шихта) for the production of enamels in glass and porcelain factories, and in the production of enamels for coating insulators in electro-ceramic factories; it is used in other areas such as plastic products and marble in the preparation of welding consumables.

Two. Grouping deposits’ complexity of geologic settings for exploration purposes

2.1. Following the Instruction "Classification and guide of Mineral Reserves Mineral Resources of Deposits", approved by the order No. 203 of the Minister of Mining of Mongolia, dated on September 11th, 2015, the carbonate rock deposits and areas are divided into one of I, II, III and IV groups on the basis of tonnage, volume, grade, thickness, density, extension and structure of the ore body as follows:

2.2. **Group I:** This category includes the deposits where mineral body is not or less destructed, with simple geological settings, and stable thickness, formed strata, strata-like and massive bedding, and ore quality is evenly distributed throughout the deposit. The reserve of carbonate rock is very large and large. The deposit's reserves are classified as Proved (A) category.

The deposits with large and very large reserve include Sebryakov chalk deposit in the Volgograd province, the Novorossiysk marl deposit in the Krasnodar Territory, the Chanvichsky limestone deposit in the Perm province, the Dolnite deposit in Bosnia and North Ossetia, the Nilansky limestone deposit in the Khabarovsk Territory, Russia and the Biluu deposit in Mongolia.

2.3. **Group II:** This category includes the mineral deposits with variable thickness, internal structure, and quality, destructed, uneven distribution of primary minerals, complex geological settings, or simple formations but difficult mining conditions. The reserve of carbonate rock is moderate. The deposit's reserves are classified as Measured (B) category.

The deposits with moderate reserve include Russian, Kumovogorsk limestone of Ryazani region, Zaruchevievskii dolomite of Leningrad province, Logovskii deposit of Belogorodsk and Sugdukh limestone deposit of Mongolia.

2.4. **Group III:** This group includes deposits with abrupt changes in the thickness and internal structure of the mineral body, destructed, qualitatively altered extremely uneven distribution of the main useful components, and very complex formations. The deposit's reserves are classified as Measured (B) and Indicated (C) categories.

The larger deposits of the group include Russian, Kuran limestone of Sverdlovsck province, Khrapovits limestone of Vladimir province, Dankov dolomite of Lipetsk province, Pikalev flux limestone of Leningrad province, and Taskano-Vstrechenskii limestone deposit of Magadan province.

The medium and small deposits of the group include Shilow chalk of Uliyanovsk province, Taborovsk dolomite of Sverdlovsk province, Ezdochenskii chalk deposit of Velogorod province and Khutul, Darkhan and Shandkhudag limestone deposits of Mongolia.

2.5. **Group IV:** This group includes deposits with very sharp changes in the thickness, internal structure and quality of the mineral body, severely destructed, uneven distribution of the main mineral components, and very complex geological formations. The deposit's reserves are classified as Indicated (C) category.

The medium and small deposits of the group include Russian Slantsevskii limestone of Leningrad province, Verkhoturov dolomite of Krasnoyarsk territory, Monomakhov limestone of Primory territory, Uglov limestone of Novogorod province and Alymukhamet limestone deposit of Bashkortostan.

2.6. Group IV carbonate deposits are almost practically insignificant. However, if the demand for carbonate raw materials is high and there is an urgent need, the group's deposits can be used for production purposes in limited quantities, temporarily and for a short period locally.

2.7. If most of the reserves (at least 70%) of a carbonate deposit (section) belong to an area with a complex settings (in terms of geological settings and mineral quality), it is included in the group of complex degree.

Three. Geologic settings of deposit and studies of mineral composition

3.1. For the explored deposit, it is necessary to have a topographic map at scale of 1:1 000-1:10 0000, which would correspond to its geological settings and distribution of mineral resource. All exploration and operational workings' excavations (bore holes, trenches, dug holes, tunnels and underground mines and other), boreholes, profiles and stations of detailed geophysical observations, as well as natural outcrops of ore bodies and ore-zones should be instrumentally tied. Subsurface mining works must be plotted on the plan maps as indicated by engineering survey work (markscheider work). Surveying plans of mining horizons are usually drawn at scale 1:200 to 1:1 000.

3.2. The geological settings of the deposit should be studied in detail and it should be plotted on 1:1 000-1:10 000 scale geological map (depending on complexity of geological settings and size) and detailed geological sections. If necessary, a three-dimensional block model can be constructed and studied, and geological maps, sections, and resource maps can be drawn on scales larger than 1: 1 000.

Boundary of mineral body and fractures should be drawn in geological map, sections and plan. For this purpose, the results of sampling from natural outcrops, boreholes and exploration and exploitation excavations, geophysical survey data and all other relevant materials, should be used.

Geological and geophysical surveys on the deposit provide a clear picture of the deposit's shape, size, bedding condition, internal structure, completion, cracking, karst, facies changes, and tectonic faulting of the mineral body. These parameters must be sufficiently correlated with the lithological-petrographic complex of the host rock, the folded structure and the tectonic fault. This will lay the foundation for resource estimates.

Apparently, it is necessary to justify the geological boundaries of the deposit and prospecting criteria that determine the location of prospective area within assessed resources in P_1^* category are estimated.

3.3. In the vicinity of the deposit surface, the composition and thickness of the cover sediments, the outcrop of the carbonate rock, the upper boundary of the conditional rock distribution, the degree of its occurrence in the case of karst, and tectonic faults and its feature need to be determined and studied in detail. For this purpose, in addition to natural outcrops, site clearance excavations, trenches, dug holes, shallow boreholes, and surface geophysical methods will be used.

* *The geological map of the district / region marked with a mineral deposit with a scale of 1:25 000–1: 200 000 and a stratigraphic column is considered to meet the requirements of the guidelines. The geological map and section show the geological settings of the area, the basic geological structure and lithological-petrographic complex of the rocks, their bedding conditions, known deposits, distribution patterns, as well as the prospective area. The geological map and section should be produced using the results of geophysical survey. The interpretation of geophysical anomaly which is drawn by scale of geological map of the region, should be plotted on a unified plan.*

3.4. The depth exploration of carbonate rocks carries-out by diamond drilling and sometimes in combination with geophysical method (on surface and boreholes). Exploration excavation (first of all dug hole) are done to control and verify drilling work, or to study subsurface part, to determine average density of rocks and to take technological sample. Depending on the geological settings of the deposit, excavation is required under certain conditions. Its type, size and purpose are related to drilling work. On other words, in a case that certain purpose is not fulfilled by drilling work, excavation work should be used in addition.

Borehole construction and technological regime for drilling mineral bodies are aimed at obtaining the core in maximum recovery. The core should be cleaned from drilling mud.

In order to exploit the deposit by pre-planned horizon, the depth of borehole will be planned and selected to fully penetrate the thickness of the layer. In this case, structural borehole should be drilled to determine the distribution of carbonate rock laying beneath the horizon and to define the depth to mine by open-pit method.

Fully revealing section is required when productive layer is obliquely or vertically oriented and its thickness continues to deeper. To do this, inclined drilling is to be done. The spacing of drill holes should be shorter than specified in this guideline in order to obtain the fully revealing section along the exploration line.

The direction of the borehole inclination on the exploration line, the inclination angle and the distance between the boreholes, and the depth of the borehole shall be selected as follows:

- Adjust the borehole inclination in the opposite direction to the dipping
- The inclination angle of the borehole shall be chosen to be as close as possible to the determination of the actual thickness of the rock, or at least 30 (60°) degrees,
- The first borehole is planned with the assumption that the productive layers are intersected as completely as possible,
- The second borehole should be planned to intersect the lower part of the intersected layer by the previous borehole at the top of the borehole; and to reveal the next layer (up to the planned horizon),
- The third borehole shall be selected based on the depth of the inclined borehole and the distance to the previous borehole (distance between boreholes) so that the top or bottom of the layer is intersected according to the above principle.

