

## Mineral Resource Potential of Tajikistan: As an Important Component of Sustainable Development of the Silk Road Economic Belt

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The presence of rich natural resources and their rational use is the basis of dynamic and sustainable development of the state and society in general. The most effective integrated use of natural resources, which include mineral resources, predetermines the development of productive forces, the development of new areas, and the deployment of new industries, solves the problems of employment and contributes to economic growth of the state.

Tajikistan, locating in the center of the Silk Road, was famous from the ancient times with its rich deposits of gold, silver, lead, precious and semiprecious stones such as noble corundum, ruby, noble spinel, turquoise, lapis lazuli, amethyst and others.

Tajikistan has significant mineral resources. Over 400 different mineral deposits are revealed and explored in different degrees of detail by systematic geological investigations.

The main component of energy resources of Tajikistan are coal deposits. 41% of potential coal reserves of Central Asia are concentrated in the bowels of Tajikistan. 36 coal deposits and coal manifestations are revealed in Tajikistan, which predicted to have reserves of 3.7–4 billion tons. The explored coal reserves of Tajikistan

estimated as 714.2 million tons. The coal is represented by lignite, coke and bituminous coal and also anthracite. The biggest coal deposits are Shurab lignite deposit in the north, Fan-Yagnob, Magian, Kshtut-Zauran, Ziddi deposits of bituminous coal, Nazaraylok anthracite deposit in the central Tajikistan and Raunov deposit of bituminous coal in the Gorno-Badakhshan Autonomous Province.

In Tajikistan oil and gas deposits are concentrated in the north – Tajik part of Ferghana valey and in the south- west- within the South-Tajik depression. In the north of Tajikistan following oil and gas deposits are discovered, explored and being exploited: Ravat, Kanibadam, northern Kanibadam, Ayritan, Selroha, Madaniyat, Niyazbek, Northern Karakchikum, Obi-Shifo and Mahram, which are located in Kanibadam and Isfara districts of Sughd Province. The available explored hydrocarbon reserves to date are significantly depleted, which requires detailed geological prospecting and exploration.

The prospects of detecting of large oil and gas deposits within the Tajik part of Ferghana petroliferous region are far from exhausted. According to preliminary estimates, the approximate value of the extractive hydrocarbon reserves in the north of Tajikistan is

estimated at about 280 million tons of oil. According to other sources, the potential reserves of oil of the Northern Tajikistan are estimated at 56 million tons and gas — 61 billion m<sup>3</sup>.

The Gas and oil deposits of South-Western Tajikistan are concentrated in three petroliferous regions: Dushanbe, Vakhsh and Kulob. The expert's associate large reserves of natural gas with the first, lower structural level which includes Jurassic carbonates deposits. According to geophysical data, large reservoirs of natural gas in the Jurassic deposits occur at depths of 6–7 km and more.

One of the main gas deposits in Dushanbe petroliferous region is “Komsomolskoe” which is located at north of Dushanbe city. In the Dushanbe region, there are also revealed Shohambari and other oil and gas deposits.

In the Vakhsh petroliferous region Kyzyltumshuk oil and gas and Akbashadyr, Kichikbel oil deposits are known.

In the Kulob petroliferous region, which is eastern continuation of the Amudarya oil and gas basin, in 1970–1980s oil and gas deposits of Beshtentak, Sulduzy, Khoja-Sartez and Somonchi were discovered. Predicted reserves of hydrocarbon resources of South-Western Tajikistan constitute:

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oil — 102 million tons and gas — 814 billion m<sup>3</sup>.

Today, in the South-Western Tajikistan prospecting and exploration for hydrocarbon mineral resources are being carried out by “Tethys Petroleum Limited” and OJSC “Gazprom”. According to estimations of the experts of “Tethys”, which conduct prospecting and production of oil and gas in the Kulob region, there are significant reserves of hydrocarbons in this region. According to them promising reserves are: oil about 200 million tons, and gas — 230 billion m<sup>3</sup>. All in all, the total oil reserves in Tajikistan are 467 million tons and gas — 1036 billion m<sup>3</sup>.

The metallurgical complex of Tajikistan, mainly represented by non-ferrous metallurgy enterprises of incomplete technological cycle — Mining and Processing Plants (Adrasman, Anzob, Takob MPP); gold mining (JV “Aprelevka”, JV “Zarafshan”, SUE “Tilloyi Tojik”) and refining of gold (Chkalovsk refinery SUE “Vostokredmet”); aluminum production (the company “TALCO”) and others. The steel industry represented by cast-iron foundries engineering enterprises related to “small metallurgy”.

