THE KAOLIN RAW MATERIAL BASE OF UZBEKISTAN AND THE PROSPECTS FOR ITS USE

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Abstract. *Kaolin is a claey sedimentary rock consisting of kaolinite and associated mainly with weathering crusts. Kaolin is widely used in the paper, ceramics, refractory, paint, rubber, cable, cosmetic and pharmaceutical industries. In addition, one of its modern directions is aluminum mining. The main large deposits of the world are located in Ukraine, the Czech Republic, and Great Britain and belong to the type of hydrothermal deposits. Primary and secondary kaolins from the Angren deposit are part of the raw material base of our republic.*

Keywords: *kaolinite, halloysite, dickite, deposit type, State, Tashkent, Zirabulok-Ziyovutdin, Central Kyzylkum, Sultanuwais, Oltintov, Altyntov2, Alliance, Angren, fireclay, weathering leather, GOST requirements.*

Kaolin is a clayey rock consisting primarily of kaolinite; characterized by high fire resistance, low plasticity and relatively large sizes of clay particles. Mica associated with volcanism was formed as a result of weathering or hydrothermal alteration of rocks (granitoids, gneisses, shales, etc.). Its general formula is Al2O32SiO22H2O. The main mining industryrals are kaolinite, halloysite and dickite. It belongs to a series of sedimentary rocks and is found in white and gray colors. Easily distributed in water, its main physical properties are good plasticity, high cohesion, excellent insulation and fire resistance. The formation of kaolins is mainly associated with the weathering process. Primary kaolins are formed mainly as a result of crushing and sedimentation of granitoid intrusions, and secondary ones - as a result of their repeated crushing. Kaolin is widely used in the paper, ceramics, refractory, paint, rubber, cable, cosmetic and pharmaceutical industries.

Among primary kaolins, the main geological and industrial subtypes are eluvial - Ukrainian, Czech, British and hydrothermal-metasomatic deposits. Among secondary kaolins, deposits of sedimentary type, represented by redeposited products of the weathering crust, are of leading industrial importance - Ukraine (Pologovskoye, Ekaterinovskoye), USA (Georgia); subtype of kaolin sands – deposits of Bulgaria, Russian Federation; polygenic subtype, represented by washed away and redeposited products of the decay crust - sediments of China, Great Britain and Uzbekistan [1].

Main Kaolin Mining industryrals (Worldwide) [2]

Table 1

№	Mining industryral	Amount of main component (%)
1	Kaolinite $Al_2Si_2O_5(OH)_4$	SiO_2 – 46,54; Al_2O_3 – 39,50; H_2O – 13,96
2	Dickitt $Al_2Si_2O_5(OH)_4$	SiO_2 – 46,54; Al_2O_3 – 39,50; H_2O – 13,96
3	Halloysite $Al_2Si_2O_5(OH)_4 \cdot 2H_2O$	SiO_2 – 40,90; Al_2O_3 – 34,66; H_2O – 24,44
4	Kvars	SiO_2 – more than 99% plus 10 % H_2O

	SiO_2	
5	Potassium feldspar $KAlSi_3O_8$	SiO_2 – 64,7 Al_2O_3– 18,4 K_2O – 16,9
6	Muscovite	SiO_2 – 45,0

The price of high-quality kaolin on the Chinese market is $400 per ton.

It varies up to $1000. In the USA it is $160 per ton. In Russia, enriched kaolin of the KJF-1 brand costs 7,750 rubles/kg. The price of kaolin in Uzbekistan is 170,000 sum/t. Unenriched secondary kaolin – 69,388 sum/t. (exchange price) [1].

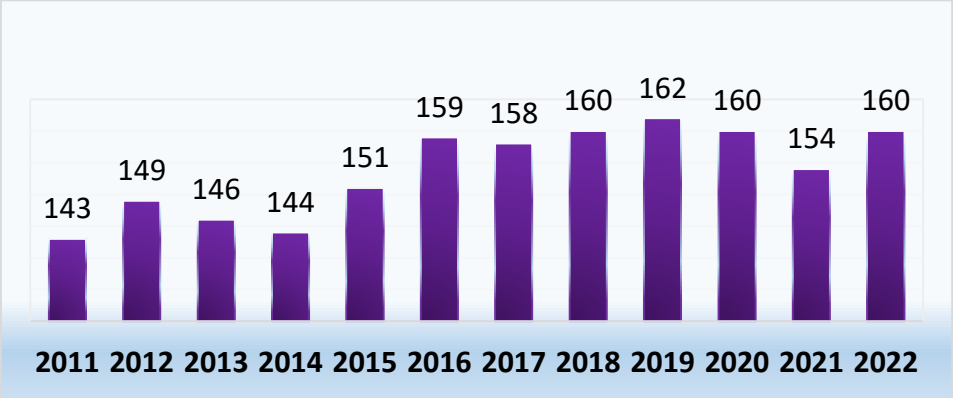


Figure 1. Average annual prices of kaolin on the US market in 2011-2023. ($/t) [1]

Proven world reserves of kaolin are estimated at 14.8 billion tons.