Exploration methodology-type of excavation work and size, geophysical survey and its purpose, density of exploration grid, sampling type and method should conform the grouping of deposits complexity of geologic settings. While reserve estimation should meet the requirements of the category.

This is defined due to the exploration geophysical tools, the potential for mining and drilling, as well as the exploration experience and the geological characteristics of the bedding of similar deposit.

3.5. In the drilling technology to intersect the mineral body, the core recovery should not be lower than 90%. The accuracy of the determination of the core recovery shall be systematically monitored by controlling measurement. If the core recovery is reduced, it is recommended to take actions (dry drilling, using drilling mud etc.) to increase the core recovery.

3.6. The type of exploration excavations, their ratios, distances and locations are determined by the complexity of the geological settings of the deposit. The bedding condition, shape, size and location characteristics of the mineral body, as well as the proposed mining method, are also related to the complexity of the geological settings of the deposit.

Table 7 shows the general data for recommended density of exploration grid to the Russia and Common wealth countries. It can be used for geology-exploration work planning and reserve estimation, but cannot be strictly adhered to. For example: depending on the depth of the borehole and the inclination angle of the drilling and other factors, the distance between the boreholes on the exploration line will be several times closer than recommended in order to obtain a fully revealing section.

Density of exploration grid for carbonate rocks deposit

Table 7

Deposit group	**Type of deposit**	**Density of exploration grid (m), by reserve category**		
		A	**B**	**C**
I	Very large, large-sized strata and strata-like bedding with stable settings of mineral body, thickness and quality	150-200	200-400	400-600
II	Medium and small-sized strata and strata-like bedding with stable settings of mineral body, thickness and quality		100-200	200-400
III	Medium and small-sized strata and strata-like bedding with unstable settings of mineral body, thickness and quality	-	100-150	150-300
IV	Medium and small-sized strata and strata-like bedding with very unstable settings of mineral body, thickness and quality	-	50-100	100-200

Comment: The P_1 category exploration grid at the evaluated deposit is 2-4 times sparse compared to the C category grid due to the complexity of the geological settings of the deposit.

3.7. Lithological sorting in the cross section, contouring the distribution area of carbonate rocks, determining the structure and thickness of the stripped soil, studying the surface relief of the productive seam, major tectonic faults, karst strips, as well as deep geophysical surveys will be used to study rock fractures. Optimal method of geophysical survey should be selected in correlation with distinctive features of geological settings of the deposit. The accuracy of the geophysical materials should be verified by excavation works and drilling data.

3.8. It is necessary to identify the areas that need to be studied in detail at the deposit being explored. The part that can be extracted in the first priority should be selected. The number and size of the area that is going to be studied in detail will be determined based on the subsoil owner's proposal and the feasibility study (FS). The density of sampling and exploration excavation grid of these parts should be denser comparing with the rest part of the deposit.

The collected information from the detail-studied part will be used to estimate the reserve for the rest part of the deposit and accuracy assessment of reserve estimation parameters.

The degree of investment risk, exploration experience and subsoil user estimates for the development of a similar deposit at the time of a mining project shall determine in each case the appropriate ratio of different categories of reserves and the possibility of using all or part of the C category reserves.

3.9. Each excavation of exploration, exploitation, and exposures of carbonate rocks must be documented according to appropriate instruction. Documentation should fully reflect the lithological composition of the rocks, structure, texture, fractures, fragmentation and weathering grade. During the documentation, changes in the thickness of the productive thickness in the contact zone of host rock, veins, veinlets, silicification, secondary quartzite, dolomitization and other alteration developed in the productive layer, and activation features of inclusion, cavities, rock disintegration, tectonic fractures and mylonite zones, weathering and karst should be determined.

Layered strata should be subdivided into layers, beds and units differing in lithological composition, physical and mechanical properties, degree of karst and fracturing. Layers and units identified in separate excavations must be linked together in sections built along the strike and dip of the productive thickness.

The quality and completeness of the initial documentation should be consistent with the geological characteristics of the deposit. The rules for producing maps, excavation works and core logging, as well as the initial documentation of all geological material, must be systematically monitored in accordance with the procedures established by the competent authority. The results of this inspection shall be certified by an act.

Furthermore, it should be controlled and assessed quality of geological and geophysical sampling (consistency of cross-section and weight of samples, their position corresponding to the peculiarities of the geological structure of the deposit, the completeness and continuity of sampling, the presence and results of control testing), the representativeness of mineralogical and engineering-geological studies, the determination of volume weight, sample processing and quality of analytical work.

3.10. All exploration and mining excavations where minerals have been discovered, as well as specific rock outcrops should be sampled. The sampling method and methodology to carry out in resource estimation and exploration stage should be selected in relation to geological characteristics of the deposit. The selected methodology must be the most effective, economically efficient and guaranteed for expecting result. The sampling grid should be uniform.

The sample to study the chemical composition of carbonate rock should be taken from each mineral layer revealed by excavation. If the layer is thick, the sample should be collected by section with 1-4 m long.

The selection of the appropriate sampling interval (sample length) should take into account the specified thickness of the mineral standard (conditional) and non-standard (non-conditional) layers. The barren rock units should be distinguished from the productive layer and include it to the samples if it is not exploitable. The length of the sample section can be extended during exploration, especially the exploration of deposits in operation, because its settings and composition of productive thickness have been sufficiently studied and determined.

However, it should not exceed half of the planned height of the bench of open-pit. The deposit can be mined by selective method when the rocks filling the karst formations. They should be sampled separately in order to determine the possibility of their use or to exclude them from the calculation of reserves. Sampling shall be carried out using a channel method covering complete thickness to reveal the productive layer in the surface outcrop and in the contact zones of the exploration excavations. When sampling the ore bodies, revealed by trenches, a sample should be taken from the floor of the trenches. Prior to channel sampling, orientation element of bedrock should be measured. The cross-section of channel sample depends on the degree of homogeneity of the mineral and is usually taken (5x3) - (10x5) cm.

Sampling from borehole core shall be performed continuously along the cross section of the carbonate rock. Cut along the long axis of the core and take one side as a sample. A sample is usually taken half of the core by cutting along the long axis of the core. The validity of the selected sampling method should be monitored in ways that are more representative and the channel sampling should be controlled by the results of bulk and strip sampling.

In addition, data from bulk samples taken to determine the bulk density in pillars, technological samples, as well as data from experimental production are used for control.

Core sampling can be monitored by the results of dug hole sampling penetrated along the borehole axis, and at the deposit being mined - by exploitation exploration and mining materials, respectively.

The volume of control sampling should be sufficient for statistical processing of the results and reasonable conclusions about the absence or presence of systematic errors, and, if necessary, for the introduction of correction coefficients.

The sample collected to study the chemical composition should be processed according to scheme defined on the deposit.

The value of the coefficient K is usually taken equal to 0.05 with a homogenous quality and equal to 0.1 with a heterogeneous quality of carbonate rocks or the content of toxic impurities in them, close to the limiting technical conditions. The rules of sample processing scheme and the value of the coefficient K have to be approved by data of similar deposit and experimental study.

3.11. Because carbonate rocks are used in various industries, its quality also requires different requirements (chemical and mineral composition, physical-mechanical and technological properties), which makes it expensive to study. In order to save these costs, first, based on program to study its quality, the optimal complex to use these rocks should be determined and feasibility study to carry out efficient exploration should be processed.