In the Northern Tajikistan deposits and manifestations of magnetite and hematite ores are discovered in the Karomazor mining area, one of which is Chokadambulak iron-ore deposit. Estimated reserves under the industrial category C1 are about 60 million and predicted 100 million tons. Likewise a deposit of magnetite is discovered in the Western Pamir which is called Barch. The predicted resources of the Barch deposit are estimated at 270 million tons. The concentration of iron in this deposit is up to 52%. There are some more deposits of magnetite ore in the Basin of Kharangon River which are regarded to the category of very small deposits.

According to reserves of polymetallic ores Tajikistan is one of the leading countries in the world. Lead and zinc deposits, mainly, are

distributed in the Karamazar mining area, in the Northern Tajikistan, which are grouped within four ore units. These are Altyntapkan, Adrasman, Kansay, and Kuruksay ore units. Besides the polymetallic deposits of Karamazar there are some lead and zinc deposits discovered also in other regions of Tajikistan. In particular, on the Pamirs the most promising is regarded Gunyabay deposit (South-East Pamirs). In the South-West Tajikistan discovered manifestations of lead and zinc are Baljuvan, Sangisabz, Khojamaston, and Yokunj. These manifestations are those of the Alpine age, hydrothermal genetic type and stratiform character. The total reserves of lead in Tajikistan are estimated at 6550 thousand tons, 1800 thousand tons of which are proven. According to total and proven reserves of lead, Tajikistan is among the 10 top holders of lead reserves.

The main deposits of tin ores are located in Central Tajikistan and South Pamir. The revealed resources of tin constitute 73 thousand tons; total reserves 20 thousand tons, 8 thousand tons of which are proven reserves. Tin ore objects of Central Tajikistan are located within Zarafshan-Hisar geological and structural zone. Here they form the actual tin ore deposits — Mushiston, Kumarh Rama; integrated tin and wolfram deposits — Takfon; pegmatite deposits — Samzhen and deposits with manifestations, where tin is present as an impurity-Sarymat tungsten and gold-tungsten Jilau, etc. The most significant and large tin ore object in the Zarafshan-Hisar zone is Mushiston deposit, which is located in 40 km east of Panjakent city. The reserves of this deposit calculated on the phase of preliminary exploration have been estimated, under the category C1, at 50 thousand tons of tin.

There are more than 70 deposits and manifestations of tin. Pamir is considered as a large tin ore province. Tin ore objects of Pamir as well as Central Tajikistan need further estimation by conducting detail

geological explorations.

The largest and well explored among over then 40 known, in Tajikistan, deposits and manifestations of wolfram is Maykhura deposit. The exploitation reserves of ore in Maykhura wolfram deposit have been estimated at 2 million tons. Besides wolfram, the ore also contains high amount of associated metals such as zinc, selenium, tin, silver, cadmium and copper. Mining conditions in this deposit are favorable.

By total resources of antimony, Tajikistan takes the second place in the world. The total reserves of antimony constitute 310 thousand tons, from that 170 thousand tons are proven reserves. Mercury and antimony deposits of Tajikistan are mainly located within Zarafshon-Hisor zone and on the Pamirs. The industrial reserves of mercury and antimony, calculated on Jijikrut, Konchoch and Shing deposits of Magian group (Panjakent district). These deposits are included to South Tien-Shan antimony-mercury belt, which except Tajik deposits also contains antimony-mercury objects of Kyrgyzstan.

Gold and silver deposits are known in the Northern, Central Tajikistan and on the Pamirs. In South-West Tajikistan there are placer deposits of gold. The gold deposits in Tajikistan are represented by native as well as placer deposits.

Gold deposits of Karamazar mining area in the Northern Tajikistan are regarded as quartz-carbonate (Au, Ag) and quartz-gold-sulphide veiny types. The first type includes deposits Shkolnoe, Aprelevka, etc., and Burgunda, Ikkizhelon, Kyzylcheku deposits belong to the second type. Gold deposits of Karamazar are regarded to the category of Small deposits with reserves of 3–8 tons. It is envisaged, by an investment project, to build up the capacity of processing of ore up to 720 thousand tons per year with extraction of 0.8 tons of gold and up to 4 tons of silver.