Reserves of kaolin raw materials in the world [1]

Table 2

№	Countries	2021-year (thousand tons)	2022 -year (thousand tons)
1	USA	4.300	4.600
2	Brazil	1.200	1.200
3	China	8.400	8.400
4	Czech	3.100	3.100
5	India	8.400	8.400
6	Iran	1.900	1.900
7	Mexico	240	240
8	Spain	270	270
9	Turkey	1.750	1.700
10	Ukraine	2.330	600
11	Uzbekistan	5.000	5.000
12	Other countries	12.500	13.000
	Total:	49.300	48.000

If you pay attention to the following statistics, the total stock in 2022 decreased by 1,300,000 tons compared to 2021. In terms of reserves, India is in first place, Uzbekistan is in second, and the United States is in third. Although Ukraine performed well in 2021, the figures fell sharply in 2022. As of 2022, a total of 13,000 thousand tons have been recorded in other countries.

The demand for these raw materials is constantly felt in the industry of Uzbekistan. Many sectors of the republic's economy require high grades of kaolin. In practice, all volumes of

consumed kaolin raw materials are provided by private mining industries in the republic. Due to a shortage of quality raw materials, many industrial enterprises are forced to import kaolin concentrate from abroad. Primary and secondary kaolins from the Angren mining industry are part of the raw material base of the republic. An important raw material base can serve as a number of mining industries and manifestations of different levels of prospects, developed in the area near Tashkent, in the Zirabulok-Ziyovutdin mountains, Central Kyzylkum and Sultanuwais [3].

The number of more than 30 objects includes the mining industrys "Apartak", "Northern Angren", "Ablik", "Angren" with the sites "Oltintov", "Oltintov-II", as well as "Karnob", "Zakhkuduk", "Aksoy" (Kaskyrtov), “Garbiy Omontoitov”, “Ovminzatov”, “Orazoli” and “Khodzhako”. deposits and occurrences included. The main operating mining industrys in Uzbekistan are the Oltintov, Oltintov-2, Alliance and Angren mining industrys.

As of 01/01/2022, the reserves included in the state balance of mining industryral reserves of the Republic of Uzbekistan are A+B+C1 - 222,690.5 and C2 - 1,063,815.8 thousand tons. Of these, primary kaolins A+B+C1 - 54,520.1 thousand tons by categories,
According to C2, it is 39.919 thousand tons. Secondary kaolins: A+B+C1-
168,170.4 thousand tons, C2 – 1,023,896.8 thousand tons [3].

Calculation of mining industryral reserves on the state balance sheet of five kaolin deposits as of January 1, 2022

Table 3

Mining	**A+B+C_1 (thousand tons)**	**C_2 (thousand tons)**	**Off-balance sheet (thousand tons)**	**Mining production in 2021 (thousand tons)**
Altyntov (primary kaolin)	5 391,8	6 934	-	3,6
Altintov 2 (primary kaolin)	4 049	-	-	-
Alliance (primary kaolin)	1 154,9	-	-	44,7
Angren (primary kaolin)	43 924,4	32 985	38 127	200,2
Angren (secondary kaolin)	168 170,4	1 023 896,8	5 537	8 269,7

The productive thick layer of the **Angren** mining industry (Tashkent region) is represented by two genetic types: primary and secondary genetic types, which lie under coal-containing sediments and together form the Jurassic kaolin layer. Secondary kaolins are divided into gray (thickness from 5 to 50 m) and variegated (thickness 15-30, less often up to 40 m) types depending on color and formation conditions. Various colored kaolins do not meet the requirements of some

industries due to their high content of iron oxides. Both enriched and unenriched gray kaolins can be used in the refractory and ceramic industries [3].