For this purpose, it is necessary to determine the potential demand for carbonate raw materials in the exploration area and adjacent areas where the carbonate rocks are not spread.

In the study of carbonate rocks, first of all, the suitability of raw materials for high-quality chemical plants is determined. If it is not suitable, it is necessary to study the possibility of using it for other purposes. Although the carbonate rocks usage is limited in chemical industry but it is used widely in other industrial branches so it has to be studied.

For the exploration of large deposit, exceeded reserve from needs of chemical industry can be evaluated for raw materials of flux and refractory, and other part for raw materials of refractory dolomite flour.

It is impractical to evaluate carbonate rocks suitable as fluxes or for the production of refractories as raw materials for the building materials industry and other sectors of the national economy that do not impose high requirements on the quality of raw materials.

3.12. The rational complex of chemical and physical methods for determining the mineral and component composition of carbonate rocks can be used. The complex is included in methodical instruction of "Comprehensive assessment of the quality of carbonate raw materials" approved by the protocol of Scientific Council of Mineral Research Methods of the Ministry of Natural Resources of the Russian Federation (NSOMMI) on October 26, 1995.

This complex includes chemistry, radiography, X-ray spectral, fluorescence, thermal analysis, electron paramagnetic resonance and infrared spectroscopy.

The chemical composition of carbonate rocks is established using methods approved by the relevant state standards or the Scientific Council for Analytical Methods of the Ministry of Natural Resources of the Russian Federation (NSAM).

All ordinary samples of carbonate rocks are analyzed for CaO, MgO, CO_2 and insoluble residue in hydrochloric acid. Other indicators stipulated by the standards and technical conditions for the planned complex of directions for the use of carbonate rocks, during the exploration of the field, are determined only in terms of ordinary or in-group samples that uniformly characterize the deposits in plan and section.

In order to get an idea of the features of the chemical composition of rocks, which determine the possible areas of usage and the main technological properties (especially the direction of use is unknown), it is necessary to additionally analyze for SiO_2, Al_2O_3, Fe_2O_3 and loss on ignition from some of the ordinary samples taken from the exploration grid that intersected the productive thickness. This will give you an idea of the chemical composition of the carbonate rock, which reflects the industry and technological characteristics of the application.

If these data are not sufficient for a comprehensive assessment of the deposit, additional analysis and testing may be required. For this purpose, in most cases content of SO_3 and P_2O_5 is determined.

The manganese content is determined in addition to the limestone intended for use in the production of color cement and in the food and rubber industries. Total Na_2O+K_2O is determined in the rocks for production of sugar, calcium carbide and cement and the content of useless impurities such as Ba, As, Pb, and F is determined in raw materials for the production of mineral feeds. The sand content of the rock used in the rubber plant must be determined.

Group samples are compiled from weighed portions of duplicates of ordinary samples with the same degree of grinding. The procedure for combining ordinary samples into group samples, their placement and total number should ensure uniform sampling of the main varieties of carbonate rocks and the identification of patterns in the change in their composition along the strike and dip of the deposit.

The mass of duplicate sample should be proportional to the length of the corresponding sectional sample. It is necessary that grouped samples characterize the complete intersection of certain types and varieties of carbonate rocks by excavation workings or boreholes.

With a high thickness of homogeneous layers of carbonate rocks, the length interval of the group sample should be limited the height of the open-pit bench. The procedure for combining ordinary samples, the location and total number of group samples, as well as the types of analyzes are justified in each individual case, based on the characteristics of the deposit and the requirements of the industry.

The study of the associated minerals and components contained in the carbonate rock will be carried out in accordance with the “Methodological Recommendations for Comprehensive Study of Mineral Deposits and Estimates of the Co-components” expected to be developed in Mongolia. Currently, this type of recommendation has not been developed, therefore, similar recommendation can be used such as “Methodological recommendations for the comprehensive study of deposits and the reserve estimation of associated minerals and components” developed in 2007 in Russia.

3.13. Quality control of sample assay should be regularly and systematically verified in accordance with established method and methodology and the results of the control should be processed according to established guidelines and methodologies. In addition, regular geological inspection over analysis must be conducted during the period of exploration despite lab assay. Controlling analysis must include main and secondary components and toxic impurity.

3.14. To determine random error of the laboratory, the internal control mark taken from the duplicate sample shall be tested in the main laboratory where it is being tested. Also, external assay check is conducted by a lab certified for external check in order to reveal the regular errors and give assessment. The assay samples sending to external check will be duplicate sample of internal check sample. All assay samples should be able to represent all type and sort of minerals and content class of the component. Internal control is a strict procedure that covers the highest content of the useful component.

3.15. The assay amount for external and domestic lab check must be capable of being represent each classification of content identified during the analysis period (a season, half year and a year). The classification on content should correspond to the requirements for reserve estimation standard. In case of enormous amount of samples analyzed (more than 2000 per year), 5% of total samples should be submitted to external check. On the other hand, in case of few quantities, at least 30 samples from each type of ore should be sent to external lab check.

3.16. Periodic (quarterly, semi-annual, annual, etc.) data for internal and external check of each content class will be processed separately for each laboratory and analysis method that performs the basic analysis. Statistical processing of test data to assess system errors (random errors) based on the results of standard sample tests is performed on a regular basis (quarterly, annually, etc.) by classifying each content group of useful component and each analyzed laboratory. The measures are being taken to eliminate the resulted errors. The calculation of random and systematic errors in the analysis, both internally and externally, shall be carried out in accordance with commonly used methods. Random errors detected by domestic geological check must not exceed the limit indicated in the table 8.

Otherwise, assay results performed by the lab are unaccepted; the assay along with internal assay check is repeated. Consequently, the reason for causing defects in lab results should be revealed and measures are taken to correct it.

Acceptable limit of random errors corresponding to
categorization of ore component grade of carbonate rocks

Table 8

Mineral component	Content class of components in ore*, %	Acceptable RMS errors %	Mineral component	Content class of components in ore*, %	Acceptable RMS errors %
CaO	>60	1.5	K_2O	>5	6.5
	40-60	2.0		1-5	11
	20-40	2.5		0.5-1	15
	7-20	6.0		<0.5	30
	1-7	11	P_2O_5	5-10	4.0
MgO	>60	2		1-5	5.0
	40-60	25		0.3-1.0	6.5
	20-40	3		0.1-0.3	9
	10-20	4.5		0.05-0.1	12
	1-10	9		0.01-0.05	22
	0.5-1	16	Na_2O	>25	4.5
SiO_2	>50	1.3		5-25	6.0
	20-50	2.5		0.5-5	15
	5-20	5.5		<0.5	30
	1.5-5	11	L.O.I	20-30	2
Al_2O_3	15-25	4.5		5-20	4
	10-15	5		1-5	10
	5-10	6.5		<1	20
	1-5	12	S	2-10	6
Fe_2O_3	10-20	3.0		1-2	9
	5-10	6.0		0.5-1	12
	1-5	12		0.3-0.5	15
	0.1-1	20		0.1-0.3	17
				0.05-0.1	20
				<0.05	30

Note: If the components identified in a deposit are different from those in this table, the acceptable limit of relative mean squared error is determined by interpolation metho*d.

3.17. In case of discrepancies in the external check, an arbitration shall be conducted. The laboratory is licensed for arbitration. The control test shall be performed on a duplicate sample and, if the sample is not sufficient, the results of the previous test shall be taken. The control includes 30 to 40 samples from each content class to determine whether there are systematic errors in the primary and external control samples. 10-15 test samples should be taken from each group of standard composition for control analysis and should get the result.