About 90% of revealed reserves of gold in Tajikistan are concentrated

in its central part. The main deposits are located in the Basin of Zarafshon River. Here we have three medium (8–20 tons of gold) and 6 large (over 20 tons of gold) deposits. These are Jilau, Taror, Gizhdarva, Shahboz, Uchkol, Kum-Manor, Verkhniy Kumarg, Chore and Eastern Duoba. These deposits belong to the quartz-carbonate-sulphide gold formation and are part of Hisor-Zarafshon gold-rare metal belt. In the central Tajikistan another promising gold ore object is Pakrut deposit.

In the South Tajikistan placer gold deposits are discovered in the Valley of Yakhsu River, where they are associated with alluvial deposits of the buried valleys. On Pamirs also there are known native and placer gold deposits. These are usually small deposits and manifestations. The most promising deposit in this region is Rangkul deposit of placer gold.

With 65812 tons of total reserves of silver, Tajikistan is on the third place in the world after Poland (11 500 tones) and Australia (74 900 tones) and with confirmed reserves of 44000 tones takes the second place after Poland. The location of silver deposits is in the North and Central Tajikistan and in Pamir. There are several silver deposits in Karamazar such as Kanjol, Chestu, Boyarbek and silver-polymetallic deposit of Bolshoy Kanimansur. Polymetallic-silver deposit of Bolshoy Kanimansur which is located 70 km to north-east of the Khujand city is among the largest in the world. Explored reserves of silver are estimated at more than 50 000 tones. The calculated reserves of polymetallic-silver ores are estimated at 1 billion tones. The average silver content in the ores is  $49 \text{ g ton}^{-1}$ , lead — 0.49% and zinc — 0.38%. Copper, bismuth, cadmium and other rare metals and rare earth ores are useful components of the characterized deposit.

In the early 1980s, the feasibility report (a business plan) was compiled, according to which the exploitation of Bolshoy Kanimansur associated

with the construction of a large mining and metallurgical enterprises (careers, enrichment plant, metallurgical plant ) with all objects of industrial and social infrastructure. On the basis of overburden rocks construction of numbers of enterprises for producing construction materials such as cement, bricks and etc was planned.

Industrial importance in Central Tajikistan has silver deposits of Mirkhant (1500 tons of silver) and Simich (2650 tons of silver) which are located in the basin of Zarafshan in Panjakent area. Another interesting and prospective silver ore deposit is Akjilga deposit in the Pamir. The deposit is located at an altitude of 4200 on the northern slope of the North-Alichur ridge between the rivers of Bazardara and Bazerrik and includes in the eponymous ore field.

More than 50 deposits of rock salt were revealed in Tajikistan. Deposits of rock salt make huge industrial categories A + B + C1 — 3.6 billion tons, C2 — 71 billion tons. 5 deposits were explored and taken to the balance. These deposits are Qamishqurgan in Asht district, Sughd province (northern Tajikistan) Tutbulak in Yovon district, Hojamumin and Hodzhasartez in Kulob, Khatlon province (Southern Tajikistan) and Shorbelskoe in Murghab district, Gorno-Badakhshan province (Eastern of Tajikistan).

Sources for getting boron in Tajikistan are borosilicate minerals associated with skarn bodies and boron-containing brines of salt lakes, which are spread jointly with iodine and bromine, as well as with deep underground water of oil deposits. Reserves of boron ores by B + C1, estimated at 82125 tons, B<sub>2</sub>O<sub>3</sub> — 7410 tons.

From mineral resources of the industrial complex Tajikistan have deposits of glass and ceramic raw materials (quartz sand, wollastonite, and clay pottery), asbestos, talc, refractory clay, barite, fluorite, bentonite.

Tajikistan is rich in various kinds of construction minerals. The deposits

of the construction mineral resources discovered and explored in all regions of the country. They are represented by deposits of cement, ragged and facing stones, raw materials for bricks, sand and gravel, limestone, gypsum, various clays, building sand, mineral paints, raw material for the production of haydite, agglomerite and thermal insulation materials, etc. Cement raw material has a crucial role and is primary importance in the construction industry of all countries of the world. It is typical to Tajikistan as well, especially due to construction of large hydroelectric power plants, industrial plants, bridges, residential complexes and others requiring a large amount of reinforced concrete structures and products.