Primary kaolins are efficiently enriched in centrifuges. Their enriched varieties can be used in the production of high-voltage insulators, as a filler in paper production, in the production of sanitary products and household porcelain products (RTU UzSSR 849-60). Secondary kaolins are products of redeposition. Their mining industryral composition is less complex and consists of kaolinite, quartz, pyrite, feldspar and plant detritus. Depending on the color and conditions of occurrence, gray (from 5 to 50 m thick) and variegated (15-30 m thick, less than 40 m) varieties are distinguished. In general, the average chemical composition of kaolins in the mining industry (%): Al2O3 – 19.38-25.44; SiO2 – 55.17-67.16; Fe2O3 – 1.42-2.10; TiO2 – 0.58-0.60; CaO – 0.36-0.41; MgO – 0.22-0.64; K2O – 0.66-1.24; NaO – 0.05-0.10; colored kaolins: Al2O3 – 18.44-26.65; SiO2 – 56.15-68.11; Fe2O3 – 3.01-4.04; TiO2 – 0.5-0.6; CaO – 0.18-0.24; MgO – 0.12-0.44; K2O – 0.74-1.66; Na2O – 0.08-0.09; SO3 – 0.08-0.14 [4].

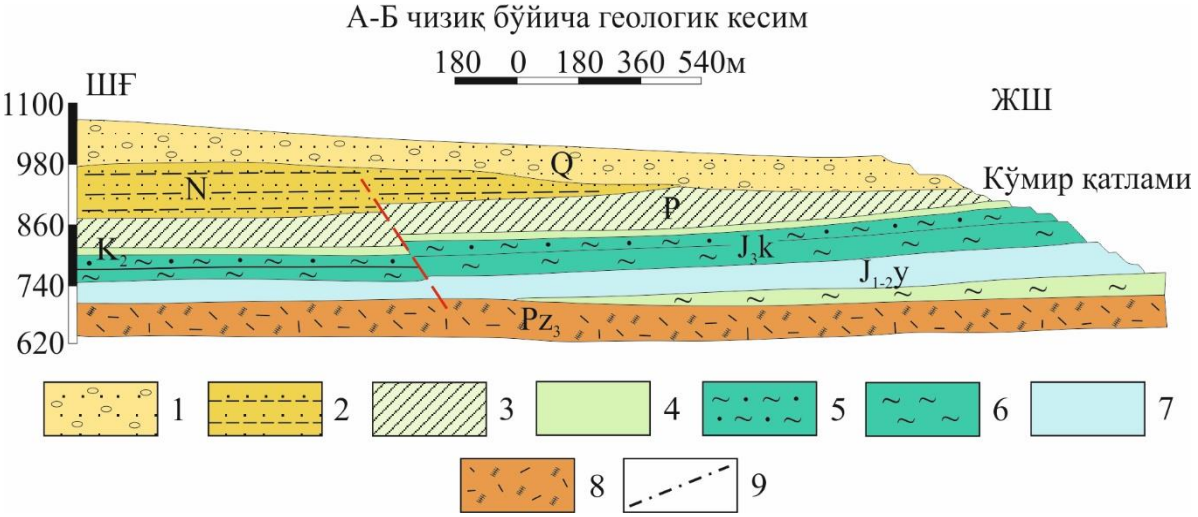


Figure 2. Scheme of the opening of variegated and gray secondary kaolin coal at the Angren mining industry [3]: *Quaternary system: 1 – gravel, sand, silt; Neogene system: 2 – clays, marls, conglomerates, sandstones; Paleogene system: 3 – sandstones, sands, clays, gravel, limestone-shell rocks, marls; Cretaceous system: 4 – clays, siltstones, sands, marls; Upper Jurassic, kaolin suite: 5 – secondary variegated kaolins (useful mining industryral); Lower-Middle Jurassic, Angren (Coal) Formation; 6 – secondary gray kaolins (mining industryral) and coal complexes; 7 – coal seams; Upper Paleozoic: 8 – primary kaolins; 9 – tectonic disturbances.*

Productive thick layers of the ***Altyntov*** mining industry (Navoi region) are represented mainly by weathering crust formed over granites. The thickness of the useful thick layer varies widely: from 2.4 m to 6.4 m in the western part, from 2 m to 13 m in the central part, from 1 m to 4.2 m in the eastern part [3].