When the arbitration analysis confirms the systematic differences, it is necessary to find out their causes and develop measures to eliminate them, as well as to decide whether it is necessary to re-analyze all samples of this class and the period of operation of the main laboratory or to introduce an appropriate correction coefficient into the results of the main analyses. Without arbitration analysis the introduction of correction coefficient is not allowed.

Any errors at the stages of delineation of ore contact due to results of sampling, processing, and checking and determination of parameters should be evaluated.

Internal and external check is performed for each content class and its results are processed quarterly (quarterly, semi-annually, and annually) and the test method is separate (different) for each laboratory that performs the basic test.

Arbitration control is carried out only when systematic discrepancies between the results of analyzes of the main and controlling laboratories are revealed according to the data of external control, which necessitate the introduction of correction coefficient or affect the reliability of delineating the bodies of a mineral resource and selected industrial (technological) types.

3.18. The mineral composition of natural varieties of carbonate rocks, as well as their textural and structural features should be studied using mineralogical-petrographic, physical, chemical and other types of analyzes. In this case, along with the description of individual minerals, their quantitative assessment should also be made. Particular attention should be paid to the study of the distribution of harmful impurities by the forms of mineral compounds and the nature of their localization (in the cement of carbonate rock, in veins, in clay fillings of cracks, etc.).

3.19. During exploration, if the intended use of carbonate rock depends on the physic-mechanical properties of the rock, samples shall be taken for physic-mechanical testing.

The final sorting and discovery of the type of ore deposit must be completed on the basis of geological and geotechnical mapping and ore technology recording on the each natural type of ore identified within the scale of the entire deposit. Samples are taken at least in two or three intersections from the characteristic varieties of rocks. The number of sample and its intersection will be defined considering the structure of productive layer, thickness, distribution area and stability of its quality and composition.

From excavations, depending on assay type, the grab sample should be taken with sizes of 5x5x8 cm, 20x20x20cm, and 30x30x30cm. If the productive thickness has layered structure and composed of thin layers, then the grab sample should be collected from the near the surface, middle part as well as bottom part of each layer. When, the productive layer is thick and massive with homogenous composition, the samples are taken every 3-4 m (in terms of thickness).

When taking sample from borehole for physical-mechanical test, 15 samples which its dimension meeting the requirements of the relevant state standards.

The physical-mechanical properties of the carbonate rock should be analyzed according to requirements of industry standard and technical specification. When studying physical and mechanical properties, the strength of rocks, average density (volumetric mass), density, porosity, water absorption, as well as natural moisture are determined. For most applications, it is necessary to define the lumpiness of carbonate rocks. Grind ability is determined for carbonate rocks used in cement production, and whiteness in the rubber and pulp and paper industry.

3.20. The determination of the volumetric mass and moisture content of a mineral must be carried out for each identified natural variety of mineral and internal substandard layers using a laboratory method or by removing pillars. It is also possible to determine the volumetric mass by absorbing scattered gamma rays by performing a certain amount of monitoring.

If there are layers of different lithological composition in the strata-type deposit (limestone, dolomite, marl, etc.), zones or areas with different degrees of fracturing and crushing, the bulk density is established for each type of rocks.

Simultaneously with the volumetric mass on the same material, the moisture content of the mineral is determined. The correction for natural moisture content is not entered into the calculation results; only the moisture content at which the volumetric mass (density) of the rocks is established is indicated. Samples used to study bulk density and moisture content should be characterized mineralogically, granulometrically and chemically.

3.21. By the result of studying the chemical and mineralogical composition and physical-mechanical properties, the natural and industrial (technological) types will be defined and further enrichment method should be clear. The industrial (technological) type and sort will be finalized as a result of technological research.

Four. Studies of ore technological properties

4.1. The technological properties of the carbonate rocks should be studied in detail to obtain basic data for planning the technological scheme of the most appropriate and comprehensive use and processing of minerals.

The testing of the technological properties will be carried out in mineralogy-technological, small technological, laboratory, expanded laboratory and semi-industrial samples in laboratory and semi-industrial laboratory conditions. If there is an experience in processing similar raw materials, it allows using of proven laboratory test results.

For varies stages of geology-exploration work, sampling of the technological research will be conducted according to the methodical recommendation for technological sampling. If this type of recommendation has not yet been developed, a similar methodical recommendation can be used such as "Hard mineral and rock: Technological sampling during the geology-exploration work" STO RosGeo 09-001-98 standard of Russian geological society.

4.2. To identify technological types and varieties of raw materials, geological and technological mapping is carried out, in which the sampling grid is selected depending on the number and frequency of intermittency of natural varieties. In this case, standard of "Hard mineral and rock: Geology-technological mapping" STO RosGeo 09-002-98 standard of Russian geological society (approved by decree no. 17/6 dated on 28 December 1998) can be followed.

The feature of the natural varieties of carbonate rocks revealed in the certain deposit has to be determined by mineralogy-technological and small technological samples taken by specific grid. As a result of testings on the samples, geological and technological categories of the ore are determined and the industrial type of the ore is identified; meanwhile, geology-technology maps, plan maps and sections are produced.

Requirements for the quality of certain types of carbonate rocks are regulated by the relevant standards and specifications (see Appendix).

4.3. The technological study should be done under laboratory condition in laboratory and expanded laboratory samples. The laboratory samples is performed by taking 1-2 samples from each type of carbonate rock with industrial significance. Expanded laboratory sample determines the industrial (technological) types of carbonate raw materials. This sample is collected from each natural type that provides the average content of certain raw material industrial type in the deposit.

The sample weight of the laboratory technology test is 2 to 15 kg. Usually, for technological study, 1 m of core with a diameter of at least 40 mm (with length of at least 10 cm) or one or two grab samples with size of 15x15x15 cm is taken.

4.4. Semi-industrial technological test is performed according to the program agreed by subsoil owner and project organization conducting test. Samples for semi-industrial technological tests should characterize commercial varieties or mixtures of varieties in proportions corresponding to the volume of their joint extraction and processing at the factory. The program determines the direction, nature, volume of semi-industrial technological tests and the mass of samples.

The technological accuracy of the processing of carbonate raw materials must produce test results for products that meet the requirements of national standards and specifications.

4.5. Expanded laboratory and semi-industrial technology samples should be appropriate for the individual type of technology or the average content of all deposits. Interlayers of substandard carbonate rocks, as well as interlayers and veins of other rocks, material of karst fillings and various inclusions (siliceous and other material), which cannot be excluded during mining (depending on the mining scheme), should be included in technological samples.

It should be sampled to fully determine the technological characteristics of raw materials that meet the standard requirements for the deposit area considering the possibility of changes in characteristics of carbonate rock along the strike and deep.

To assess the technological properties of rocks in deep horizons, which are difficult to access for the collection of laboratory and semi-industrial samples of large mass, it is necessary to use the revealed regularities in the change in the quality of raw materials from the upper studied horizons.

4.6. Based on the results of laboratory and semi-industrial technological studies, the technological properties of all selected industrial types and varieties of carbonate raw materials are determined, which determine the possibilities of their industrial use for the main and other purposes. If carbonate rock is not meeting the industrial requirement by its natural properties, the possibility for enrichment

If the carbonate rock does not meet the production requirements due to its natural properties, look for opportunities to enrich it and, if necessary, relevant research should be carried out.

4.7. Hygienic-radiation analysis of the carbonate rock is performed according to the Mongolian standard of MNS 5072:2018, MNS 5626:2006 (radium equivalent) and “Radiation safety norm” (NRB-99) approved by Russian Ministry of Health on 2 July 1999.