Tajikistan, since long time ago, has been famous for **its precious and semiprecious stones**. Deposits of semiprecious and gemstones were found in the North and Central Tajikistan, especially in the Pamir. Pamir differs from other regions by significant reserves of precious stones such as: ruby, noble spinel, clinohumite and etc. The deposit of “Kukhilar”, which is one of those deposits with significant reserves of gemstones, locates in Ishkoshim district, the Gorno-Badakhshan region. The main mineral is noble spinel (lali Badakhshon) and jewelry clinohumite. The deposit of pure corundum-ruby “Snezhnoe” is in Murghab district of Gorno-Badakhshan province. This deposit is represented by reserves of ruby and collectible corundum.

Tajikistan is **rich in various mineral springs** and by the number of mineral springs Tajikistan takes one of the first places in Central Asia. 128 mineral water springs were discovered by geologists throughout the republic. They vary in the degree of mineralization, temperature, balneological active elements content, chemical and gas composition. Based upon specific components mineral water are divided into carbonaceous, hydrosulfuric, iodine and bromine, siliceous and radonic; upon the

degree of mineralization they are divided into fresh water to strong brine; by gas content-carbonaceous, hydrosulfuric, nitrogenic, methanoic; by temperature from cold to very hot. Among them there are the mineral springs like thermal spring of Khoja Obigarm, Obigarm, Garmchashma, carbonaceous (narzan) spring of Khoja Sangkhok, Anzob, Navobod, Sist, Langar, hydrosulfuric-Khochilyor, Khuji, Tambulak, Pushion; bromine-Khojaikon and salty - Mingbatman, Jigarsuhta, Sharshar etc.

Hot water spring of Khoja Obigarm is located at an altitude of over 2000 m, and is unique. Siliceous water with the temperature from 65 to 93.5 °C and radon steam are very effective in the treatment of many diseases. There is a unique steam emanatorium built on the site of the steam output of this spring, which is one of two such emanatoriums in the world. On the southern slope of the Hissar ridge, at an altitude of 3000 m there is another spring of narzan type, with the name of Khoja Sanghok. The water is used both as therapeutic and for drinking and is called "Anzob".

In the Southern Pamir, there is one of the best carbonaceous mineral

springs — Garmchashma which is considered as an attraction. Its hot water (up to 62 °C), with flow rate reaching 7 L s<sup>-1</sup>, gets out along fractures, from the great depths come to the surface in the form of gushing griffins, located on the crest of the travertine ledge. Based upon the chemical composition the waters of this spring are hydrosulfuric, carbonaceous, siliceous, bicarbonate-chloride, sodic and with metaboric acid content. Content of hydrosulfide is 170 mg L<sup>-1</sup>.

Lately, the mineral spring called Avj has been getting popularity because of having good therapeutic property. On the basis of this spring a new department of regional hospital was built up in Ishkoshim with a treatment building with 50 beds. The water here has a temperature of 36 °C and is narzan type, which is used for drinking.

There are some springs like Borjomi (Bahmyr, Mihmandjuly, Jartigumbez), which are located on the South-Eastern Pamir. By the chemical composition the water of those springs is sodic hydrocarbonate with the content of carbon dioxide (up to 114 mg L<sup>-1</sup>), fluorine, cesium, rubidium,

lithium, copper, arsenic, zinc, and lead.

Nitrogen thermals (mineral water springs such as Jilandy, Tokuzbulak, Yashilkul, Issykbulak, Yamchin, Shahdara, etc.) were found in the valleys of Alichur, Shahdara, Murghab, and Aksu rivers. The temperature of water in these springs varies from 32 to 74 °C. Gas composition is represented mainly by nitrogen (98%). By chemical composition the water is hydrocarbonate sulphate, sodic and rarely is sulfate hydrocarbonate, sodic and calcic. Many nitrogen thermal springs (Jilandy, Tokuzbulak, Jashilkul, Shohdara, etc.) are used by local people in sanitary and medical purposes. Especially popular one is Jilandy spring which locates at the Pamir tract. High water temperature (72 °C), big flow rate, availability of balneological components and convenient location allow to organize an excellent hydrothermal clinic on the basis of this spring.

Further study of mineral resources, attracting large investors for their development is strategically important objectives for the sustainable growth of sovereign Tajikistan, which will contribute to sustainable development of the Silk Road Economic Belt.