Chemical composition of kaolin rocks, % (by weight): SiO2 - 65.3-76.5 average (72.2); Al2O3- 14.56-21.06 (16.9); Fe2O3- 0.50-2.66 (1.1); CaO- 0.70-1.28 (0.9); Na2O- 0.10-0.93 (0.41); K2O- 1.25-5.50 (3.04); MgO- 0.10-0.55 (0.16); TiO2- 0.12-0.41 (0.23); SO3 - 0.10-0.17 (0.12). Granulometric content,%: residue on a 5 mm sieve – 3.3; 2.5 mm – 15.05; 1.25 mm – 28.72; 0.63 mm – 16.50; 0.315 mm – 21.85; 0.14 mm – 11.28; 0.14 - 2.8 sieved. Mining industrial composition (%): quartz 19.9-52.2; potassium feldspar - 4.3-16.6; plagioclase - 2.4-11.0; clay mining industrials - 17.7-59.9; biotite – 6.0-11.3; chlorite – 2.7-9.5; calcite – 1.5-2.0; dolomite –

1.6-4.4; siderite – 0.7-0.8; pyrite – 0.0-1.7; gypsum – 1.3-11.1; amphibole – 3.5-10.2; sericite - 3.1-22.7 [5].

The quality of kaolin enriched in accordance with GOST 213287-75 “Kaolin enriched for fireclay products” concentrate grade Sh-2 and GOST 390-96 Fireclay fireclay and semi-enzymatic and general-purpose gross industrial products grade ShA-2 for fireproof products. Sustainable brick meets the requirements [3].

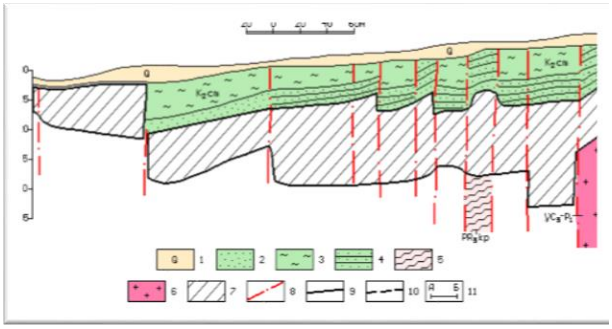
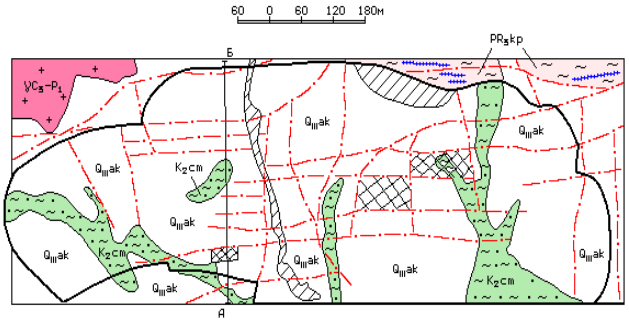


Figure 3. Schematic geological map of the Oltintovo mining industry Fig. [5] ***3.1. Section in direction A-B [5]***

1st Quaternary deposit; 2nd sand; 3-clay; 4—Upper Proterozoic sandstones, blue Kpatos formation; 5-siliceous rock, quartz, carbonaceous graphite, phyllite shales, Late Carboniferous-Early Permian intrusive massif; 6-granite; 7-quartz-kaolin weathering crust (mining industryrals) associated with granites; 8-tectonic disturbances; 9- reserve circuit, calculated according to category B+C1; The reserve scheme is calculated according to category 10-C2; Section 11

*Primary kaolins of the **Altyntov-2** deposit (Navoi region) are the northwestern continuation of the kaolins of the Altyntov deposit. Kaolins are associated with the pre-Cretaceous weathering crust developed along the Altinto intrusions. The average thickness of the useful layer is 12.7 m [3].*

Chemical composition of kaolin rocks, % (by mass): SiO2 – 55.08-78.74 average (70.12); Fe2O3 – 0.61-4.6 (2.17); Al2O3 – 10.16-24.3 (17.039); TiO2 – 0.05-0.57 (0.17); CaO – 0.63-2.66 (1.05); MgO – 0.55-2.22 (1.04); SO3 – 0.11-4.02 (0.64). Under semi-industrial conditions, a concentrate was obtained that complies with the requirements of GOST 21287-75, GOST 390-96, GOST 23037-99 and GOST 19607-74 [5].