Five. Studies of hydrogeology, engineering-geology, ecology and other natural conditions of deposits

5.1. The studies of hydrogeological condition of the deposit is conducted based on "Instruction for conducting Hydrogeological Surveys during Thematic, Medium and Large-scale Hydrogeological Mapping and Mineral Resource Exploration Works, and Requirements to the Exploration Activities" approved by order of No. A/237 on December 12th, 2017 by Minister of Mining and Heavy Industry, Mongolia.

The hydrogeological study will be conducted for the deposit to determine and study the main aquifers, the most watered areas and zones. In addition, the ground water use or its utilities should be resolved by the hydrogeological study.

It should be determined the parameters such as lithological composition, thickness, water collector type, and recharge condition of each water bearing horizons, and other water bearing horizons and their interdependence of surface water recharge and water table.

It is necessary to calculate the possible water inflows into mine workings and the development of water reduction and drainage measures. In addition, chemical composition and bacteriological condition of water flooding the deposit should be studied. It has to be assessed the water aggressiveness with respect to concrete, metals, polymers, and the content of useful and harmful impurities in them, the possibility to use the drainage water into industrial water supply of the future mine enterprises and to extract and process useful components from mine water. It has to be determined condition of drainage water disposal, the impact of mine water discharge and water reservoirs on the hydrogeological condition of the deposit area, possible changes in the condition. It is necessary to give a recommendation whether subsequent, and detailed study is required or not. As well as need to evaluate the impact of mining water on the environment.

In addition, potential sources of household and technical water supply for future extraction and processing plants.

Based on the methodology used, the resource estimates for the use of wastewater drained from the mine will be calculated.

The results of the hydrogeological survey will provide recommendations on the processing of the mine planning in the following areas: to drain geological massif, water drainage, use of drained water, source of water supply and environmental protection issue.

5.2. Engineering-geological survey conducted during the exploration at deposits, aims to provide required information for developing the mining project (to make basic calculation of open-pit and pillars and to process passport of drilling-blasting and mounting works) as well as improving the safe access of mining excavation works. Methodical recommendation for conducting engineering-geological condition studies of the deposit (hereinafter referred to as geotechnical studies) shall be followed.

If this type of recommendation has not yet been developed, similar recommendations such as "Methodological manual for studying engineering-geological conditions during ore exploration" and "Engineering-geological, hydrogeological and geo-ecological study during the exploration and operation of the ore deposit" can be used.

In results of the research on the engineering-geological condition of the deposit, it has to determine following items:

- Physical-mechanical properties that define the strength of ore, its host rock and cover sediments in natural and water-saturated conditions;
- Engineering-geological features of rock massifs in deposit, its anisotropy, rock composition, cracking, tectonic faulting condition, feature of texture, characteristic of karst in rocks, fracturing in weathering zone and other major trouble-causing factors to mining operations.

The quality characteristics need to be studied in detail including potential factors that may adversely affect human health due to the rock properties (gas emissions, rock burst threats, landslides, radiation, and geothermal conditions etc.) and physical-mechanical properties that determine the stability of underground excavation and open pit walls.

5.3. In addition, temperature regime of sediments, upper and lower boundary of permafrost, distribution boundary and depth of thaw area and possible changes of physical characteristics of rock during thawing and re-freezing have to be determined in regions with the development of permafrost.

5.4. If there are underground and open pit mines with same hydrogeological and engineering-geological conditions that are operating in the area of the deposit, the information about engineering-geological condition and watering of the underground and open pit mining should be used to determine this type of characteristics.

5.5. By the result of the engineering-geological study, underground excavation, prospective assessment of the stability of the open pit sidewall and the materials to calculate the key parameters for open pit should be obtained.

5.6. It is necessary to specify the areas identified as having no mineral resources should be designed for industrial and residential-civilian objects, waste of barren rock and stockpile. This should be an area unsuitable for agricultural and forestry production.

5.7. In addition, it is required to provide information about whether there are construction materials in the region and there is a possibility to use the cover and host rocks of the deposit as construction raw materials.

5.8. The ecological studies cover following issues:

- To determine basic parameters of natural environment: degree of radiation, air quality, ground and underground water, characteristics of topsoil, animal and plants etc.,
- To predict potential impacts of the proposed construction on surrounding environment: emission of dust into the neighboring area, ground and underground water contamination, soil contamination with waste water from the mining plant, air quality pollution by gases and dust emitted into the atmosphere etc.,
- To evaluate natural resources allowed for mining operation: woods, water resource for technical application, locating areas of main and subsidiary plant facilities, soil, host rock and uneconomical commodity dump etc.,
- To determine character of impacts, intensity, source activity dynamic of contamination and theirs boundary of impact zones etc.,

It is also necessary to give recommendations for environmental protection measures.

Determination of topsoil thickness, conducting agrochemical analysis on loose sediments, assess potential adverse impacts on soil and rock units as well as possibility of the extracted areas to be recovered with vegetation cover are significantly important to solve issues related to biological rehabilitation.

5.9. As a result of detailed studies of hydrogeology, engineering geology, geoecology and mining geology, the primary data is collected necessary for project proposal. In case of a deposit characterized by complexity of hydrogeology, engineering geology and other mining conditions for the purpose of mining and processing plant construction, project implementor and the lisence holder will develop a joint program including proposal of further studies, order and periods of implemented operation.

5.10. Within the framework of comprehensive studies of a deposit, the explorers may identify other recoverable minerals formed in host rock and overlying assemblage and promote them to the industry to which the valuable minerals are applicable. If this type of recommendation has not yet been developed, similar recommendations such as "Recommendation for a comprehensive study of deposits and reserve estimation of associated minerals and components", Russia, 2017 can be used.

Six. Reserve estimation

6.1. Reserve estimation and classification of carbonate rock deposit is completed in accordance to the requirements of the "Classification and guideline of mineral resources and reserves of deposits" approved in 2015.

6.2. The block units of deposits and ore-bodies for reserve estimation are characterized by following items:

- the same degree of exploration parameters and study level determining the quantity and quality of mineral resources;
- homogeneity of the geological structure or approximately the same or similar degree of variability in the thickness, internal structure of the ore bodies, the ore composition, the main indicators of the quality and technological properties of the ore;
- stability of ore-body positions, the reserve blocks of the ore bodies located in the same structural element;
- common mining and technology conditions of operation;
- according to the dip of steeply dipping deposits, the reserve blocks should be divided by the projected horizons of excavation or borehole, taking into account the planned mining sequence;
- If it is impossible to geometrize and delineate industrial types of raw materials, their quantity and quality in the counting unit is determined statistically.

6.3. The following additional conditions should be taken into account when calculating the reserves, which reflect the characteristics of the carbonate deposit:

6.4. **The Proved (A) category** reserve is calculated in the 1st group of deposit subjected to its detailed study area. The reserve in exploitation contour of the Group 2 deposit being mined may be included in this category.

For reserves in this category, based on a sufficient number of intersections and analyzes. It is necessary to determine the thickness of bedding and the quality of carbonate rocks, the degree of karstification (no more than 10%), as well as areas where there are large karst cavities that can be geometrized, must be reliably determined; established in detail, excluding the possibility of other options for delineating and linking, the position of the identified industrial (technological) types of rocks, tectonic faulting, as well as the boundaries between zones of weathered rocks and rocks not affected by weathering; the fracturing of rocks was studied, discontinuities and the amplitude of displacements were established; the boundaries of technological types (varieties) of carbonate rocks have been established.

It should be distinguished the technology types of carbonate rock, determine the ratio of different contaminants, the composition of varieties and the nomenclature of products used in production. If it is not possible to geometrize, it can be defined by statistical method.

Within the extent of exploration and exploitation excavation of the detailed study of the Group 2 deposit, as well as in the geologically justified zone of the extrapolation of the Group 1, the reserves shall be estimated in **Measured (B) category** if the body width does not exceed the allowable excavation of Measured (B) category along the strike and dip.

It can be countered in several ways, if the industrial (technological) type of rock, tectonic faulting, and the accuracy of the study of the spatial location of the karst do not significantly affect the settings and location of the deposit.

Within the boundary of reserve block of **Measured (B) category,** development degree of fractures should be defined and contacts of weathered and non-weathered rock should be distinguished. The amplitude of displacements will be identified in the zones with significant tectonic faulting.

If it is not possible to contour the industrial (technological) type of rock, its spatial distribution and pattern of quantitative ratio can be defined by statistical method. The quality of the identified types of rocks should be characterized by all parameters stipulated by the conditions.

The exploration (borehole) grid permitted in this grade shall be used in the calculation of the potential (C) category, and the information obtained shall be the approved mining data for the mining of the deposit.

For the area of the deposit that subjected to **reserve estimation in Indicated (C) category**, the geological information and results have to be confirmed by the result of the detailed survey of the deposit, and for the mine operation area - by the results of exploitation of the deposit. In addition, boundary of area that subjected to reserve estimation in Indicated (C) category can be configured out along with boreholes, and extrapolation lines taking in account the data of geological setting. The width of extrapolation zone should not exceed the distance between the allowable excavation of the Indicated (C) category along the strike and dip.

Natural basic varieties and industrial type of the carbonate rock should be determined within the reserve boundary. If it is not possible to contour the industrial (technological) type of rock, its spatial distribution and pattern of quantitative ratio can be defined by statistical method. The quality of the identified types of rocks should be characterized by all parameters stipulated by the conditions. Their spatial distribution and general pattern of quantitative ratio of sort and varieties are established.

Form, size and internal structure of accumulation should be explained and condition of geo-technical and engineering-hydrogeological during exploitation.

Identified resource (P_1) are allocated during the exploration of deposits of all groups of complexity by single exploration excavation in the zone of geologically grounded extrapolation, taking into account the data of geological constructions, geophysical and other studies.

The quality of carbonate rocks, the distribution and ratio of industrial (technological) types of rocks are taken according to the data of a few number of exploration intersections and natural outcrops, or by analogy with more detailed explored areas of the field.

6.5. For all categories of reserves, the extrapolation is prohibited in the direction of zones of tectonic faulting, increased karst content, wedging out and splitting of layers, deterioration of the quality of carbonate rocks and mining and geological conditions of field development.

6.6. The reserves are calculated separately by categories, mining methods, industrial (technological) types and grades of raw materials, taking into account their economic value (recoverable-balance, unrecoverable-non-balance). If the deposit has been under mining operation, the total reserves should be classified into three categories as follows due to their degree of study and estimated separately: reserves prepared for the mining as a result of the exploration and mining stage exploration, extracted reserves and the unrecovered reserves hosted in safety pillars.

6.7. If the feasibility studies assure any deposits to be potentially profitable in the future if kept under surface without recovering, economical if recovered as by-products, or more profitable if kept in storage for later application, they may be considered as resources. The reasons for classifying the reserves as unrecoverable-non-balance (economic, technological, hydrogeological, mining, environmental, etc.) should be indicated.

6.8. The reserves in large water body, reservoirs, settlements, strictly protected areas, and protection zones with natural, historical, and cultural monuments, shall be excluded. The reserves in the protection zone of real estate and agricultural facilities shall be included in the recoverable-balance, unrecoverable-non-balance reserves or deducted from the reserves, taking into account the cost of relocating buildings and structures in accordance with the reserve standard.

6.9. Clauses of 6.6, 6.7, and 6.8 are used during the production reserve estimation in the stage of Feasibility study to mine the deposit.

6.10. When using a computer for calculating reserves, it is recommended to use software systems that provide the ability to view, check and correct the initial data, constructions (coordinates of exploration excavations, inclinometer data, marks of lithological and stratigraphic boundaries, results and plans of sampling, conditional parameters, etc.), and the results of interim calculations and the summary results of the calculation of reserves. Output documentation and machine graphics must meet the existing requirements for these documents in terms of composition, structure, form, etc.

6.11. At the developed deposits, in order to control the completeness of the development of previously approved reserves and substantiate the reliability of the calculated new reserves, it is necessary to compare the data of exploration and operation by reserves, conditions of occurrence, morphology, thickness, internal structure of ore bodies, content of useful components. If this type of methodical recommendation has not yet been developed, the “Methodical recommendation for comparing the data of exploration and development of solid mineral deposits" can be followed, which is approved by the Ministry of Natural Resources of Russia in the prescribed manner.

The comparison material should contain the contours of previously approved reserve by the Mineral Resources Professional Council, excluded ones because unverified, as well as excluded reserve (extracted reserve and safety pillars) from reserve registration with information on reserve registered in the State reserve registration (balance of previously registered reserve by the Mineral Resources Professional Council). Tables of reserve movement (by categories, ore bodies and the deposit as a whole) and the reserve balance are expressed with a characteristic of their quality in the contour of depleted reserves, reflecting the change, approved by the authorized expert body, reserves during additional exploration, losses during mining and transportation, yield of marketable products and losses when processing minerals.

The comparison results are accompanied by graphics illustrating the change in the understanding of the mining and geological conditions of the field.

When analyzing the comparison results, it is necessary to assess the reliability of development data, and to establish changes in individual calculation parameters (calculation areas, accumulation capacities, quality indicators, volumetric mass, etc.). It is necessary to consider the compliance of the adopted methodology for detailed exploration and calculation of reserves with specific features of the geological structure of the field and its influence on the reliability of determining the calculation parameters.

For a deposit, where the non-confirmation of the reserves or quality of the mineral is established, the comparison of the exploration and development data, as well as the analysis of the reasons for the discrepancy should be carried out jointly by the organizations that explored and develop the deposit.

If the exploration data as a whole are confirmed by the development or the existing minor discrepancies do not affect the technical and economic indicators of the mining enterprise, the results of the geological survey can be used to compare the exploration and development data.

For a deposit where, in the opinion of the subsoil user, the reserves and (or) quality of the minerals approved by the Mineral Resources Professional Council were not confirmed during development, or it is necessary to introduce correction coefficient into the previously approved parameters or reserves, it is mandatory to perform a special calculation of reserves based on additional exploration and operational exploration and assessment of the reliability of the results obtained during these works.

When analyzing the results of the comparison, it is necessary to establish the magnitude of changes during operational exploration or the development of calculation parameters approved by the authorized expert body (thickness of mineral body, calculation areas, contents of useful components, volumetric masses, etc.), reserves and quality of minerals, as well as to find out the reasons for these changes.

6.12. The calculation of the reserves of carbonate rocks as cement raw materials is made and submitted for approval by the authorized expert body simultaneously with the calculation of the reserves of clay raw materials of the deposit, which will serve as the raw material base of the corresponding cement plant.

If it is planned to supply the clay component of the cement raw material charge from the developed field with approved reserves, then the report with the calculation of the reserves must contain information on the remaining reserves and their quality, and the calculation of the provision of the enterprise with both components (limestone and clay) of the cement blend (schicht) for the amortization period should be given.

In addition, in the report with the calculation of reserves, it is necessary to indicate the specific sources of obtaining other components of the cement raw material blend (gypsum, pyrite cinders, and hydraulic fluxes) and provide information on their quality, stocks and delivery volumes.

6.13. Resource estimates for accompanied components are based on a methodical recommendation to estimate reserve and use comprehensively of mineral resources. If this type of recommendation has not yet been developed, a similar recommendation such as "Recommendation for a comprehensive study of deposits and calculation of reserves of accompanied components", 2007, can be used.