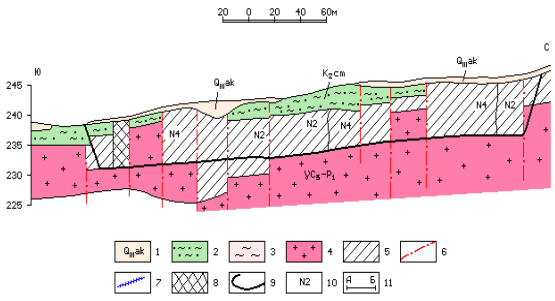


Figure 4. Schematic geological map of the Oltintov-2 mining industry [5] ***Fig. 4.1. Section in direction A-B [5]***

Upper Quaternary deposits of the Akchinskaya formation; 1 - lens of loess, conglomerate and gravelite, Cretaceous system, upper part, Cenomanian level; 2- clays and sandstones, Upper Proterozoic, Kokpatas Formation; 3- shales, siliceous rocks, intrusive complex; 4- double-sided

mica granites; 5-quartz-kaolin weathering crust (mining industrial) associated with granites; 6- tectonic disturbances; 7-quartz vein; 8. The area is allocated from reserve calculations; 9- design reserve contour; number of kaolin weathering areas; Section 11

*Kaolins from the **Alliance** mining industry have the best physical, chemical and technological properties. After enrichment, this will be enough to meet the needs of the republic's porcelain industry for 20-25 years. In addition, the kaolin and quartz-feldspathic concentrates obtained from them meet the requirements of individual GOSTs for the preparation of sanitary ceramics, facing tiles, technical glass, and silicate products [3].*

Based on the results of technological tests, it was established that kaolins are suitable for the production of the following products:

- kaolin concentrate KF-3 (GOST 21286-82), concentrate yield - 39.28%;

- quartz-feldspathic concentrate for the glass industry KPShS 0.2-11.5 (GOST 13451-77), concentrate yield - 18.7%;

- sand for the production of bricks and silicate-concrete products (OST 21-1-80), rent - 34.94%. [6].

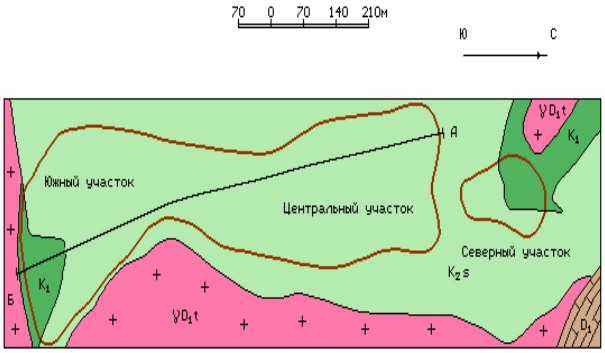


Figure 5. Geological map of the Alliance mining industry [6]

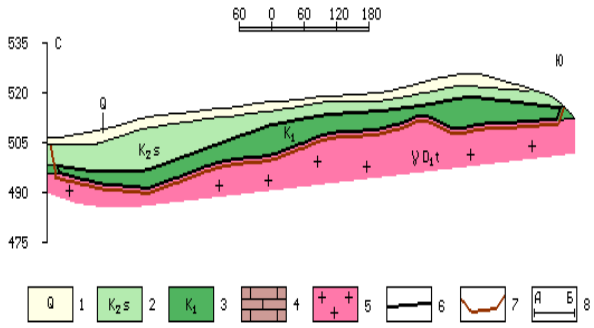


Fig. 5.1. Section in direction A-B [6]

Quaternary deposits; 1-loam, suspension, sand, chalk system, upper part, Cenomanian layer; 2-kaolin clay, sandstone, lower section; 3-primary kaolin (mining industryral), Devonian system; 4—limestones, intrusive complex; 5- granite; 6. Estimated contour of primary kaolin reserves; 7th pit circuit; Section 8

Both the demand for each type of raw material and its importance in the industry change over time. The main reasons for this are reflected in the development of time and the creation of many types of equipment that meet the requirements. In addition, the importance of kaolin in industry in the past and present is different. Currently, kaolin is widely used not only in the porcelain industry, but also in the paint and varnish industry, in the preparation of cosmetic materials, in pharmaceuticals, in the creation of insulating products, in paper production, and in the rubber industry.

The production of aluminum from kaolin is also considered one of the achievements of modern economics.

As a result of research conducted by Z.N. Mamajonov and I.T. Shamshiddinov at the Angren site, it was shown that kaolins from the Angren mining industry can be processed using the sulfuric acid method. To do this, kaolin clay was calcined at a temperature of 650-700°C for at least 1 hour and washed with 60% concentrated sulfuric acid to remove metal oxides. As a result of the study, the separation of aluminum oxide was 97.1%, iron – 82.5% [7].

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