6.14. Report on exploration work result with reserve estimation, should be processed in accordance to relevant guidelines developed by the Mineral Resources Professional Council and when submitting the copy of the report to the State geological database, the relevant documents should fulfill the requirement.

Seven. Study degree of deposit

7.1. According to the "Guidelines for classification of mineral resources and deposit reserves" approved by Decree no. 203 of Ministry of Mining dated on September 11, 2015; any deposits are classified into following two items: evaluated deposits (resource) and explored deposits.

The former category defines whether the property needs further exploration whereas the latter category defines its preparedness for mining production stages.

7.2. When evaluating the deposit of carbonate rocks, its potential production value, efficiency for conducting exploration work and the overall size of the deposit should be determined, and distinguish the best prospective area for the next stage of exploration and the total area of mining.

The deposit is completely or partially explored in order to do preliminary geological and economical evaluation and prepared for reserve estimation while determining reserve estimation coefficient and feasibility study basis.

The reserve of evaluated deposit is categorized by Identified resource (P_1) and Indicated "C" category by its study degree.

Considerations about the methods and systems of field development, the possible scale of production are substantiated on a consolidated basis on the basis of analogous projects, while the technological enrichment schemes, taking into account the integrated use of raw materials, the possible yield and quality of commercial products are determined on the basis of laboratory samples; capital costs for the construction of the mine, the cost of marketable products and other economic indicators are determined according to aggregated calculations based on analogous projects.

The evaluation of water supply conditions for the production and consumption purposes relies on local hydrogeological survey results, existence of water points, and available data resulted from prospecting and exploration work of the property. Environmental impact assessment must be carried out in order to reveal potential adverse impacts caused by the mining operation.

Based on the exploration results and experts' conclusion and recommendation the experimental production and processing can be completed on the most explored part representable the whole evaluated property for the purpose of detailed studies of ore body, its size, location, and mineral composition and optimization of ore enrichment and processing technology mode.

The experimental extracting production as an integral part of the property exploration program is carried out during the period up to three years with the official permission from the relevant authorities of mining and natural environment issues.

The experimental extracting production has to be made on the depth and marginal continuity of the property in the case of necessity of additional exploration in order to reveal more specific characteristics of the geologic settings of the property (shape, structure and grade change), to specify the proper mining-geological and technical conditions, as well as to select ore enrichment and processing methods (identifying natural and production types of ore and determine their ration).

The experimental extraction can also be conducted at the property where a new type of ore is identified or a new extraction technology is tested (e.g. powder ore pumping through a well). In addition to this enrichment technology application, the experimental production can be carried out as a technological pilot in a small-sized enrichment plant prior to establishming a complex mining plant, which aims to verify the selected ore concentration mode.

7.3. The ore body is required to be explored well enough by borehole and exploration excavation to determine its reserve amount, quality, technological characteristics, exploration hydrogeology and mining technical conditions. In this case, the study should be well enough to perform feasibility studies for making a decision on the conditions and procedures for the development of the deposit, as well as to construct a new mining plant or reconstruction at the mining site.

The explored deposit must meet the follow up criteria in accordance to its available data resulted from the surveys.

- Any properties must be referred to one of the groups categorized in the guidenline and the reserves are classified in compliance with standard parameters reasonably developed on the basis of technical - economical estimation.
- The research results of mineral components of ore, chemical composition, technological characteristics and ore technological types allow the project implementors to select optimal mode of ore technology processing, extract complex minerals, find the possibilities for the further use of waste materials removed from processing plant, and determine the possibilities to store and bury waste and tailings.
- Mineral resources (contained in groundwater and stripping soil rocks) that contain minerals coexisting with carbonate rocks will be classified as reserves or resources on a condition basis. Its value and usability should be sufficiently studied.
- The results of hydrogeology, engineering geology, geoecology and other mining conditions must be the fundamental background for the feasibility studies for establishment of extraction and processing plant while meeting the relevant requirements of environmental protection and mining safety.

- In the representative parts of the property there should be studied the geologic settings, mineral composition, quality, economic grade as well as ore body structure in detail.
- Potential adverse impacts to natural environment during or after the mining and processing operation must be identified and possible solutions to mitigate such consequences should be recommended.
- The indicators to be taken for reserve estimation will be based on the production volume of the future extraction and processing plant and reasonably completed feasibility study results.
- The appropriate ratios for the different reserve categories are determined on a case-by-case basis, taking into account the potential business risks to subsoil users and experts of the State Mineral Professional Council.

The amount of Possible "C" category resources that can be included in the Group I and II mining projects is determined by the project implementers in consultation with the experts of the State Mineral Professional Council, taking into account the geological settings of the deposit, mining methods, system selection, and experience used in similar projects. The decision will be made in the form of recommendations by the State Mineral Professional Council.

The term "explored property" includes those deposits which pass through the evaluation stages of geological and production reserves, feasibility studies, meet the all the relevant standards and as a result, are revised and approved by State Mineral Professional Council.

Eight. Re-estimation and registration of deposit reserves

In case of big difference identified in reserve amount, mineral quality and economic evaluation of the property between previously conducted survey result and ongoing mining operation or additional exploration results, the reserve estimation can be re-reconducted under follow up conditions as initiated by company or legal entity carrying out exploration and mining activities or relevant state authorities of mineral affairs and Inspection Agency.

In the event of a significant deterioration in the economic condition of the plant, re-estimation and verification of reserves will be initiated by the license holder in the following cases.

- exploration - resulted reserves and its quality cannot be verified by the result of extraction activities;
- the price of product regularly goes down by 20% or more even when production cost is stable or invariable;
- common requirement for mineral quality has been changed;
- unapproved reserves that have been excluded or planned to be excluded (in the process of additional exploration, exploration and mining), as well as those that cannot be mined due to technical and economic conditions, exceed the norms and mineral reserve that proved being excluded from the balance sheet of the mining industry (more than 20%) in accordance with applicable regulations.

Re-estimation and registration of subsoil reserves shall be initiated by the state administrative and specialized inspection bodies in the following cases, such as violation of the interests of the owner (state) of subsoil resources, especially unjustified small amount of taxable income.

The state authorities and inspection agency might request the re-estimation if:

- the reserve amount gets increased more than 50% compared to the previously registered amount during the mining stage exploration and mining operation;
- product price gets steedily increased by more than 50%;
- there is introduced a new technique and technology that can significantly increase production capacity;
- in the ore body or host rocks there are discovered new toxic impurities and economic components which were unidentified when the property is submitted;

It is not necessary to do re-estimation if some economic issues caused by temporary extraction and processing delays (geology, technology, hydrogeology, changes and complication in mining conditions, temporary drop of price in the world market etc.,) could be solved by using available indicators of extraction.

Attached is a list of current technical specifications and basic standards for carbonate raw materials.

References

1. “Guideline for classification of mineral resources and deposit reserves” approved by Mining Minister Order#203, dated on September 15.
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3. Project task “Guidelines for applying the classification of mineral resources and deposits to a particular type of mineral” (Annex no.2 of Order D/195, Ministry of Mining and Heavy Industry, dated on August 13, 2018)
4. "Procedures for conduction of the prospecting, exploration and mining works on mineral resources" (Annex to Order no. A/20 of Ministry of Mining and Heavy Industry dated on February 05, 2018)
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10. Shaandar P., 2015. Limestone deposits of Mongolia // Non-metallic mineral resources. UB, "Soyombo printing", p. 506-515.

Mongolian standards of carbonate rocks

Appendix no.1

MNS 3395: 1982 — Marble gravel. Technical requirement
MNS 3969: 1987 — Natural stone tile. Technical requirement
MNS 0554: 1987 — Lime
MNS 4580: 1998 — Construction lime
MNS 963-91 — Limestone for producing construction and technological lime Technical condition
MNS 347: 2002 — Lime for construction and technological uses. Technical requirement
MNS 3091: 2008 — Cement. General technical requirement
MNS 0974: 2008 — Portland cement. Technical requirement

Appendix no. 2

Standards and technical condition of carbonate raw material following in Russia

Limestone:	
Black metallurgy	
TU 57-43-000-00196368-97	Limestone and flux limestone (Aluminum oxide, cement, lime and flux production of Pikalevskii deposit)

TU 0751-001-26282295-00	Flux limestone of Bilinbaev deposit
TU 0750-002-001869-96	Limestone of Turgoyaksk deposit
STP 105-AO-12-02	Fractionated flux limestone for agglomerate production of Belorucheisk
OST 1463-80 (cancelled)	Flux limestone for blast furnace
OST 1464-80 (cancelled)	Flux limestone for steel smelting and ferroalloy production
TU 14-15-60-78	Limestone for converter lime production
OST 14-16-165-85	Steel smelting and ferroalloy production lime
TU 0751-00013-05778402-01	Flux limestone of Galiyanskii deposit
TU 0750-005-0018056-97	Lime technological stone of Olishanetskii deposit (Agglomerate and pellet production for smelting of steel and cast iron)
Non-ferrous metallurgy	
TU 57-43-060-00196368-97	Limestone and flux limestone
TU 48-7-2-77	Flux limestone (copper production)
Chemical industry	
TU 6-18-21-04-85	Limestone for calcined sodium production of “Soda” Open joint stock company
STP -044-15-85	Limestone uses for calcium chloride production of Kirovo-Chepetsk chemical factory from Sysoevskii open-pit
TU 6-08-313-74	Limestone for feed production
GOST 1460-81	Calcium carbide. Technical condition
TU 6-01-878-80	Bilyutinskii deposit limestone for calcium carbide production
TU 113-12-79-04-89	Limestone for boron production
TU 6-18-216-75	Loose limestone named “Pukhlyak” using for production of calcium carbide, chemically precipitated writing chalk, superphosphate, lemon oxide and lime chloride and neutralizing water body, as well as using for construction purpose. Mining and chemical plant.
TU 6-01-1108-77	“Tatarskii klyuch” deposit limestone to produce natural carbonate filler-calcite
Construction material production Technical condition for the main types of raw materials for the production of Portland cement clinker (Ministry of Construction material production, Russia, 1969)	
TU 6-01-894-74	Bilyutinskii deposit limestone (cement production)
TU 21-20-15-74	Slantsevskii deposit limestone (cement production)
TU 14-1-893-74	Crushed limestone of Vysokogorskii ore occurrence
TU 400-1-196-80	Gorenskii deposit limestone for Portland cement clinker production
TU 5743-060-00196368-97	Limestone and flux limestone (Pikalevskii deposit)
STP 00204872-12-94-P	Limestone of “Soda” Open joint stock company for cement production
OCT 21-27-76	Carbonate rock to produce construction lime (cancelled)

GOST 23671-79	Lump limestone for glass production
GOST 9179-77	Construction lime
Agriculture	
GOST 14050-93	Limestone (dolomite) flour
TU 2189-326-00008064-99	Local lime fertilizer
TU 14-15-56-78	Flux limestone waste used for liming acidic soils (Barsukov Ore Mining Administration)
GOST 26826-86	Limestone flour (TU 21-Russia 839-82) used in the production of Mineral feeding of farm animals and birds. Mineral feed limestone and seashells
Sugar production	
TU 0750-004-001868856-95	Technological limestone using for sugar production of Olishanetsk deposit
Pulp and paper production	
TU 13-190-74	Carbonate rock raw materials required for cement production and sulfite cellulose plants (Sakhalin province)
TU 6-01-982-75	15-30 mm fraction (bleach the color of the cellulose) of chemically pure limestone of Bilyutinsk deposit
Writing chalk for various purposes	
GOST 17492-72	Writing chalk. Basic types, brands and technical requirements
GOST 4415-75	Chalk for electrode coatings (writing chalk). Technical condition
GOST 8252-79	Chemically precipitated writing chalk
GOST 12085-88	Natural enriched chalk. Technical condition
TU RF-763-92	Dispersed natural technical chalk
TU 6-18-119-76	Ground chalk for superphosphate industry
TU 5743-007-05346453-96	Lump natural, crushed and ground chalk (used in the construction and repair of buildings, in the production of glass, fiberglass, ceramic products and other building materials)
TU -21-10-70-89	Lime used in the production of all-mash and mineral feeds
Dolomite:	
Black metallurgy	
TU 14-16-28-89	Flux dolomite
TU 14-8-232-77	Crushed dolomite for the production of converter refractories
OST 14-84-82 (cancelled)	Metallurgical raw dolomite
OST 14-85-82	Metallurgical burnt dolomite
TU 0753-009-00186861-98	Metallurgical raw dolomite of Dankovskii deposit
TU 0753-002-26282295-00	Metallurgical raw dolomite of Bilinbaev mine
Construction material production	
GOST 23672-79	Dolomite of glass production. Technical condition

OST 21-27-76 (cancelled)	Carbonate rocks of construction lime production
TU 21-RSFSR-840-95	Lump polishing lime (from dolomite of Melekhevo-Fedorovskii deposit)
Agriculture	
GOST 14050-93	Limestone (dolomite) flour
TU 2189-326-00008064-99	Local lime fertilizers
TU 14-1-2277-77	Calcareous material extracting from dolomite (flux) for neutralizing acidic soil (from waste of the Dankovsky dolomite plant)

Note: TU-technical condition; STP- Enterprise standard-industrial inner standard; OST-branch standard; GOST-State standard; TU RF- technical condition of Russia

Terminology

Appendix 3

Mongolian	Russian	English
Байнгын зөрүү	системические погрешности	systematic errors
Бутрамтгай чанар (хэврэгшил)	хрупкость	fragility
Гажа (кальцитын элс)	гажа	alm
Доломитын давирхай	смолодоломит	dolomite resin
Доторлогоо	футеровка	lining, padding
Дулаан тэсвэрлэлт	теплостойкость	thermal stability
Жишгийн үзүүлэлт	кондиционные показители	condition indicators
Илрүүлэх бүрэн зүсэлт	полный перекрытий разрез	discovering section
Ил уурхайн хажуу	борт карьера	side of the open pit
Өргөтгөсөн(томсгосон лабораторийн дээж)	Укрупненная лабораторная проба	expanded laboratory assay
Санамсаргүй/тохиолдолын алдаа	случайная погрешность	random error
Тогтмол/байнгын	стационарный	stationary
Тунгаагаагүй шохой/түүхий	негашёная известь	burned,unslaked lime
Хайлалтын/шатаалтын үеийн алдагдал	потери при прокаливании	loss on ignition

Хамгаалалтын тулгуур	целик	protective pillars
Хөнгөн цагааны исэл	глинозем	aluminium oxide
Цайруулах чанар	качество отбеливания	bleaching quality
Цэвэр шохой	жирная известь	fat, rich lime
Чулуун чөмгийн хэрчим	столбик керна	core piece ???
Чулуунцар	клинкер	clinker
Шахалт	сжатие	compression
Ширхэглэлийн бүрэлдхүүн	гранулометрический состав	particle size
Шорвог ус (рассолоос өндөр концентрацтай ус буюу нуурын шорвог)	рапа	brine
Шохойлог туф (травертин)	известковый туф (травертин)	calcic tuff (travertine)
Шохойн гурил	известняковая мука	calcareous powder
Шохойн сүү	известковая молока	calcareous milk

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